Food and Agriculture Organization of the United Nations

REPUBLIC OF TURKEY
MINISTRY OF AGRICULTURE AND FORESTRY

Biodiversity of Turkey

Contribution of Genetic Resources to Sustainable Agriculture and Food Systems

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Contribution of Genetic Resources to Sustainable Agriculture and Food Systems

Edited by
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Paeonia turcica – endemic ornamental plant, symbol of EXPO-2016

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Within this publication, most of the photos were selected from photo archive of ***"Agriculture and People Photo Contest".*** This contest has been conducted by Ministry of Agriculture and Forestry, Department of Training and Publication for 10 years. It has been a great success to document not only the interaction between Turkish agriculture and society, but also the treasure in Turkish agriculture.

Foreword

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Vladimir Rakhmanin,
FAO Assistant Director-General
and Regional Representative
for Europe and Central Asia

FAO and Turkey have been strong partners for many years. Since 2006, we have collaborated through the FAO-Turkey Partnership Programme on achieving food security and sustainable agriculture in Central Asia and Caucasus.

Biodiversity of Turkey: Contribution of genetic resources to sustainable agriculture and food systems reflects this inspirational partnership, and our shared appreciation of the great variety of genetic resources in Turkey. It also recognizes the efforts of the Ministry of Agriculture and Forestry to promote biodiversity – particularly in agricultural production.

The biodiversity maintained in Turkey is important for national food security, but it also has wider regional importance. The diverse soil and agro-climatic conditions of Turkey are often similar to those of other countries, making it possible to adopt Turkish agricultural techniques elsewhere in the region.

Genetic resources found in Turkey are an essential part of the national landscape, local culture, traditions and society. For this reason, selecting genetic resources and traditional management practices for inclusion in this book was a challenging task. The authors made every effort to present a diverse and balanced picture.

Through *Biodiversity of Turkey: Contribution of genetic resources to sustainable agriculture and food systems,* FAO hopes to contribute to maintaining and enhancing agricultural biodiversity, and building awareness in the wider community.

The story of Turkey's food, agriculture and environmental heritage can be found in many sources. However, the paramount objective of this book is to create public awareness about the value of biodiversity by bringing this information to a broader public audience as well as to the attention of decision makers, officials and educators.

We would like to acknowledge the distinguished experts for their valuable contributions to making this book a reality. Special thanks go to the Turkish Ministry of Agriculture and Forestry for its continuous strong support. By working to maintain biodiversity, they are making an important contribution to future global food security.

Foreword

Agriculture in Turkey is practiced using modern techniques and cutting-edge technology. We are constantly seeking to ensure sustainable production, viability, competitiveness and economic development in rural areas. Therefore, Turkey pays attention to the continuous efforts to enhance research and development, and to transfer know-how to the sector.

Turkey has a profound understanding the significance of sustainable agriculture and food systems and environmental sustainability, which requires taking measures against ecosystem degradation. An integral part of this is to protect the diverse genetic resources globally and locally.

Turkey is blessed with rich biodiversity providing substantial benefits in agriculture and food systems. This fascinating land was home to Anatolian civilizations beginning in the Paleolithic age, like Çatalhöyük, Hittites, Amazons, Assyrians, Hebrew, Troy, Phrygia, Lydia, Lycia, Ionian Greeks, Roman, early Christian, Byzantine, and Ottoman. It was also a hub to spread revolution and knowledge across the region for millenniums, which has transformed human history forever. Recent studies have shown that the first farmers, who spread into Europe 8 000 years ago, came from Anatolia in Turkey, replacing the hunter-gatherer cultures that lived there. Remains unearthed at ongoing excavation sites in Göbeklitepe in Şanlıurfa Province have the potential to re-write the history of agriculture in Turkey. Several scientific papers report that wheat originated and spread to world from Karacadağ Mountain in southeast Anatolia. The same region is also known as the place of origin of not only wheat but also different major crops including lentils and chickpeas, which play an important role in feeding the world.

Biodiversity of Turkey: Contribution of genetic resources to sustainable agriculture and food systems explains Anatolian rich genetic diversity with a flourish due to this extraordinary legacy of agricultural practices, which dates back to ancient times in this fertile land. This book presents selected genetic resources and their contribution to sustainable agricultural practices and food systems. However, this is just a sample – many others could also have been covered.

Our profound hope is to inspire every individual to be actively involved in preserving our tremendous wealth in biodiversity by creating a genuine admiration towards sustainability through this publication, which has been prepared passionately.

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Dr. Bekir Pakdemirli,
Minister for Agriculture and Forestry, Republic of Turkey

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Preface

Biodiversity is defined as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems". Biodiversity includes diversity within and among species, and diversity within and among ecosystems. It covers not only living things, but their environment as well.

Living organisms have strong interactions with each other and with all components of the ecosystems they share. Humans benefit from biodiversity and ecosystem services in many ways – from provision of food and raw material to regulating and controlling of environmental interactions, pests and diseases, and water resources; from recreational, cultural and spiritual spaces to the clean environment created through organic cycling.

Turkey hosts three biogeographical regions: Mediterranean, Euro-Siberian and Irano-Turanian. Each region hosts endemic species and a variety of ecosystems. The Mediterranean Region has the world's largest cypress forests. The Euro-Siberian Region covers the entire northern belt from Bulgaria in the west to Georgia in the east. This region is mostly temperate deciduous forests and high alpine meadows. The Irano-Turanian Region extends all the way from the Eastern Aegean Region towards central, east and south east Anatolia. This region is predominantly a typical steppe grassland. Wetland and marine ecosystems also enable suitable and clean breeding habitats for many aquatic species.

Worldwide, biological diversity is declining at an alarming rate. Habitats are being fragmented, and land, water and air are steadily polluted. Despite ever-increasing environmental problems, the terrestrial and aquatic environments of Turkey are among the least polluted habitats in Europe. Likewise, agricultural lands are among the least polluted ones due to the limited use of artificial fertilizers and chemicals.

Turkish people enjoyed a nomadic lifestyle on the endless steppes and mountains of Central Asia before they moved to Anatolia and other parts of the world. Therefore, Turks have always been dependent on biodiversity, ecosystems and their services for thousands of years. Even today it is a common practice to go hunting and fishing, collecting herbs, mushrooms, medicinal and aromatic plants from nature. People treat not only their own diseases, but also those of their animals by using herbs found in the nature. That is to say, there has been always an interaction between society and the environment.

In Anatolia, knowledge of genetic diversity is passed down from generation to generation, and respect for the environment is centuries old. The first legislation concerning the conservation of forest ecosystems were issued by the Ottoman Empire in the XV century. Establishment of *in situ* conservation areas dates back to the 1950's, whereas before long the concept was accepted globally. Currently, 7.24% of land in Turkey is officially protected. Nevertheless, the existing protected areas fail to preserve all components of biological diversity and habitats.

"Biodiversity of Turkey: Contribution of genetic resources to sustainable agriculture and food systems" is intended to provide basic information on the biological wealth of Turkey and the contribution of genetic resources to daily life and food security. The book is organized into ten chapters and provides general information on geographical features and agro-ecological zones, diversity of genetic resources, agriculture and biodiversity, conservation

and utilization of genetic resources in crop and livestock husbandry, forestry, fisheries, and pharmaceutic and aromatic industries. Each chapter has been prepared after a search of all available literature on the topic and with the valuable contributions of eminent scientists.

The images in the book are the result of photo competitions run by the Ministry of Agriculture and Forestry (MAF) as well as photos taken by scholars of related topics and professional photographers. This publication also includes a review of recent literature, reference list and links to online material.

The book also appreciates the outputs of the FAO-Turkey Partnership Programme (FTPP) that have focused on achieving food security and combatting rural poverty in countries in Caucasus and Central Asia since 2006. Thanks to the results achieved so far in the first phase of FTPP and through intervention under the scope of the second phase of FTPP and launch of the FAO-Turkey Forestry Programme (FTFP), the necessary significance has been attached to biodiversity conservation as a cross-cutting issue in agriculture and forestry. Without a comprehensive understanding and acknowledgement to both complex transboundary and local level complex interactions, it is not possible to protect genetic wealth. Thus FTPP and FTFP support the beneficiary countries not only to craft their own journey to address local biodiversity issues, but also to build a common perspective and to have better regional practices on conservation of biodiversity particularly in sustainable agriculture and forestry.

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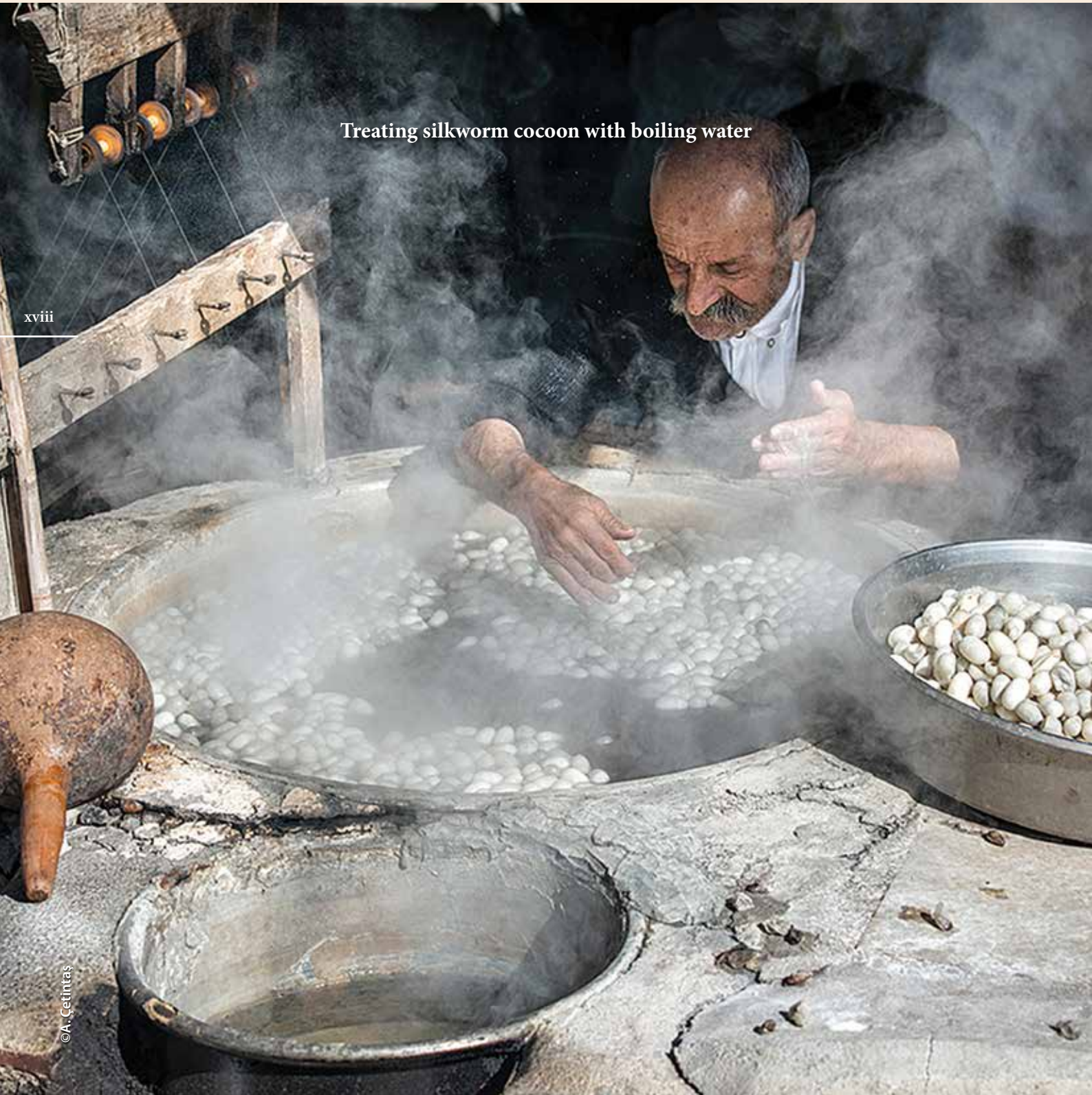
Acronyms and Abbreviations

AARI	Aegean Agricultural Research Institute
BCE	Before Common Era
CA	Conservation Agriculture
CBD	UN Convention on Biological Diversity
CIMMYT	International Maize and Wheat Improvement Center
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
ECPGR	European Cooperative Programme for Plant Genetic Resources
EU	European Union
EUFORGEN	European Forest Genetic Resources Programme
EUROPAM	European Herb Growers Association
FAO	Food and Agriculture Organization of the United Nations
FTFP	FAO-Turkey Forestry Programme
FTPP	FAO-Turkey Partnership Programme
GAP	Good Agricultural Practices
GB	Gene Bank
GDAR	General Directorate of Agricultural Research and Policies, MAF
GDNCNP	General Directorate of Nature Conservation and National Parks, MAF
GDP	Gross Domestic Product
GEF	Global Environment Facility
GIAHS	Globally Important Agricultural Heritage Systems
GMZ	Gene Management Zone
ha	hectare
ICARDA	International Center for Agricultural Research in the Dry Areas
IPM	Integrated Pest Management
IUCN	International Union for Conservation of Nature and Natural Resources
IUFRO	International Union of Forest Research Organizations
km	kilometer(s)
MAP	Medicinal and Aromatic Plants
masl	meters above sea level
MAF	Turkish Ministry of Agriculture and Forestry (Turkish Ministry of Food, Agriculture and Livestock and Turkish Ministry of Forestry and Water Affairs merged on 09 July 2018 to MAF)
MFAL	Turkish Ministry of Food, Agriculture and Livestock
MFWA	Turkish Ministry of Forestry and Water Affairs
NGBG	Nezahat Gökyiğit Botanic Garden in İstanbul
NGO	Non-governmental Organization
SIS	Turkish State Institute of Statistics
TL	Turkish Lira
TÜBİTAK	Turkish Scientific and Technological Council

TÜİK	Turkish Statistical Institute (previous name SIS)
UN	United Nations
UNDP	UN Development Programme
UNESCO	UN Educational, Scientific and Cultural Organization
UPOV	International Union for the Protection of New Varieties of Plants
USD	US dollar
WB	World Bank
WHO	World Health Organization
WWF	World Wide Fund for Nature



Treating silkworm cocoon with boiling water

Turkish alphabet

The names of administrative locations and geographic objects in the book are indicated in Turkish. Therefore, it is considered to provide the Turkish alphabet (Turkish: Türk Alfabesi) that is derived from the Latin, consisting of 29 letters. It has all the letters in the English alphabet, except «q», «w», and «x». In addition, seven of which (ç, ğ, ı, i, ö, ş, and ü) have been modified from their Latin originals for the phonetic requirements of the language. This alphabet represents modern Turkish pronunciation with a high degree of accuracy and specificity

Turkish		English approximation
Ç	**ç**	“ch”, as in “chin”
Ğ	**ğ**	no exacts equivalent in English, similar to “kh” sound
I	**ı**	“i” as in “Martin”
İ	**i**	“i” as in “it”
Ö	**ö**	“o” a in “World”
Ş	**ş**	“sh” as in “shadow”
Ü	**ü**	“u” as in “flute”

Ancient granaries in Taşkale, Karaman Province had been established in volcanic formation many centuries ago. Today those ancient granaries allow storing wheat, barley, lentil, chickpea, and walnut without using pesticides thanks to its favourable location and climatic conditions. Taşkale is known as homeland of the ancestors of great leader Atatürk who is the founder of Turkish Republic lived

Introduction to Turkey

Chapter I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The Republic of Turkey lies in the Northern Hemisphere where the "Old World Continents" (Asia, Africa, and Europe) meet (Figure 1). Its total land border is 2 875 km, shared with Greece (203 km) and Bulgaria (269 km) on the northwest, with Georgia (276 km) on the northeast, with Armenia (325 km), Azerbaijan (18 km), and Iran (529 km) on the east, and with Iraq (378 km) and Syria (877 km) on the south. Total length of the sea border is 8 333 km.

Turkey's surface area is 780 043 km^2, 97% of which lies in Asia (Anatolia) and the remaining 3% in Europe (Thrace). Turkey's land area (excluding water bodies) is 769 604 km^2. For comparison, this is about equal in size to countries Mozambique or Zambia in Africa or Chile in South America, almost as large as the total land area of France and UK, and a bit larger than the state of Texas, USA.

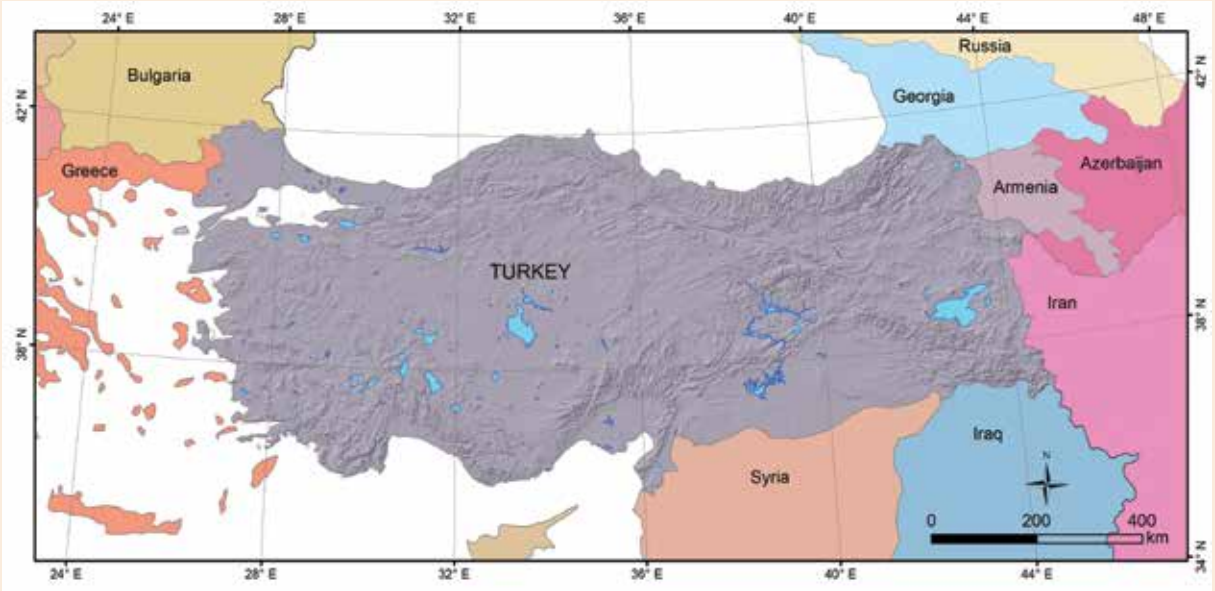
The Turkish shoreline stretches for 8 210 km along the Mediterranean Sea in the south, the Aegean Sea in the west, and the Black Sea in the north. In the northwest there is the important inland Sea of Marmara, between the straits of the Dardanelles and the Bosporus, important waterways that connect the Black Sea with the rest of the world. The country is roughly rectangular in shape, measuring 1 600 km from west to east, from 25°40' to 44°49' E longitude, and 650 km from south to north, from 35°51' to 42°06' N latitude.

With this geographically important position, its large land area (in the top 40 largest countries in the world), and its constantly increasing population, Turkey continues to have a crucial role in determining stability in this part of the world.

Population

In the first census conducted in 1927, the population of the Republic of Turkey was recorded as 13 648 000 and as of December 2017, it was 80 810 525 (Figure 2). The current yearly population growth rate is 1.35% with the population projected to be 84 247 088 in 2023, which is the centenary of the republic, and 93 475 575 in 2050.

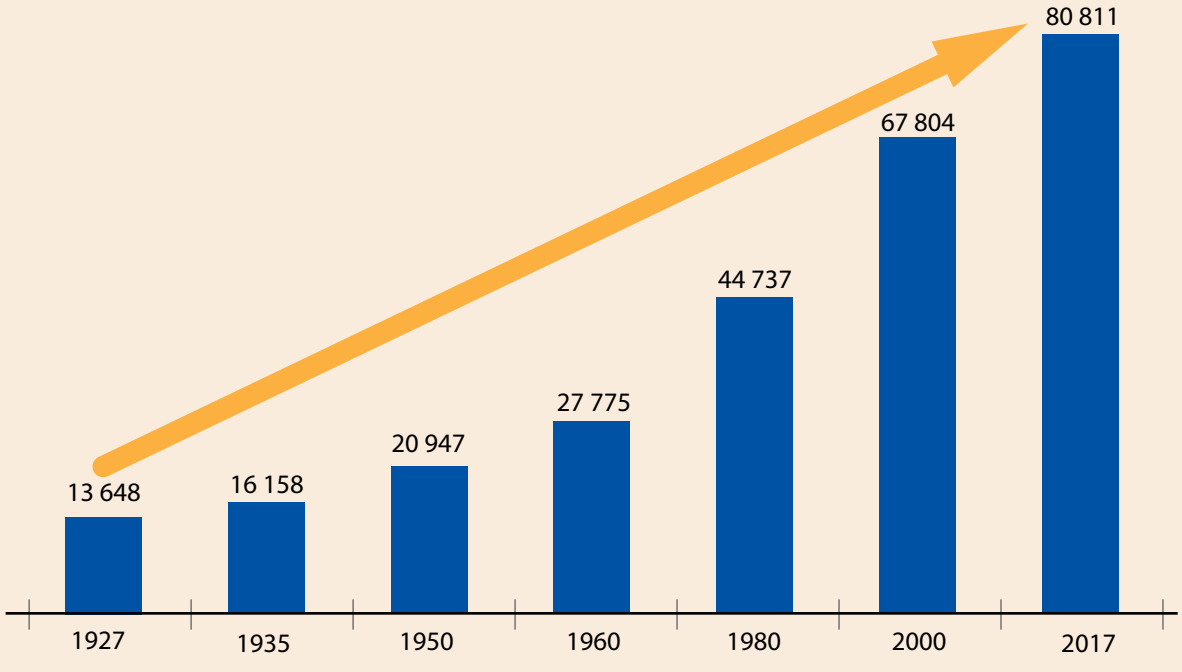
Population distribution by gender is almost equal (50.2% male, 49.8% female) and the majority of the population comprises of young people, with about 56% of the population below 35 years of age (Figure 3).



Source: Ministry of Food, Agriculture and Livestock (MFAL), 2017

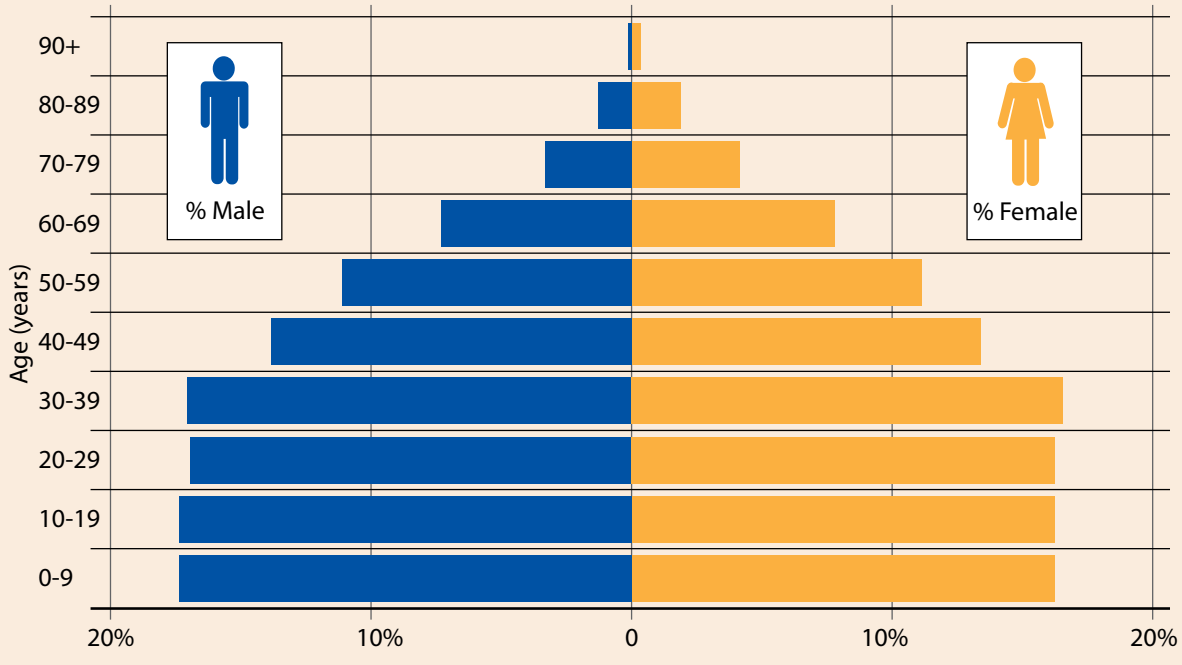
Figure 1. Map of the Republic of Turkey

Turkey's labor force is around 30.2 million people. This makes the country the third largest labor force market in Europe. Turkey's young population is an important contributor to labor force growth and has boosted the country's rank over its competitors.



Source: Turkish Statistical Institute (TÜİK), 2018

Figure 2. Trends of population growth, 1927 to 2017 (in thousands)



Source: TÜİK, 2018

Figure 3. Age pyramid, 2016

Topography

Turkey is divided into 81 administrative-geopolitical provinces and seven non-political geographical regions, namely, Aegean, Marmara, Black Sea, Eastern Anatolia, Southeastern Anatolia, Mediterranean, and Central Anatolia (Figure 4). Each of the regions possesses unique climatic and ecological features, which can change sharply over very short distances (Figure 5). Overall, the average elevation is 1 141 meters above sea level (masl). Major causes of topographic diversity are the tectonic movements of recent geologic periods and the accumulation of volcanic products, which have created many of the elevated areas.

High-elevation areas (>1 000 masl) constitute 57% of the total area (Table 1).

The high plateau region of Anatolia rises progressively towards the east and is divided by valleys formed by 15 rivers, including the Dicle and Fırat (Tigris and Euphrates), which originate in eastern Anatolia and flow southward to the Persian Gulf through Syria and Iraq and are important water resources and of great historical importance. The largest river entirely within Turkey is the Kızılırmak, which flows northward past Ankara into the Black Sea.

Among the lakes, Lake Van (3 713 km^2), Lake Tuz (1 500 km^2), and Lake Beyşehir (656 km^2) are as large as inland seas (Figure 5).

Anatolia consists of an inner high plateau bordered by west-to-east mountain ranges along the north and south coasts. The southern mountain range (Taurus) at the west is close to the Mediterranean coast and is cut with very steep gorges. The range continues initially north-eastward as the Anti-Taurus, but curves in an arc to

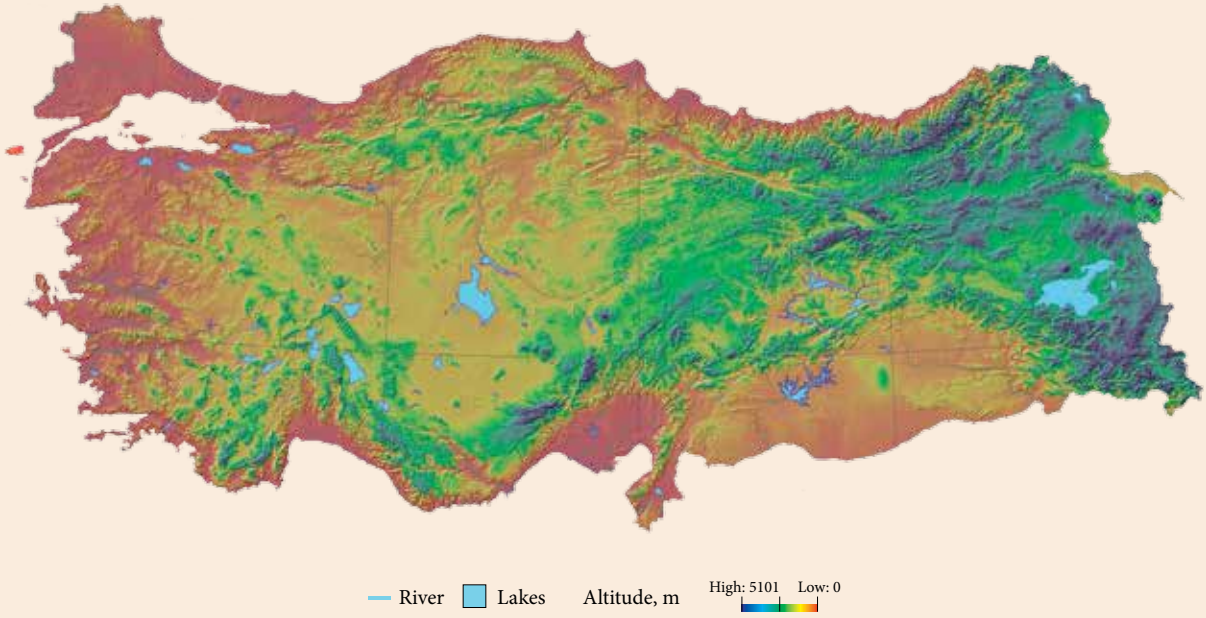
Table 1. Distribution of area by elevation

Elevation (m)	Portion of total area (%)
0 to 500	18
500 to 1 000	25
1 000 to 1 500	30
1 500 to 2 000	16
> 2 000	11

Source: Karagöz, 2000

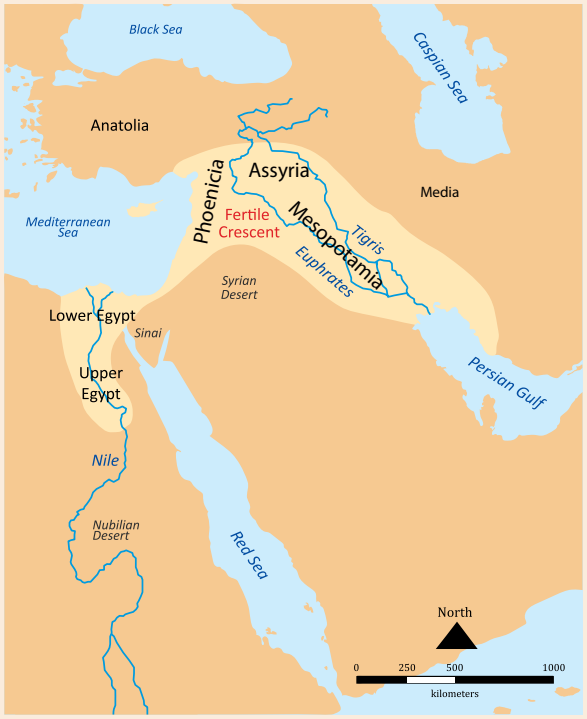
Source:MFAL, 2017

Figure 4. Geographic regions and their associated provinces



Source: MFAL, 2017

Figure 5. Physical and elevation map



Source: MFAL, 2017

Figure 6. The Fertile Crescent

the southeast embracing a southern, outer plateau, constituting the northern arc of the Fertile Crescent (Figure 6), which is the northern extension of the Syrian Desert. Central Anatolia is a high plateau at an elevation between 800 and 1 000 masl, with several mountains rising much higher.

Towards the inner part, the plateau slopes gradually flatten to a basin containing a large salt lake – Lake Tuz. In the north of Anatolia, mountain ranges are higher and closer to the sea towards the east, allowing a narrow, green and fertile belt along the Black Sea coast. The Central Anatolian plateau, cleft by canyons and dominated by volcanic peaks, forms the heartland of Turkey.

Eruptions of the volcanoes Mounts Erciyes (3 916 masl) (Figure 7) and Hasan (3 268 masl) (Figure 8) three million years ago covered the plateau surrounding Nevşehir with tufa, a soft stone comprised of lava, ash, and mud. Due to the soft structure of this material it can be easily excavated and thousands of shelters, homes, and sacred places were excavated here in the past. This plateau was one of the cradles of human civilization and today the area called "Cappadocia" is an important tourist attraction.

At Aşıklıhöyük and Göbekli Tepe, remains of settlements from as early as the VIII millennium BCE have been unearthed (Figures 9 and 10). The area is the homeland of many peoples and a historic area of

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Figure 7. Mount Erciyes

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Figure 8. Mount Hasan

confrontation between the East and West, beginning with the transition from the Hattis people to the Hittites.

At many points in the Black Sea Region, mountain ranges rise to over 3 000 masl. Elevation falls gradually towards the west of the Pontic mountain range. Several north-running rivers cut valleys from the plateau to the Black Sea. One of the Transboundary Rivers of Turkey, the Çoruh River, passes through this region up to Georgia. The tallest dam in Turkey, Deriner Dam (249 m), was constructed on the Çoruh River in Artvin Province.

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Figure 9. Excavation area at Aşıklıhöyük (in Aksaray Province)

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Figure 10. Excavation area at Göbekli Tepe (in Şanlıurfa Province)

Eastern Turkey is rugged land with high elevations, a more severe climate, and greater precipitation than on the Anatolian Plateau. The average elevation of the peaks is greater than 2 000 masl. The highest point of Turkey, Ağrı Dağı (5 172 masl), is in this area. Many of the peaks are extinct volcanoes that were active not long ago, as indicated by widespread lava flows. Eastern Anatolia is the largest region of Turkey with 163 000 km^2 of land, 21% of the total area of the country.

South eastern Anatolia is much lower and flatter than Eastern Anatolia, falling from 800 masl in the north to 400 masl at the Syrian border. The topography of the region

is very suitable for construction of a series of dams to meet national energy and irrigation requirements. Therefore, there are many dams constructed in the region.

The region is flat in the south and hilly in the north. Karaca Dağ (Mount Masia, 1 919 masl), a basaltic mountain, is the highest point in the area. Karaca Dağ is a very important mountain from the viewpoint of wheat genetic resources, because the area around it has been proposed as the area of origin of the first cultivated wheat.

The European section (Thrace) is a very heterogeneous fertile hilly land. The Istranca (Strandzha) Mountains which border the Black Sea are a low continuation of the northern range of Anatolia and are composed largely of schist. Most of this region is occupied by undulating plains drained by the Ergene River. On the northwest of the Sea of Marmara is the low sandstone range of Tekir Dağı which continues southwards into the Gelibolu peninsula.

Climate

The climate of Turkey is very diverse with several major climate types (Figure 11). The subtropical steppe climate is found in the mid-part of the continental Central Anatolia Region and the Van-Iğdır district over the most-eastern part of the continental Eastern Anatolia Region. The temperate-rainy or humid-temperate west-coast climate without a dry season is predominantly found in the Black Sea Region with the exception of the western sub-region. The dry summer subtropical Mediterranean climate is found in Marmara, Aegean, Mediterranean and, Southeastern Anatolia Regions and the western and southern portions of the continental Central Anatolia Region. The cold snowy forest climate with a dry summer is found over a relatively large zone including the mid-northern portions of the continental Central and Eastern Anatolia Regions of Turkey. The cold snowy forest climate, humid in all seasons, is found over relatively small areas in the northern portions of the continental Central Anatolia Region and the northern Eastern Anatolia sub-region (mostly Erzurum-Kars sub-region) of Turkey.

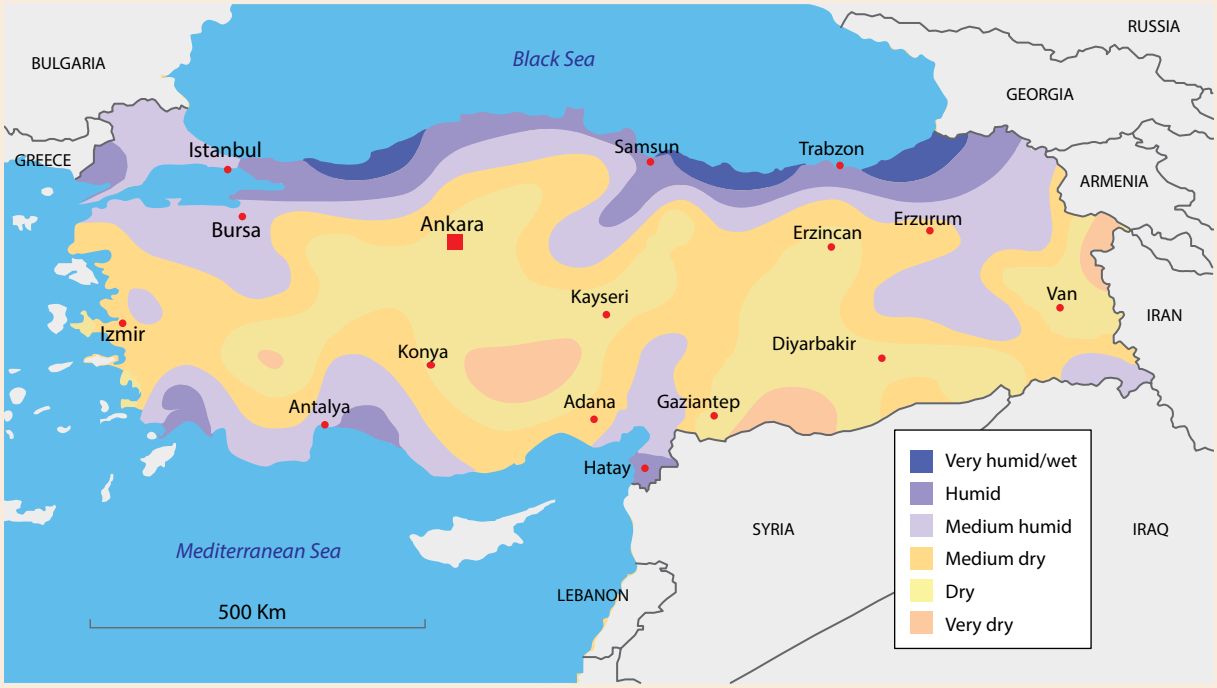


Figure 11. Climate regions

Average annual temperatures vary widely throughout the country influenced by elevation, topography, and orientation about maritime or continental conditions (Figure 12). Throughout the year, highest temperatures are recorded in July and August. Average temperature during these two months is 27 °C on Mediterranean and Aegean coasts and 22 to 24 °C on the Marmara and Black Sea coasts. The average annual temperature varies between 18 to 20 °C on the south coast (Mediterranean), falls to 14 to 15 °C on the west coast (Aegean) and depending on the elevation, temperature fluctuates between 4 to 18 °C in the interior.

Soil

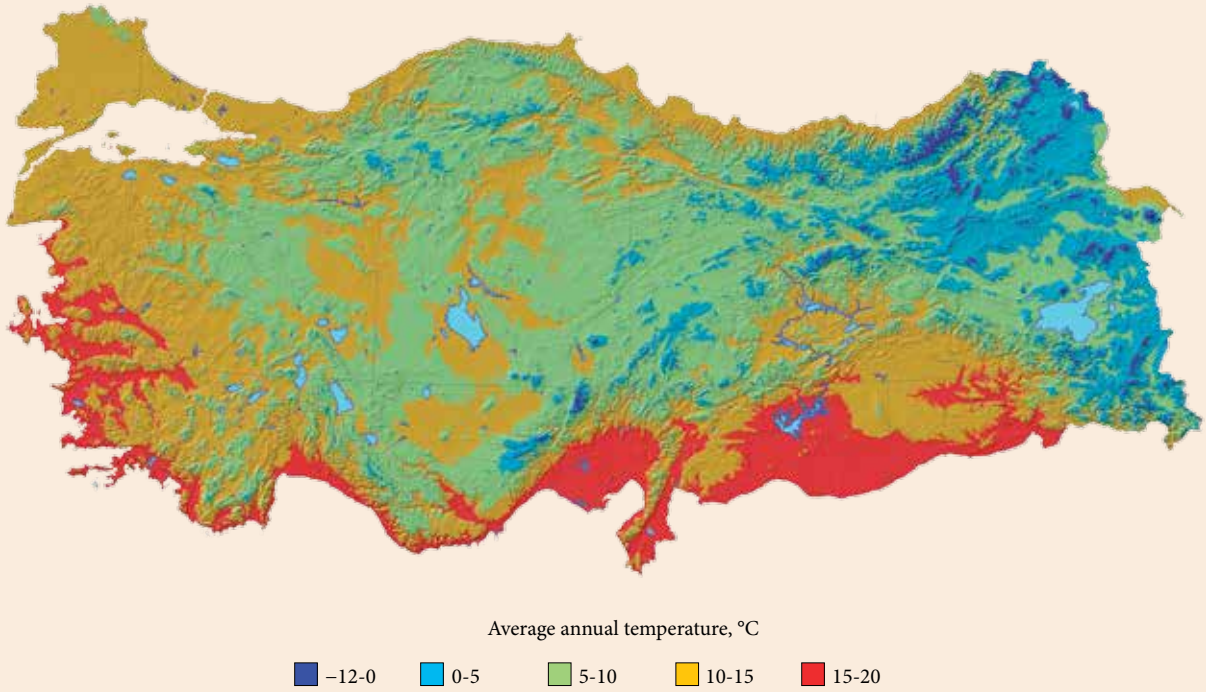
Soil is a heterogeneous system whereby various characteristics dynamically affect one another. Physical features of the soil include different aspects, such as depth, granularity, structure, and texture, percentages of air and water, temperature, color, soil reaction (pH), and organic matter content. Soil properties along with topographic and climatic conditions play the major role in governing the vegetation that will develop in a given area.

Of the total land area of Turkey, about 38 million ha are cultivated of which 6.23 million ha were irrigated in 2015. Alluvial constitutes the most important group of arable soils. Several soil groups have been recognized in different geographical zones (Figure 13). The dominant soils of central Turkey belong to the reddish brown and brown groups, most of which are devoted to cereal crop cultivation.

Grumusol and rendzina soil groups are found in Thrace and south of the Marmara Sea.

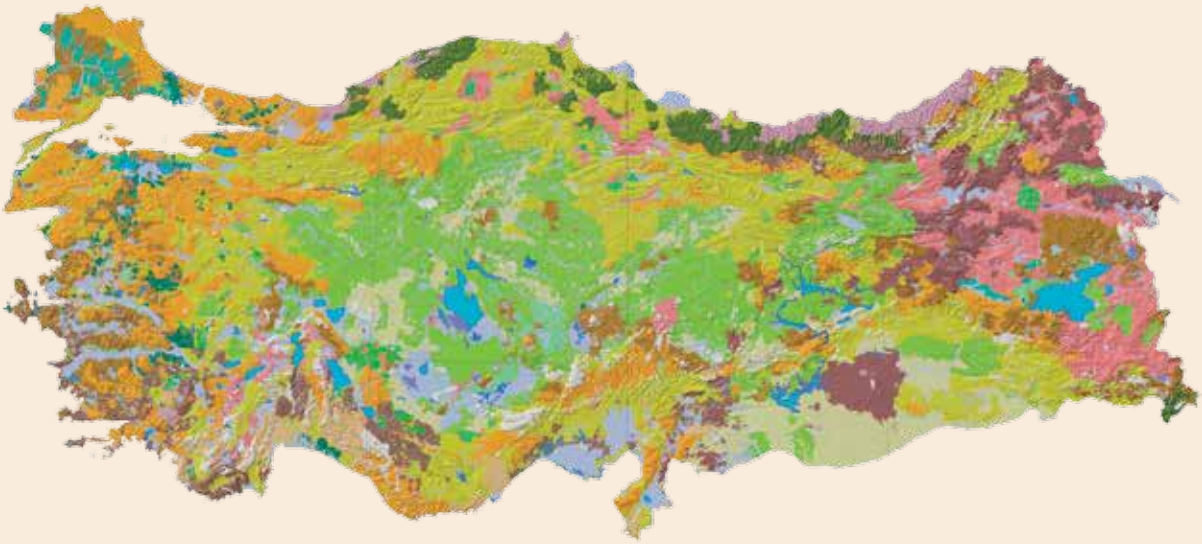
The following list describes the distribution of major soil groups:

- Black Sea coast-Brown soils in general, podsolic and chernozem soils at the eastern part,
- Aegean and Mediterranean coasts – Mediterranean terra rossa soils,
- Mountains and high elevation areas with sufficient rainfall-forest and rendzina soils,



Source: MFAL, 2017

Figure 12. Average annual temperature



Source: MFAL, 2017

Figure 13. Soil map

- Arid areas – brown and reddish-brown soils,
- Semi-arid areas – lime-free brown, chestnut, and reddish chestnut soils,
- Plains and adjacent slopes – alluvial and colluvial soils,
- Volcanic areas – volcanic soils.

Soil-use capability classes and their proportion of the total land area are given in Table 2. Almost two-thirds of the soils of the country are characterized as class VI or higher and thus are generally unsuitable for crop cultivation.

Table 2. Area of soil-use classes and percentage of total land area

№	Soil-use class and description	Area, ha	%
I	Few limitations restricting use	5 086 084	6.5
II	Moderate limitations reducing choice of plants or requiring moderate conservation practices	6 712 873	8.6
II	Severe limitations reducing choice of plants, requiring special conservation practices, or both	7 282 763	9.4
IV	Severe limitations reducing choice of plants, requiring very careful management, or both	7 425 045	9.5
V	Not likely to erode but with other limitations, impractical to remove, mainly useful for pasture, range, forestland, or wildlife food and cover	127 934	0.2
VI	Severe limitations making them generally unsuitable for cultivation, mainly useful for pasture, range, forestland, or wildlife food and cover	10 825 762	13.9
VII	Very severe limitations making them unsuitable for cultivation, mainly useful for grazing, forestland, or wildlife	35 836 350	46.0
VIII	Limitations nearly precluding use for commercial crop production, mainly useful for recreation, wildlife, or water supply or for aesthetic purposes	4 542 896	5.8
	Total area:	77 839 707	100.0

Source: Karagöz, 2000

Summary of Turkish geographic information:

- Total area of Turkey is 783 562 km^2, out of that 98% is land area and 2% is water bodies of lakes and dams.
- Turkey is 37th in land size among all other countries.
- Turkey has 2 871 km land border, including with:
  - Greece – 203 km,
  - Bulgaria – 269 km,
  - Georgia – 276 km,
  - Armenia – 325 km,
  - Azerbaijan – 18 km,
  - Iran – 529 km,
  - Iraq – 378 km,
  - Syria – 877 km.
- The total sea border is 8 333 km.
- The highest point is the summit of Mount Ağrı, 5 172 masl.
- The longest river within Turkey is Kızılırmak, 1 355 km.
- The two longest transboundary rivers are the Fırat (Euphrates) (971 km within Turkey and 2 800 km in total length) and the Dicle (Tigris) (523 km within Turkey and 900 km in total length).
- The largest lakes are Lake Van (3 713 km^2 and 451 m deep) and Lake Tuz (1 500 km^2 and 2 m deep).
- The largest reservoirs are the Atatürk Dam (817 km^2) and the Keban Dam (675 km^2).

Agriculture and Biodiversity

Chapter II

Turkey is considered one of the leading countries in the world in agriculture and related industries with rising exports in many kinds of agricultural products, placing the country among the world's largest producers. Agriculture is of key importance, both in social and economic terms. Agriculture is still the occupation of a major part of the Turkish population, despite the constantly rising share of the industry and service sectors.

Turkey is one of the few self-sufficient countries in the world in terms of food production. Fertile soil, adequate climate, and rainfall permit growing almost any kind of crop. Farming is conducted in all regions, but it is less practiced in the mountainous eastern regions where the main agricultural activity is based on animal husbandry. The rapid industrialization after the 1930's, supported by government policies, caused a decline in agriculture's share of overall income. The agricultural sector's share of the GDP was almost 50% in 1950; by 2016 it was only about 6%. Despite the decreasing share in GDP, the value of agricultural production has been rising, reaching USD 32.6 billion in 2016, corresponding to 119 billion TL.

Turkish agriculture sector employs about 5.1 million people that constitutes 18.9% of the total employment which was about 27 million as of March 2016, declining from approximately 29% in 2004 and 25% in 2012. Considering the increase in the production during the same period, this means the efficiency of the agricultural sector has risen significantly.

Turkey is one of the countries with the largest proportion of agricultural lands (about 50% of total land area), with a total agriculture area of 38 328 000 ha (Table 3). About 36% of the country consists of arable land, about 16% of which is irrigated.

On a production value basis, crop production amounted to 74% of the 2016 agriculture, forestry, and fishing production value.

Of that portion, cereals and other annual field crops accounted for 40%, fruit and spice crops accounted for 33%, and vegetable crops accounted for 27%. The average area of a Turkish farm is 6.63 ha. Subsistence and semi-subsistence farming are important characteristics of Turkish agriculture. These farms are typically characterized by low production with only a small fraction of that being marketed off farm.

Turkey is the top producer in the world of hazelnuts, figs, apricots, and cherries by far, second in melons, leeks, raisins, and cherries (sweet and sour), and third in other products such as spices, chillies and peppers, strawberries, chestnuts, chickpeas, pistachios, walnuts, vetches, lentils, green beans, cucumbers, watermelons, fresh grapes, and honey.

Grain production is highly dependent on government policies. More than 36 million tonnes of grain was produced in 2016. The government supports grain production through intervention prices and by direct subsidies for fertilizer, fuel, and certified seed. The main products in the grain

Table 3. Agricultural area by type of production

Land use	Area, 000 ha	Percentage
Annual crops	15 574	40.6
Vegetable crops	804	2.1
Ornamental crops	5	0.01
Fallow	3 998	10.4
Permanent crops	3 329	8.7
Pasture and meadow	14 617	38.1
Total	38 328	100.0

Source: TÜİK, 2018

group are wheat, barley, and maize which constituted approximately 58%, 19%, and 15%, respectively, of the total grain production by volume in 2017.

Wheat is produced in almost every province with a total production of approximately 21 million tonnes, with an average yield of 2.69 tonnes/ha in 2017. It is also the main crop in many provinces, especially in the Central Anatolia Region. The average yield is lagging behind the 2016 EU-28 average yield of 5.26 tonnes/ha. The main reasons behind this deficiency are the large number of small-sized farms, poor organic matter content of soils, inefficient input usage, as well as negative climatic conditions.

Despite the relative decline in agriculture's share of GDP in the last 30 years, this sector still plays an important role in foreign trade. Turkey exports many agricultural products such as cereals, pulses, industrial crops, sugar, nuts, fresh and dried fruits, vegetables, olive oil, and livestock products. The main export markets are European Union (EU), the United States, and the Middle East. Total exports of agriculture, forestry, and fishing products were valued at 5.8 billion USD in 2016.

Organic farming activities are becoming increasingly widespread in Turkey. Although the area allocated to organic farming has fluctuated in the last several years, there had been a rather consistent increase up to a high of 842 216 ha in 2014. In 2016, while the acreage of organic farming had decreased to 523 777 ha, the production amount had increased to 2 473 600 tonnes produced by 67 878 organic farming enterprises. The number of organically produced crops in 2016 was 238, its highest level to date.

Diversity of Genetic Resources

Of the world's seven bio-geographic regions, three (Mediterranean, Euro-Siberian, and Irano-Turanian) have elements in Turkey (Figure 14), each of which has unique species and natural ecosystems. The Mediterranean element hosts the largest cypress forests available in the world. The Euro-Siberian element is comprised of the Black Sea mountainous forest involving alpine pastures.

The Irano-Turanian element includes the steppes of Central Anatolia and Eastern Anatolia. Climatic and geographical features change within short intervals of space due to Turkey's position as a bridge between two continents. Consequently, it has the character of a small continent from the stand point of biological diversity with forest, mountain, and steppe, wetland, coastal and marine ecosystems and different forms and combinations thereof (Figure 15).

This extraordinary ecosystem and habitat diversity has produced considerable species diversity. Faunal biological diversity is quite high in Turkey compared with that of other countries in the temperate zone. Invertebrates account for the largest number of species, with an estimated 60 000 to 80 000 species, the majority of which are insects. The insect subclass Pterygota (winged insects) alone has 22 125 identified species in 18 orders in Turkey.

The total number of vertebrate species identified to date is near 1 500. There are 694 freshwater and marine fish species, 460 bird species, 30 amphibian species, 161 mammal species, and 120 reptile species.

The number of vascular plant species in Europe (excluding Turkey) is about 12 500 with 28% of these species being endemic to Europe.

Within Europe, the Mediterranean Region has the highest plant diversity.

Turkey is one of the world's richest countries with regard to diversity of plant species, hosting 167 families, 1 320 genera and 9 996 species (Table 4).

Source: MFAL, 2017

Figure 14. Three of the world's biogeographic regions are in Turkey

Source: MFAL, 2017

Figure 15. The diversity of land use and land cover in Turkey

Table 4. General characteristics of Turkish flora

Category	Native	Endemic	%[1]	Alien	Cultivated	Total
Family	154	0	0.0	10	3	167
Genus	1 220	14	1.1	76	24	1 320
Species	9 753	3 035	31.1	174	69	9 996
Subspecies	1 985	500	25.2	1	3	1 989
Variety	858	253	29.5	7	2	867
Hybrid	258	61	21.4	8	2	268
Total taxa[2]	11 466	3 649	31.8	171	70	11 707

Source: Güner *et al.*, 2012

1. The percentage of endemic taxa within the native taxa category.
2. Totals here are not simple summations of the columns. The numbers of a species with subspecies and varieties more than once, and endemic hybrids have not been included.

Endemism

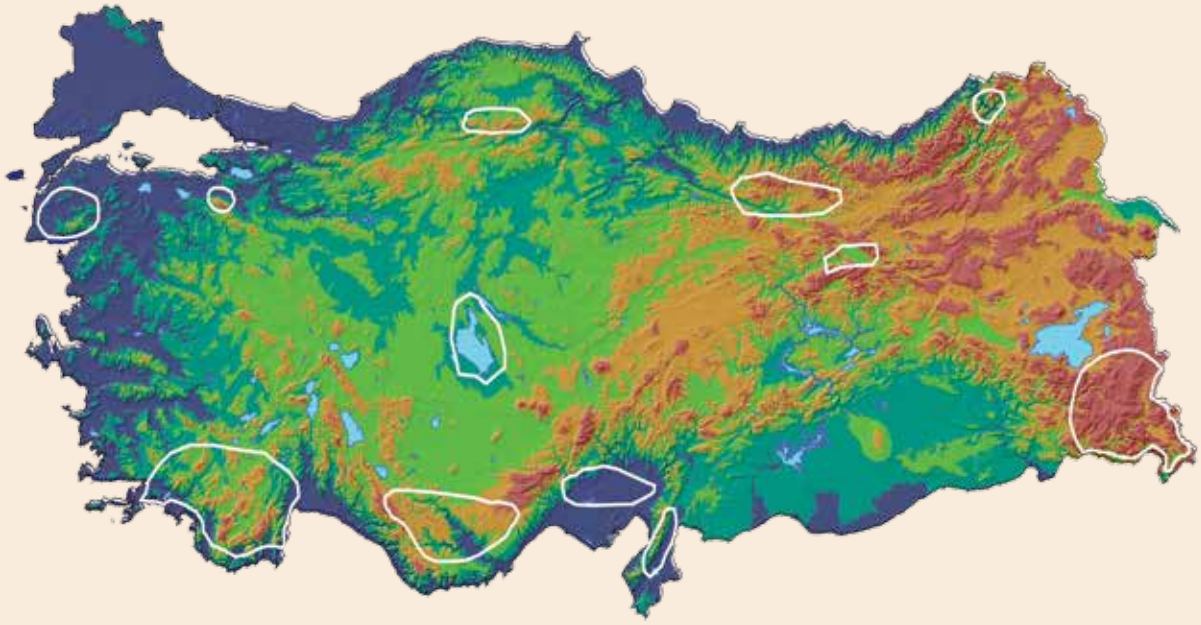
A species, or other category of organism that is unique to a defined geographic location such as an island, nation, country, or habitat type is considered endemic to that location. The endemism rate of the Turkish flora is 31.8% and each year new such species are identified. The richest plant family for endemism in Turkey is Asteraceae having a total of 572 endemic taxa, followed by Fabaceae (385 taxa) and Lamiaceae (326 taxa). Also 14 genera are endemic. Other plant families, and some genera, with high endemism rates are given in Table 5. The rate of endemism is relatively high when compared with other European countries such as 18% in Spain, 15% in Greece, 3% in France, and only 0.1% in Poland.

Due to exceptional amount of endemism that brings a huge responsibility to Turkey, it is to ensure that these species are adequately protected from threats or extinction, particularly for those which are related to the crops upon which much of the world depends. Of the country's seven geographical regions, the Mediterranean Region boasts the highest number of endemic species confined to a single region. Within that region, Antalya is the richest province with 587 endemic plant species. High levels of endemism within Turkey are concentrated in specific areas (outlined in Figure 16), such as the Amanos Mountains, the Ilgaz Mountains, the Central Taurus Mountains, the Taşeli Plateau, the Bolkar and Aladağlar Mountains, the Kaz Mountains, Uludağ Mountain, the mountains between Gümüşhane and Erzincan, the Munzur Mountains, and Lake Tuz and its saline steppes. Of the 3 649 endemic plant taxa in Turkey, several are relatives of crop species that feed the world, i.e., some field crops (such as wheat, barley, rye, oat, linseed, lentil, chickpea and pea), pasture plants (such as alfalfa, clover, sainfoin, vetch, and grasses), and horticultural plants (such as cherry, apricot, plum, almond, fig, and grape).

Plant genetic diversity by geographical region

The seven geographical regions can be divided into 21 sections based on their unique climatic, ecological, and vegetation features (Figure 17). The following text describes the vegetation features of the seven regions. The number of endemic taxa in the 21 sections is given in Table 6.

Eastern Anatolia Region. This region is very rich in forage and pasture plants and is a gene center for many of them such as lucerne (*Medicago*), clover (*Trifolium*), vetch (*Vicia*), sainfoin (*Onobrychis*), and chickling vetch (*Lathyrus*). The area is generally at high elevation and the pastures are severely degraded by heavy grazing. The



Source: MFAL, 2017

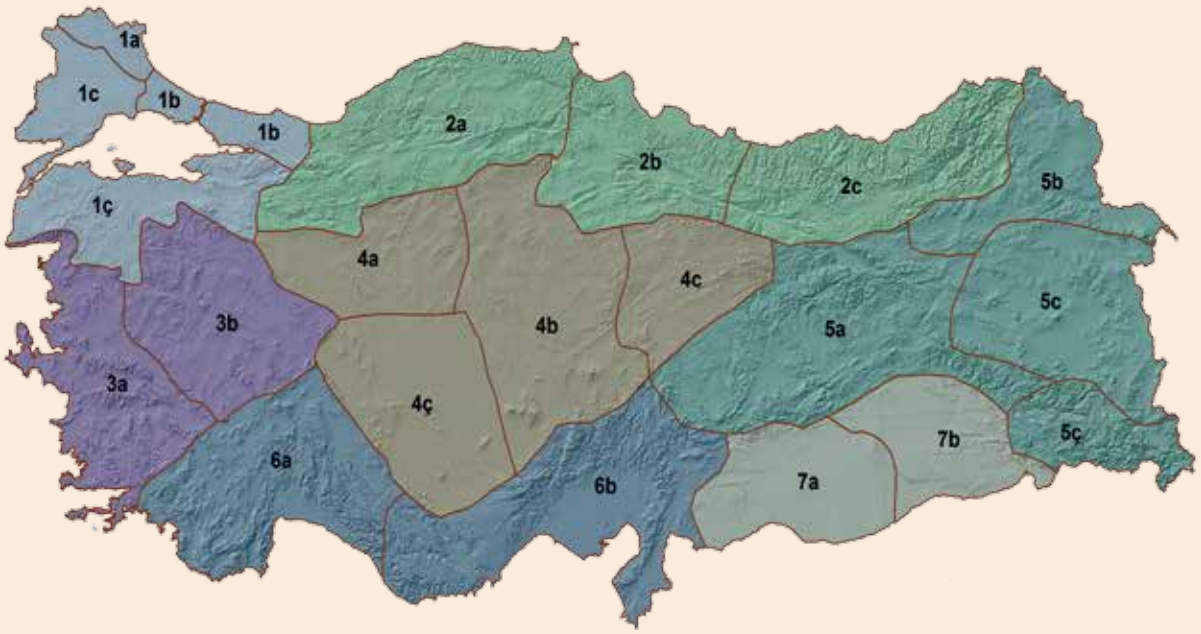
Figure 16. Areas with high plant endemism rates are outlined with white against the backdrop of topographic elevations

Table 5. Plant families with high rates of endemism, with examples of included genera with high endemism rates

Family/Genus	Taxa	Endemic taxa	Endemism rate, %
Scrophulariaceae	486	232	47.7
Verbascum	398	195	49.0
Campanulaceae	209	94	45.0
Caryophyllaceae	755	308	40.8
Bolanthus	10	9	90.0
Gypsophila	62	38	61.3
Paronychia	55	26	47.3
Rubiaceae	228	90	39.5
Lamiaceae	844	326	38.6
Sideritis	61	41	67.2
Boraginaceae	412	142	34.5
Alkanna	45	30	66.7
Paracaryum	35	21	60.0
Asteraceae	1 693	572	33.8
Cousinia	39	26	66.7
Centaurea	217	110	50.7
Fabaceae	1 356	385	28.4
Ebenus	15	14	93.3
Astragalus	501	216	43.1

Source: Extracted from Güner *et al.*, 2012

most persistent grass species of the pastures are fescue (*Festuca*) and wheatgrass (*Elymus* and *Agropyron*). Although this is the coldest part of the country and heavy grazing has been going on for many decades causing serious genetic erosion, it is still possible to find very beneficial plants in the pastures. This is because the native pasture plants are highly persistent and well adapted to the area.



Source: MFAL, 2017

Figure 17. The seven geographical regions and their associated vegetation-type sections

Table 6. Number of endemic taxa by sections of the seven geographical regions

Geographical region	Section		Number of endemic taxa
Marmara	1a	Strandzha	22
	1b	Çatalca-Kocaeli	69
	1c	Ergene	26
	1ç	South Marmara	232
Black Sea	2a	West Black Sea	327
	2b	Central Black Sea	219
	2c	East Black Sea	467
Aegean	3a	Main Aegean	389
	3b	Central West	274
Central Anatolia	4a	Upper Sakarya	309
	4b	Central Kızılırmak	451
	4c	Upper Kızılırmak	359
	4ç	Konya	418
Eastern Anatolia	5a	Upper Fırat (Euphrates)	731
	5b	Erzurum-Kars	188
	5c	Upper Murat-Van	130
	5ç	Hakkari	182
Mediterranean	6a	Antalya	951
	6b	Adana	1 023
Southeastern Anatolia	7a	Central Fırat (Euphrates)	144
	7b	Dicle (Tigris)	–

Source: Güner et al., 2012

An example of uniqueness: *Thermopsis*

Thermopsis turcica Kit Tan, Vural & Küçüködük (*piyan* in Turkish) an endemic species, belongs to Fabaceae family. It has a restricted area of distribution in Afyonkarahisar and Konya Provinces. Only two viable populations are located at southwest parts of Eber and Akşehir lakes. It is categorized as Critically Endangered according to International Union for Conservation of Nature and Natural Resources (IUCN) threat categories. The plant is unique with its propagation characteristic having three or more pods on each flower. Among the 18 000 members of Fabaceae family, this characteristic is peculiar to only *Thermopsis turcica*.

Figure 18. *Thermopsis turcica* at sides of Eber Lake in Afyonkarahisar Province

Figure 19. *Thermopsis turcica* grows three pods per ovule

Southeastern Anatolia Region. At the northern end of the Fertile Crescent, which is considered the primary gene center for cereals and food legumes, this region is very rich in wild relatives of wheat (*Triticum* and *Aegilops*), lentil (*Lens*), chickpea (*Cicer*) and some of the forage plants such as peas (*Pisum*), vetch (*Vicia*), and chickling vetch (*Lathyrus*).

Pistachio (*Pistacia*), Euphrates poplar (*Populus euphratica*), oak (*Quercus brantii*), red pine (*Pinus brutia*), and wing-nut (*Pterocarya fraxinifolia*) are native to the area.

Mediterranean. This is the most important region for forest trees and wild plants. The rate of endemism is very high. Chickpea (*Cicer*), medicinal and aromatic plants (for example, species of *Sideritis* or *Origanum*), laurel (*Laurus nobilis*), caper (*Capparis spinosa*), and bulbous-tuberous plants (orchids and others) are the major plants. The region is also very important for trees: cedar (*Cedrus libani*), Taurus fir (*Abies cilicica*), beech (*Fagus*), junipers (*Juniperus*), and olive (*Olea*).

Aegean and Marmara Regions. In the Mediterranean Region, there are many wild relatives of cultivated plants such as wheat and its relatives (*Aegilops* and *Triticum*), chickpea (*Cicer*), broad bean (*Vicia faba*), and forest trees, as well as many endemic species.

The Aegean Region is very rich in species of the Orchidaceae family (*Orchids*), sweet marjoram (*Origanum majorana*), ironwort (*Sideritis*), and walnut (*Juglans regia*), stone pine (*Pinus pinea*), Kazdağı fir (*Abies nordmanniana* ssp. *equitrojani*), olive (*Olea europea*), almond (*Amygdalus communis*), and sweetgum (*Liquidambar orientalis*). The Marmara Region is rich in chestnut (*Castanea sativa*), alder (*Alnus*), and hornbeam (*Carpinus*). Kazdağ (*Ida Mountain*) is one of the most important areas of the country from the viewpoint of genetic diversity.

Black Sea Region. This region is important for such forest trees as pine (*Pinus*), fir (*Abies*), spruce (*Picea*), linden (*Tilia*), fruits (*Prunus, Cerasus, Pyrus,* etc.), medicinal and aromatic plants such as snow drop (*Galanthus*), autumn crocus (*Colchicum autumnale*), sweet marjoram (*Origanum majorana*), and some pasture plants.

Central Anatolia Region. Much of the grazing areas here are covered with steppe vegetation. Alfalfa (*Medicago*) and wheatgrass (*Agropyron* and *Elymus*) are widespread. Milkvetch (*Astragalus*) is a very typical plant of degraded pastures.

The transitional zone between northern and southern Central Anatolia is very rich in endemic plants. The main forest trees are elm (*Ulmus*), black pine (*Pinus nigra*), and Scots pine (*Pinus sylvestris*). Rose (*Rosa*), sage (*Salvia*), rock rose (*Cistus*), and many other shrubs and herbaceous plants are also native to the area. The Lake Tuz area is very rich in plant species as well as endemism with almost 50 endemic plant species.

Plant genetic resources

Turkey is located at the intersection of two major Vavilovian gene centers – the Mediterranean and the Near Eastern gene centers, both of which had a key role in the emergence of cereals and horticultural crops from such genera as lint (*Linum*), onion and garlick (*Allium*), barley (*Hordeum*), wheat (*Triticum*), oat (*Avena*), chickpea (*Cicer*), lentil (*Lens*), pea (*Pisum*), grape (*Vitis*), almond (*Amygdalus*), plum (*Prunus*), and sugarbeet (*Beta*). There are five micro-gene-centers in which more than 100 species display wide variation and which are the origin or center of many important crop and other economically important plant species such as medicinal plants and fruit tree species. These micro-gene-centers offer very important genetic resources for the future sustainability of many plant species cultivated across the world.

Micro gene-centers of economically important crops:

- Thracian and Aegean areas: Bread wheat, durum wheat, Poulard wheat, club wheat, small red wheat, lentil, chickpea, melon, vetch, lupine, and alfalfa;
- Southern and Southeastern Anatolia: Wild emmer, goatgrass, pumpkin, watermelon, cucumber, bean, lentil, broad bean, grape vine, and forage crops;
- Samsun, Tokat, and Amasya provinces: A large number of fruit species, bean, lentil, broad bean, and other forage legumes;
- Kayseri Province and its surroundings: Almonds, apple, peas, grape vine, lentil, chickpea, alfalfa, and sainfoin;
- Ağrı Province and its surroundings: Apple, apricot, cherry, sour cherry, watermelon, and forage legumes.

Plant genetic resources in Turkey relevant to several food crops (cereals, food legumes, and horticultural plants), are presented in Tables 7, 8, and 9, respectively. Those relevant to animal feeding such as forage legumes and forage grasses are listed in Tables 10 and 11, respectively.

The production area of forage crops is 9.5% of the total area under cultivation. While pastures have lost their productivity due to continuous and irregular grazing, natural pasture is still, however, the main habitat for many species of legumes, grasses, and other plant families. Plant genetic resources of a great many medicinal and aromatic plants (Table 12) and industrial crops (Table 13) are also found in Turkey.

Forest trees include natural or cultivated species used as firewood or timber in industry. They also serve for protective

Leymus cappadocicus

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Table 7. Main cereal genetic resources

Genus	Number of Species	Subspecific taxa	Endemic taxa	Relevant crop
Triticum	11	1	–	Wheat
Aegilops	17	6	–	Wheat
Amblyopyrum	1	2	–	Wheat
Hordeum	9	4	–	Barley
Secale	8	3	2	Rye
Avena	8	6	–	Oats

Source: Güner et al., 2012

Table 8. Main food legume genetic resources

Genus	Number of Species	Subspecific taxa	Endemic taxa	Relevant crop
Cicer	12	2	7	Chickpea
Lens	4	4	–	Lentil
Pisum	2	5	–	Pea

Source: Güner et al., 2012

Table 9. Main horticultural plant genetic resources

Genus	Number of Species	Subspecific taxa	Endemic taxa	Relevant crop
Allium	179	41	77	Onion
Lactuca	33	2	6	Lettuce
Crataegus	24	9	10	Thornapple
Amygdalus	13	3	4	Almond
Pyrus	11	12	3	Pear
Cerasus	10	12	2	Cherry
Daucus	7	–	–	Carrot
Prunus	3	2	–	Plum
Malus	2	5	1	Apple

Source: Güner et al., 2012

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Table 10. Main forage legume genetic resources

Genus	Number of Species	Subspecific taxa	Endemic taxa	Relevant crop
Trifolium	106	61	13	Clover
Lathyrus	64	19	22	Bitter vetch
Vicia	62	38	11	Vetch
Onobrychis	55	18	33	Sainfoin
Medicago	51	25	8	Alfalfa
Trigonella	32	2	10	Fenugreek
Lupinus	6	4	1	Lupin

Source: Güner et al., 2012

Table 11. Main forage grass genetic resources

Genus	Number of Species	Subspecific taxa	Endemic taxa	Relevant crop
Festuca	43	21	27	Fescue
Bromus	37	17	6	Bromegrass
Poa	30	1	6	Bluegrass
Elymus	21	18	10	Wheatgrass
Phleum	10	6	–	Timothy
Lolium	8	4	–	Ryegrass
Agropyron	2	3	1	Wheatgrass

Source: Güner et al., 2012

(prevention of erosion, hydrologic disturbance, and air pollution) and recreational purposes. Important coniferous and deciduous forest tree species found in Turkey are given in Table 14. Oak (*Quercus*) is the richest in diversity, represented by 39 taxa, followed by pine (*Pinus*). All the trees listed here, except for eucalyptus, are native.

Table 12. Main medicinal and aromatic plant genetic resources

Genus	Number of Species	Subspecific taxa	Endemic taxa	Relevant crop
Salvia	99	14	57	Sage
Hypericum	96	20	47	St. John's wort
Sideritis	45	15	40	Mountain tea
Thymus	40	6	18	Thyme
Origanum	27	5	15	Oregano
Mentha	10	5	–	Mint
Digitalis	8	2	3	Fox glove
Lavandula	3	3	–	Lavender
Thymbra	3	4	1	Mediterranean thyme
Melissa	1	2	–	Lemon balm

Source: Güner et al., 2012

Table 13. Main industrial plant genetic resources

Genus	Number of Species	Subspecific taxa	Endemic taxa	Relevant crop
Linum	42	2	26	Flax
Papaver	36	20	15	Poppy
Pimpinella	25	10	6	Anise
Beta	9	5	1	Beet
Carthamus	7	3	–	Safflower

Source: Güner et al., 2012

Table 14. Main forest trees

	Genus	Number of Species	Subspecific taxa	Endemic taxa	Common name
Coniferous	*Pinus*	7	12	2	Pine
	Juniperus	7	9	2	Juniper
	Abies	3	4	3	Fir
	Picea	2	1	–	Spruce
	Cedrus	1	–	–	Cedar
	Cupressus	1	–		Cypress
Deciduous	*Quercus*	24	15	5	Oak
	Populus	8	4	–	Poplar
	Tilia	4	3	–	Lime
	Betula	4	–	1	Birch
	Alnus	2	6	–	Alder
	Carpinus	2	1	–	Hornbeam
	Fagus	2	–	–	Beech
	Eucalyptus	2	1	–	Eucalyptus

Source: Güner et al., 2012

Gene management zones (GMZs)

A GMZ is defined as "an area containing populations, and long- term monitoring sites with the aim of in situ conservation of target taxa." The context of GMZs was developed through the "*In situ* Conservation of Genetic Diversity Project" which was funded by Global Environment Facility (GEF) and implemented between 1993-1998 in Ceylanpınar State Farm, Kaz Mountain and Central Taurus Mountains. The aim of the project was to establish several *in situ* protection areas for the wild relatives of wheat (*Aegilops speltoides* var. *speltoides, Ae. speltoides* var. *ligustica, Ae. tauschii, Triticum boeoticum* and *T. dicoccoides*) and several tree species such as wild plums (*Prunus divericata*), chestnuts (*Castanea sativa*), red pine (*Pinus brutia*), black pine (*Pinus nigra*), and Kazdağı fir (*Abies equitrojani*). As a result of the study, six sites for wheat wild relatives were established at the Ceylanpınar State Farm and five sites for chestnut and four sites for wild plums were established in Kaz Mountain.

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Genetic Diversity of Cereals

Chapter III


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Wheat

The most-planted cereal specie for Turkey is wheat, of which Turkey provided about 2.3% of the world's overall production in 2016. Wheat is the main staple crop and an indispensable part of Turkish life. Wheat accounts for 67% of all area under cereal crops, by far the largest share. About 21.5 tonnes of wheat were produced on 7.67 million ha in 2017. Besides its significant economic importance, wheat has social and cultural as well as historical value. The history of wheat in Turkey dates back to at least 10 000 years ago, when it first entered the life of human beings. Wheat has been a driving force for formation and development of cultures: it represents fertility, it is sacred, and it is something that should not be dropped on the ground and wasted.

Today, in Turkey three out of every four farmers grow wheat. The most important value connected with wheat is bread which has an important place in Turkish people's food consumption. Wheat produced with local varieties have different tastes and several production methods are used in the many Anatolian cultures. Among bread types, the *somun* is contemporarily the most common but *bazlama, tandoori, saç, fetir,* and *top* are also popular in different regions. Potato, chickpea, and other ingredients can also be added to breads depending on the customs of specific regions. Anatolian wheat culture is not limited to bread alone, but also includes *yufka, kadayıf, bulgur, erişte, kuskus, makarna,* and *keşkek* as popular products.

According to Turks, bread symbolizes human existence and the "human battle with life" as expressed by the proverb "battle for bread" (*ekmek kavgası*). The man/woman of the house earns bread for his/her family. This is always hard because they have to "obtain their bread from stones" (*ekmeğini taştan çıkarmak*), as the common Turkish proverb says. Sometimes it is difficult to "earn the bread" (*ekmeğini kazanmak*), because "the bread is in the mouth of the lion" (*ekmek aslanın ağzında*), as described in other common Turkish proverb. In Turkish culture, when a child gets its first tooth, it is an occasion of joy and excitement especially for mothers. A dish made of boiled, hard wheat plays an important role in this event.

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Figure 20. Local bread oven (*tandır*)

Both the meal and the ceremony are commonly named the same: *"diş buğdayı"* or *"diş hediği"* (tooth wheat). *Hedik* refers to the traditionally cooked wheat dish eaten on this specific occasion.

Boiled and pounded hard (durum) wheat, called *bulgur* in Turkish, is another common name for this traditional meal.

Bulgur plays an important role in Turkish cuisine. It has a high nutritional value and it is also considered an ideal grain for a vegetarian diet. A popular soup, the traditional Anatolian winter soup *tarhana* or sourdough soup, although varying from one region to another in Turkey, usually consists of a combination of cracked wheat (or flour), yogurt, and vegetables. The bulgur or flour is kneaded, proofed, and fermented, and then it is dried and ground into a "meal". Portions of the meal are rehydrated by adding water or milk, vegetables, and spices and boiled for serving as a soup.

Turkey is known as one of the centers of origin and genetic diversity for wild wheat, and species related to wheat. These species are of great importance for the adaptation, spread, and evolution of wheat, particularly for the genetic improvement of bread wheat. Archaeological studies show that the Fertile Crescent, which includes southeastern Turkey, is the motherland of wheat.

Many remains relating to wheat have been found in excavations. For example, wheat silos of 4 200 to 5 900 tonnes dating from the XIII century BCE have been found in Hattuşa near Çorum, the capital of the Hittites who established the first empire in Anatolia. İvriz Rock relief near Konya by the Hittites also shows the social and religious importance of wheat. The wheat silos and remains of wheat found near the temple and palaces of Urartu in Patnos, a district of Van, dating from 800 to 700 BCE, indicate that similar traditions have gone on for thousands of years.

Wheat has kept its importance throughout the civilizations of Anatolia (Table 15). Turkey hosts a great variety of wild and cultivated wheat species. In terms of the

Table 15. Plant remains found in excavations

Date (BCE)	Site	Plant remains
7500	Aşıklı Höyük	Einkorn, emmer, hard wheat, barley, lentil, bitter vetch, pea, chick pea
7200 to 6500	Çayönü	Wild einkorn, emmer, and barley, cultivated einkorn and emmer, pea, lentil, vetch, lint
6750	Hacılar	Wild einkorn, cultivated emmer
6500	Can Hasan	Wild einkorn, cultivated einkorn, wheat, barley (2-rowed), lentil, vetch
6000 to 5000	Çatal Höyük	Cultivated einkorn, emmer, wheat, barley (naked), pea, vetch
6000 to 5000	Erbaba	Cultivated einkorn, emmer, wheat, barley (2-rowed and naked), pea, lentil, vetch

Source: MFAL, 2017

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Figure 21. Collaborating for the common prosperity

number of wild relatives of wheat, Turkey ranks the first in the world. All the species constituting the primary gene pool of modern wheat are present in the flora.

Wild and cultivated wheat and close wild ancestors and relatives, classified in two genera (*Aegilops* and *Triticum*) and three ploidy levels (diploid, tetraploid, and hexaploid), are represented in Turkey (Table 16).

Modern varieties of wheat as the outputs of the "Green Revolution" were introduced to Turkey through the semi-dwarf wheat from Mexico in the 1960's.

The modernization of agriculture in Turkey and the intensified use of inputs and modern varieties allowed significant increases in grain production. Because of this, however, production of local wheat varieties and landraces either decreased or were abandoned entirely.

Table 16. Genetic resources of wheat in Turkey

Ploidy	Taxon
Diploid (2n = 14)	*Aegilops caudata, Ae. comosa* ssp. *comosa* and ssp. *heldreichii*
	Ae. speltoides var. *ligustica and var. speltoides, Ae. tauschii*
	Ae. umbellulata, Ae. uniaristata
	Triticum baeoticum, T. monococcum
	T. urartu
Tetraploid (2n = 28)	*Ae. biuncialis, Ae. columnaris*
	Ae. cylindrica, Ae. geniculata
	Ae. kotschyi, Ae. neglecta
	Ae. peregrina, Ae. triuncialis ssp. *persica,* and ssp. *triuncialis*
	Ae. crassa
	T. carthlicum, T. dicoccoides
	T. dicoccon, T. durum, T. polonicum
	T. timopheevii, T. turgidum
Hexaploid (2n = 42)	*Ae. juvenalis, Ae. neglecta*
	Ae. vavilovii
	T. aestivum

Source: E. Cabi, 2010

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Figure 22. *T. baeoticum* (2n=14) (left), *T. dicoccoides* (2n=28) (middle), *T. aestivum* (2n=42) (right)

Barley

Barley is the second most important cereal of Turkey, mainly grown for animal feed. In 2017, 2.42 million ha were cultivated with barley, production was 7.1 million tonnes, and yield was 2.93 tonnes/ha, almost equal to the world average. Around 160 000 tonnes of the production is used in the malting industry. Domestication of barley took place 7 000 years ago in the Fertile Crescent. Among the wild relatives, *Hordeum spontaneum* is the progenitor of cultivated barley and is still widely used in barley breeding. There are nine species and four subspecies of barley in Turkey (Table 17).

Table 17. Genetic resources of barley in Turkey

Taxon
Hordeum bogdanii, H. brevisubulatum ssp. *violaceum, H. bulbosum, H. distichon, H. geniculatum, H. marinum, H. murinum* ssp. *murinum*, ssp. *glaucum*, ssp. *leporinum, H. spontaneum, H. vulgare*

Source: Güner *et al.*, 2012

Rye

Rye is the cereal best suited to poor soil conditions. It is generally produced for animal feeding, but in recent years rye bread consumption is increasing.

Cultivation area was 101 092 ha, production was 320 000 tonnes, and yield was 3.17 tonnes/ha in 2017. In addition to *Secale cereale*, Turkey hosts five other related taxa (Table 18).

Table 18. Genetic resources of rye in Turkey

Taxon
Secale anatolicum, S. cereale var. *cereale*, var. *ancestrale, S. ciliatoglume, S. leptorhachis, S. montanum, S. segetale* ssp. *segetale, S. sylvestre, S. vavilovii*

Source: Güner *et al.*, 2012

Oat

Oat is the fourth-ranked cereal crop with almost 112 880 ha of production area, 250 000 tonnes of production and 2.21 tonnes/ha of yield in 2017. In addition to *Avena sativa*, Turkey hosts seven other related species (Table 19).

Table 19. Genetic resources of oat in Turkey

Taxon
Avena barbata ssp. *barbata*, ssp. *atherantha, A. byzantina, A. clauda, A. eriantha, A. fatua* var. *fatua*, var. *glabrata, A. sativa, A. sterilis* ssp. *sterilis*, ssp. *ludoviciana, A. wiestii*

Source: Güner *et al.*, 2012

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Figure 23. Variation in barley

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Figure 24. Awnless barley

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Figure 25. Rye cultivation

©N. Sarı

Figure 26. Oat

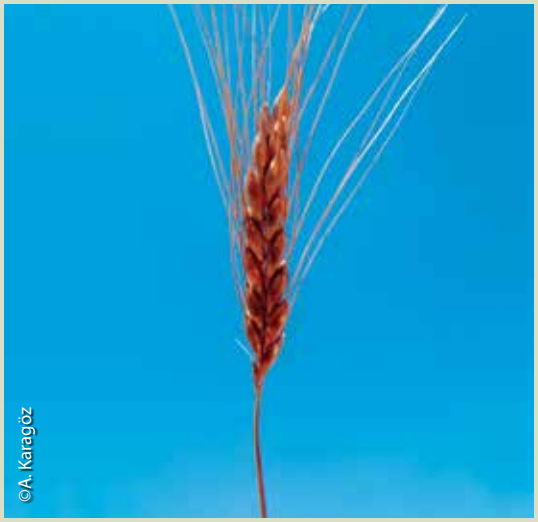


Figure 27. *T. dicoccon*

Figure 28. *T. monococcum*

Hulled wheat

Wheat, in general, no matter the ploidy level, can be divided into two types: hulled wheat and free-threshing wheat. Hulled wheat differs from free-threshing wheat with its persistent enclosing hull, which does not separate from the kernel with ordinary threshing. Two hulled wheats, einkorn (*Triticum monococcum* var. *monococum*) and emmer (*T. dicoccon*), have a thousand-year history of cultivation in Anatolia, as charred grain of emmer in archaeological excavations testify, and they are still cultivated in some parts of Turkey, on sloping and marginal lands by poor farmers, where no other crops can be economically grown.

This group of wheats are known in Turkish as *kaplıca* which means covered or hulled. More specifically, the diploid hulled wheat (einkorn) is called *siyez* (and is typically cultivated in Kastamonu Province for bulgur production) and the tetraploid one (emmer) is called *gernik* (in the north) and *kavılca* (around Kars Province). Siyez is not suitable for bread making because the grains are too coarse to be milled into flour. The grains are first immersed in water, then completely dried and ground on a stone mill by traditional techniques. In some areas, it is also used as animal feed. The area on which these species are cultivated is rapidly declining. It was around 140 000 ha in 1964, but dropped to 3 076 ha in 2017 with a total production of 4 459 tonnes. If such a trend continues, hulled wheat may disappear from Turkey.

Recently local governments and nongovernmental organizations (NGOs) are working towards the recovery of these species. A local NGO in Kars Province promotes cultivation of emmer wheat. In the meantime, Ihsangazi Municipality of Kastamonu Province together with a local NGO are undertaking activities for promotion and dissemination of einkorn bulgur.

Figure 29. *T. dicoccon* in the field

Wheat landraces

The diversity of wheat (*Triticum* spp.) in Turkey is large, in terms of the wild related species, landraces, and botanical varieties. Farmers have identified, selected, multiplied, and preserved landraces and botanical varieties for millennia. It is commonly agreed that wheat has originated in the Fertile Crescent.

Wild relatives of wheat are widespread in Turkey, especially in the southeastern part of country. Diploid wheat (einkorn) was first cultivated in the Karacadağ Region of southeastern Turkey, and from there dispersed to the other parts of the world. The genera *Triticum* and *Aegilops* have several species (Table 16) that are considered to be ancestors or wild relatives of wheat.

Several cultures and farming societies have successively occupied Anatolia (Asia Minor) since the prehistoric beginnings of agriculture until today. For over 500 generations, farmers have inherited and passed on diverse genetic resources of crops. They gradually improved their material by selecting for several desirable characteristics such as bigger or bigger and better tasting grains, uniform germination, non-shattering, non-lodging, uniform ripening, and fast growing. Natural selection due to year-to-year variation in climatic and changing environmental conditions also contributed to the shaping of this diversity producing types that are better adapted to the conditions under which they were grown. Such human-influenced, naturally adapted crops are termed landraces.

For wheat, a landrace is normally a heterogenic population consisting of homogeneous genotypes. The individual genotypes of a landrace are homogeneous because wheat is self-pollinating, and every type typically reproduces itself.

Figure 30. Diversity in a wheat landrace

Figure 31. Bread wheat

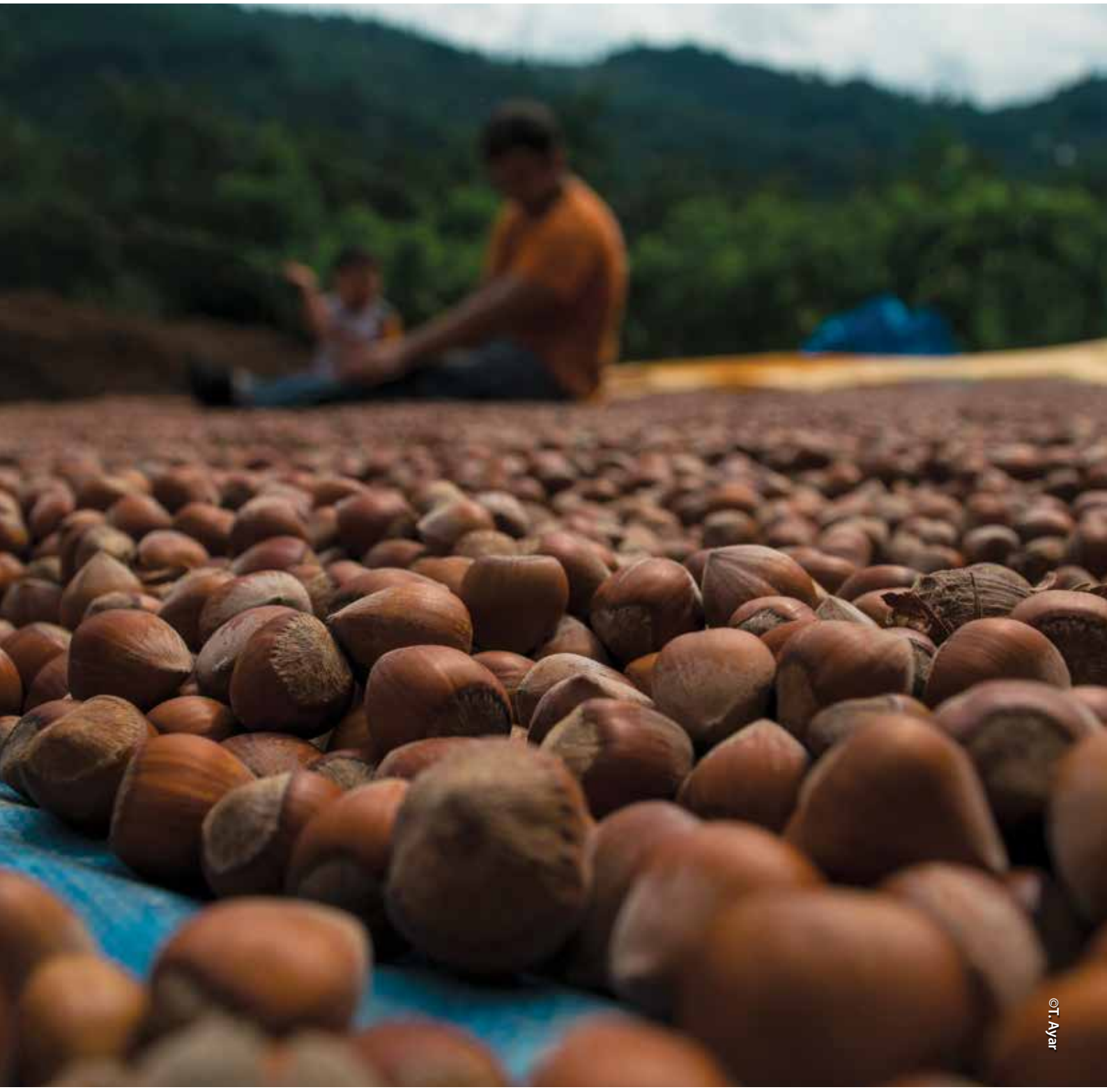
The landrace population is heterogenic because it is typically comprised of multiple genotypes, all sown and harvested together. It was estimated that in the early XX century, a wheat landrace was comprised of 3.7 different genotypes, based on observable morphology (morphotypes).

A landrace is typically identifiable and usually has a local name. It is not the product of 'formal' crop improvement and is characterized by a specific adaptation to the environmental conditions of the area of cultivation (e.g. tolerant to the biotic and abiotic stresses of that area) and is closely associated with the uses, knowledge, habits, dialects, and celebrations of the people who saved and continue to grow it. Landraces continually undergo adaptation processes for however long they are grown and thus they may possess valuable genetic variation for biotic and abiotic stresses waiting to be discovered.

Turkish farmers cultivated their landraces widely until the second half of XX century.
With the introduction of mechanization, agricultural research, use of fertilizers and chemicals, new varieties began to replace the landraces and the heritage of landraces began diminishing. For example, today the estimate of genotype diversity in a landrace has dropped to a few morphological types per landrace. However, farmers continue to produce wheat landraces in specific niches for several reasons, including grain yield, straw yield, disease resistance, cold tolerance, drought tolerance, and grain quality. It is estimated that wheat and barley landraces are grown on an area exceeding 0.55 million ha today in Turkey. According to a study conducted between 2009 and 2014, and several other previous studies, landrace farmers are found mostly in remote mountainous subsistence communities with very little grain trade where small areas are planted to wheat with relatively simple production technologies.

After thousands of years of cultivating them, farmers embraced their local varieties and landraces by giving them hundreds of different names in different regions. Based on a survey published in 1939, farmers named the wheat landraces based on several attributes such as grain color (26.9%), optimum planting time (18.5%), origin (7.7%), spike characteristics (5.6%), grain characteristics (3.0%), and various other aspects such as plant height, earliness, human names, or names of persons providing the seed of the landrace. Of the given landrace names, 20.1% did not refer to any specific characteristic. Only 0.2% of the landraces were unnamed.

Diversity of Fruits, Vegetables and Grapes



Chapter IV

The long history of agriculture and diverse ecosystems in Turkey provided adaptation of fruit species to specific regions. About 75 fruit species, including 16 subtropical and 59 temperate zone fruit species and 60 vegetable species are commercially grown. The number is increasing with the cultivation of wild species, such as St. Benedict's thistle (*Cnicus benedictus*), chicory (*Cichorium intybus*) or jujube (*Ziziphus jujuba*) or relatively recent introduction of non-native species like feijoa (*Acca sellowiana*), avocado (*Persea americana*) or pecan nut (*Carya illinoinensis*). High level of adaptation to a specific agroecosystem help to grow these species with low inputs mostly under rain-fed conditions. Typical examples are pistachio nut, hazelnut, figs and grapes.

Hazelnut production region is the northern Black Sea with high levels of precipitation. Pistachio production is concentrated at the southeastern Anatolia, in Gaziantep, Şanlıurfa and Siirt Provinces where summer is very hot and dry and winter is cold. Fig trees are grown for commercial sun-drying of fruit in Aydın and İzmir Provinces for centuries. Seedless grapes utilized as dried is concentrated in Gediz valley where Mediterranean climate prevails.

In terms of export value, top ten fresh fruit and vegetables exported from Turkey, in the decreasing order are mandarins, lemon, tomatoes, grapes, cherries (sour and sweet), orange, pepper, pomegranate, peaches and grapefruit.

Turkey produces nearly 75% of the world hazelnut production and supplies 70-75% of the trade. Hazelnut is known to be produced for 2 300 years in northern Anatolia and exported from Turkey during the last six centuries.

In 2016/17 season, 235.8 thousand tonnes of hazelnut was exported at a value of USD 1.8 billion.

Sun-dried fruit comprise a significant share among Turkish exports. In 2016 the share was 441.8 thousand tonnes worth USD 1.3 billion. Dried grapes, apricots and figs make up the bulk and contribute to the export value by 74%. Additionally, dried apple, dried plums, pine nuts, apricot kernels, pistachio nuts, almond and walnuts are also exported.

Fruits

Nuts

Hazelnut (*Corylus avellana* L., *C. colurna* L., *C. maxima* Mill. and hybrids). In Turkey, there are two major areas where hazelnuts are grown: the eastern and the mid-western Black Sea Regions. Traditionally, the eastern Black Sea Region starting from Ordu and Giresun Provinces and continuing along the coast up to the Georgian border accommodate the main hazelnut orchards. These orchards are mostly on slopes and grown as rain-fed. The second and comparatively newer production area is located in the mid-western part of the Black Sea Region and extends westward from Samsun up to Düzce and Kocaeli. Hazelnut is native to Caucasus Region.

Cultivated and wild related species of hazelnut found in Turkey are *Corylus avellana* var. *avellana*, *C. avellana* var. *pontica*, *C. colurna*, and *C. maxima*. The main species of economic importance is *C. avellana* common hazel, but most cultivars in the Black Sea Region are hybrids between *C. avellana* and *C. maxima*. *C. avellana* var. *avellana* is the most cultivated specie. The presence of wild relative and species diversity allowed natural hybridization and selection of better performing types by the farmers for further multiplication. The national hazelnut depository is located at the Hazelnut Research Institute of the MAF.

The hazelnut crop is typically grown within 30 km from the coast to the elevations up to 1 000 masl, but production at elevations above 500 masl is at risk of chill and frost damage. Wild hazelnut species occur in natural forests at different parts of Turkey. Its production is supported by state on slopes as a tool to prevent soil erosion.

The orchard establishment on slopes traditionally relies mostly on close proximity planting of a group of nursery trees together, named as *"ocak"* rather than solitary trees. New orchards especially on low-lands or areas with mild slopes are promoted as single-trunk plantings.

Corylus colurna L., Turkish hazelnut, is a fast growing and attractive species with ornamental value and present in forests. It is a timber species with pinkish-brown hardwood timber of fine quality. The tree is useful in binding soil preventing erosion, the leaves are used to feed cattle, and its nuts are eaten by wild animals. It produces a large attractive nut, consumed locally in the Black Sea Region, but is not under commercial production in Turkey. Harvesting must be done by sustainable methods to reduce threat to the species.

Hazelnut is a good raw material for the food industry. Around 80% is used in the chocolate industry; 10 to 12% in biscuit, pastry, and other bakery products; 3 to 4% is used as snacks, and the rest are used for ice-cream making and oil extraction.

The hazelnut tree itself is multi-functional, providing more than the nuts. The shells after hulling are used as fuel in homes, leaves and fruit remains are used for making compost, and the branches are used for making baskets and fences.

Hazelnut has great socio-economic importance, especially in the Black Sea Region. Due to limitations in land availability and harsh climatic conditions, this region has a long history of domestic migration towards western part of Turkey. Even so, many families kept their hazelnut orchards since it can be managed as low-input crop.

Thus, it still is an additional source of income for most families. Harvest is the period during which every member of the family come back to their hometowns and contribute and enjoy the harvest and drying of hazelnuts.

Pistachio (*Pistacia*). Pistachio is one of the most valuable nuts. Turkey hosts seven species and wild relatives of the nut as *Pistacia atlantica, P. eurycarpa, P. khinjuk, P. lentiscus, P. palaestina, P. terebinthus, P. vera,* and *P. x saportae.*

Among them, the female trees of *P. vera* yields the edible pistachio nuts of great commercial importance. Some of the wild species such as *P. terebinthus, P. khinjuk,* and *P. atlantica* have economic importance as rootstock for cultivated pistachio.

Wild *Pistacia* trees are known to be present, and nuts consumed in southeastern Anatolia for more than ten thousand years. Excavations in Körtik tepe (Diyarbakır) and Göbekli tepe (Şanlıurfa), where work started relatively new in 2000 and 1995 respectively, put forth remains of wild pistachio and almond nuts. Both sites are located at the northern top of the `Fertile Crescent`.The nut remains found in Körtik tepe until now belong to the pre-pottery Neolithic period (12 400-11 700 years ago) and those found in the third layer in Göbeklitepe date back to 10 500 years ago. Both the drawings and the remains present in these two archeological sites reveal a different ecosystem than today. Southeastern Anatolia, the major pistachio nut growing area, today provides a suitable climate for pistachio trees or shrubs despite the very low annual precipitation (300 to 400 mm), poor soils, very hot summers, and rather cold winters.

In Turkey, there are over 59 million trees belonging to the *Pistacia* genus with a wide range of diversity and local uses in addition to their role in the natural or agroecosystems. In the Aegean, Marmara, Mediterranean, and Central Anatolia Regions, *P. atlantica* often occurs as a relic of destroyed forests but is sometimes planted as a shade tree. Its seeds are used for tanning and for soap making, and resin is applied as an antiseptic to wounds. Seeds are roasted, ground, and placed in metal coffee pot filled with water, and boiled just like Turkish coffee. *P. khinjuk* and

P. eurycarpa are found near the Iraqi and Iranian borders in Southeastern Anatolia. Oil extracted from *Pistacia khinjuk* is used for treatment of hair loss and soap making. *Pistacia lentiscus* var. *chia* L. is distributed in the Mediterranean, it is native to northern Africa, southern Europe and western Asia. Turkey is within its native distribution range.

Pistacia lentiscus L. (mastic tree) is native to Mediterranean Region and is cultivated for its resin to be used as a flavoring agent in culinary and distillery especially in the areas where locally present. In ancient times, the resin was used as a natural gum due to its healing properties but now its synthetic formulations are used in gums. In Turkey, mastic tree occurs in a small area in the western Çeşme Peninsula of İzmir Province, where it is under protection.

The studies on its multiplication give way to its planting however, its slow growth hinders establishment of commercial orchards.

Among all *Pistacia* species found in Turkey, *P. vera* has the highest commercial importance and is the most widely grown especially in southeastern provinces of Gaziantep, Şanlıurfa and Siirt. Gaziantep Province leads in pistachio production, as single-crop plantations and/or also in mixed plantations with olive and grape. Şanlıurfa Province also has large pistachio plantations and the acreage is increasing. Most of the traditional Turkish pistachio cultivars have a good ratio of split and have green smaller kernels with higher oil content and rich aroma. These types are utilized mainly in the food industry in chocolate and in sweets with heavy syrups like *"baklava"* or *"kadayıf"*. Turkish *baklava* (pakhlava) made with pistachio is a globally well-known sweet pastry.

Almond (*Amygdalus communis* L.). There are 24 species within *Amygdalus* genus, all of which are deciduous shrubs or small trees, existing in temperate forests of Asia and Europe.

***Pistacia* Tree**

©E. Bağcı

Figure 32. Almond tree

Amygdalus species are found primarily in the Old World, mainly in southwestern and central Asia, majority being in Iran and Turkey. Anatolia is considered as secondary center of almond. Several taxa are endemic to Turkey (Table 20). It grows throughout Anatolia except the northeast region, where annual rainfall exceeds 2000 mm, and the high elevations of the eastern Anatolia, where it is extremely cold. Almond was multiplied by seedlings growing from seeds for millennia, therefore a tremendous diversity developed until commercial varieties have been planted on large scale. Almond trees differ widely in respect to vigor, yield, nut and kernel quality, and flowering time.

Almonds have many traditional uses. Fresh and soft fruits are harvested and marketed as the earliest fruit in early spring and is consumed mostly with slight addition of salt. Almond kernels are sold in summer nights by vendors along the roadways in the city center as an appetizer after removing the skin and cooling on ice in the Aegean Region. Almond cookies are prepared with bitter almond. *"Keşkül"* a typical Turkish pudding is prepared with almond. Almond oil is used as a scent and a smoothing agent for skin and as a base in cosmetics. The green fleshy exocarp and mesocarp is utilized as animal feed locally.

Table 20. Genetic resources of almond in Turkey

Taxon
Amygdalus balansae (endemic), *A. carduchorum, A. carduchorum* subsp. *serrata* (endemic), *A. communis, A. fenzliana, A. graeca, A. korshinskyi, A. kotschyi, A. lycioides, A. lycioides* var. *lycioides, A. orientalis, A. trichamygdalus, A. trichamygdalus* var. *elongata* (endemic), *A. trichamygdalus* var. *trichamygdalus, A. webbii, A. zielinskii* (endemic).

Source: Güner *et al.*, 2012

Walnut (*Juglans regia*). Walnut is considered a heritage tree with a long juvenile period and long-life productivity passing from generation to generation. Walnut is native to a wide geography that includes Near East and Turkey. Being well adapted to several ecosystems, it is distributed all over Turkey. Wild trees are found in mixed deciduous and coniferous forests.

Walnut is a fruit species grown for its nuts that gained popularity due to their health properties. Turkey is among the major walnut producing countries. State supports walnut production, therefore the area planted with grafted varieties, having the quality demanded by the market is continuously enlarging.

Walnut is mainly used in the confectionery industry, for Turkish sweets served in heavy syrup as *"baklava"* and *"kadayıf"*, and as an ingredient in food industry as in bakeries for bread, walnut bars, and walnut cookies. Oil extracted from walnuts is used in the pharmaceutical and cosmetic industries. The hard shell used as a fuel.

Furniture made of walnut timber is valued and expensive. Its leaves and green shells produce a pigment used in mixtures of hair dyes locally

Chestnut (*Castanea sativa*). Chestnut trees occur naturally throughout the eastern Black Sea, Marmara, Aegean and Mediterranean Regions in the natural forest ecosystems. Due to diseases, Bursa province of Marmara Region, which once known as the capital of

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Figure 33. Walnut

©M. Türkeş

Figure 34. Chestnut

chestnut production, lost its significance. During the last few decades, Aydın Province leads in commercial chestnut production. Being a native forest species, chestnuts were harvested, consumed and marketed from the available populations in natural ecosystems. Evaluation of the genetic resources resulted in registration of types that had higher nut quality. Within the Turkish chestnut genetic resources, nuts vary in size and their composition and processing performance differs. During the last few decades, the chestnut varieties having large sized nuts that can be easily blanched, are being grafted onto the seedlings in their natural habitats or are planted in barren areas with suitable soil (low soil pH) and climatic conditions.

Chestnuts are accepted as a winter delicacy in Turkey and sold in the streets as roasted. They are consumed at homes during family gatherings as roasted or boiled, traditionally mentioned with stoves for roasting in cold winter nights. Candied chestnuts were known as a specialty of Bursa Province for decades. Nowadays, as its production became commercially important, the processing industry also developed in İzmir and Aydın Provinces. It is also processed to make chestnut flour (starch) that is used as a thickener. Its flowers are important pollen source for honey production. It is a valuable forest specie with precious wood quality and trees are planted as an ornamental plant in urban amenity gardens.

Pome fruits

Apple (*Malus*). Apple is one of the most produced and traded temperate fruits. Turkey lies in the West Asia and Europe origin center and are known to have substantial diversity. Most of the world's commercially produced apple cultivars belong to *Malus domestica*. Apples have been grown in Turkey since as early as 6500 BCE and its domestication began from a large and rich gene pool. The accessions are maintained in the germplasm plots of the research institutes in Turkey for further breeding programs.

Other apple species found in Turkey are: *M. pumila, M. sylvestris, M. sylvestris* ssp. *orientalis*, *M. sylvestris* ssp. *orientalis* var. *microphylla* (endemic), *M. sylvestris* ssp. *orientalis* var. *orientalis,* and *M. sylvestris* ssp. *sylvestris. Malus sylvestris* and *M. sylvestris* ssp. *orientalis* are widespread in forests, mixed scrub, streamside rocky slopes, and field edges at different elevations. In general, the fruits of these species tend to be small, rough, and very sour tasting, so they are generally not used for fresh consumption but processed by drying, as concentrate for juice and beverages, or as jam.

Turkey is one of the most important apple producers in the world with production not merely confined to the temperate agricultural zones, but also extending to the higher

subtropical plains along the Mediterranean and Aegean Sea coastlines. There are over 600 local apple cultivars in Turkey with a huge variability in size, shape, color, aroma, ripening period, tree vigor, and disease and pest resistance.

The uses of the different cultivars depend on their properties. Cultivar Amasya is a very important Turkish variety not only because it has good taste and aroma, but also because it can be successfully stored for long periods. Apple is mostly consumed in the country either as fresh or as processed. Apple export ranked seventh among fruits in 2015.

Pear (*Pyrus*). Pear is the second most important pome fruit in Turkey after apple. Turkey hosts many pear genetic resource taxa, some of which are endemic namely *P. anatolica, P. serikensis,* and *P. yaltirikii* (Table 21). *Pyrus serikensis* is found in a very small area near the town of Serik in Antalya Province of the Mediterranean Region. There is a conservation program planned for this species. *Pyrus yaltirikii* is in the western part of the Eastern Anatolia Region.

Pyrus anatolica is a nationwide remnant of the oak forests in western Turkey. There are about 500 local pear cultivars with great diversity in fruit size, shape, color, and texture and some have resistance to fire blight.

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Figure 35. Pear

Table 21. Genetic resources of pear in Turkey

Taxon
Pyrus amygdaliformis var. amygdaliformis, P. amygdaliformis var. *lanceolatus, P. anatolica* (*endemic*), *P. communis* ssp. *communis, P. communis* ssp. *caucasica, P. communis* ssp. *sativa, P. elaeagnifolia* ssp. *bulgarica, P. elaeagnifolia* ssp. *elaeagnifolia, P. elaeagnifolia* ssp. *kotschyana, P. hakkarica* (*endemic*), *P. nivalis, P. oxyprion, P. salicifolia* var. *salicifolia, P. salicifolia* var. *serrulata, P. serikensis* (*endemic*), *P. syriaca* var. *syriaca, P. syriaca var. microphylla, P. yaltirikii.*

Source: Güner *et al.*, 2012

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Hawthorn (*Crataegus*). Turkey is rich in genetic diversity of *Crataegus* species, which, in general, exist in the understories of open woodlands, in open pastures, or the edges of hedgerows. Turkey hosts 23 hawthorn taxa, 10 of which are endemic. It covers overgrazed pastures and abandoned farm fields. Many of its species are used as ornamentals.

Fruits are usually eaten fresh and have been used as a folk medicine since ancient times. It is a rich source of flavonoids. Fruits ripen in late summer and are highly attractive to wildlife, which consume the fruit and disperse the seeds. Hawthorns of arid regions are suitable as frost-resistant rootstocks for pear and quince.

Quince (*Cydonia*). Quince has an important place in Turkish culture and tradition. Trees are found in forests and as wild shrubs at elevations ranging from 10 to 1 000 masl. Quince blossom time is recognized as the beginning of summer season and is mentioned in folk songs. The main species, *C. oblanga,* is widely grown in Turkey, especially in western Anatolia, for its edible fruits. Quince orchards are established with grafted varieties suitable for fresh consumption. The fruit is consumed as a pome fruit, can be cold-stored and consumed throughout the winter. Some quince cultivars are used as table fruits whereas some others that are not directly edible are used for jam and marmalade. *Eşme* and *Ekmek* are the two important cultivars for fresh consumption because of their soft and fine texture. Quince is also used in juice processing.

Oleaster (*Elaeagnus angustifolia*). The oleaster tree is also known as wild olive and Russian olive. It is native to southern Europe and western Asia. Turkey hosts two varieties of *E. angustifolia* namely var. *angustifolia* and var. *turcica* (endemic) and *E. rhamnoides* (sea buckthorn). Oleaster is the plant of dry, stony, sandy soils with very little organic matter. It is deciduous with leaves remaining green throughout the year. Stands are present even in river banks and sea shores where water table is quite high. Also, oleaster is tolerant to drought, wind and heat. In some places it is used as wind break against erosion. It is a thorny shrub and it can be pruned into fence to protect fields, vegetable gardens and orchards.

Dried fruits are consumed with pleasure in the villages throughout the winter. Its wood and the remaining branches from pruning make excellent fuel.

Medlar (*Mespilus germanica*). Medlar fruits are hard, acidic, and high in bitter tannins when harvested from the tree. They become edible only after softening either by keeping in the storage for a certain period or by some treatments. Softened fruits wrinkle and their color turns to brown. Pickled fresh medlar made with honey is unique to eastern Turkey.

Stone fruits

Stone fruits belong to the *Prunus* genus, which includes more than 400 species of flowering shrubs and trees, some being highly important commercially. More than 2 million ha are planted with *Prunus* crops such as almond, apricot, cherry, plum and peach.

Apricot (*Armeniaca vulgaris,* syn. *Prunus armeniaca*). Apricots are cultivated in Turkey in habitats varying from warm temperate areas to subtropical regions. The major production areas in Anatolia are Malatya, Elazığ, Erzincan, and Erzurum Provinces as well as the Aras Valley of Iğdır Province. Dried apricot is a major source of agricultural income for Malatya and neighboring areas. Dried apricot ranked second in 2016 among exported dried and processed fruits with a value of over USD 289 million.

Additionally, there are several early apricot varieties for fresh consumption in the Aegean and Mediterranean Regions with low chilling requirements. Apricot is consumed as fresh, sun-dried or processed. Turkish apricots are mostly dried as a whole since major drying varieties are free stone, on the other hand fruits are dried as halves in many other apricot producing countries. Pits are removed from the stalk end by squeezing at the initial stage of drying without cutting the fruit into half. Fruit are sun-dried after sulphuring or as natural without any pretreatment. Apricot fruit is used as the raw material for jam, marmalade, and various snacks. The edible seeds, if sweet, are consumed as appetizers or are processed with chocolate as almonds.

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Figure 36. Cherry

Cherry (*Cerasus*). All cherries, sweet, sour and mahaleb cherry belong to the *Cerasus* genus. The total number of cherry taxa is 23, including three, which are endemic to Turkey: *C. erzincanica, C. hippophaeoides,* and *C. incana* var. *velutina.* Some of the species and varieties originated from mountains of the Black Sea Region. The origin of sour cherry is the area between Caspian Sea and north Anatolia mountain ranges. Thus, the Latin name of sour cherry (*Prunus cerasus* L.) derives from the old name of the city *"Kerasus"* in the Black Sea Region of Turkey which is today known as Giresun. Kütahya Province is traditionally known to possess a rich population for sour

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Figure 37. *Cerasus mahaleb*

cherry. Studies performed on sour cherry populations in the Aegean Region and in Gaziantep have revealed a rich variation among sour cherry types in terms of fruit size, color, taste, shape (mostly round, and more rarely oblate, heart and kidney shaped), juice color and yield, fruit/pit ratio, aroma, total soluble solids and total yield.

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Wild or sweet cherry (*Cerasus avium*) grow in most parts of Turkey. In the Black Sea Region, wild cherry is found along the forest sides or more rarely found in mixed forests as individual trees or small groups. They are mostly located under low elevations and can be found up to 1 700 masl. The mahaleb cherry or St Lucie cherry (*Cerasus mahaleb*) is wide-spread in Turkey, though scarce near the coasts. This species is used as a rootstock, both for sweet and sour cherry cultivars especially for their drought and high soil pH resistance and semi-dwarf growing habit.

Cherry production and export are important enterprises in the western Aegean Region due to early ripening. As the market demand increased cherry harvest and marketing period extended further eastward with newly established orchards first to Isparta, then at the higher elevations of the Taurus mountains and east Anatolia. Cherries have various uses and rich genetic variation supports these diversified uses. Sweet and sour cherry fruit are consumed as fresh or used in processing industry. Sour cherry fruits are dried mainly after removing the pit or fresh fruit are processed as jam or juice. Sweet cherry varieties with white or light pink color are sulphured and put in a brine solution for the confectionary industry.

They are rarely dried. The seeds of *C. mahaleb* are used in food industry as a spice due to its peculiar fragrant smell and taste comparable to bitter almonds with cherry notes. The bark, wood, and seeds contain coumarin and have anti-inflammatory, sedative and vasodilation effects. Mahaleb liqueur is also prepared locally.

Plum (*Prunus*). Anatolia is one of the centers of genetic diversity for *P. cerasifera, P. insititia, P. spinosa,* and *P. domestica. Prunus spinosa* is found as widely dispersed in northern, western, and southern Anatolia is the center of origin where natural hybrids originated between *P. ceracifera* and *P. spinosa,* and their hybrids were disseminated further as progenitors of *P. domestica* in Europe. The Caucasus mountains near the Caspian Sea extending towards the Black Sea is reported as the origin for *P. domestica* and its ancestors.

Due to the closeness to the genetic centers, six taxa are found in Turkey as *P. cocomilia, P. divaricata, P. divaricata* var. *divaricata, P. divaricata* var. *pissardi*, *P. spinosa*, and *P. domestica* (common plum). Wild *P. divaricata* trees distributed at Kazdağı (northwest Aegean Region) were identified and later the population was evaluated in an *in situ* conservation project.

Dogwood (*Cornus*). The Cornelian cherry, *Cornus mas,* occur as shrubs or small trees in northeastern Anatolia. Six other dogwood taxa are found in Turkey as *C. sanguinea, C. sanguinea* ssp. *australis, C. sanguinea* ssp. *cilicica, C. sanguinea* ssp. *sanguinea,* and *C. sanguinea* ssp. x *czerniaewii.* Fruits are used fresh and for making jams, jellies, fruit candies, soft drinks, and as a medicine against constipation.

Small fruits

Strawberry (*Fragaria*). Both F*ragaria vesca* and *F. x ananassa* have been grown in Turkey since the XVI century. Almost all of production comes from small family farms. The wild strawberry (*F. vesca*) is the most extensively distributed specie of the genus. It occurs worldwide in temperate and subtropical regions and in highlands of the tropics.

In Turkey it is especially found in forest areas of northwestern, northern, southern, and eastern Anatolia. *Fragaria x ananassa* (the commonly grown strawberry) differs from *F. vesca* by having generally much larger fruits. *Frageria viridis* is found in meadows and in forests in northwestern Anatolia, flowering in both spring and late summer. It is tolerant to acidic soils. Fruits are small, relatively firm, greenish to pink in color, and highly aromatic.

The majority of strawberry growers employ modern intensive cultivation methods such as soilless cultures, raised beds,

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Figure 38. Strawberry production in field

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Figure 39. Strawberry

plastic mulch, and drip irrigation. In the Mediterranean and the Aegean coastal areas, plastic walk-in high tunnels or glasshouses with soilless cultures are used for early production.

Some of the growers include beehives in the plastic tunnels or glass-houses to help fertilization. Bumblebees are used rarely for this purpose. Strawberries are consumed in Turkey as fresh or processed in jams, syrups, liqueurs and cakes. *Osmanlı* and *Ereğli* cultivars are very popular domestic strawberry varieties with aromatic, but small-sized fruit.

Raspberry and blackberry (*Rubus*). While Turkish people have been long familiar with the *Rubus* genus, cultivation of raspberry and blackberry is rather new and still occurs at small scales. In 2016, for raspberry, the total cultivation area was 519 ha, producing 4 312 tonnes, and for blackberry, 314 ha were cultivated, producing 2 468 tonnes. Turkey hosts 16 taxa of *Rubus*. Wild raspberry and blackberry are widespread in the rural landscape all over Turkey.

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Figure 40. Blackberry

Wild species of *R. idaeus* (red and yellow raspberry) are distributed in forests of northeastern Turkey, especially on degraded river banks, meadow margins, and rocky slopes as shrubs with creeping branches.

Mulberry (*Morus*). Mulberry is widespread all over Turkey and as a dried fruit known for centuries. Its fresh and dried fruits gained commercial importance during the last few decades. It is an important source of income for smallholders in eastern and southeastern Turkey. The sweet, white, purple, or red fruits are eaten fresh or preserved dried. Green leaves are feed for silkworms. Of the three species grown in Turkey, white mulberry (*M. alba*) is more common in eastern and central Anatolia and accounts for 95% of Turkey's mulberry production. Mulberry fruits are boiled to obtain a juice concentrate,

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Taditional specialty is prepared by hanging walnuts on a string and then dipping into thick mulberry juice concentrate a couple of times to cover walnuts (*cevizli sucuk*)

which is further spread on sheets to obtain mulberry spreads. Another traditional specialty is prepared by hanging walnuts on a string and then dipping into thick mulberry juice concentrate a couple of times to cover walnuts (*cevizli sucuk*). The sweet, white or red fruits are eaten raw but usually dried. Yellowish-brown heartwood and yellow sapwood are used for making tools and musical instruments.

The black mulberry (*M. nigra*) is widespread in Anatolia and has the sweetest fruits of the three species, but accounts only for 2% of mulberry production. The dark-red fruits are stewed and used to produce beverages and medicinal purposes. The third species, red mulberry (*M. rubra*), is also native to Anatolia and has been cultivated there for many years, accounting for 3% of mulberry production.

Mediterranean fruits

Olive (*Olea*). Olive cultivation originated around 4000 BCE somewhere in Asia Minor, which includes what is today, Turkey. The existence of wild olive forests in southern and southeastern parts of Turkey suggests a role in the original domestication and cultivation of olive. Recent archaeological discoveries are unearthing olive oil mills in various parts of the country dating from the X to the VII century BCE. Olive production has been a major economic activity in Anatolia since then.

Currently 320 000 family farms are involved in olive production. Three provinces of the Aegean Region produce 48% of the national crop (Aydın contribute with 25%, İzmir with 14%, and Muğla with 9%). The Aegean Region is followed by the Marmara Region with two of its provinces providing 13% of the national production (Balıkesir with 8% and Bursa with 5%). Two sub-species of olive occur in Turkey: *Olea europaea* and *O. europea* var. *oleaster*, with some 80 varieties produced commercially.

The cultivated area devoted to olive trees has increased during recent years, with about 174 million olive trees were grown in 2016, on 700 000 ha. These varieties vary significantly in respect to the fruit size, shape, texture, composition, ripening period and olive and oil quality. Some of the varieties are given geographic indication due to their supreme quality under certain geographic conditions.

About 24% of olive production is processed for table olives and 76% is used for oil production. Despite the huge domestic consumption, Turkey is one of the world's important exporters of different kinds of table olives with a value of about USD 117 million.

Pomegranate (*Punica granatum*).
Pomegranate is one of the traditional fruits cultivated for centuries in Turkey which is one of the gene centers of pomegranate diversity. Wild forms are distributed from Anatolia towards other Mediterranean countries. Many different types and forms all contributed as germplasm for the genetic improvement of the crop.

The species is grown in regular orchards sporadically mixed in other fruit trees, and in roadside hedges from the coastal to the mountainous areas. Pomegranate cultivation in Turkey has increased, especially in the Mediterranean, Aegean, and South-eastern Anatolia Regions, because of increasing export possibilities due to increased volumes of *Hicaz* variety and to the crop's reputation as a functional food.

Pomegranate varieties are classified in three groups, sweet, sour (acidic) and semi-sour. This variation enables different uses of pomegranate fruit. Pomegranates are eaten fresh or used for juice extraction. Fruits are processed for canning and making pomegranate juice concentrate (syrup) to be used in salads contributing a sour flavor. Since 1988, Turkish pomegranate production has grown over tenfold due to increasing demand and market opportunities (45 000 tonnes in 1988; 465 200 tonnes in 2016).

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Historical evidence of olive cultivation in Mediterranean Turkey

Figure 41. Olive tree

The origins of olive, its cultivation and domestication, has been a disputed matter. The current view is that a change from wild to cultivated olive populations took place in a large area of the eastern Mediterranean that includes what is now the southern part of Turkey. Several examples of olive cultivation and olive oil extraction can be found on the southern and western Turkish coasts.

The area is bounded by the Kalykadnos (Göksu) and Lamos (Limonlu) rivers and lies between Erdemli and Silifke, districts of Mersin province. It is known that this area was within the territory of Olba, and it's in the eastern part of Rough Cilicia. It has very suitable conditions for viniculture and olive production now. The antiquity of such production is suggested by the considerable number of ancient agricultural

Figure 42. Lever and screw press with perforated press piers at the fulcrum, Karadedeli Akhayat

Figure 43. Tower used as olive press building in Adamkayalar

production facilities that have been identified in Rough Cilicia. Research there has brought to light that olive oil and wine production had a significant place in the region's economy.

Identification of buildings set aside specifically for olive oil production suggests that there was a separate and different organization for it than for wine production. These buildings contain mortar-shaped crushing basins and round-shaped crushing stones, which rotated in these basins, lever and screw presses, press beds as well as collecting barrels and tanks, either portable or cut into the bedrock. It is known that lever and screw presses with perforated press piers at the fulcrum were used for olive oil production.

These were located within the buildings and constitute the main criteria for identifying the buildings as olive oil workshops. The workshops are located at points near the ancient cities on the coastline and on roads leading to settlements in the mountains. The sites of workshops also vary.

In the most ancient settlements in the mountainous terrain at 150 to 500 masl, the workshops are found within the settlements, which contain usually more than one workshop. However, some buildings identified as olive oil workshops stand independent from any settlements. While wine production installations have been identified at higher elevations, olive oil workshops are found, in general closer, to the coastline.

Although there are difficulties in precisely dating the olive oil workshops and production facilities identified in Rough Cilicia, archaeological materials found in and around these workshops help date the last use of the site. The fact that the settlements in the region were extensively used in the Roman period and Late Antiquity (a period between the II and VII centuries CE) could be evidence for dating. This date is supported not only by the architectural features and various symbols, but also by the tombs and altars nearby, suggesting extensive use and constructional activities in the indicated period.

Figure 44. Charred olive drupe remains from Late Chalcolithic Era

Figure 45. Olive harvest

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Figure 46. Drying figs

Fig (*Ficus carica*). Fig is one of the leading export crops of Turkey traditionally. The largest fig populations are located on the shores of the Black Sea, Marmara, Aegean, Mediterranean Regions, and along rivers in Southeastern and Central Anatolia Regions (but also in open areas, in mixed forests, on stony slopes, in river valleys, and in rock fissures). Turkey hosts two subspecies of *Ficus carica* namely: *F. carica* ssp. *carica* and *F. carica* ssp. *rupestris*. Wild figs are found in the valleys of Siirt, Diyarbakır, and Gaziantep Provinces of the Southeastern Anatolia Region, in Elazığ Province of the Eastern Anatolia Region, and on Ahır Mountains of Kahramanmaraş Province in the Mediterranean Region. These regions are also known to have other *Ficus* species with edible fruits. Figs are consumed raw, dried (or partially dried) or deep-frozen. Nearly 65% of the total fig fruits on fresh basis are sun-dried.

Dried figs are marketed as whole, cut, sliced, ground or minced as paste (with or without seeds). Fig fruit can be prepared in various ways for use in pies, puddings, cakes, bread, or ice cream. Whole fruits are preserved in sugar-syrup or prepared as jam.

Citrus. Although citrus plants are not native to Turkey, they are among the top export crops of the agricultural sector. The production of all citrus crops in Turkey has been increasing steadily in the past 20 years. This is mainly due to increasing number of citrus orchards, improvement obtained by better yielding varieties, and increasing extension services for the producers.

As of 2016, oranges accounted for about 43% of citrus production, while tangerines, lemons and grapefruits follow by 31%, 20%, and 6%, respectively.

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The Mediterranean Region accounts for about 90% of all citrus grown in Turkey, and the Aegean Region makes up most of the rest. Tangerine is the major citrus crop grown in the Aegean Region.

High difference between day and night temperatures promote earlier ripening of satsuma mandarin fruits, to allow better export opportunities to the European markets. Bodrum district has a local mandarin variety known with its strong aroma, and geographic indication is given to this mandarin variety.

Tea (*Camellia sinensis*). Tea is the indispensable breakfast beverage of Turkish people, and as a crop, it is one of the most important crops for both for producers and consumers. It is also a species that has been introduced quite late to Turkey. The first attempts to cultivate tea started with introduction of tea saplings in the early XX century with the establishment of the Turkish Republic.

Initially the Black Sea Region was chosen for these introduction trials. The Tea Production Station was established in Rize to set up preliminary adaptation trials.

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Figure 48. Tea plantation at sloping area

Zihni Derin, a civil servant of the Ministry of Agriculture was assigned to conduct them. The first material was introduced from Batumi Province of Georgia, also bordering the Black Sea. Results of preliminary trials indicated that tea plant can perform well under humid and subtropical conditions of the eastern Black Sea Region. The prevailing conditions help tea plants produced without any disease or pest problems. Recently, relatively large area was converted into organic management and organic certified tea is marketed within Turkey and exported. Overall tea production area is 76 207 ha, and fresh tea leaf production is 1.3 million tonnes.

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Figure 47. Tea plant

The total tea export value of Turkish tea is USD 18 million. The tea monopoly was terminated in 1984, and since then the private sector has been involved in production together with the government-run Çaykur Company, which is still the leading tea company in Turkey.

Miscellaneous other fruit species. There are many minor fruit species produced in Turkey such as cane apple (*Arbutus unedo*), blueberry (*Vaccinium myrtillus*), persimmon (*Diospyros kaki*), myrtus (*Myrtus communis*), rose hips (*Rosa canina*), and cactus pear (*Opuntia ficus-barbarica*). Most of these species (except *D. kaki*) are not established as regular orchards, but rather are found as single or few plants around home gardens or farms and are generally harvested from wild. Persimmon has become popular in recent years and regular orchards are being established in southern and western Turkey.

In 2016, the number of persimmon trees reached over 1.1 million and production was 34 650 tonnes. Persimmon fruit are consumed as fresh but recently drying as a whole fruit or as sliced started to be practiced.

Vegetables

Although major solanaceous vegetables such as tomato, pepper, and eggplant are not native and introduced after XV century to Turkey, Turkey can be considered as a secondary center of diversity for them after hundreds of years of intensive cultivation in Anatolia.

Turkey is the fourth largest vegetable producing country in the world and the second country in melon and watermelon production. Tomato takes the first rank for vegetable exports, followed by pepper and cucumber (Table 22).

Protected production systems such as plastic tunnels, low tunnels, high tunnels, and greenhouses are used, especially in the Mediterranean and Aegean Regions, for early production of tomato, cucumber, and watermelon. Soilless culture is widespread in protected cultivation systems. Antalya Province and its Kumluca District are the center of protected cultivation in Turkey and key exporters of tomato, pepper, and eggplant. Adana and Mersin

©T. Özata

Figure 49. Celery harvest

Table 22. Amount and value of Turkey's top exported vegetable crops in 2016 ranked by value and their share (%) in total

Vegetable	Amount, tonnes	%	Value, USD 1 000	%
Tomato	486 028	44.9	239 880	53.2
Pepper	97 312	8.9	90 021	19.9
Squash	59 715	5.5	33 905	7.5
Cucumber	47 812	4.4	28 175	6.3
Potato	191 136	17.6	22 778	5.1
Onion	105 932	9.8	12 547	2.8
Eggplant	21 755	2.0	12 362	2.7
Carrot	73 767	6.8	10 855	2.4
Total	1 083 457	–	450 533	–

Source: MFAL, 2017

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Figure 50. Lettuce harvest in a greenhouse

Provinces in the Mediterranean and the Aegean Region are also very important in out-of-season vegetable growing areas. Enterprises associated with protected cultivation destined for the export market generally have cold-storage and packaging facilities.

In the Aegean Region, most of the vegetable production under protection is realized in two different ways: (1) modern structures mostly soilless where heating is done with geothermal sources since energy cost is comparatively high in Turkey, and (2) simple non-heated plastic structures where two growing periods as autumn and spring are identified.

In case of two-cycle, autumn and spring, vegetable production under protected conditions, there is a gap during the cold winter months. Seedling for the sowing period are grown during these months. Onion, garlic and leek are the three *Allium* species used in Turkish cooking. In Turkey, there are more than 170 *Allium* species and nearly 70 of them are native to Turkey. Onion is grown for its green plants and for the bulbs. Marmara Region is the center for onion production. Tablets dating back to Sumerian period 2600-2100 BCE mention garlic use. Taşköprü is well-known for its garlic and has obtained the geographic indication due to its peculiar quality.

Turkey consumes most of the vegetables produced in the open-field within the country and seasonal vegetables are used in cooking and served as the main dish. Major vegetable species grown in Turkey and known as summer vegetables are eggplant (*Solanum melongena*), okra (*Abelmoschus esculentus*), zucchini (*Cucurbita pepo*), beans (*Phaseolus vulgaris*), pea (*Pisum sativum*) and black-eyed beans (*Vigna sinensis*).

Brassicas species, such as cabbage (*Brassica oleracea* var. *capitata*), kale (*B. o*. var. *acephala*), kohlrabi (*B. o.* var. *gongylodes*) and cauliflower (*B. o.* var. *botrytis*), celery (*Apium graveolens*), leek (*Allium ampeloprasum*), artichoke (*Cynara scolymus*) and broad bean (*Vicia faba* var. *major*) are accepted as major vegetables found in winter season. Crops, such as lettuce (*Lactuca sativa*), cucumber (*Cucumis sativus* and *C. flexuosus*), tomato (*Solanum lycopersicum*), broccoli (*B. oleraceae* var. *italica*) are consumed as salads almost throughout the whole year. Watermelon (*Citrillus lanatus*) and melon (*Cucumis melo*) are the major fruits consumed during the hot summer periods.

Minor vegetable crops. There are over 600 species of plants collected from nature and consumed as vegetables. Some of the prominent and most widely collected vegetable species are mallow (*Malva* spp.), knotgrass (*Polygonum* spp.), eastern borage (*Trachystemon orientalis*), vitex (*Vitex agnus-castus*), wild fennel (*Foeniculum vulgare*) and wild asparagus (*Asparagus* spp.).

©A. Işık

Figure 51. Melons ready for marketing

Viticulture

Grape (*Vitis vinifera*). Historically, grape has always been one of the most important agricultural crops and it continues to be such today. This long history of cultivation and utilization have paved the way to rich genetic resources. In Turkey, the main institute in charge of preserving viticulture genetic resources is the Tekirdağ Viticulture Research Institute where about 1 200 local grape varieties collected from all over Turkey are conserved as field gene bank. A safety duplicate set of the accessions are preserved at the Manisa Viticulture Institute. All material has been morphologically and molecularly characterized and registered in accordance with internationally accepted rules.

Vineyards cover 1.1% of Turkey's agricultural land area, and grape accounted for 13.1% of Turkey's fruit production in 2016. Grape is grown almost in all regions; however, the varieties and utilization differ significantly.

Table grapes. Turkey is the second country after China for table grape production. In terms of acreage devoted to table grapes, the Mediterranean Region leads, and the Aegean Region is second, but in terms of production, these ranks are reversed. Common white table grape varieties include *Sultani Çekirdeksiz, Razaki, Italia, Yalova Incisi, Hatun parmağı, Müşküle, Bozcaada Çavuşu, Parmak,* and *Çiftlik,* while the common colored table grape varieties include *Alphonse, Lavallée, Karaerik, Trakya Ilkeren, Lival, Muscat Hamburg, Ribol, Kozak Siyahı, Horozkarası, Tekirdağ Ç. Pembe Germe, Red Globe, Hönüsü.*

Raisin (dried) grapes. Turkey led the world with 22% of the global total dried seeded and seedless raisin production in 2016. Seedless raisins made up 66% of the total amount of raisins produced in Turkey and 75% of that is exported. The main cultivars of seedless raisin grape grown in Turkey are *Sultani çekirdeksiz* and *Yuvarlak çekirdeksiz.* These grapes are sun-dried directly or after pre-treatments. Bulk of the Turkish raisin production comes from *'Sultanas'* which are dipped into an alkaline (potassium

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Figure 52. A vineyard

carbonate) solution prior to drying, which promotes water loss and enhances drying. Golden bleach raisins are treated with sulphur. They are very pale in color. Seedless grapes are marketed also as fresh both for the domestic and foreign markets. Some part of the production goes to distilleries for wine or alcohol making *Rakı,* the well-known Turkish spirit is made of alcohol, derived from seedless grapes.

The Mediterranean Region (Kilis Province) and Southeastern Anatolia Region (Gaziantep, Adıyaman, Mardin, and Diyarbakır Provinces) share the highest rank for seeded raisin production.

The southern Central Anatolia Region (Nevşehir and Konya Provinces) is the second most important region. Popular seeded raisin grape varieties include *Kilis Besni, Kilis Rumi, Besni, Rumi, Horozkarası, Karadimrit, Çalkarasi, Banazi siyahı, Kerküş,* and *Sergi karası*.

Wine grapes. Turkey's wine production volume was around 120 million liters in 2016. Approximately 12% of total grape production is processed for wine making in 2016. In the last 20 years, significant progress has been achieved with production of wine from both local and foreign wine grape varieties and wine quality has advanced significantly.

A popular local red wine grape is processed from *Kalecik karası*, grown in Denizli and Ankara Provinces. Two other major native varieties are *Öküzgözü* which is grown in Denizli, Antalya, Gaziantep, Adıyaman, Elazığ, and Malatya Provinces and *Boğazkere* which is grown in Diyarbakır Province.

Grapes for juicing and other purposes. Less than 10% of the fresh grapes produced in Turkey are used as juice for a variety of different products such as molasses, sausage (*orcik*), dried fruit pulp (*bastık*), *köfter, muska,* and *tarhana.*

A limited amount is used in the making of vinegar, grape juice, and *hardaliye* (grape juice flavored with mustard). These products can be processed directly from a specific mainly local variety or sometimes prepared from the amount that could not be marketed as fresh.

Figure 53. Grape harvesting

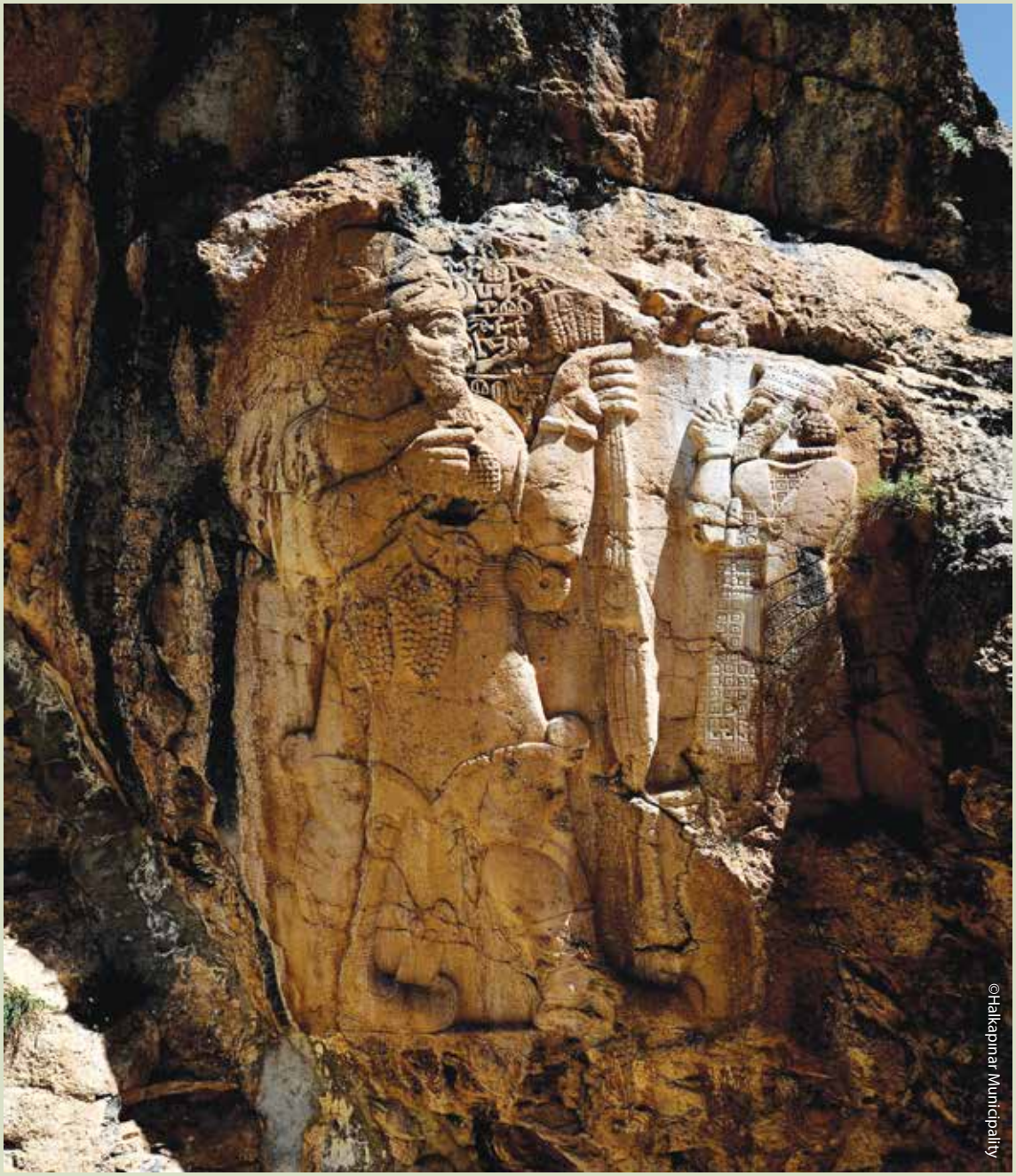
The İvriz relief depicting God Tarhunzas and King Warpalawas of Tuwana Land from the VIII century BCE

This is the best-preserved agricultural monument dating from the Hittite civilization. The relief, in Karaman Province, is around 4.2 m high and 2.3 m wide. God Tarhunzas of Tuwana is the large figure on the left with spikes of wheat in his hand and grape clusters hanging at his sides meaning that he is the god of fertility.

The smaller figure on the right is Warpalawas, the king of Tuwana. His hand is raised in a sign of respect and salutation to the god.

The inscription in Luwian hieroglyphs in front of the god's face and behind the kings back has been deciphered to read:

"I, King Warpalawas of Tuwana Dominant and hero,
I planted this vine, while I was a prince in the palace.
May Tarhunzas give them fertility and abundance."



Ornamental plants

The physical and climatic conditions of Turkey are suitable for production of a variety of ornamental plants. Turkey's flora itself is the source of thousands of ornamental plants as rough and readily usable material. Yalova and Antalya Provinces have tremendous potential for ornamental plant production in both protected cultivation and open field conditions. Protected cultivation is widely used to extend the growing season. Ornamental plant production is very import for Antalya Province, with carnation, *Gerbera, Gypsophilla,* and *Lisianthus* as the prominent crops. Carnation ranks first in production and mostly exported.

Turkey is a rich source of diversity for some ornamental bulb species such as *Galanthus elwesii*, *G. woronowii*, *Eranthis hyemalis*, *Anemone blanda*, *Leucojum aestivum*, *Cyclamen hederifolium*, *C. coum*, and *C. cilicium*. International trade of tuberous and bulbous plants is subject to quotas, issued by MAF every year.

Export of some plant species such as all those in the Orchidaceae (orchid family) and Nyphaceae (lotus family) as well as species of *Allium* (onions, garlic, etc.), *Crocus* (saffron), *Muscari* (grape hyacinth), *Tulipa* (tulips), *Iris* (iris), *Eminium, Biarum, Pancratium maritimum* (sea daffodil), *Hyacinthus orientalis* (common hyacinth), and *Gentiana lutea* (bitterwort) are completely prohibited by law.

Some species are allowed to be exported at a specified number of bulbs either collected from nature or cultivated. Trade of some of the species are allowed only if they are cultivated. A geophyte collection is established at Yalova Atatürk Horticultural Central Research Institute. Turkish flora has been investigated by many well-known botanist researchers. Some state institutes as well as few private arboreta (Karaca Arboretum in Yalova and Nezahat Gökyiğit Botanic Garden in İstanbul) keep collections of ornamental species that are under risk of erosion.

The diversity in the flora and ecological conditions has helped Turkey to cultivate and market a wide range of ornamentals. The cultivation area of ornamental plants and numbers of flower types produced are given in Table 23.

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Figure 54. Tulip field

Table 23. Cultivation area of ornamental plants and number of cut flowers plants and bulbs produced in 2016

Plant	Area m^2	Number
Anemone	10 400	1 188 000
Freesia	155 989	17 820 150
Gerber daisy	1 136 032	128 063 850
Sword lily	586 900	15 068 000
Rose (cut)	1 808 882	89 415 150
Gypsophilla	252 040	17 980 040
Iris	24 650	1 038 000
Carnation	4 823 955	593 260 930
Chrysanthemum	637 215	44 915 925
Tulip	413 430	40 601 005
Lilium	767 589	13 310 185
Lisianthus	152 864	9 521 500
Daffodil	415 560	13 808 850
Orchids	18 750	269 000
Goldenrod	127 900	18 302 500
Statice	27 000	183 000
Hyacinth	44 870	1 568 350
Gillyflower	161 199	6 425 640
Other cut flowers	384 012	25 256 300
Subtotal	**11 949 237**	**1 037 996 375**
Indoor plants	1 312 793	38 150 927
Outdoor plants	34 721 572	412 227 915
Bulbs	597 305	25 337 330
Total	**48 580 907**	**1 513 712 547**

Source: MFAL, 2017

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Cultural uses and values attached to horticultural crop production

Festivals and Exhibitions. Cultural values have been noted earlier for some specific crops, such as the role of olive oil in the wrestling tradition. In the past, many dye plants have been grown for their importance in specific cultural traditions. A number of provinces are known for specific plant products and festivals are held around them, for example, festivals for orange blossom, tomato, watermelon, artichoke, wild herbs, fig, grape, einkorn, emmer or wine vintage. Specific examples include the Golden Orange Film Festival and competition organized in Antalya Province and Golden Boll Film Festival in Adana Province where cotton is locally important.

In 2016, Turkey hosted first Horticultural International Exhibition in Antalya Province. The theme of the EXPO 2016 was selected as "Flower and Child". 190 countries were invited to participate to this spectacular event.

Figure 55. Opening Ceremony of EXPO 2016

Figure 56. An example of plant sculptures

Traditional cuisine

Turkish cuisine classifies vegetable dishes cooked with olive oil without meat as a separate division in the national menu. In almost all restaurants, menus offer special dishes under the section *zeytinyağlılar* (dishes with olive oil) and they are served cold.

Olive oil is used in cooking many of the vegetable dishes with meat, rather than any other plant or animal-based oils, since it enriches the taste of beef or lamb meat dishes. Some typical dishes featuring olive oil are "*karnıyarık* (eggplant stuffed with a mixture of minced meat) and "*imam bayıldı*" (eggplant stuffed with onions, tomatoes, garlic and parsley). Other widely prepared dishes are "*sarma*" (wrapping or rolling grape, cabbage or chard leaves with a mixture of various vegetables), "*dolma*" (stuffing green pepper, eggplant, squash blossom, summer squash, artichoke, celery root, and tomatoes with the same mixture) for pickling or cooking with or without meat.

The Black Sea cuisine is known for *"kara lahana"* (kale or leaf cabbage) in local dishes such as cabbage soup, stuffed cabbage leaves, pickled green beans, salted cherries, and boiled chard with poached eggs. Turkish baklava made from pistachio or walnut is the leading sweet pastry, which is indispensable for special occasions, such as holy days when it is served to guests.


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Genetic Resources of Medicinal and Aromatic Plants

Chapter V


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The history of medicinal plants is as old as human history. In addition to the importance of plants for human nutrition and clothing needs, people recognized their role in health and have developed from them a variety of drugs for use in the treatment of disease. Ethnobotanical research with diverse human cultures has helped in the discovery of novel herbal medicines. Some of the oldest records of medicinal use of plants are from Sumerian and Assyrian cultures, which benefited 5 000 to 3 000 years ago from the use of up to 250 different plants.

Because of the diversity of human cultures and customs that have occupied over time what is now Turkey, there has been a great accumulation of knowledge of traditional medicine from Anatolia. For example, De Materia Medica by Pedanius Dioscorides (40 to 90 CE) from Anavarza, which is located within the boundaries of Adana Province may be assumed to be the oldest comprehensive document on Anatolian folk medicine.

Medicinal and Aromatic Plants (MAP) in Turkey are mainly used for curing stomach and kidney disorders, fever, cold and cough, bleeding and wounds, fungal and bacterial infections, burns and pains, insect bites and poisoning, influenza, diarrhoea, rheumatism, insomnia, fatigue and weakness, jaundice, tension, cirrhosis, cancer, and cardiovascular diseases. The most common Turkish MAP used in traditional medicine are presented in Table 24.

Technological innovations of the XX century, especially synthetic drugs and social and political changes led to a sharp reduction in the use of plants as medicines.

However, after the 1990's, the discovery of new uses for MAP coupled with serious side effects of some synthetic drugs and higher costs of synthetic drugs have caused MAP to become popular again.

The herbal medicine market in Turkey amounts to approximately USD 3 billion. The main export herbs include oregano, sage, laurel, myrtle, rosemary, aniseed, cumin,

Table 24. The most common MAP used in traditional medicines in Turkey

Scientific name	Common name	Scientific name	Common name
Achillea millefolium	Yarrow	*Lycopodium annotinum*	Stiff club moss
Aconitum anthora	Aconit	*Malva neglecta*	Mallow
Alkanna tinctoria	Alkanet	*Mandragora autumnalis*	Mandrake
Althaea officinalis	Marsmallow	*Matricaria chamomilla*	Chamomilla
Anethum graveolens	Dill	*Melissa officinalis*	Lemon balm
Anthemis nobilis	Roman chamomile	*Mentha piperita*	Mint
Artemisia absinthium	Mugwort	*Momordica chantia*	Bitter melon
Atropa belladonna	Belladona	*Myrtus communis*	Myrtle
Borago officinalis	Borage	*Nerium oleander*	Oleander
Calendula officinalis	Marigold	*Nigella sativa*	Black cumin
Capparis spinosa	Caper bush	*Ocimum bacilicum*	Basil
Capsella bursa-pastoris	Shepherd's purse	*Origanum minutiflorum*	Oregano
Ceratonia siliqua	Carob	*Origanum onites*	Pot marjoram
Chelidonium majus	Greater celandine	*Paeonia mascula*	Peony
Chenopodium album	Lamb's quarters	*Papaver rhoeas*	Red poppy
Cichorium intybus	Chicory	*Papaver somniferum*	Poppy
Conium maculatum	Poison hemlock	*Peganum harmala*	Harmal
Coriandrum sativum	Coriander	*Pimpinella anisum*	Anise
Crocus sativus	Saffron	*Pistacia terebinthus*	Terebinth
Cuminum cyminum	Cumin	*Polygonum cognatum*	Indian knotgrass
Cyclamen cilicium	Cyclamen	*Polygonum bistorta*	Meadow bistort
Datura stramonium	Devil's snare	*Portulaca oleracea*	Purslane
Delphinium staphisagria	Delphinium	*Primula officinalis*	Primrose
Digitalis lanata	Foxglove	*Rosmarinus officinalis*	Rosemary
Dracunculus vulgaris	Black dragon	*Rubai tinctorum*	Madder
Drimia maritima	Sea squill	*Rumex acetosella*	Sorrel
Ecballium elaterium	Squirting cucumber	*Ruscus aculeatus*	Butcher's broom
Equisetum vesicaria	Horsetail	*Ruta graveolens*	Rue
Ferula communis	Giant fennel	*Salvia fructicosa*	Sage
Foeniculum vulgare	Fennel	*Sambucus nigra*	Elder
Galanthus elwesii	Snowdrop	*Scolymus hispanicus*	Golden thistle
Gentiana lutea	Yellow gentian	*Silybum marianum*	Milk thistle
Geranium tuberosum	Geranium	*Tanacetum balsamita*	Costmary
Glycyrrhiza glabra	Licorice	*Teucrium polium*	Mountain germander
Gundelia tournefortii	Tournefort's gundelia	*Thymus sepyllum*	Thyme
Gypsophila arrostii	Baby's breath	*Tilia cordata*	Linden
Hyoscyamus niger	Black henbane	*Tribulus terrestris*	Caltrop
Hypericum perforatum	St John's wort	*Trigonella foenum-graecum*	Fenugreek
Inula viscosa	Elecampane	*Tussilago farfara*	Coltsfoot
Laurus nobilis	Laurel	*Urtica dioica*	Nettle
Lavandula stoechas	Lavender	*Valeriana officinalis*	Valerian
Leucojum aestivum	Summer snowflake	*Viscum album*	Mistletoe
Liquidambar orientalis	Oriental sweet gum	*Vitex agnus-castus*	Chaste tree

Source: Baydar, 2012

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Figure 57. *Thymus cilicicus*

black cumin, coriander, fennel, fenugreek, caper, liquorice, sumac, mahaleb, linden, lemon balm, paprika, gypsophila and some geophytes such as *Leucojum aestivum*, *Cyclamen hederifolium* and *Galanthus elwesii* in previously determined amounts.

Processed or semi-processed essential oils of oil-bearing rose, oregano, sage, and citrus and extracts such as morphine, oleoresins, resins, concretes, absolutes, and gums are in the export list of MAP. Along with the rising popularity of MAP, increasing demand for new and better quality products emerged in society. For production of high quality MAP products, several conditions must be satisfied such as identification of proper plants and plant parts to be used in products, correct collecting time, accurate method of curing, shipping, storing, and packing of harvested material, operation of precise chemical extraction method, storage of chemical substances in suitable environments, usage of correct dosage for application of extracted chemicals, and correct mixing conditions when an application consists of several plants or extracts. Although there has been a resource base of MAP-related traditional knowledge, all the above-mentioned issues have been the subject matter for many research studies.

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Cultivation versus wild harvesting of medicinal and aromatic plants

MAP used as raw materials for the herbal medicine trade, and the pharmaceutical and cosmetics industries are obtained in two ways, through wild collection or agricultural cultivation. Local dealers obtain material from local collectors and growers. After harvest or collecting from nature, material is sold to plant trading and exporting companies by village cooperative, regional traders or local dealers. The growing demand for MAP has not only resulted in increased risk for overexploitation of wild plant populations, but also of increased interest in cultivation of them.

About 200 of the MAP of Turkey have export potential and 70 to 100 MAP are already exported. However, despite this significant potential in terms of wild-collected and cultivated MAP, the country could benefit more from this diversity. Small-scale cultivation of MAP can be an effective conservation option to reduce the impact of over harvesting of the target species and to generate alternative income and employment opportunities for rural development. Traceability and strict documentation requirements for good agricultural practices and proper processing practices are becoming more important in the EU countries. Various purchasers will have different expectations and requirements, but some points are relevant for all MAP: efficacy, safety, traceability, supply, and demand. The cultivation of plants according to good agricultural practices means using established standard operating procedures that will ensure good quality and safety, and thorough documentation of all actions and procedures to ensure complete traceability.

About 350 MAP species are involved in internal trade in Turkey, whereas only about 100 of them are currently involved in foreign trade. Providing and promoting the sustainable wild-collection and cultivation of these species is necessary for meeting the needs of present and future generations.

Wild harvesting MAP. In Turkey, as in most countries, most MAP are collected from their natural habitats (Figure 58). About 90% of over 1 000 European native species are primarily wild-harvested. In the markets, MAP are offered mainly as dried plant parts (roots, rhizomes, leaves, stems, bark, flowers, fruits, seeds) or sometimes as mixture of several plant parts or even as the whole plant.

Traditionally, rural people are those who collect and dry wild MAP and transport these raw materials to markets (Figure 59).

As a result, systematic collection and processing of MAP offer promising new income and employment opportunities to improve the livelihoods of the rural poor in an environmentally sustainable manner (Figure 60).

Uprooting causes serious gene and soil erosion especially when collecting is undertaken at commercial scale. The continued commercial exploitation of these plants has resulted in the reduction of populations of many species in their natural habitats. Conservation, more efficient utilization and cultivation are urgently needed steps to be taken for those MAP that are endangered due to overexploitation, to enhance their long-term survival and maintain the existing genetic diversity.

Cultivating MAP. Collecting from wild is not a sustainable way of supplying a desired amount of good quality material at a desired time. Systematic research, development, and production are the basis of a sustainable supply system. Despite several advantages of cultivation over wild harvesting, several drawbacks, mainly cost and difficulties of cultivation, must be resolved. In any case, the material supply conditions should be evaluated considering the state of wild populations of each species.

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Figure 58. Wild collection example: *Sideritis congesta*

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Figure 59. Harvested wild plants available in a market in Diyarbakır Province of Turkey

©F. Tekin

Figure 60. *Fritillaria imperialis*

Some of the economically important MAP such as opium (*Papaver somniferum*), tea (*Camellia sinensis*), aniseed (*Pimpinella anisum*), cumin (*Cuminum cyminum*), fennel (*Foeniculum vulgare*), coriander (*Coriandrum sativum*), caper (*Capparis spinosa*), fenugreek (*Trigonella foenum-graecum*), black cumin (*Nigella sativa*), Turkish oregano (*Origanum onites*), common sage (*Salvia officinalis*), mint (*Mentha piperita*), basil (*Ocimum basilicum*), balm (*Melissa officinalis*), oil rose (*Rosa damascena*), lavander (*Lavandula intermedia*), saffron (*Crocus sativus*), hops (*Humulus lupulus*), hemp (*Cannabis sativa*), paprika (*Capsicum annuum*) and sesame (*Sesamum indicum*) have been cultivated for many years in Turkey (Figure 61 and 62).

There are regions that specialize in cultivation of particular MAP: for example, tea, saffron, and hemp in the Black Sea Region; hops in the south of the Marmara Region; opium poppy in Aegean and Mediterranean Regions, paprika, mint, and purple basil in the South and Southeastern Anatolia Regions.

For MAP, the current international legal instruments legislating trade (e.g., CITES) and The Bern Convention on the Conservation of European Wildlife and Natural Habitats are insufficient alone for Turkey to ensure the sustainability of the target species in their habitats. Therefore, creation and adoption of national legal instruments is necessary to achieve success in the sustainability of MAP.

FAO supports MAP conservation and sustainable utilization in Turkey through technical capacity building activities. For instance, a project called "Protection and Cultivation of Medicinal and Aromatic Plants in West Mediterranean Region in Turkey" was implemented between 2012 and 2014.

Since the systems involved in MAP conservation tend to be complex, with

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Figure 61. *Origanum onites*

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Figure 62. *Salvia officinalis*

many variables and many types of actual or potential stakeholders, FAO's intervention has been very beneficial for MAP management as complementary to the national efforts.

MAP conservation is undertaken through *in situ* and *ex situ* conservation programs. Other related research activities include propagation, domestication, breeding of MAP species, and search for new MAP products.

Pharmaceuticals and agro-industry of MAP

Turkish pharmaceutical companies manufacture a wide range of products, mostly with generic formulae. The pharmaceuticals industry also produces active ingredients primarily antibiotics and analgesics, by using fermentation, extraction, and synthesis methods.

The general techniques of MAP extraction include maceration, infusion, decoction, pressing, distillation, and percolation, extraction with organic solvents and supercritical CO_2, and aqueous-alcoholic extraction by fermentation. The Opium Alkaloids Factory in Afyonkarahisar Province has been producing over 20% of the morphine consumed by pharmaceuticals industries all over the world since 1977. This factory produces morphine, recrystallized morphine, morphine hydrochloride, morphine sulphate, codeine base, codeine phosphate, and codeine hydrochloride after solvent extraction of cultivated opium capsules.

MAP have several other uses in Turkey, such as herbal teas, flavors, beverages, aromatics, cosmetics, perfumes, ornamentals, regulators, antibiotics, antioxidants, and agro-chemicals apart from their use as herbal medicines. Some aromatic plants rich in scent molecules are used for essential or volatile oils by using water/steam distillation, solvent supercritical liquid extraction, manual hydraulic pressing, etc.

The main aromatic isolates obtained commercially from aromatic plants are essential oils and aromatic waters, which are mainly used as flavors and fragrances for foods, soaps, detergents, cosmetics, perfumes, colognes, and lotions. Turkey produces essential oils from oil-bearing rose, oregano, laurel, sage, lavender, rosemary, myrtle, geranium, aniseed, cumin, and citrus. Besides, Turkey produces some aromatic extracts like concretes, absolutes, oleoresins, hydrosols, resins, turpentine's, pomades, waxes, and gums.

Pyrus serikensis

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The role of MAP in rural development and livelihood security

With increasing demand for natural products derived from MAP, collection and cultivation of them have now become a popular and economically feasible commodity. Proper utilization of natural resources will help employment opportunities of future generations as well as economic development of the rural people. Sustainable harvest is known to be the most important conservation strategy for all wild harvested species and their habitats.

One of the examples for wild harvested materials in Turkey is bay laurel (*Laurus nobilis*) (Figure 63). This plant grows along the entire coast line of the Mediterranean Region and its leaves and berries are collected to produce dried bay leave and essential oils. The soaps made of laurel oil are widely used.

High quality, standardized (first grade) bay leaves are exported after cleaning, drying, and sorting for use as a spice. Annually Turkey exports over 11 000 tonnes of bay laurel leaves for a return of over USD 32 million.

Another example of the role of MAP for rural development in Turkey is farming of oregano (*Origanum onites* and *O. vulgare* ssp. *hirtum*) in Denizli and Manisa Provinces of the Aegean Region. In particular, many low-income villagers in Denizli Province have been farming oregano (*O. onites*) (Figure 64) since 2000 to replace tobacco (*Nicotiana tabacum*) cultivation.

Thymbra spicata

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Figure 63. Bay laurel blossom

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Figure 64. Oregano under cultivation

Orchids in Turkey are under serious threat!

Figure 65. Orchid

Figure 66. Tubers of *Ophrys umbilicata*

About 1 000 species of geophytes (plants with underground storage organs) are grown in Turkey. The majority of these have economic potential as both ornamental and medicinal plants.

Turkey is especially rich in members of the Orchidaceae family which is represented by 26 genera. Turkey harbors 271 orchid taxa in its native flora.

Sahlep is a special flour made from the tubers of dried wild orchids including species of *Orchis* (60 taxa, 1 endemic), *Ophrys* (105 taxa, 36 endemic), *Serapias* (10 taxa), *Platanthera* (4 taxa), and *Dactylorhiza* (40 taxa, 14 endemic). The *sahlep* flour which contains a nutritious starch-like polysaccharide called "glucomannan" is the main ingredient of famous Turkish ice-cream, beverages, and desserts. For one kilogram of dried *sahlep*, tubers of around 1 000 orchids are needed. Vast quantities of tubers are collected for this reason.

Many orchids produce only a few tubers under the ground, so they are threatened by extinction because of over-collection. However, research on the cultural production of the species is continuing.

Turkey: The country of sages and ironworts

Figure 67. *Salvia fruticosa*

The sage genus (*Salvia*), a member of the Lamiaceae family, consists of valuable medicinal and aromatic plants as a source of essential oils and aromatic chemicals. *Salvia* species are both cultivated and collected from the wild, especially in the Mediterranean Region. There are about 700 species of *Salvia*, but only a few species are commercially important in the world. Turkey is one of the leading countries that exports the dried sage leaves, with more than 1 500 tonnes per year. There are over 99 species and 14 subspecies (58 of them are endemic) in the flora of Turkey, but *S. fruticosa* (Greek sage) and *S. tomentosa* (Anatolian sage) are generally collected wild.

Sage leaves are largely used as herbal tea and as part of traditional remedies. They are also used in sage-oil production by steam distillation using commercial stills (alembics) in southern parts of the Aegean Region.

The ironwort genus (*Sideritis*), also in the Lamiaceae family, has 45 species, 15 subspecies with 40 endemic taxa. Ironworts are all collected from nature at full-bloom stage, dried, then marketed to herbalists or bundled and exported. In Turkey, *S. congesta, S. erythrantha, S. pisidica, S. libanotica* ssp. *linearis, S. perfoliata, S. stricta, S. sipylea, S. trojana,* and *S. tmolea* are the most exported and consumed species as herbal tea.

An example of recently found species in Turkey: *Crocus musagecitii*

Rose oil and lavender from Isparta Province

Figure 68. Rose oil factory in Isparta Province

Isparta Province is known as the "Rose and Lavender Valley of Turkey" because of the extent of oil-bearing rose (*Rosa damascena*) and lavender (*Lavandula × intermedia*) cultivation and industry. It has been the main production center of these for over 130 years. The Valley turns into pink color during May and June when the roses flower, and purple color during July and August when lavender flowers.

Rose oil and rose water

Oil-bearing rose contains a high-value volatile oil used in the fragrance and cosmetic industries. Isparta Valley is the most important oil-bearing rose production center, together with Kazanlak Valley of Bulgaria, in the world. Both Turkish and Bulgarian rose oils are produced from hydro-distilled pink petals which are hand-picked during early morning in the flowering season.

The first oil rose cultivation in Isparta Province started in 1888 and rose oil was first distilled in 1892 by Ismail Efendi (1840-1915) during the Ottoman Empire. Today, about 12 500 tonnes of fresh rose flowers harvested from 3 000 ha are processed every year in the region including Isparta, Burdur, Denizli, and Afyonkarahisar Provinces (with approximately 80% of total coming from Isparta Province). The climatic and soil properties of this region are ideal for oil-bearing rose cultivation. The air humidity, cloudiness, insolation, and precipitation during the flowering season (May and June) contribute to produce roses with high yield and quality. Over 10 000 families are involved in oil-bearing rose cultivation.

Figure 69. Oil rose plantation in Isparta Province

With a world market demand for organic rose production, for the last 25 years, about 10% of the rose planting area in Isparta Province has been devoted to organic production. Organic rose oils are mainly exported to Germany, France, Japan, Switzerland, Belgium, England, other European countries and USA. Organic rose products bring a price premium, costing 20% more than conventional products.

Lavender

Its cultivation started in 1971 and rapidly expanded, especially in Isparta Province. At the harvest time, inflorescence are cut and then gathered in bundles. For dry flower production, bundles are laid out in a well-aerated, shaded environment. From 5 kg of fresh lavender floral axis, 1 kg of dry flower is obtained. For oil production, fresh flower bundles are taken to distillers where oil is produced with steam distillation. Around 50 to 70 kg of fresh flowers are needed to produce 1 kg of lavender oil.

Figure 70. Lavender plantations in Isparta

Fritillaria mughlae

Genetic Diversity of Forest Systems

Chapter VI


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Forests are natural resources that provide economic, ecological, socio-cultural, moral and material benefits to humanity such as food, fuel, shelter, clean air and water, medicine, income sources, employment and recreation area. As an ecosystem, forest is a shared living ecosystem in which trees, accompanying plants, animals and microorganisms interact with each other and abiotic elements in a balanced manner.

Forest ecosystems are acknowledged for their importance in terms of the ecosystem goods and services they provide. Ecosystem goods and services provided by forests can be summarized as:

- Resources (wood and non-wood forest products),
- Biospheric services (biodiversity conservation, climate regulation),
- Ecological services (water, soil, health and security),
- Social services (recreation, leisure, hunting, ecotourism, sports),
- Amenity services (cultural, spiritual, historical).

In addition to such services, forest ecosystems are a vital basis for food security, poverty reduction, and sustainable development, especially for forest-dependent villagers in rural areas.

Forests cover 28.6% (22.3 million ha) of country surface area in 2017. Forests are generally located on mountainous areas. The Black Sea, Mediterranean, Marmara and Aegean Regions have the highest forest cover, while the Eastern Anatolia, Southeastern Anatolia, and Central Anatolia Regions have the lowest.

Forests are not only sources of wood but also several types and species of non-wood products. As of 2016, total timber production was 17 009 998 m^3 for industrial use and 4 877 067 m^3 for fuel.

The same year number of non-timber items was 54 in the inventory of Ministry of Forestry and Water Affairs (MFWA) with a total production of 54 043 tonnes. Figure 71 reflects amount of major non-wood forest production by years in Turkey. Significant non-wood forest products of Turkey are given in Table 25.

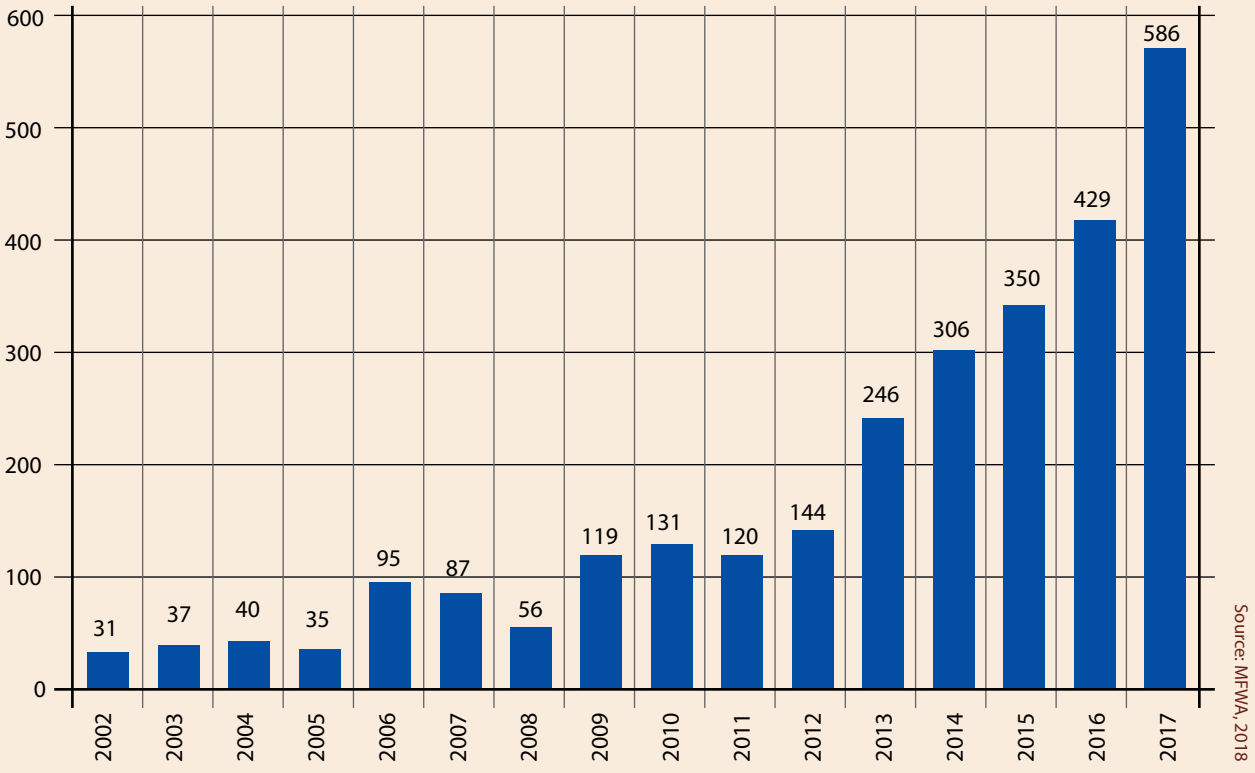

Figure 71. Production amount of non-wood forest products in Turkey for given years, tonnes

Table 25. Some of the non-wood forest plants, production harvested area and production

Scientific name	Name	Collected plant part	Harvested area, ha	Production, tonnes
Cyclamen spp.	Cyclamen	Bulb	14 492	5 276
Castanea sativa	Chestnut	Fruit	65 808	40 388
Pinus pinea	Stone pine	Fruit	60 870	48 445
Arbutus spp.	Strawberry tree	Fruit	39 724	15 693
Ceratonia siliqua	Carob	Fruit	27 049	4 397
Crataegus spp.	Thorn apple	Fruit	12 207	9 099
Pyrus spp.	Pear	Fruit	3 592	13 212
Malus sylvestris	Apple	Fruit	2 778	3 023
Rosa canina	Rose	Fruit	10 223	1 720
Cistus spp.	Rockrose	Leave	138 405	61 499
Erica spp.	Heaths	Leave	10 900	3 633
Rosmarinus officinalis	Rosemary	Leave	7 128	5 646
Thymus, Origanum, Satureja, Thymbra, Salvia, Sideritis	Thyme, Oregano, Savory, Thyme, Sage, Ironworth	Leave, flower	328 889	26 315
Tilia cordata	Linden	Leave, flower	12 640	868
Laurus nobilis	Bay laurel	Leave, fruit	128 600	311 270
Myrtus communis	Myrtle	Leave, fruit	23 412	12 676
Rhus coriaria	Sumac	Seed	17 375	7 278

Source: General Directorate of Forestry, Non-wood Forest Product Department, 2017

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Figure 72. Chestnut fruit ready for harvesting from the forest

Current state and characteristics of Turkey's forest diversity

The forest ecosystems in Turkey show great diversity in structure, composition and processes; from west to east and from north to south. Euro-Siberian Phytogeographical Region has deciduous forests (beech, chestnut, and hornbeam), humid and semi-humid coniferous forests (black pine, Scotch pine, spruce, fir), dry oak and pine forests (oak, black pine, Turkish pine), shrub lands (pseudo-maquis and oak-hornbeam) formation.

Mediterranean Phytogeographical Region is dominated by the elements of maquis and garigue formations such as kermes oak, sandal, gum, myrtle and laurel. Coastal and low-altitude areas are covered by Turkish pine, middle to high altitude (1 000-1 900 m) areas are covered by black pine, Taurus fir and cedar forests and juniper formations.

Irano-Turanian Phytogeographical Region accommodates Central Anatolia steppe woodlands dominated by oak and juniper species, black pine forests, oak and juniper forests in transition regions and dry oak

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Figure 73. Mediterranean forest

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Figure 74. Mediterranean forest on karstic limestone

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Figure 75. İğneada Longos Forest National Park

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Figure 76. Forests are feed sources for wild animals and birds during the winter

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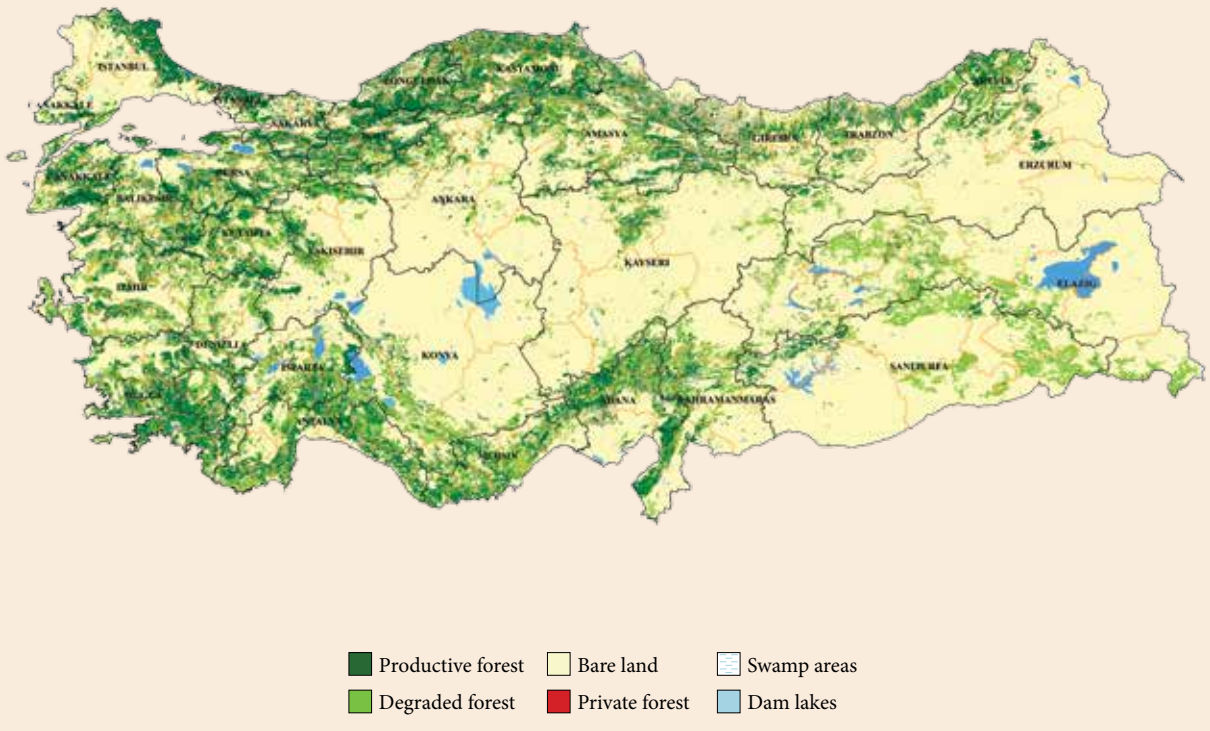
Figure 77. Forest at Black Sea Region

forests in east Anatolia.

Forest ecosystems of Turkey provide suitable habitats for a great number of bird species, endemic plant species and other wildlife species. These ecosystems provide habitats for wild relatives of many cultivated plant species and mushrooms.

Around 62% (13.9 million ha) of forests of Turkey are homogeneous that ratio of trees in mixed groups is less than 10%. Percentage cover of coniferous, deciduous and mixed forests are 48%, 33% and 19%, respectively. Coniferous forests are found at varying altitudes from sea level to the tree line. Deciduous forests are prevalent and relatively perpetual along northern Turkey. Most of the forests are of natural origin.

Half of the forest is categorized as "productive", with a canopy cover over 11% while the other half is degraded to various extents. Around 77% of the forests is fully developed while rest is coppice or newly grown shoots from tree stumps. Distribution of the forests of Turkey is given in Figure 78.



Source: General Directorate of Forestry

Figure 78. Forest map of Turkey, 2015

Forest biodiversity in Turkey is conserved by means of two strategies, namely, *in-situ* and *ex-situ*. *In situ* conservation of forest biodiversity takes places in ***gene conservation forests*** and ***seed stands*** with national parks, nature reserves, biosphere reserve, and nature parks also contributing to preservation efforts. About 260 gene conservation forests exist for 42 coniferous and deciduous species to preserve the genetic diversity of tree species. Gene conservation forests are selected for protecting genetic diversity of forest tree species in their natural habitat and managed by special plans. Seed stands chosen in specific geographic regions among natural stands with superior quality of trees with desired characteristics are scattered all over Turkey for seed production of 35 species.

Another strategy applied to conserve genetic resources is *ex-situ* conservation such as seed banks, seed orchards, provenance trials, and seed-store centers as well as in botanical gardens and arboreta, although the latter two also include exotic plant species. Systematic tree breeding activities began in Turkey in 1969 and a National Tree Breeding Programme initiated in 1993, targeting the most widespread and valuable tree species: Turkish pine (*Pinus brutia*), black pine (*Pinus nigra*), Scots pine (*Pinus sylvestris*), Lebanon cedar (*Cedrus libani*) and oriental beech (*Fagus orientalis*). There are 179 seed orchards for 12 tree species covering 1 413 ha. The conservation status of forest ecosystems is summarized in Table 26.

Table 26. List of *in-situ* and *ex-situ* conserved forests managed by MAF, 2018

Conservation Type (mainly *In-situ*)	Number	Area, ha
National parks	43	846 053
Nature parks	243	106 453
Nature conservation areas	30	46 797
Nature monuments	112	7 488
Biosphere reserve	1	27 152
Wildlife development areas	81	1 189 308
Protection forests	55	250 033
Gene conservation forests	308	42 093
Seed stands	321	42 350
Seed orchards	185	1 424

Source: MAF, 2018b

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Forest genetic resources are protected and managed by the MAF and mainly its subordinated General Directorate of Forestry.

General Directorate of Nature Conservation and National Parks (GDNCNP) is the main responsible unit to conserve natural resources and biodiversity of Turkey together with forest ecosystems as well as other ecosystems type of Turkey such as wetlands, mountains, and marine. Almost all Turkey's forests (more than 99%) are located on state-owned lands and managed by General Directorate of Forestry.

©M. Türkeş

Figure 79. *Abies nordmanniana* subsp. *equi-trojani* forest in Kazdağları National Park

General Directorate of Combating Desertification and Erosion mainly works on development of the strategy and policy documents on conservation of the natural values and mitigating desertification and erosion.

There are several policy documents and legislation for enhancing policy and regulation support on sustainable forest management. Turkish National Forestry Programme 2004-2023 is the major policy document for sustainable forest management. Furthermore, Constitution of the Republic of Turkey (Article 169), Forest Law (Law No. 6831), Forest Management Planning Regulation (2008) are the legislation and regulations supporting sustainable forest management in Turkey.

Main policy to improve the sustainable management of the forests is *"make use of all kinds of benefits provided by forests through ecosystem management approach, integrated planning and implementation of forestry activities at watershed base in active participation and collaboration with forest organization and other stake holders"*.

About 10% of Turkey's populations live in forest villages or forest-neighboring settlements where forest resources make a vital contribution to livelihood. Recent years, the management authority of forest ecosystems in Turkey attaches substantial importance for non-wood forest products to enhance the income generated from forest ecosystems. Urban dwellers are also paying ever growing interest in forests particularly with respect to their biodiversity, environmental and social functions.

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Figure 80. *Pinus nigra* forest at Honaz Dağı National Park

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Figure 81. *Pinus brutia* forest, Beydağları National Park

Chestnut (*Castanea sativa*): Turkey's multipurpose tree

Chestnut contributes significantly to rural livelihoods and economies in Turkey. The wood is used for fuel, timber, and other wood products including window frames and raw material for furniture industry. In some areas, tannin is extracted and used as a replacement for chemical tannins. Honey production from chestnut flowers is an important non-wood forest production and can reach high retail prices. Turkey is ranked the number three chestnut fruit producer in the world with an annual production of 62 904 tonnes per year in 2017.

Chestnut fruits are harvested on about 200 000 ha of forests and used for candy production and domestic consumption while some are exported. Northeastern Turkey and the Caucasus are the area of origin of chestnut and its highest genetic diversity is found in those areas.

Figure 82. Chestnut blossom

Figure 83. Chestnut honey making in progress

Sweetgum (*Liquidambar orientalis*): A native tree at risk

Figure 84. Sweetgum forest in Fethiye

The natural range of oriental sweet gum is a limited area in southwest Turkey and Rhodes Island of Greece, at altitudes up to 1000 masl.

Sweetgum tree produces balsam which is a rare characteristic among forest trees. The balsam is obtained from the tree by splitting the bark and harvesting the sap fluids. The oil extracted from the sap is used as a fixative in producing soap and cosmetics.

It is also used for skin treatments. In ancient times, the sweetgum tree was used as incense in rituals to expel evil spirits. In 1947 the natural distribution area of oriental sweet gum was 7 000 ha. Today it is limited to about 503 ha. Most of the trees have been damaged due to poor balsam production methods, which involve wounding to stimulate and increase the production. According to IUCN it is categorized as vulnerable to extinction.

Figure 85. Seed capsule of sweetgum tree

Bay laurel (*Laurus nobilis* L.): A tree with mythological prescription

Bay laurel is native to West and Central Black Sea, Marmara, Aegean and Mediterranean Regions in Turkey between 600-800 masl. It grows up to 10 m. The wood strength is low, but the bay is an aromatic plant and the smell is very strong.

It is the symbol of immortality because of staying green in summer and winter. In ancient Greece, bay laurel had been dedicated to Apollo.

Bay laurel is an aromatic evergreen tree or large shrub with green, polished leaves, native to the Mediterranean Region. There is a wide use of bay such as perfume, soap, food, medicine and lacquer in chemical industry.

Both leaves and fruits contain essential oils. Oil extracted from fruits are used for soap making. The plant is the source of a spice used in a wide variety of recipes among Mediterranean cuisines. The leaves are added whole to sauces or dishes while cooking. Bay leaves are used almost exclusively as flavor agents during the food preparation stage. Turkey is the most important producer and seller of dry bay leaves in the world.

Figure 86. Bay laurel tree

Figure 87. Bay laurel blossom

Stone pine (*Pinus pinea*): Valuable nuts

Stone pine covers approximately 100 000 ha of land in Turkey, in pure or mixed stands with Turkish pine (*Pinus brutia*). It is also widely used in special forestation areas. Stone pine tree can be easily recognized by the typical umbrella shape of mature trees with a large and rounded crown.

The species can be found mostly in western Anatolia, İzmir-Bergama (Kozak) and Aydın-Koçarlı towns.

Pine nuts, a non-wood forest product with higher value than the tree's timber, are harvested from stone pines. After 8-10 years of planting, it starts to be economically harvested. Production period of stone pine is up to 100 years.

Figure 88. Stone pine forest

Figure 89. Cones harvested for pine nuts


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Diversity of Animal Genetic Resources

Chapter VII

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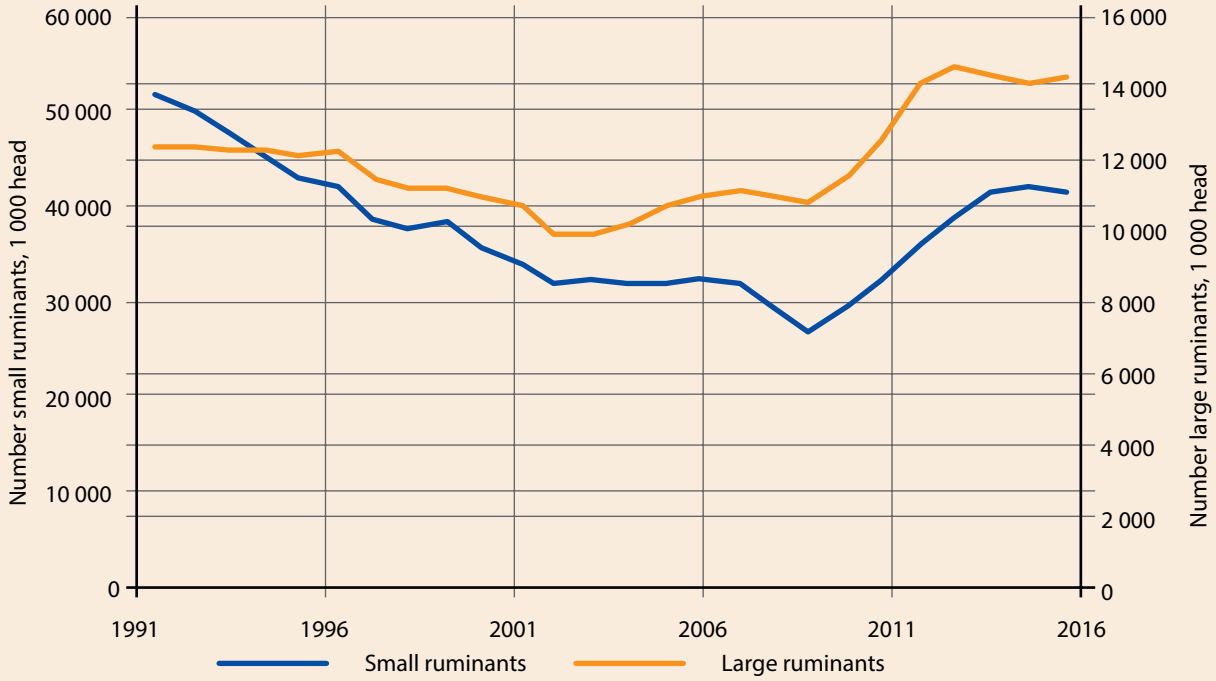
Conditions in Turkey are favorable for animal husbandry. Traditionally most farmers raise a few cattle, some small ruminants, and poultry to meet their domestic needs.

Unlike in the past, most cattle today are under intensive husbandry management receiving better care and feeding conditions as well as better veterinary care. The situation for small ruminants has not changed that much from the past and the majority are raised under traditional systems.

The number of small and large ruminants have been steadily increasing from 2009 through 2015, with a small change in 2016 (Figure 90).

This trend results in a significant increase in animal products, indicating a structural change in the livestock sector through a move to more intensive and productive systems.



Source: TÜİK, 2018

Figure 90. Number of small and large ruminants from 1991 to 2016

The pasture resources

Pastures have been the basic source of forage for thousands of years. At the beginning of the XX century when 12 million people were living in Turkey, a relatively small number of animals were grazed on natural pasturage and there was no serious pasture management problem.

After the end of World War I, there were 44 million ha of natural grazing land, occupying 58% of the country and handling about 20 million head of livestock.

After World War II, animal numbers remained almost the same, while grazing areas were reduced to 43 million ha. Since then there has been a sharp increase in animal numbers and a further decrease in pasture area, due to mechanization of agriculture and plowing of pasture to gain crop land.

Today, pasture and meadow area has decreased to 14.6 million ha (Figure 91). The number of animals grazing on Turkey's pastures is over four times more than their carrying capacity.

Distribution of pasture areas by geographical regions, their share and average forage yields are given in Table 27. Because of long years of overgrazing, pastures have lost not only their productivity but also quality.

The percentage of desirable plants in the plant cover is 10 to 20%. Depending on the region and grazing pressure, plant cover of pastures is between 10 and 50%.

Pastures still play an important role in ruminant feeding, providing about 69% of crude protein, 62% of starch, and 33% of roughage needs for ruminant livestock. The rest of the feed is obtained from cultivated forages, concentrates, cereal and grain legume straw, and agro-industry by-products and residues.

Pasture degradation is the most important factor reducing productivity of livestock, because there are few incentives for individuals to reduce grazing pressure by such means as limiting number of animals, reducing the grazing period, or conducting timely grazing.

The social and economic circumstances of the population are changing rapidly. As a result of migration from rural areas to urban areas, the number of people involved in agriculture declined to 18.9% in 2016.

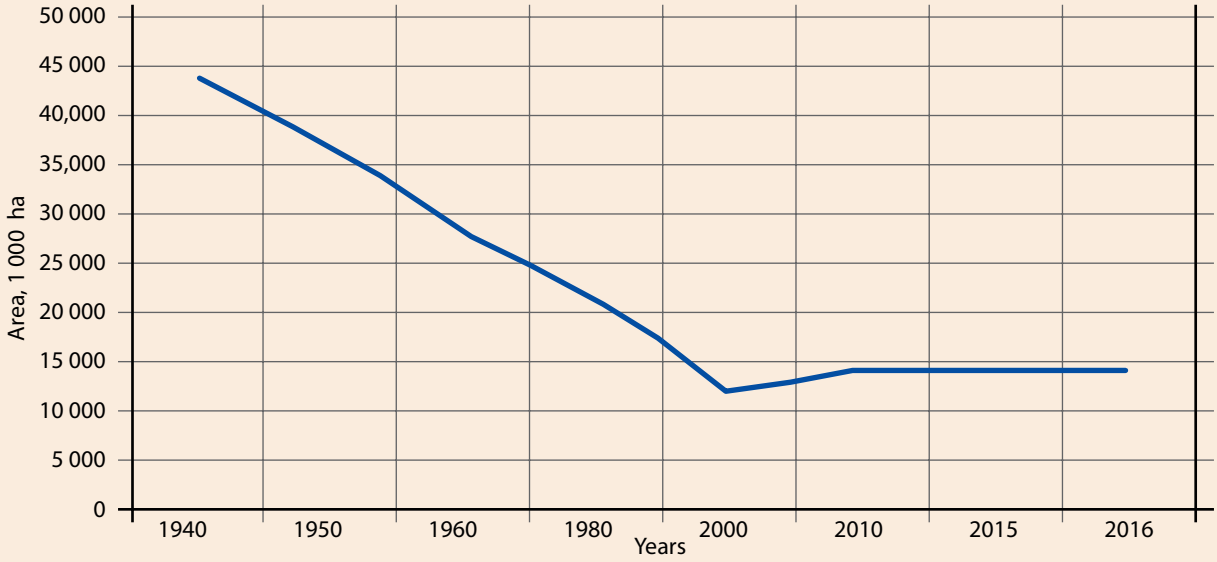
There are reasons for this decline. Changes towards sedentary systems resulted in a shortage of labor on grazing areas. The majority of young rural people spend up to ten months per year working in the cities.

Labor requirements are met by either hiring shepherds or modifying the animal husbandry system to use more cost-effective strategies. As the number of people declines in rural areas, specialist animal producers are increasing their animal numbers.

Table 27. Distribution of pasture areas by geographical regions

Region	Pasture area ha	%	Forage yield kg/ha
Eastern Anatolia	5 485 449	37.5	900
Central Anatolia	4 570 182	31.3	450
Black Sea	1 533 605	10.5	1 000
Southeast. Anatolia	1 012 576	6.9	450
Aegean	802 879	5.5	600
Mediterranean	659 334	4.5	500
Marmara	552 662	3.8	600
Total	14 616 687		

Source: MFAL 2017



Source: TÜİK, 2018

Figure 91. Changes in pasture area between 1940 and 2016

The Pasture Law

Pastures provide the main source of feed for animals and are a source of plant genetic resources as well. The constantly deteriorating pasture conditions forced governments to take urgent restoration and conservation measures.

The "Pasture Law" was adopted in 1998, setting out basic rules and procedures for sustainable use of pasture resources. The Law aims to allocate pastures to villages, municipalities, and village communities. MAF is the authorized body to determine the amount, location, and boundaries of pasture pieces to be allocated to relevant entities, then the boundaries are recorded in title deeds.

According to the Law, pasture lots can be leased under certain conditions provided that the lessee undertakes to improve the pasture.

The allocated pastures are not allowed to be used for other purposes.

The Law also has provisions to prevent over-grazing. It is envisaged by the Law that the carrying capacities of pasture pieces be determined by specially established commissions which then grant the grazing rights to the villages. Nomadic grazing was given attention by regulating the movement and grazing rights of herders. The Law recognized the importance of NGOs and their role in conservation of natural resources and collaborations were promoted.

Commissions have been working since the Law was issued to determine the capacities, boundaries, and villages for allocation of pastures. Over 40% (6.2 million ha) of the total pasture area had been allocated to villages by the end of 2015.

Condition of natural pastures by geographical region

Black Sea Region. Due to favorable climate the most productive rangelands are located here. The most productive pastures and alpine pastures are in the east of the region. Annual average dry matter production is 1 000 kg/ha. Another advantage of these pastures over the other regions is that their productive season is longer. Pastures with highest productivity are in high elevation areas. Hence herders move to highlands in summer and stay there until the end of the grazing season. This sort of nomadic grazing or traditional transhumance is known as *yayla* in the area (Figure 92). The resulting grazing pressure is high, including in forest areas.

Eastern Anatolia Region. There are fewer livestock in this area, so pasture conditions are better than in the rest of the country. The climate is well suited to pasture growth and the flora is very rich in most of the desired pasture plants such as *Festuca valesiaca* (Volga fescue), *Koelaria cristata* (Junegrass), *Thymus squarrosus* (thyme), and species of *Agropyron* and *Elymus* (wheatgrasses), *Bromus* (brome grasses), *Poa* (bluegrasses), *Medicago* (alfalfas), *Onobrychis* (sainfoins), *Trifolium* (clovers), *Sanguisorba* (burnets), *Artemisia* (mugworts), and *Teuchrium* (germanders). Because of the harsh topographic and climatic conditions in most of the region, Eastern Anatolia is essentially an animal husbandry region. Average hay production from natural pasture is around 900 kg/ha. The yayla transhumance type of grazing is also practiced in this area.

Southeastern Anatolia Region. The most heavily grazed areas occur in this region. The climate is semi-arid, and pastures dry out very quickly at the end of June. There is some nomadic grazing in the region. Since there is little spring and summer grazing, some of the livestock are moved to Eastern Anatolia

Figure 92. On the way to *yayla* in the Black Sea Region

pastures or to high mountain pastures of the southeastern Taurus Mountains in the west. Average hay yield of the natural pasture is 450 kg/ha.

Mediterranean Region. The principal vegetation above 500 masl is maquis, with the dominant plant being kermes oak (*Quercus coccifera*), a small shrub. Although there is some intensive animal husbandry around the big cities, the area is not suited for grazing large ruminants. About a quarter of the national goat population is in this region. Average hay yield of the pastures is 500 kg/ha. As in Southeastern Anatolia, vegetation at lower elevations dries out very early, stock owners move their livestock to higher elevations (as in the case of Black Sea and Eastern Anatolia Regions) for seven to eight months, and then return to their settlements at the end of the grazing period.

Aegean Region. Conditions here are similar to those of the Mediterranean Region with characteristic Mediterranean maquis (macchie or garrigue) vegetation. Hay yield of the pastures is around 600 kg/ha.

Marmara Region. This is mainly an area of intensive animal husbandry and is the least important region with respect to pastures. Average hay yield of the pastures is about 600 kg/ha.

Central Anatolia Region. Central Anatolia is an extensive high plateau with only a few high mountains and is suitable for the type of summer grazing practiced in the Black Sea, Mediterranean, and Eastern Anatolia Regions. Annual rainfall varies between 250 to 500 mm. Because of hot summers, the pastures dry out at the beginning of summer. Grazing pressure is so high that plant cover can no longer protect the soil. Major plants are *Thymus squarrosus*, *Festuca valesiaca*, *Agropyron cristatum*, *Poa bulbosa*, and *Artemisia fragrans*. These are the least productive pastures of Turkey. Annual forage yield is around 450 kg/ha. Animals generally graze on fallow lands and stubble during the summer.

Farm animal genetic resources

Archaeological findings show that sheep and goats were domesticated in the regions neighboring Anatolia (Figure 93). The diversity of species and breeds of domestic animals observed in Anatolia is testament to the prosperity of the different cultures that lived in this region over different periods. Today, animal genetic resources prosperity of Turkey is due to the varying environmental conditions and geography and the preferences of animal breeders.

Based on molecular genetic data and archaeological evidence, a significant amount of animal and plant domestication took place in the Fertile Crescent, which includes the southeastern and eastern parts of Turkey. The Fertile Crescent still has valuable and diverse genetic resources relevant to domestic animal and plant species.

Among animal species domesticated for food and agriculture, cattle, sheep, chicken, goat, and swine are the leading species which are now widely bred on a global scale. In addition to these animals which are prominent in terms of numerical and genetic diversity, the horse, bee, quail, camel, donkey, pigeon, turkey, silkworm, goose, cat, partridge, dog, buffalo, duck, pheasant, and rabbit species also contribute to domestic animal genetic diversity.

Statistics for livestock numbers, meat and milk production, live animal and meat export and import for the period 2006 to 2015 are given in Table 28. About 47% of the cattle are of high-yielding breeds, 41% are cross-breeds, and 12% are indigenous breeds (2016). These numbers were 19%, 44% and 37% respectively in 2002.

©Museum of Anatolian Civilizations

Figure 93. Alacahöyük reliefs from 1399-1301 BCE at Museum of Anatolian Civilizations, Ankara

Table 28. Statistics for livestock numbers, meat and milk production and live animal and meat export and import for the period 2006 to 2015

Item	2009	2011	2013	2015	2016
Cattle, 1 000 head	10 724	12 386	14 415	13 994	14 080
Buffalo, 1 000 head	87	98	118	134	142
Sheep, 1 000 head	21 750	25 032	29 284	31 508	30 983
Goats, 1 000 head	5 128	7 278	9 226	10 416	10 345
Horses, 1 000 head	167	151	136	123	120
Donkeys, 1 000 head	234	199	181	155	151
Mules, 1 000 head	52	48	46	43	38
Red meat 1 000 tonnes	413	777	996	1149	1173
Total milk 1 000 tonnes	15 404	19 395	23 889	25 540	25 199
Live animal imports 1 000 USD	33 664	1 028 121	346 448	322 768	603 822
Live animal exports 1 000 USD	24 366	6 215	13 464	34 473	27 914
Meat and products imports 1 000 USD	1 600	513 600	25 275	106 852	42 001
Meat and products exports 1 000 USD	154 896	390 255	614 698	444 415	370 847

Source: TÜİK, 2018

Ruminant livestock production systems

Starting from the establishment of the Republic of Turkey in 1923, large ruminants have been preferred over other kinds of farm animals. Several steps have been taken by the governments to increase large ruminant production. The main efforts have been given to genotype improvement. Initially local breeds were improved through selection; several breeds were thus treated. Programmes were implemented to distribute pure and cross-breed livestock to farmers. Later, artificial insemination centers were

established. In remote areas, where artificial insemination was not feasible, bulls of high-yielding breeds were delivered to villages. In the meantime, several research and extension projects have been organized by means of local and foreign resources. Inputs such as breeding material, medicine, feed and shelter, and animal health care have been subsidized by the state. Today animals are vaccinated free of charge against infectious diseases.

Cattle breeds. Turkey substantially meets its total milk and red meat needs from cattle breeding with its 14 million head of cattle. Import of pure breeds has been practiced by all governments. Consequently, the share of pure and cross-breeds in Turkey has increased to 87% today, from 55% in 2000. The Holstein cattle breed is the most raised, followed by Brown Swiss and Simmental breeds. Local breeds Native Black cattle, Gray cattle, East Anatolian Red, Kilis, and Zavot breeds are at risk of extinction.

Several local breeds that are described in old literature, such as, Halep, Çukurova, Dörtyol, Kırım, Kıbrıs, Seferihisar, Kafkasya, Malakan, Diyarbakır, Karacadağ, Urga, Siyah (Kalmuk), Eleşkirt, and Karaisalı have already become extinct.

Figure 94. Gray cattle

Gray cattle (Figure 94), which can maintain, feed, and breed in nature without any human intervention, at high elevations of rough and forests in western Anatolia and Thrace, where none of the exotic breeds can survive.

East Anatolian Red (Figure 95) is a medium- or small-bodied breed which is reared in Erzurum and the surrounding area. The area is typically characterized as rough, high-elevation mountain rangelands. While this breed can easily utilize high sloping lands and marginal areas of this region, exotic cattle breeds and their cross-breeds have increased at the expense of East Anatolian Reds. The East Anatolian Reds

Figure 95. East Anatolian Red cattle

Figure 96. Zavot cattle

Figure 97. Native black cattle

were preferred in the past for their meat quality as well as the characteristics of their milk which was used to make çivil cheese (a traditional East Anatolian cheese) and butter.

Zavot breed (Figure 96) has been providing meat, milk, and draft power for constraints of its region and the breeding conditions of the time. However, the breed cannot compete with exotic breeds in terms of yield and consequently local breeders have tended recently to prefer exotic breeds or crossbreds because of a decline in the Zavot's market value and increased use of technological developments.

The numbers of this breed have started to decrease due to the influence of artificial insemination.

Native Black breed (Figure 97) was reared for meat and milk and is a small-framed short-horned breed, adapted to the steppe climate of the Central Anatolia Region. It can survive harsh conditions with poor feed and is highly resistant to diseases and parasites.

Kilis or South Anatolian Red breed (Figure 98) was reared for meat and milk from İçel to Şanlıurfa and Kilis Provinces. This breed has adapted to warm climate of Southeastern Anatolia and Mediterranean Regions.

Figure 98. South Anatolian Red (Kilis) cattle

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Figure 99. Southern Yellow cattle

Native Southern Yellow breed (Figure 99) was reared for meat and milk in provinces from Mersin to Hatay and Şanlıurfa and in regions between the Taurus and Amanos mountains and the Mediterranean Sea.

Anatolian water buffalo (Figure 100)is an important animal genetic resource, which has been providing milk, meat, and draft power for centuries. Buffalo milk has an average fat content of 8% and its meat is preferred for use in traditional sausage production. The population numbered around 1 million in the 1970s, but has decreased significantly until 2007, and there has been a slight increase since then. Number of water buffaloes reached 142 000 in 2016. The reason for increment is increasing demand for buffalo yoğurt (yoghurt) and cream.

Sheep breeds. Turkey has large suitable areas for small ruminant breeding due to its geographic, climatic conditions, and agricultural production structure.

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Figure 100. Anatolian water buffalo

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Figure 101. Akkaraman sheep

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Figure 102. Norduz sheep

Native sheep breeds constitute the larger part of the total 32 million sheep population. Diversity of sheep genetic resources is higher than other farm animals with 45 recorded sheep breeds. However, some important breeds are under threat of extinction, therefore conservation programs have been launched for them.

Native sheep genetic resources such as Güney Karaman, Dağlıç, Herik, Tuj, Kıvırcık, and Hemşin breeds are under threat. Sakız, Çine Çaparı, and Norduz breeds are at critical state. Ödemiş and Halkalı breeds have already become extinct.

Depending on the region, sheep rearing systems have different characteristics, ranging from intensive to pasture based, pastoral, and almost completely free-range systems. Each native sheep breed has different and important characteristics.

For instance, meat quality of the Kıvırcık breed, the adaptability to extreme conditions of the Gökçeada and Çine Çaparı breeds, and the high fertility rate, milk yield of the Sakız breed are favorable distinct characteristics.

Akkaraman breed (Figure 101 and 104) is the most common, both in terms of total numbers and area of distribution. They are well adapted to poor pastures of arid regions. Its population is distributed throughout the Central Anatolia and Eastern Anatolia Regions.

Other sheep breeds found in the Central Anatolia Region are Kangal Akkaraman, Malya, Orta Anadolu Merinosu, and Ramlıç. Other breeds in the Eastern Anatolia Region are ***Tuj***, ***Norduz*** (Figure 102) and ***Morkaraman*** (Figure 103).

Dağlıç breed is one of the many found in the inner parts of western Anatolia. Others raised nearby are Acıpayam, Pırlak, Çine Çaparı, and Karya. In the Southeast Anatolia Region and the surrounding area, breeds such as İvesi, Güney Karaman, Hamdani, Karakaş, and Zom are common. Karayaka, Hemşin, Herik, Bafra, and Karakul breeds are the widely reared in the Black Sea Region and the surrounding area.

Kıvırcık breed is considered as the common native breed of Thrace, Marmara, and the north Aegean Region. It is well adapted to cold, and humid environmental conditions of bushy steppes. Other breeds reared in these same areas are Karacabey Merino, Gökçeada, Türkgeldi, Tahirova, and Bandırma.

Sakız breed (Figure 105) is reared under intensive conditions in İzmir as well as along

Figure 103. Morkaraman sheep

Figure 104. Akkaraman sheep herd

Figure 105. Sakız sheep

Figure 106. Hemşin sheep

Figure 107. Colored Angora goats

Figure 108. Mohair products

the Aegean and Marmara Regions coastlines, while Gökçeada sheep, a semi-wild breed, is well adapted to the environmental conditions of the Gökçeada Island where they are reared in an almost free-range system.

Hemşin breed (Figure 106) is an example of adaptation to local conditions where climate is quite rainy and humid pastures are rough and sloppy. Even under these conditions, it has a considerably high meat yield.

Goat breeds. Turkey has 10.4 million goats most of which are reared for hair. Goats are especially common in the Aegean, Mediterranean, Marmara, and Southeastern Anatolia Regions. Milk goat breeding is practised mainly in western Anatolia. Among native goat genetic resources, Kıl and Kilis breeds maintain their populations, whereas the Malta and Norduz breeds are under threat of extinction.

Anatolia is the origin of ***Ankara (Angora)*** goat (Figure 107), which is reared primarily in Ankara, some other parts of the Central Anatolia Region, and in Eastern Anatolia. Differing from other goat breeds, the Angora is specifically raised for its thin, shiny, and silky hair fiber called "mohair" which is unique to this breed. For many centuries, mohair has been an important source of income (Figure 108).

Numbers of Angora goats are steadily diminishing. There were around 6 million head of this breed in 1960, the number was reduced to 206 000 in 2015. Angora goats with colored mohair are raised primarily in Siirt, Mardin, and Şırnak Provinces, where they are known as "Siirt goat". The Color of Siirt goat mohair can be brown, black, gray, golden, cream, or silver. The colored mohair is generally used for production of blankets, rugs, bags, carpets, and pillows. A delicious dish called *büryan* made from Angora goat meat is special to the Siirt and Bitlis Provinces. It is cooked in 2-to-3 meter deep wood-fired pits.

©MAF

Figure 109. Honamlı goat

Long-term measures are needed for sustainable conservation of colored Angora goats and the local products which are important features of the past and present cultural heritage in these areas.

Honamlı breed (Figure 109), apart from being a symbol for the Taurus Mountains, is also a source of livelihood for people living in the area known as Teke. This breed has been *in situ* conserved in Konya-Seydişehir, Antalya-Döşemealtı, and Isparta-Gelendost areas within the framework of a community-based conservation program. Honamlı is originally known as the breed of nomadic tribes called *yörük*.

Poultry

The poultry sector in Turkey has shown significant progress since the 1990's, becoming the most advanced branch of animal husbandry. Poultry meat is the major protein source in the diet of Turkish people. Chicken meat accounts for about 63% of the total meat production of Turkey (2016). In addition, approximately 18.1 billion eggs are produced annually. Initially, production was limited to small-holder family investments

©MAF

Figure 110. Denizli rooster

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Figure 111. Gerze chicken

where higher unit costs applied, however, there was a structural change in the sector by investments in integrated facilities, increasing both their number and capacity. In other words, the poultry sector is more specialized now than in the past, with products at higher standards and good quality in most regions. In recent years, turkey production sector has also advanced, primarily by intensification of production. The share of turkey meat production of the overall poultry sector was 2.7% in 2015.

Honey bee genetic resources

The major prerequisites for successful beekeeping are a suitable bee flora flowering over a wide range of time. The flora of Turkey is quite suitable for apiculture, and beekeeping has a significant role in agricultural productivity. The benefits of beekeeping are twofold, production of honey and other products and pollination of crops and other plants.

The total number of honey bee colonies was 7.9 million and honey production was 105 000 tonnes in 2016. Turkey ranked second internationally in terms of honey production in 2013.

Denizli and ***Gerze chicken breeds*** are adapted to varying climatic conditions and geographical regions. Although the origin of the Denizli breed (Figure 110) is known to be Denizli Province and the area surrounding it, they are now dispersed throughout Anatolia and Thrace. Denizli roosters are famous for their 20-to-25 second long crow duration.

Gerze breed (Figure 111) was bred for egg production and hobby purposes. Breeding can be done under semi-intensive or extensive conditions.

Caucasian honey bee is one of the four important, profitable bee breeds of the world. The high valleys of the Central Caucasus are considered as the origin of the Caucasian honey bee.

Ardahan and Arvin Provinces have been identified as the center for the Caucasian honey bee in Turkey. Its most notable characteristic is its long tongue, with which it is able to forage for nectar from flowers with deep corolla tubes. As soon as the sugar ratio of nectar in flowers reaches 10 to 11%, Caucasian honey bees start collecting, whereas the ratio needs to be over 18% for other bee breeds. This increases the

©S. Akbulut

Figure 112. Honey harvesting

©M. Köseoğlu

Figure 113. Honey bee on duty

pollination efficiency of the Caucasian honey bee. Compared to the lowland type, the mountain type is regarded as more docile and resistant to diseases, shows less swarming sense and greater wintering ability, and is more efficient in terms of honey yield. All of the Caucasian honey bees are well adapted to areas with severe winter conditions.

Silkworm genetic resources

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Figure 114. Treating silkworm cocoon with boiling water

Silkworm *(Bombyx mori)* is one of the most profitable income-generating activities that one can successfully undertake for a short period of time.

It is generally regarded as a secondary occupation by the farmers involved in this activity. Sericulture used to be more widespread than it is now.

It began losing popularity in the early 1990's. Sericulture was practiced in 576 villages by 2 001 households using 5 303 boxes of silkworm eggs in 2016. The resulting amount of silkworm cocoon production was 103 tonnes.

Compared to 1991, when almost 30 000 households were involved in sericulture, current numbers appear to be too small, but there has been a steady increase in the number of households involved in this sector in recent years.

Turkey is one of the few countries in the world to produce its own production

©MAF

Figure 115. Silkworms and cocoons

material. Silkworm eggs lose viability in one year, therefore eggs need to be reproduced every year.

Bursa Provincial Directorate of MAF is the responsible public institution to conserve genetic resources of 15 different silkworm lines by an *ex situ in vivo* conservation method. Among them three silkworm lines ***Bursa Beyazı Alaca***, ***Bursa Beyazı***, and ***Hatay Sarısı*** were registered in 2004. Bursa Cocoon Sales Agricultural Cooperatives Union (KOZABİRLİK) is now responsible for management of silkworm production material.

Cat, dog, and rabbit genetic resources

Cats. Van Cat (Figure 116), which is an ancient breed from the territory of Lake Van in eastern Turkey, is now raised all over the country and in other regions of the world. Its body is mid-sized and the chest is large and deep. There are three types distinguished by eye color: "one eye blue, the one other amber", "both of them blue", or "both yellow". There are two types of hair color, either completely white or with yellowish stains on the head, back, legs, ears, or tail. It is friendly with humans and active with a good hunting instinct, likes to play games, and can adapt to different environmental conditions. An unusual trait for a cat, it likes to play with water and also swims. It pays more attention to cleaning compared to other cat breeds. Van breed is one of the officially registered national domestic animal breeds of Turkey and a research center is dedicated for Van Cat breed research under Van Yüzüncü Yıl University.

Angora cat (Figure 117) is native to Ankara Province and the surrounding area. It takes its name from Ankara city, the place of origin. Its body is mid-sized with harmoniously proportional parts. The body is covered with silky, long, white, and bright hairs, especially longer on the neck and tail. This feature was used to improve other cat breeds' hair quality in the past. Similar to the Van breed, there are the same three eye-color types. Angora cat likes to be close by humans and is faithful to its owner. Their maternal and hunting instincts are high. It is a very clever cat breed with highly developed learning ability.

Figure 116. Van cat

Figure 117. Angora cats

Dogs. Kangal breed (Figure 118) originates from Sivas Province but historically it is extensively raised throughout Anatolia to protect small ruminant flocks and as a guard dog. It has a well-built, big body with a deep and large chest and a mid-length waist. Kangal dogs are loyal to their owner and docile especially towards children and women. Its maternal instinct is good. It is brave, clever, strong, speedy, and agile. It uses its strong chest and forelegs when fighting. It has natural instincts for flock protection, and so it does its duty without human directions. It is adapted to cold and dry environments and can run as fast as 50 km/h.

Figure 118. Kangal

Figure 119. Adult Akbaş (above) and puppies (below)

Kangal breed is declared as national domestic breed and official institutions under MAF and universities with NGOs conduct pedigree breeding and conservation programs.

Akbaş breed (Figure 119) is mainly reared in Sivas, Afyon, Eskişehir, and Ankara Provinces as guard dogs and to protect small ruminant flocks. The body is medium sized and muscles are well developed, posture is athletic and elegant. Hair color is white, but the nose and mouth are black. Akbas dogs are loyal, calm and tender to their owners and due to their high protection instincts, they are skeptical of strangers. This brave, strong, agile and intelligent breed is adapted to continental climate, and resistant to harsh conditions.

Rabbits. Ankara (Angora) rabbit is a medium-sized breed that is mainly reared for wool and meat production (Figure 120).

©MAF

Figure 120. Angora rabbit

Their white, long, slim, dense, soft and bright wool is convenient for weaving. Its light, thin, heat sealing and transaudient characteristic makes the wool suitable for the textile industry and as well as many other areas such as aviation and medicine. Hot climate affects wool yield negatively, therefore it is best raised in cool climate.

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Aquatic Biodiversity

Chapter VIII

Turkish waters encompass a wide range of habitats, including open sea, marine, streams, and lakes. Besides their ecological, socio-cultural,and economic values, these habitats provide food, water, shelter, and space for aquatic animals and plants.

The Turkish shoreline stretches for 8 300 km along the Mediterranean Sea in the south, the Aegean Sea in the west, and the Black Sea in the north (Figure 121). In the northwest there is also the important inland Sea of Marmara, linked via the Bosporus Strait with the Black Sea and via the Dardanelles strait with the Aegean Sea. The Turkish coastline lies in two major biogeographical regions that exhibit varying ecological features. One is the eastern Mediterranean Sea, which covers the Aegean Sea and the Sea of Marmara and the other is the Black Sea. The salinity range varies greatly among these seas from south to north, being highest in the Mediterranean (average: 37 ppm) and lowest in the Black Sea, which once was a freshwater lake (average: 17 ppm).

The Mediterranean Sea is one of the world's biodiversity hot spots. It is a semi-enclosed sea that is linked to the Atlantic Ocean, characterized by oligotrophic conditions with low primary productivity. It is however considered to be a relatively species-rich region with a high endemic fish fauna. This richness increases eastward from the Atlantic Ocean across the Mediterranean. Most of the fish species in the Mediterranean Sea are of Atlantic origin. The high fish endemism is at risk, due to the increasing introduction and spread of Indo-Pacific fish species drawn to the seemingly more favorable conditions for them in the currently warming Mediterranean Sea.

The Black Sea is also a semi-enclosed basin that supports a dynamic brackish water ecosystem receiving a large volume of river runoff. The cooler and less-salty surface water of the Black Sea flows through the Bosporus Strait into the Sea of Marmara and then into the Mediterranean Sea. The more saline and dense Mediterranean water enters the Black Sea in the opposite direction underneath the surface layers, a density-driven hydrological regime that

Source: R. Saygılı, 2008

Figure 121. The main water bodies of Turkey including seas, rivers, reservoirs, dam lakes and natural lakes

©I. Turan

Figure 122. Purse-seine fishing along the Black Sea coast

essentially supports marine life in the Black Sea and forms the migration pathways of fish occurring there. The coastline is narrow along the Black Sea leading to a low benthic diversity. In the Black Sea, there is almost no marine life in depths beyond 150 m. Those depths form one of the world's largest aquatic dead zones, due to layers of toxic hydrogen sulphide and lack of oxygen caused mainly by the limited water exchange and high organic input.

Although the Black Sea has relatively low aquatic diversity, it supports high fish abundance in near shore waters. Depletion of top predators like dolphins, bluefin tuna, bonito, and bluefish has triggered a range of ecosystem effects altering the food web dynamics. As a result, the population sizes of planktivorous fish, such as anchovy, increased considerably in Black Sea. On the other hand, the Black Sea has been a major oil and natural gas transit route over recent years creating further environmental challenges.

Coastal and Marine Biological Diversity

The fact that the seas surrounding the country are with different characteristics makes it possible to differentiate biological resources. In Turkish waters, a total of 512 marine fish species have been listed, including recently recorded invasive species. Actinopterygii (the ray-finned fishes) is the most common fish taxon on the list (with 446 species) followed by Elasmobranchii (one of the two subclasses of cartilaginous -a firm, elastic, flexible type of connective tissue- with 64 species). The checklist indicates that the Aegean Sea is the most species-rich coastal area with 449 species, followed by the Levantine (the countries bordering on the eastern Mediterranean).

Important fish species live in the Black Sea both in terms of biodiversity and economic

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Figure 123. Long-snouted sea horses (*Hippocampus guttulatus*) found near-shore in the Black Sea

value. European anchovy, horse mackerel, atlantic bonito, bluefish, sprat, Black Sea turbot, sturgeon, whiting and sea trout are the most important species.

Sea trout known also as the Black Sea Trout (*Salmo trutta labrax*) is a highly endemic species that lives in the natural environment of the Eastern Black Sea Region whose commercial value is high (Figure 124). It has been reported that three different ecotypes (sea, stream and lake) exist in the region. Due to over fishing, pollution and degradation of natural habitats caused depletion of stocks.

Sturgeons also known as living fossils that exist on earth for some 200 million years, and are very valuable in terms of biological diversity. sturgeons are represented by 27 species in the sea and fresh waters of the northern half of Asia, Europe and America and 5 species have been recorded in Turkey including Beluga (*Huso huso*), Atlantic sturgeon (*Acipenser sturio*), Russian sturgeon(*Acipenser gueldenstaedti*), Starry sturgeon (*Acipenser stellatus*) and Ship (or bastard) sturgeon (*Acipenser nudiventris*). Kızılırmak, Yeşilırmak and Sakarya Rivers are the main spawning habitats of sturgeons in Turkey (Figure 125). Fishing was legally restricted in 1971 and completely banned in 1997. Nowadays very few specimens are recorded in a year.

The Turkish Straits System consisting of the İstanbul and Çanakkale Straits and the Sea of Marmara is an internal marine system that provides water transport between the Aegean Basin and the Black Sea and serves as a biological corridor for some fish species such as atlantic bonito and bluefish. The Sea of Marmara is an unique ecosystem as transitional medium between Mediterranean Sea and the Black Sea. Despite the deterioration in environmental conditions due mainly to the anthropogenic impacts northern coasts, the Sea of Marmara has still remarkably high biodiversity but according to the reports the number of aquatic species

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Figure 124. *Salmo trutta labrax* – Black Sea brown trout

©T. Ceylan

Figure 125. Sturgeon in natural habitat

has been declining due to the overfishing, pollution and habitat destruction.

The Mediterranean Sea has a relatively large number of species but they are limited in quantity. The most abundant species are sparids, European sea bass, European eel, sharks, seahorse, Atlantic tuna, oyster, some shrimp species, octopus, squid etc.

Seagrass (*Posidonia oceanica*) is an endemic species native to the Mediterranean, as one of the indicator species of the Mediterranean ecosystem, and lives between 1-40 m (Figure 126). The structure that holds the ground is important in terms of its location in the food chain, hosting many organisms, establishing inter-species relationships, and an important source of oxygen (1 to 2 liters of oxygen per day).

However, trawling, pollution, climate change and invasive alien species threaten marine seagrass.

Eleven marine mammal species, including ten species of cetaceans (the order comprising whales, dolphins, and porpoises) and one pinniped species, namely *Monachus monachus* inhabit Turkish waters (Figure 129).

The cetaceans are:

- Fin whale (*Balaenoptera physalus*);
- Sperm whale (*Physeter catodon*);
- Cuvier's beaked whale (*Ziphius cavirostris*);
- Long-finned pilot whale (*Globicephala melas*);
- False killer whale (*Pseudorca crassidens*);
- Risso's dolphin (*Grampus griseus*);
- Bottlenose dolphin (*Tursiops truncatus*) (Figure 130);
- Striped dolphin (*Stenella coeruleoalba*);
- Common dolphin (*Delphinus delphis*);
- Harbor porpoise (*Phocoena phocoena*).

The cetacean populations in Turkish waters have undergone a remarkable decline with little sign of recovery over the last decades.

©T.Ceylan

Figure 126. Seagrass *(Posidonia oceanica)*

These apex predators play critical roles in ecosystem functioning.

All of these marine mammals are in the IUCN Red List of threatened species, with great variability in status from species to species and the hunting of all these marine mammals has been banned since 1983.

Introduction of invasive marine species remains a continued and growing threat to marine biodiversity. 400 invasive aquatic species on the coasts of Turkey was reported in 2010. Of these, *Mollusca* was the dominant group with 105 species, followed by *Polychaeta* (75 species), *Crustacea* (64 species), and *Pisces* (58 species).

A considerable proportion of these invasive species were defined as established in Turkey, revealing the growing scale of the problem. Some examples of aquatic invasive species include rapa whelk Rapana venosa, the scleractinian coral *Oculina patagonica*, the comb jelly *Mnemiopsis leidyi*, the Caribbean shipworm *Teredothyra dominicensis*, the parasitic copepod *Taeniacanthus lagocephali*, the Japanese tiger prawn *Marsupenaeus japonicus*, the grapsid crab *Percnon gibbesi*, the gaper fish *Champsodon capensis* and the poisonous pufferfish *Lagocephalus sceleratus*. Climate change coupled with the increasing introduction and spread of non-native species in the Mediterranean and Black Sea bio-geographical Regions remain a major threat to marine ecosystems and native species.

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Figure 127. Jellyfish (*Rhizostoma pulmo*)

©A. Özdemir

Figure 128. One of the introduced species in some lakes, crayfish, *Astacus leptodactylus*

©A.C. Gücü

Figure 129. Mediterranean monk seal (*Monachus monachus*), the single pinniped species found in Turkish waters

©TUDAV / A. Tonay

Figure 130. The common Bottlenose Dolphin (*Tursiops truncatus*) is the most well-known species in the world

Hamsi: A fish associated with local culture

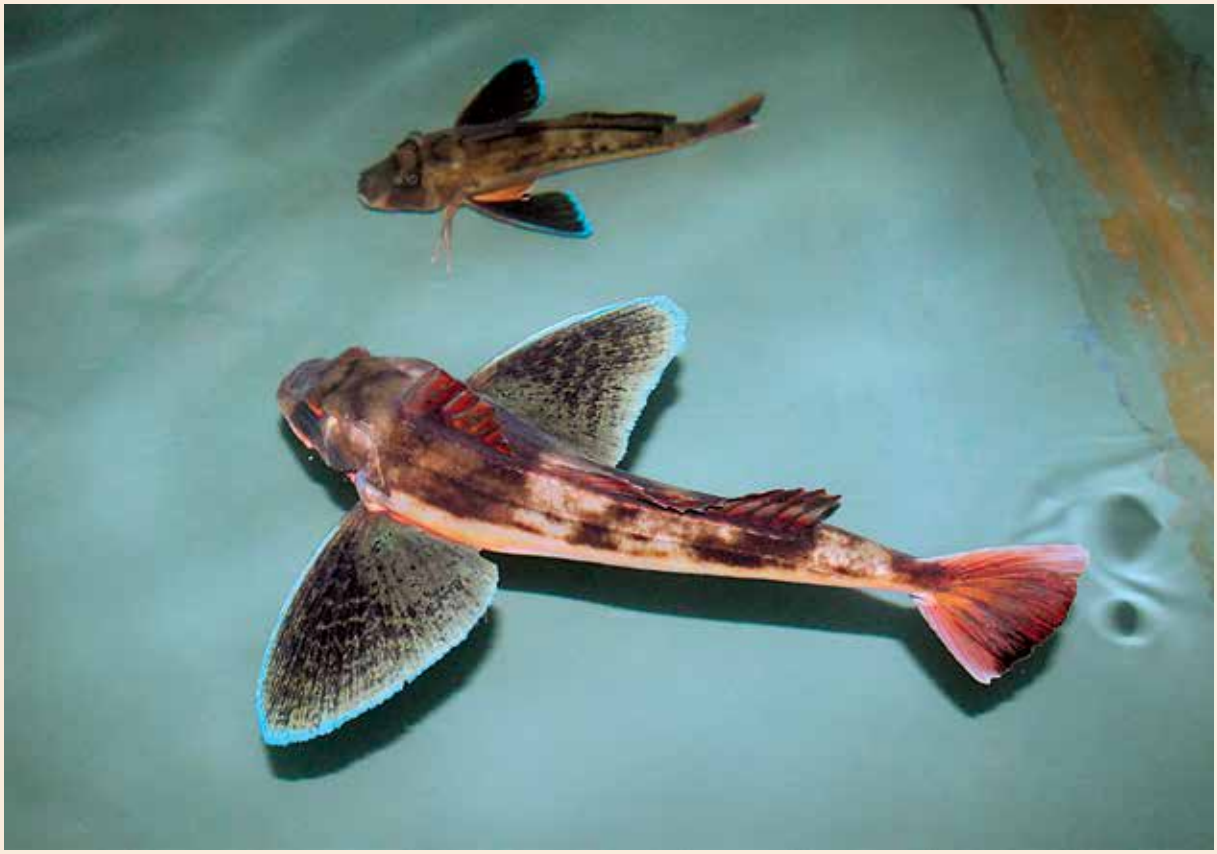
Figure 131. *Hamsi* fishing

Hamsi (the European anchovy; *Engraulis encrasicolus*) represents a unique example of a fish that invariably mingled with the cultural life in Turkey's Black Sea Region, particularly the northeast part. It is regarded as if it was something quite different from a fish. In this region, for most people, it is the king of fishes. It adds an exceptional value to the local culture. Hamsi has often been a theme of songs, literature, folk dances, and folk festivals in the region. Because hamsi are often caught in large amounts, fishers and locals are worried about fluctuations in hamsi populations, a factor even influencing the moral behavior of these people.

It is commonly said that the more hamsi is fattened, the more delicious it becomes. Fishers and people say that it is the icy-cold sea water and snow that makes the most-favored, naturally fattened hamsi. A part of the excess amount of harvest is often given free to the needy. In addition, tonnes of cooked fish are distributed free to the public in hamsi feasts organized in the cities of Black Sea Region as well as in İstanbul where a great number of people from the Black Sea Region live. It is also used as a raw material in the production of fishmeal and fish oil.

Hamsi dishes are by far the most popular dishes of Black Sea cuisine during winter time. Important hamsi dishes include: hamsi pan fried in a corn flour (*tava*); hamsi soup (*çorba*); hamsi stew (*buğulama*); hamsi meatball (*köfte*); bread (*ekmek*) with hamsi; baked hamsi with rice (*hamsili pilav*); hamsi pizza (*pide*); hamsi omelette (*omlet*); salted hamsi (*tuzlama*); and pickled hamsi (*turşu*). There is even a sweet made of anchovy. Hamsi also remains a prized, but cheap, fresh-fish choice for fish lovers from the other parts of Turkey during the winter period.

Figure 132. *Hamsi*



©M. Aksungur

Figure 133. Tub gurnard (*Chelidonichthys lucerna*)

Inland Aquatic Biodiversity

Inland water resources, composed mainly of lakes, reservoirs, rivers, and wetlands, make up about 1.5% of the surface of Turkey. Many inland fish populations are fragmented into small isolated subspecies or forms, some of them being endemic, due to a varying range of physical barriers of mountain ranges and rivers.

The inland fish fauna of Turkey belongs to different zoogeographic groups:

i) Pangea,
ii) West Palearctic and European,
iii) West and Southeast Asia,
iv) Sarmatic inland sea,
v) Mesopotamia, and
vi) Africa.

There have only been a few studies that have attempted to provide a total of the number of inland fish in Turkey. One estimate, from 2004, was 236 fish species and subspecies, belonging to 26 families, with carp being the most dominant. Of these, 42 species and 28 subspecies were identified as native to Turkey.

Some examples are: *Alburnus tarichii, A. timarensis, Aphanius anatoliae, Capoeta capoeta kosswigi, Cobitis simplicispina, Petroleuciscus kurui, Pseudo-phoxinus battalgili*, and *Salmo trutta abanticus.*

A more recent estimate, from 2014, was much larger with 371 species representing 27 families and 92 genera. In this list, Cyprinidae was the most dominant family with 193 species (52%), followed by Nemacheilidae (11%), Gobiidae (7%), Cobitidae (5%), and Salmonidae (5%). This increase in species number of the second estimate may be due, to a great extent, to the increased number of national taxonomic studies on ecological services that benefit both local and national communities since

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Figure 134. Aquatic biologists conducting a fish survey

2004 and the use of better methodologies and techniques for species and sub-species identification.

The 2014 study also reported that many species are threatened and the population sizes of a considerable number of species are declining.

Anthropogenic habitat destruction, alteration, and fragmentation; unsustainable and destructive resource exploitation practices, over fishing, aquatic pollution, eutrophication and global climate change are the essential driving forces behind this loss. The decline of aquatic ecosystems is thought to considerably affect the associated ecological processes and ecosystem structures and thus reduce the ecological services that benefit both local and national communities.

Tarek (*İnci Kefali*), *Alburnus tarichii,* is the only endemic species that has been adapted to the sodal water conditions of Van Lake. It not only exists in the lake but also in associated rivers. This enormous fish's upwards spawning migration attracts lots of people who camp around migration route to witness this extraordinary event in June every year (Figure 135). The total capture of tarek constitutes one third of total inland capture production.

Many lakes and rivers in Turkey have shrunk considerably over recent years mainly due to increasing drought and increased ground-water withdrawals, leading to profound implications for aquatic ecosystems and the species they support. The composition of native inland fish populations has been significantly changed as the result of altered natural flow regimes, mainly by building of dams.

Moreover, a number of non-native inland fish have been introduced deliberately or accidentally, into lakes, streams, and reservoirs, leading to alterations in ecosystem structure impacting the

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Figure 135. Mass upward spawning migration of tarek, endemic to Lake Van, world's largest soda lake

©N. Hız

Figure 136. Limited number of fisherwomen are involved in small-scale fisheries

Loggerhead Sea Turtle: An Endangered Species

Sea turtles, large, air-breathing marine reptiles, appeared on the earth well over 100 million years ago. They are among the oldest creatures on earth and have remained essentially unchanged throughout their evolution. They are regarded as one of the indicator species of the ocean's overall vitality. Today, there are seven species of sea turtle living throughout the world, all of which are considered either endangered or threatened. Of these, two species occur in Turkish waters: Loggerhead sea turtle (*Caretta caretta*) (Figure 137) and Green turtle (*Chelonia mydas*).

The loggerheads are at the risk of extinction in Turkish coastal areas where an estimated 30 to 50% of the Mediterranean nestling populations occur. Loggerheads have been a focus of conservation efforts in Turkey. Local people, conservationists, scientists, students, volunteers, and activist groups try to protect and monitor nestling activities. These groups, among others, clean up beaches, track the movement of loggerheads, mark nests, protect them from predators, record hatched and emerged eggs, and help baby loggerheads make their way to the sea. There are several rehabilitation centres in Turkey for sea turtles.

Loggerheads have large and strong jaws and feed mainly jellyfish, fish, squid, lobster, crabs, algae, seagrass, sponges, and corals. Loggerheads reach full maturity in 25 to 30 years, nearly half of their life span. There are around 20 breeding grounds of the loggerheads across the Turkish Mediterranean coast, most of which are now under tourism and urbanization pressures.

The loggerheads nest annually on these grounds mostly from May to August, with a peak in May to June. Nesting and hatching-out generally occur primarily at nights. The female loggerhead often lays her eggs on the sandy beaches where she once was hatched. Using moonlight, newly emerged hatchlings should find their way to the sea. Unfortunately, beach-front lighting and even distant settlement lights mislead the instinctive seaward orientation of the hatched baby loggerheads. Only a very small proportion of the hatched individuals survive to adulthood. In addition to natural threats, loggerheads face further human-induced threats such as longline and trawl fishing, marine debris (i.e., accidental ingestion of plastic bags and fishing lines), and habitat destruction of the nestling beaches, oil spills, and marine pollution.

Figure 137. *Caretta caretta*

©Y. Yılmaz

Figure 138. Cage aquaculture in Borçka dam lake, Artvin Province

abundance and composition of native fish species and other aquatic species. Some inland fish species have gone locally extinct mainly due to fish introductions. *Pseudophoxinus handlirschi* and *Alburnus akili* are examples of endemic inland species that are now considered extinct. Invasive species were reported to be the main cause of these extinctions. There is a continuous need for updating information on the conservation status of the inland fish species.

Turkey has designated a network of Specially Protected Areas for the purpose of conservation of marine biodiversity, and these constitute about 4% of national coastal waters. However, further conservation and management efforts are required for the effectiveness of the network, which covers any no-take fishery reserve.

Although resource users regard fish as a natural capital asset, intense fishing pressure has led to changes in fish size, abundance, and species composition. More actions will be required to allow increased return from aquatic ecosystem services, including fisheries. Fishing regulations dictate technical measures for the protection of commercial and vulnerable fish species. National fisheries legislation prohibits fishing of a number of fish species, including sharks, dolphins, and sturgeons, for protection purposes.

Despite their relatively ignored collective contribution to the overall national gross domestic product, both fisheries and aquaculture, directly or indirectly, contribute to local and national economies and provide approximately 53 000 jobs. The aquaculture industry has acquired notable development in the past few decades. Aquaculture, marine fisheries, and freshwater fisheries accounted for 43, 51, and 6%, respectively, of total fish production in 2016.

Anchovy typically constitute a significant part of marine capture. Atlantic bonito, pilchard, horse mackerel, sprat, whiting, gray mullet, and hake are the other primary commercial marine species.

Recovery Attempt of Sturgeon Population in Turkey

Figure 139. Tagged sturgeon

Sturgeon populations have been in endangered stage therefore fishing has been restricted more than four decades ago and eventually banned in late 1990s. Yet, still very few specimens are recorded each year.

Considering this shrinking population, MAF, the State Hydraulic Works of Turkey and the Central Fisheries Research Institute (SUMAE) and FAO collaborated under the framework of a Technical Cooperation Programme (TCP) Project named "Recovery of Sturgeon Population in Turkey: Habitat Assessment and Restocking" to support conservation activities for sturgeons in 2009-2010.

Within the scope of this project as a joint effort of the project partners, more than ten thousand tagged fingerlings (Figure 139) have been released to Kızılırmak, Yeşilırmak and Sakarya Rivers, where their main spawning habitats are in Turkey to recover sturgeon population.

As a part of this project a painting competition on sturgeon loss (Figure 140) was organized among elementary school pupils to raise awareness about sturgeons in Çarşamba distrcit in Samsun Province, where Yeşilırmak River embraces the Black Sea.

Figure 140. Winner painting in the competition (translation from Turkish):
'Please! Live! Do not go extinct my dear Sturgeon!'

©A. Özdemir

Figure 141. Local fish market

©T. Ceylan

Figure 142. Marbled crab (*Pachygrapsus marmoratus*) in the Black Sea

Aquaculture. Intensive fish farming is practiced in rivers, reservoirs, lakes, brackishwater and allocated marine off-shore areas. Limited number of aquatic species are cultured including rainbow trout, Black Sea trout, mirror carp, Siberian sturgeon and tilapia in inland waters; gilthead seabream, European seabass, common sea bream, meagre (corvina), Bluefin tuna, and Mediterranean mussel in brackishwater and marine areas.

Domestic consumers in Turkey prefer fresh fish. Annual per capita fish consumption was 6.5 kg (reported in 2016), continuing a decline in recent years. Fisheries and aquaculture made an estimated direct contribution of 3.81 billion TL (USD 1.3 billion) to the national economy in 2015.

The value of recreational fishing and other eco-tourism activities and aquatic protected areas in Turkey is not included in this figure.

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Conservation and Utilization of Plant Genetic Resources

Hevsel Gardens in Diyarbakır Province

©M. M. Süer

Chapter IX

Yedikule Bostanları in İstanbul Province

Globally, 16 928 species are threatened to go extinct or vulnerable. In Turkey there are 712 threatened species listed in Red Data Book of the International Union for Conservation of Nature and Natural Resources (IUCN) in 2017. Threats of extinction can be categorized as impacts of people's usage of plants such as excessive wild-collecting from nature for food, medicine, and other cultural purposes and as threats to plant habitat such as over-grazing, soil erosion, stubble burning, and use of heavy machinery for agricultural practices, irregular and excessive use of pesticides in agriculture, drying of wetlands, construction of big dams, urbanization, industrialization, mining activities, household and industrial waste.

Around 80% of the plants of the European and Mediterranean Region are of current or potential socio-economic use. However, there has been uncontrolled and non-sustainable harvesting of seeds, fruits, roots, rhizomes, corms, bulbs, and tubers of these species. For example, in Turkey, inflorescences of *Sideritis* species are harvested before seed setting and sometimes gathered along with the roots, putting *S. sipylea* (Spil mountain tea), *S. trojana* (Troyan tea), and *S. tmolea* (Bozdağ mountain tea) at risk.

Overexploitation for roots and rhizomes threatens *Gentiana lutea, Acorus calamus, Gypsophila bicolor, Glycyrrhiza glabra, Ruscus aculeatus*, and orchid species.

The diversity of plant genetic resources in Turkey for crops was documented in the previous section, however, the genetic diversity among crop wild relatives is being eroded at an ever-increasing rate, and the diversity of traditional landraces and old varieties of food crops is being diminished by their replacement with modern, uniform cultivars.

©M. Geçit

Conservation and utilization of plant genetic resources

Crop genetic resources and sustainable conservation of them are vital for future generations. Record numbers of humans, introduction of advances of agricultural science and technology, economic integration of the world's many diverse cultures, and globalization of agriculture threaten to destroy this legacy, enhance uniformity of cultivation practices, and lead to genetic erosion. These threats to crop genetic resources have led to the creation of conservation programs to preserve them.

There are two main genetic resources conservation strategies, namely *ex situ* and *in situ*. *Ex situ* conservation is the process of conserving components of biological diversity by removing them from their natural habitat and then housing them in artificially controlled environments such as seed banks, gene banks, botanical gardens, arboreta, and zoos. *In situ* conservation is the process of preserving and managing habitats in which populations of species considered to be genetic resources occur naturally. Such conservation efforts are typically backed up by complementary *ex situ* conservation of taxa in the managed habitats.

Plant genetic resources conservation activities were started by the establishment of the Crop Research and Introduction Center in 1964 (the more recent name of the institute is the Aegean Agricultural Research Institute, AARI). Activities were reorganized in 1976 within the framework of the National Plant Genetic Resources Research Programme with the objective of exploration, collection, conservation (both *ex situ* and *in situ*), and evaluation of existing plant genetic resources and plant diversity of Turkey for today and the future. AARI has been designated as a coordination center for the national programme.

At the present, there are different types of *ex situ* programs including seed orchards and clone banks mainly for forest tree species, gene banks (GBs) mainly used for crops and partly for forest trees, and collection gardens.

In gene banks, samples of agricultural biodiversity (seeds, cuttings, or other propagules) are stored under humidity and temperature controlled conditions or in the form of open air field gene banks. In Turkey, there are two GBs, one in Ankara at the Field Crops Central Research Institute (with 62 102 accessions) and the one at AARI in İzmir (with 59 118 accessions) (Figures 143, 144 and 145). In addition, 9 750 varieties belonging to 106 species are maintained in field GBs throughout the country run by 17 research institutes of MAF. National Botanical Garden of Turkey located in a field around 2 500 000 m^2 based in Ankara is under construction.

The opening will be in 2019 and it is going to include endemic plants garden, medicinal plants garden, geophyte plants garden, fruit tree arboretum, Research and Development Center, National Herbarium, education center and greenhouses to demonstrate the different vegetation types of Turkey. The management of genetic resources of Turkey is undertaken by the General Directorate of Agricultural Research and Policies (GDAR).

Turkish *in situ* conservation efforts were started in the 1950's, long before the concept gained wide acceptance. *In situ* protected areas have been designated under various levels of protection including national park, nature park, nature reserve area, natural site, wildlife development area, special environment conservation area, and internationally significant wetlands.

The *in situ* protected areas established for different purposes to date have reached about 6 800 000 ha in total, corresponding to about 8.6% of Turkey's surface area (Table 29).

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Figure 143. Turkish Seed Gene Bank in Ankara

However, these existing protected areas do not adequately represent all the components of biological diversity that are found in the country. For example, steppe ecosystems are underrepresented as protected areas.

In addition to *in situ* conservation of wild populations in their natural habitats, there is also need for conserving landraces of cultivated crops *in situ* in farm environments with the management practices under which they evolved.

Biodiversity research in Turkey is conducted jointly by the MAF, the Ministry of Environment and Urbanization, universities, NGOs and the Turkish Scientific and Technological Council (TÜBİTAK).

MAF coordinates and implements the agricultural research and development activities through GDAR. The GDAR is the center of the national agricultural research system.

Under the administration of GDAR, there are 10 central, 10 regional, and 28 subject-matter research centers and stations.

Mandates of GDAR are plant breeding and production, plant protection, animal breeding and husbandry, animal health, fishery and aquaculture, food and feed, postharvest technologies, biodiversity/genetic resources, organic agriculture, biosafety, and soil and water resources management.

Table 29. Protected areas, 2017

Conservation unit	Number	Area, ha
National parks	43	846 053
Nature conservation areas	30	46 797
Nature monuments	112	7 488
Nature parks	243	106 453
Wildlife development areas	81	1 189 308
Protection forests	55	250 033
Genetic conservation forests	321	42 093
Natural sites	1 273	1 322 748
Specially protected areas	16	2 460 041
Ramsar wetland sites	14	184 487
Wetland of national importance	48	714 133
Wetland of international importance	9	10 289
City forests	133	10 315
Seed nurseries	185	1 424
Clone nurseries	18	38

Source: MAF, 2018b

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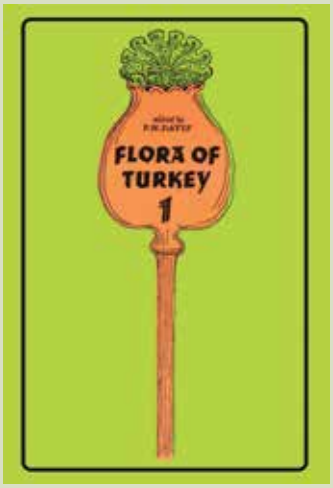
Figure 144. Seed drying room (left), cold storage (right) of the Turkish Seed Gene Bank

©G. Kırcalıoğlu

Figure 145. AARI Gene Bank in İzmir

Flora of Turkey is kept up to date



Flora of Turkey and the East Aegean Islands was published by P.H. Davis in nine volumes from September 1965 to December 1985.Since then, the Flora has received considerable attention from botanists, both in Turkey and abroad. The first Supplement, published in 1988, includes accounts of an additional 472 numbered taxa at species rank or below, together with accounts of some other imperfectly known taxa. Since the publication of the first Supplement (Volume 10), two check-lists had been published in 1994 and 1999, which included almost all the new findings relating to the Turkish flora. These check-lists provided a good starting point for the second Supplement published in 2000 which includes accounts of an additional 567 numbered taxa at species rank or below together with accounts of some other imperfectly known taxa.

Since 2000, many studies about additional taxa in the flora of Turkey have been published and many check-lists have been prepared. A Checklist of the Turkish flora was published in 2012 together with Turkish names of all the plants existing in the flora. The first volume of Illustrated Flora of Turkey was published by Turkish scientists with contributions from national and international collaborators in 2014. Second volume of the flora was published in 2018.

A milestone for plant genetic resources studies: The work of Mirza Gökgöl (1897-1982)

Figure 146. M. Gökgöl working in wheat field

Mirza Gökgöl, a leading plant scientist in the XX century, not only collected and evaluated wheat, barley, and lentil landraces as well as their wild relatives in Turkey during the period from 1929 to 1955, but also contributed to other agricultural aspects of Turkey, by publishing books on potatoes, castor bean, poppy, sweet clover, etc.

Mirza Hacızade (Gökgöl) was born on 14 September 1897 in the Ganja Province of Azerbaijan. He started school in Male High School of Ganja in 1906 and graduated in 1919. After graduation, he studied agriculture in Novoaleksandriysk Institute of Agriculture, Krakow between autumn 1916 and end of 1917. At the beginning of 1920 he enrolled in the Portici High Agricultural School, Naples, Italy. He stayed about six months in Italy then left the school and transferred to the Higher Agricultural School of Berlin, Germany. He completed his studies on 23 December 1924 but continued there as a PhD student.

After he completed his PhD studies in Germany, he was invited to Turkey by the Ministry of Agriculture to establish a research institute in İstanbul. Then he was employed by the Ministry of Agriculture in 1929 as a plant breeder. He was allocated the necessary amount of land, equipment, and tools for plant breeding activities and a budget for expenses.

He centered his work on large cereal collections and potatoes, which Turkey needed to feed the increasing population. His particular interest was the cereal collections, mostly wheat. He worked as "a one-man army" for several years characterizing landraces of several crops. Finally, he defined 256 new morphological forms (botanical varieties) for the first time in 18 000 accessions collected from 1927 to 1934. Mirza Gökgöl is considered the pioneer of plant genetic resources studies in Turkey and his publications are still referred as invaluable resources by breeders and scientists working on plant genetic resources.

Figure 147. A view from NGBG

A paradise in the middle of İstanbul: Nezahat Gökyiğit Botanic Garden (NGBG)

Recently private foundations have participated in *ex situ* conservation activities. Among them NGBG is one of the most successful examples. In 1995, Ali Nihat Gökyiğit, to commemorate his late wife, Nezahat Gökyiğit, started a planting and reforestation plan on 46 ha of land at a motorway intersection which was leased from the Roads Directorate.

Initially, the area was cleared of debris created by the motorway construction and the soil was improved prior to planting approximately 50 000 trees and shrubs. It was officially opened to the public as a Park in 2002, but as its function changed, in 2003, it became the NGBG. New thematic areas are added by incorporating untouched parts.

The mission of the NGBG is to create a beautiful educational garden that also protects the environment, a green lung for the city. NGBG aims to raise public awareness on conservation by training and educating people, conduct research activities, and publish scientific books and periodicals. For example, it publishes *Bağbahçe Magazine, Illustrated Flora of Turkey, A Checklist of the Flora of Turkey* (*Vascular Plants*), and *Gardens and Plants of İstanbul.*

Figure 148. Geophyte collection in NGBG

Farm animal genetic resources and their conservation

Farm animal genetic resources covers all animal species, breeds, strains, and populations and their wild and semi-domesticated relatives, used for food and agricultural production. They comprise about 40 species of domesticated animals that have been diversified into more than 7 000 breeds during the 12 000 years since human beings domesticated and started to raise livestock. According to the FAO, only about 42% of livestock breeds have been known well enough to permit an estimate of their status; of these, just over one half are at risk or have already gone extinct.

Animal Genetic Resources Research Coordination Unit of the GDAR monitors the national and international development of the subject and organizes relevant activities as the national focal point for animal genetic resources. This is carried out by means of two mechanisms.

One is the "National Committee on Conservation of Domestic Animal Genetic Resources" which sets the goals and policies relevant to conservation activities and the second is "the Advisory Commissions" which resolve and release recommendations on emerging issues. Stakeholders from breeders' associations, NGOs, universities, and other relevant institutions take part in the established committees and commissions.

Farm animal genetic resources conservation actions are classified into two strategies namely, *in situ* conservation and *ex situ* conservation, with the distinction that *ex situ* conservation can be further classified as taking place *in vivo* or *in vitro*. *Ex situ in vivo* conservation is the maintenance of live animal populations under artificially established environments such as zoological parks or governmental farms. *Ex situ in vitro* conservation is conducted under cryogenic conditions including the cryoconservation of embryos, semen, oocytes, somatic cells, or tissues having the potential to reconstitute live animals later. *In situ* conservation means maintenance of livestock and production systems under ordinary conditions of agriculture. All the above-mentioned methods are implemented for the conservation and sustainable use of animal genetic resources in Turkey. Special conservation flocks outside natural habitats were launched in research institutions in 1995. A "Community-Based Conservation Programme" was launched in 2005. Conservation of genetic materials in gene banks was launched with the project called "*In vitro* Conservation and Preliminary Molecular Identification of Some of Turkey's Domestic Animal Genetic Resources-I" in 2007.

Risks and projections for farm animal genetic resources

Reliable data is not available on presence, distribution, and risk status of farm animal genetic resources in Turkey. Such information is produced from research findings, expert assessments, and various surveys. Yet it is evident that significant losses have occurred in the last 50 years.

To avoid erosion in animal genetic resources, activities concerning conservation of local breeds in their original breeding areas were initiated and facilitated by means of subsidies in the form of direct payments.

At the beginning of the programme, the main difficulty encountered was to provide pure-bred animals to work with. Even some breeds were at the edge of extinction. The subsidies provided for this purpose were impressive for attracting public interest on the subject.

The state of national programs, training, and legislation relevant to biodiversity conservation

Turkey has been a party to several international agreements regulating the trade and conservation of biological resources. Some are listed in Table 30. The country has made great efforts in the implementation of these international agreements by adopting national legislative frameworks such as those listed in Table 31.

Turkey is a member of or partner to many international organizations related to biodiversity issues such as WB, WHO, UNESCO, IUCN, WWF, FAO, Bioversity International, ICARDA, CIMMYT, IUFRO, UNDP, ECPGR, UPOV, International Standard for Sustainable Wild Collection of MAPs, EUROPAM, EUFORGEN. Turkish ministries including MAF and Ministry of Environment and Urbanization are the leading institutions for the implementation of the laws and regulations related to the conservation of natural resources.

A number of NGOs such as the Turkish Foundation for Combating Soil Erosion (TEMA) and WWF-Turkey and their activities have increased lately. Protection sites (i.e. archaeological, cultural, and natural conservation), national parks, nature parks, nature conservation areas, nature monuments, biogenetic reserve areas, protection forests, gene conservation forests, seed stands, and GMZs are among the many efforts across the Turkish landscape to identify and protect natural resources and environments.

Table 30. International agreements, conventions, and treaties relevant to biodiversity signed by Turkey

Agreement, convention and treaty	Year
Barcelona Convention for the Protection of the Mediterranean Sea Against Pollution	1981
Convention on the Protection of World Cultural and Natural Heritage	1983
Convention on Long-range Transboundary Air Pollution	1983
Co-operative Program for Monitoring and Evaluation of the Long-range Transmission of Pollutants in Europe (EMEP)	1984
Convention on the Conservation of European Wildlife and Natural Habitats (Bern)	1988
Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean	1988
Convention for the Protection of the Ozone Layer (Vienna)	1990
International Convention for the Prevention of Pollution from Ships (MARPOL)	1990
The Montreal Protocol on Substances that Deplete the Ozone Layer	1990
Convention on the Protection of the Black Sea Against Pollution (Bucharest)	1994
Convention on Wetlands of International Importance Especially as Waterfowl Habitats (Ramsar)	1994
Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (Basel)	1994
International Convention for the Protection of Birds (Paris)	1996
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	1996
The UN Convention on Biological Diversity (CBD)	1997
The UN Convention to Combat Desertification	1998
Protocol on the Prevention of Pollution of the Mediterranean Sea by Transboundary Movements of Hazardous Wastes and Their Disposal (İzmir)	2003
Convention on European Landscape	2003
UN Framework Convention on Climate Change	2004
The Black Sea Biodiversity and Landscape Conservation Protocol	2004
Cartagena Protocol on Biosafety	2004
International Treaty on Plant Genetic Resources for Food and Agriculture	2006
Kyoto Protocol to the UN Framework Convention on Climate Change	2009

Source: MFAL and MFWA, 2017

Table 31. National laws concerning biodiversity conservation in Turkey

Law	Year
Forestry Law	1956
Law on Agricultural Combat and Agricultural Quarantine	1971
Law on Fisheries	1971
Environment Law	1983
Law on National Parks	1983
Law on Protection of Cultural and Natural Assets	1983
Law on Prevention of Smuggling	1986
Decree Law on Establishment of Environmental Protection Agency for Special Areas	1989
The Coastal Law	1990
Afforestation and Erosion Control Mobilization Law	1995
Decree Law on the Protection of Patent Rights	1995
Pasture Law	1998
Customs Law	1999
Animal Breeding Law	2001
Terrestrial Hunting Law	2003
Law Concerning the Approval of the Appropriateness of the Cartagena Biosafety Protocol of the CBD	2003
Law on the Organization and Duties of the Ministry of Environment and Forestry	2003
Animal Health and the Police Law	2003
Animal Protection Law	2004
Law Concerning the Approval of the Appropriateness of the Protocol on Conservation of Biological Diversity and Landscape in the Black Sea of the Convention on Protection of Black Sea Against Contamination	2004
Organic Agriculture Law	2004
Law on Protection of Breeders Rights Concerning New Plant Varieties	2004
Law on Soil Conservation and Land Use	2006
Agriculture Law	2006
Law on Amending the Environment Law	2006
Seed Law	2006

Source: MFAL and MFWA, 2017

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Gazelle protection

Figure 149. Gazelle

There are about 168 mammalian species in Turkey, 22 of them are on the verge of extinction on a global scale. Among them large herbivorous mammals are the most vulnerable ones. Sand and mountain gazelles, Anatolian wild sheep, fallow deer, and wild goats are all defined in the latest IUCN Red List of Threatened Species as "vulnerable to extinction".However, these species are more attentively protected at the local level than on the global scale. Intensive protection efforts are carried out on these species in Turkey. While gazelles have been found in a large area from Çukurova at the south to eastern Anatolia at the beginning of the XX century, their habitats shrank gradually due to over-hunting, heavy use of agricultural chemicals, habitat fragmentation, and habitat change. Today there are two gazelle species in Turkey: one small population of sand gazelle (*Gazella marica*) in Şanlıurfa Province and a small population of mountain gazelle (*G. gazella*) in Hatay Province.

Gazelle protection programs first started in 1978 at Ceylanpınar State Farm of Şanlıurfa Province with establishment of a gazelle breeding station. Later on, as the size of the protected population reached the desired number, two small populations were repatriated to nature in Kızılkuyu and Erikçe districts.

GDNCNP started a mountain gazelle breeding program by establishing a station in Hatay Province. Consequently, the mountain gazelle population significantly increased to maintenance levels. To support these conservation efforts, local NGOs are conducting public awareness activities in both provinces.

Figure 150. A small flock of gazelle in wild

Bozdağ wild Anatolian sheep protection

The Bozdağ wild Anatolian sheep (*Ovis gmelini anatolica*) used to be widespread in Turkey, but their number dropped to less than 100 in the 1960's. The GDNCNP assigned 3 430 ha of land as a protection site in Konya Province for this species.

The area was fenced, and the sheep were maintained for several years.By 1999, their number was over 600 and by the 2000's the population was at a sustainable size. However, the danger of extinction was still not eliminated.

Formerly there had been several populations in various parts of the country, but in this protection area there was only the single population confined in a single remote, uninhabited area.

In this case, two major challenges emerge: first is the decreasing genetic base and second is the risk of a disease epidemic. Having seen the risks that the population might face in the future, officials of the GDNCNP began to search for a suitable location to establish a duplicate conservation site.

Ultimately, in 2004, a part of the population was introduced to the Bozdağ station in Karadağ area of Karaman Province and protection efforts began.

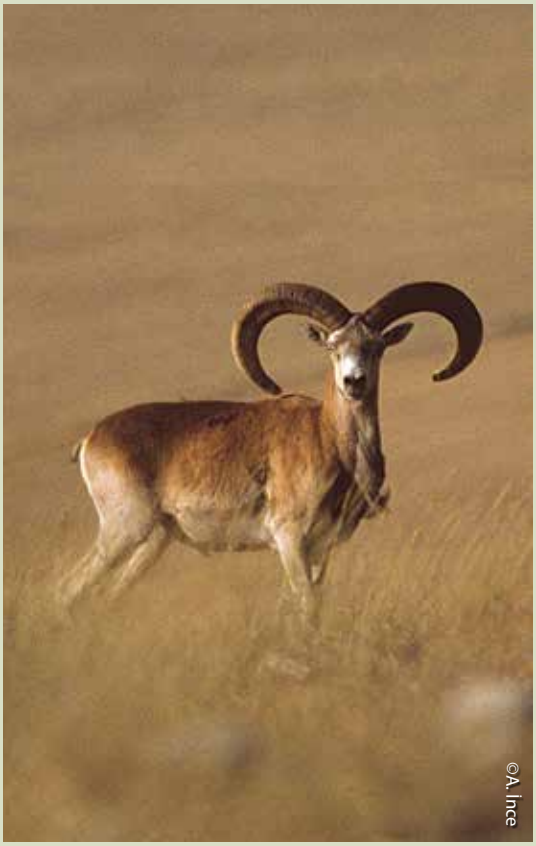

Figure 151. The Bozdağ Anatolian sheep

Figure 152. A flock of the Bozdağ Anatolian sheep in winter

Conservation of the Bald Ibis: A relict bird from ancient times

According to a legend, the bald ibis, *Geronticus eremita* (*Kelaynak* in Turkish) was freed by Noah from the ark to guide them in the flood and since then, became a symbol of spring and fertility. This large black bird's main characteristics are its featherless head and neck and an elongated, curved, sharpened red beak. Rest of their body is covered with dark blue purple feathers.

The bald ibis prefers rocky areas of North Africa, Eastern Mediterranean, and Middle East, where they can nest and breed in colonies on steep rock cliffs to protect their offspring and themselves from predators and humans. They mainly feed on insects, lizards, snails, beetles, worms, ants, snakes, and scorpions by probing with their long beak into cracks in the soil.

The Northern Bald Ibis is in the Red List of Threatened Species published by IUCN. One of the world's most endangered birds, northern bald ibises remaining in the wild were almost being extinct (by 1997, there were fewer than 100 adults in wild). The drop in their numbers was due to several reasons, mainly the use of chemicals in their feeding areas, heavy hunting, and habitat destruction in Turkey. The species is now restricted in Turkey to a small rocky area in the Birecik District of Şanlıurfa Province. The species can also be found in Morocco and lately in Syria.

The GDNCNP established a special breeding station for Kelaynaks in Birecik with the help of the Royal Society for the Protection of Birds, where they successfully saved and multiplied them in captivity. They are kept in specially constructed big nets to mate in February and March and then around mid-July they migrate further south to North Africa, returning to Birecik starting from mid-February for nesting again. During their nesting time in Birecik these social birds start out early in the morning and fly in groups to their feeding areas 10 to 15 km away from the station. The programme has been successful so far, with numbers reaching 205 as of March 2016. The intent is to allow the birds to migrate once the population reaches a stable 100 pairs, excluding the young ones.

Figure 153. Bald ibis nests in Birecik Town of Şanlıurfa Province

Bio-cultural diversity and ethno-biological heritage

Figure 154. Animal figures on the ruins of Göbeklitepe

Turkey's unique cultural and biological diversity have created a very distinctive and multilayered ethno-botanical and ethno-biological heritage. The flora is diverse and includes the wild ancestors of many cereals and other basic food plants. One third of the floral diversity is endemic. Groups of hunter-gatherers employed the plant and animal richness of Anatolia to fulfil their basic needs for food, medicine, tools, clothing, and shelter by trial and chance.

Göbekli Tepe, in the Southeastern Anatolia Region provides us with a new vision for a hunter-gatherer settlement with circles of massive T-shaped stone-pillared sanctuaries. The settlement attests to many centuries of activity, beginning at least as early as the epipaleolithic period, c. 10 000 BCE.

The pillars of these ritual compounds were decorated by low reliefs, depicting mammals such as lions, bulls, boars, foxes, gazelles, and donkeys; snakes and other reptiles; insects; and birds such as cranes and vultures. These reliefs indicate not only the richness of wildlife, but also imply the intimate knowledge and visual creativity of the inhabitants of the region.

Humans probably made a fundamental impact on this diversity. Earliest inhabitants changed their hunter-gatherer mode of subsistence, settled down, and brought the "Neolithic Revolution" about 12 000 years ago. Over millennia, farmers developed countless landraces of food plants, while still continuing to also gather from the wild.

Over 1 200 taxa of wild plants are recorded as edible in Turkey, and this heritage indicates an on-going transmission. People today in Anatolia consider wild plants as an essential part of their well-being and cultural distinctiveness. In addition to nutritional values, the "taste" of these wild plant foods, the traditional recipes of the local cuisines, and the social aspects of gathering and sharing these wild plant foods are among the basic motivations for the continuity of plant gathering for food.

Figure 155. Animal figures on the ruins of Göbeklitepe

Figure 156. General view of Göbeklitepe excavation area

Food preparation techniques

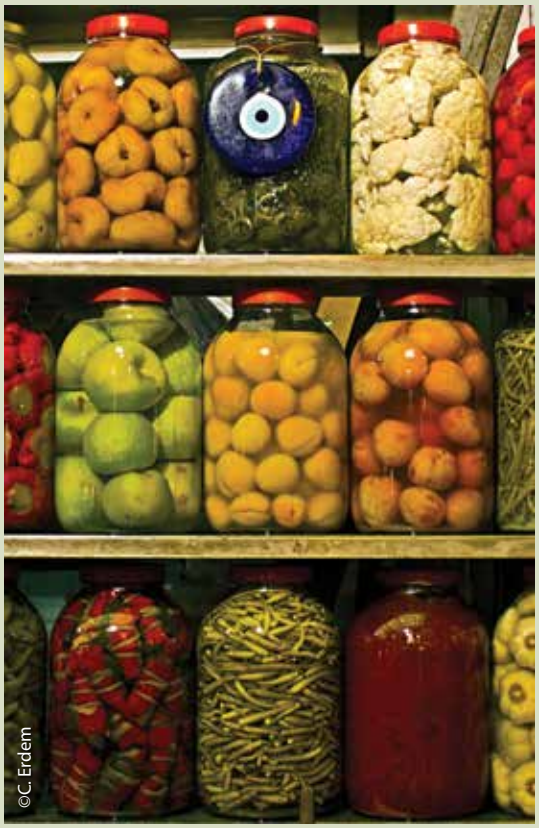

Figure 157. Pickled fruits and vegetables

Food preparation and storing techniques also show substantial diversity. Various ways of drying, boiling, roasting, fermenting, pickling, and canning have been used and foodstuffs were stored in many types of containers, including rock-cut cellars, silos, pots, and baskets. However, this long-established heritage of gathering is in a transformation stage now and has partly eroded due to rapid modernization, migration to towns, and changes in social relations.

The richness of agro-biodiversity is also in danger due to "visually appealing and more productive" modern crop varieties. In one pilot project related to fruit diversity in Muğla Province, the local names of about 550 local varieties of 28 types of fruits have been recorded. Among these, pears, almonds, and grapes lead in diversity with over 60 landraces each.

There is a need for more systematic studies on traditional knowledge by young generations of ethno-biologists, and elder generations must be encouraged to transmit the know-how to youngsters. This bio-cultural heritage is the guarantee of food, health, and industrial resources for the future.

Figure 158. Drying fruits

Globally Important Agricultural Heritage Systems

To provide systematic support to a holistic management of natural resources, in 2002 the UN FAO launched the Conservation and Adaptive Management of Globally Important Agricultural Heritage Systems (GIAHS).

Such systems are defined as "remarkable land use systems and landscapes which are rich in globally significant biological diversity evolving from the co-adaptation of a community with its environment and its needs and aspirations for sustainable development".

"Identification, Assessment and Stewardship of Globally Important Agricultural Heritage Systems for the dynamic conservation of agricultural biodiversity in Azerbaijan and Turkey" as one of the GIAHS projects conducted in Turkey and is funded through FTPP.

The targeted agricultural systems are from Southeastern Anatolia, through which the Fırat (Euphrates) and Dicle (Tigris) Rivers flow and which basically forms the upper part of the Fertile Crescent and include a natural dyeing and weaving system, a rice production system, and a grape production system.

Figure 159. Making grape molasses (*pekmez*)

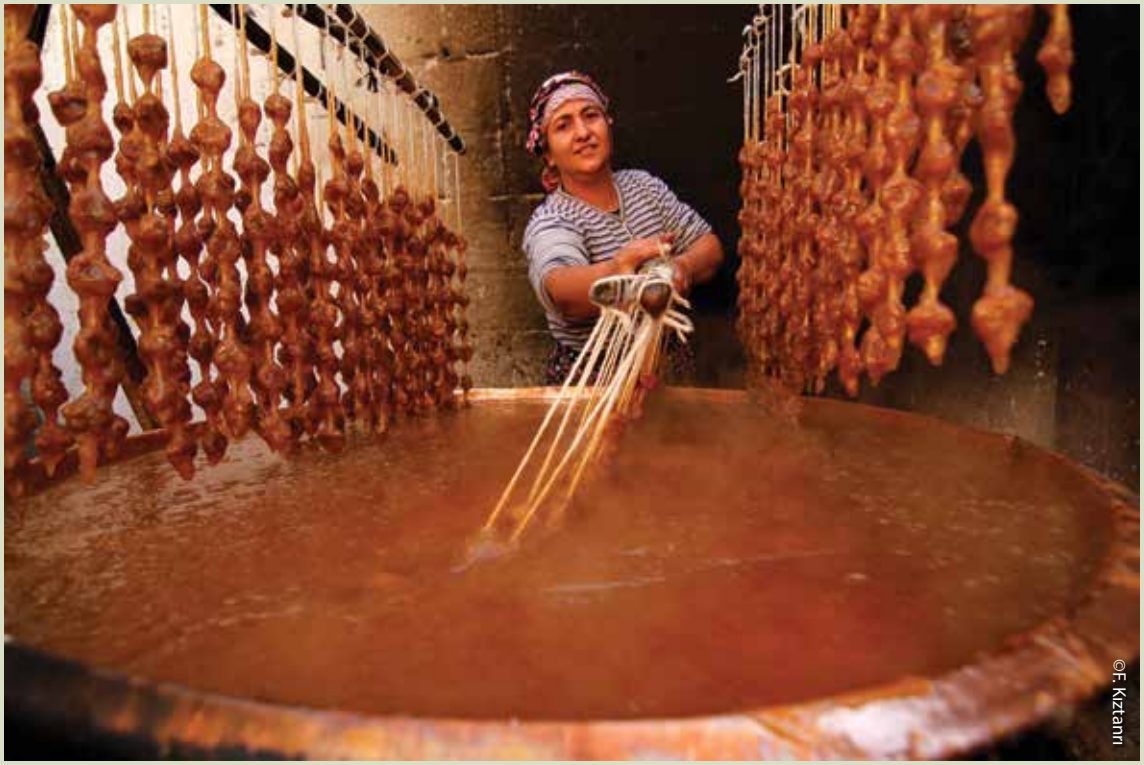

Figure 160. Many products are obtained from grapes

An example for conservation of traditional knowledge: natural dyeing and weaving by using local genetic resources

Natural dyeing and weaving, performed by disadvantaged and poor women living in rural areas, have been important sources of income for rural communities in Turkey for many decades. As it depends on dye plants, the rural community cultivated those plants on their fields in the past to provide material to the sector.

Due to lower costs of synthetic material, natural dyeing and weaving systems have been gradually abandoned. Today natural dyes have gained their former acceptance and are still the most widely used material in traditional carpet and rug weaving. There is a chain of material acquisition by different sectors. It starts with provision of sheep wool by sheep-keepers in the uplands.

The women in rural areas dye that wool by using natural dyes from plants. This dyed wool is used to weave carpets or rugs. This has been an art performed by women in remote rural areas for many years as a major source of income. Demand for naturally dyed products in and out of Turkey is high. The system is inherited as part of a local artistic tradition reflecting a rich culture and regional biodiversity.

Some of the endemic, rare, and vulnerable dye plant species are: *Isatis demiriziana*, *I. mardinensis, Hypericum salsolifolium, Verbascum glabiferum, V. lysiosephalum, V. racemiferum, V. stepporum, V. tenue,* and *Alkanna tricophilla* var. *mardinenesis* in the southeastern of Turkey, particularly in Diyarbakir Province.

Other dye plants are widespread in the region. Some examples are: *Carthamus persicus, Echinophora tenuifolia* ssp. *sibthorpiano*, *Glycyrrhiza glabra*, *G. g.* var. *glabra, G. g.* var. *glandulifera, Hypericum triquetrifolium, Juglans regia, Prosopis farcta, Punica granatum, Quercus brantii, Q. infectoria, Reseda lutea, Rheum ribes,* and *Rhus coriaria.*

Figure 161. Spinning thread with *kirmene*

From raw material to carpet

While in some areas, silk yarn is still in use, wool is the primary raw material of rugs and carpets. Sheep shearing, the first step of wool production, takes place once in a year in April, May, and June depending on the region. In most regions, the sheep are sheared on a day fixed by the local community. The community meets at a large open area and shears their sheep in a festival.

The festival is an indication of collaboration between the local people of the region with thousands of people coming from neighboring districts and provinces to participate. The second step is to produce fiber from the sheared wool. The wool is cleaned, washed, and pounded to prepare it for combing. Combs are especially prepared for this purpose which produces the wool skein. The fiber is obtained by m eans of a wool spindle that is called a *kirmene*. The final step in the preparation of the yarns prior to use is dyeing by means of local dye plants using conventional methods.

Figure 162. Weaving rug

Figure 163. Dyed threads in different colours are ready for weaving


©Y. Topçu

Protection and Utilization of Geophytes

Geophytes are multi-purpose plants utilized as medicinal, aromatic, ornamental, raw material for food, beverage, medicinal and pharmaceutical industry and food for human and wild animals. Presence of over 1 000 taxa of geophytes makes Turkey an attractive place for scientists who wish to collect and utilize them in their breeding programs.

On the other hand, collecting from nature is a common practice for hundreds of years both for local consumption and export. Wild collecting places huge pressure on the populations of some of the highly demanded geophyte species. Utilization of genetic resources, which is one of the three objectives of CBD, is not always practiced in a sustainable manner, especially in the case of geophytes.

Although Turkey runs national programs for cultivation of medicinal, aromatic and ornamental plant species, the potential within the geophytes has not been exploited at desired level by commercialization and cultivation of those species.

Two projects have been designed by Atatürk Horticultural Central Research Institute of GDAR, supported by the Scientific and Technological Research Council of Turkey (TÜBİTAK) for intensive collection, propagation, release and commercialization of suitable geophyte species. The project has also enabled the evaluation of a significant portion of the biodiversity along with inventory and registration of genetic resources, to facilitate a way through providing benefits out of use of genetic resources, which is the third objective of the CBD.

The projects entitled "The collection, characterization, cultivation and industrialization of some natural ornamentals", and "Cultivation studies of Turkey's geophytes and contributing new species and cultivars to the relevant industries" were supported by TÜBİTAK between 2005 and 2015. All the floristic regions of Turkey were covered several times at suitable times of year to locate the geophytes, then they have been collected at proper time to prepare herbarium specimen for identification, and the same areas have been visited again for collecting bulbs, corms, rhizomes and seeds to regenerate. So far 1 081 geophyte taxa, with 181 rare endemic and 461 endemic have been collected out of 7 000 populations. Total geophyte collection space of the institute is 40 000 m^2 including a geophyte greenhouse with a total volume of 2 200 m^2, which is the most sophisticated one of Turkey.

The greenhouse is equipped with coolers and humidifiers to simulate climatic conditions of original habitats of species where they have been collected. The greenhouse not only serves as *ex-situ* conservation facility but also as an environment to facilitate breeding activities such as selection, crossing between and within species and finally production of parental material of the elite lines.

The project has helped a huge collection of all geophytes of Turkey, to conserve in one facility and three volumes of books with photos of the plants. Among the collected material 31 new geophytic species have also been described. Some of newly recorded species and their locations are as follows: *Allium aksekiense* (Akseki Onion) and *Allium kayae* (Saimbeyli Onion) from South Anatolia, *Bellevalia undulatifolia* (Manavgat Hyasinth) from Antalya; *Colchicum erdalii* (Eğin Saffron) from Erzincan; *Colchicum osmaniyense* (Osmaniye Saffron) from Osmaniye; *Muscari artvinense* (Artvin Hyasinth) from Artvin; *Muscari erdalii* (Erdal Hyasinth) from Mersin; *Muscari ufukii* (Tall Hyasinth) from Gaziantep and *Ornithogalum adanense* (Adana Grass Lily) from Adana Province. Finally *Paeonia* samples collected from Çanakkale Province

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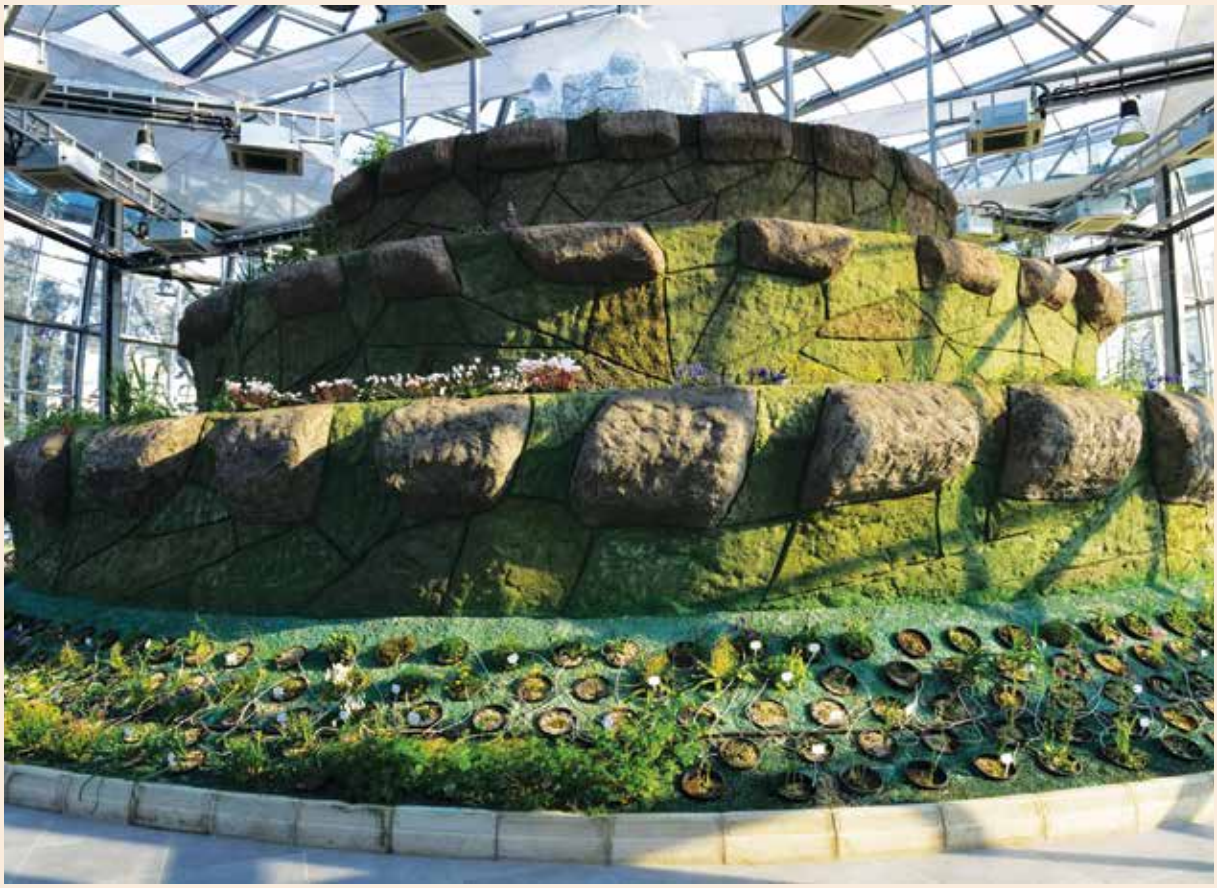

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Figure 164. Geophytes Research Center in Atatürk Horticultural Central Research Institute, Yalova Province

Colchicum baytopiorum

Lilium akkusianum

were identified as natural hybrids, and named *P.x kayae* (Mottled Peony), were subsequently added as a new taxon.

All these recently discovered natural taxa are endemic to Turkey, and intensive studies are being undertaken now for culturing and breeding objectives.

They have already been shown to have very high potential as ornamentals or for medicinal and aromatic plant industries. On the other hand hybridization and selection studies continued to release commercial varieties out of collection. So far 4 *Paeonia*, 3 *Fritillaria*, and 3 *Tulipa* species have been registered with 3 *Paeonia*, 3 *Lilium*, and 3 *Iris* varieties at the final stage of registration process.

Another output of the project is 3 volumes of "Ornamental Plants Variety Catalog" presenting 236 varieties of ornamental plants produces through hybridization and selection studies.

Figure 165. *Sternbergia candida*

Figure 166. *Scilla mesopotamica*

Figure 167. Published books


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Best Agricultural Practices for Enhancing Biodiversity

Chapter X

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Ecosystem services comprise the many resources and processes supplied by nature. Those services include clean drinking water, edible and non-edible biological products, and processes that decompose and transform organic matter.

Five categories of services are recognized:

- provisioning services such as the production of food, water, carbon and raw materials;
- regulating, such as the control of climate, soil erosion and pests and disease;
- supporting, such as nutrient and hydrological cycles, soil formation and crop pollination;
- cultural, such as spiritual and recreational benefits; and
- preserving, which includes guarding against uncertainty through the maintenance of biodiversity and sanctuaries.

Agriculture in Turkey faces many challenges nowadays. It has to produce more food, feed and other raw materials to satisfy the increasing demands of the growing population. Agriculture must also contribute to economic prosperity and social well-being, while protecting natural resources such as soil, water and biodiversity. Farming is particularly required to demonstrate how well it performs in terms of sustainability because agriculture is a user of finite resources and affects biodiversity. In this regard, there is a growing interest in Turkey, concerned with improving the relationship between agricultural production and the environment. Indeed, agricultural sustainability is a cross-cutting priority, through ecosystems conservation, biodiversity improvement, preservation of water and soil quality in agriculture-related ecosystems. Undoubtedly, biodiversity is a key aspect of agricultural sustainability, but conventional tillage farming, based on ploughing has degraded soil health and its biodiversity. Indeed, the tillage intensity influences agro-biodiversity.

Figure 168. Ploughing facilitates soil erosion and CO_2 emission

Adoption and promotion of conservation agriculture in Turkey for sustainable land, water and nature management

Conservation Agriculture (CA) is based on three interlinked principles:

1. Minimizing soil disturbance by mechanical tillage and thus seeding or planting directly into untilled soil, eliminating tillage altogether once the soil has been brought to good condition, and keeping soil disturbance from cultural operations to the minimum possible.
2. Maintaining year-round organic matter cover over the soil, including specially introduced cover crops and intercrops and/or the mulch provided by retained residues from the previous crop.
3. Diversifying crop rotations, sequences and associations, adapted to local environmental conditions, and including appropriate nitrogen fixing legumes; such rotations and associations contribute to maintaining biodiversity above and in the soil, contribute nitrogen to the soil/plant system, and help avoid build-up of pest populations. In CA systems, the sequences and rotations of crops encourage agrobiodiversity as each crop will attract different overlapping spectra of microorganisms.

It is widely recognized that CA represents one of the new "biological and ecosystems" paradigms for sustainable agricultural intensification that can include arable and perennial crops, pastures as well as trees and livestock. CA complements other systems such as agro-forestry and organic farming that can benefit from integration with CA practices, and CA-based crop-livestock systems offer high sustainable animal carrying capacity. CA experience worldwide over the past four decades has demonstrated how the simultaneous application of its principles can lead to greater and stable

Figure 169. Three interlinked principles of the Conservation Agriculture

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Figure 170. No-till planting of pulses after harvesting wheat

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Figure 171. No-till field attracts birds

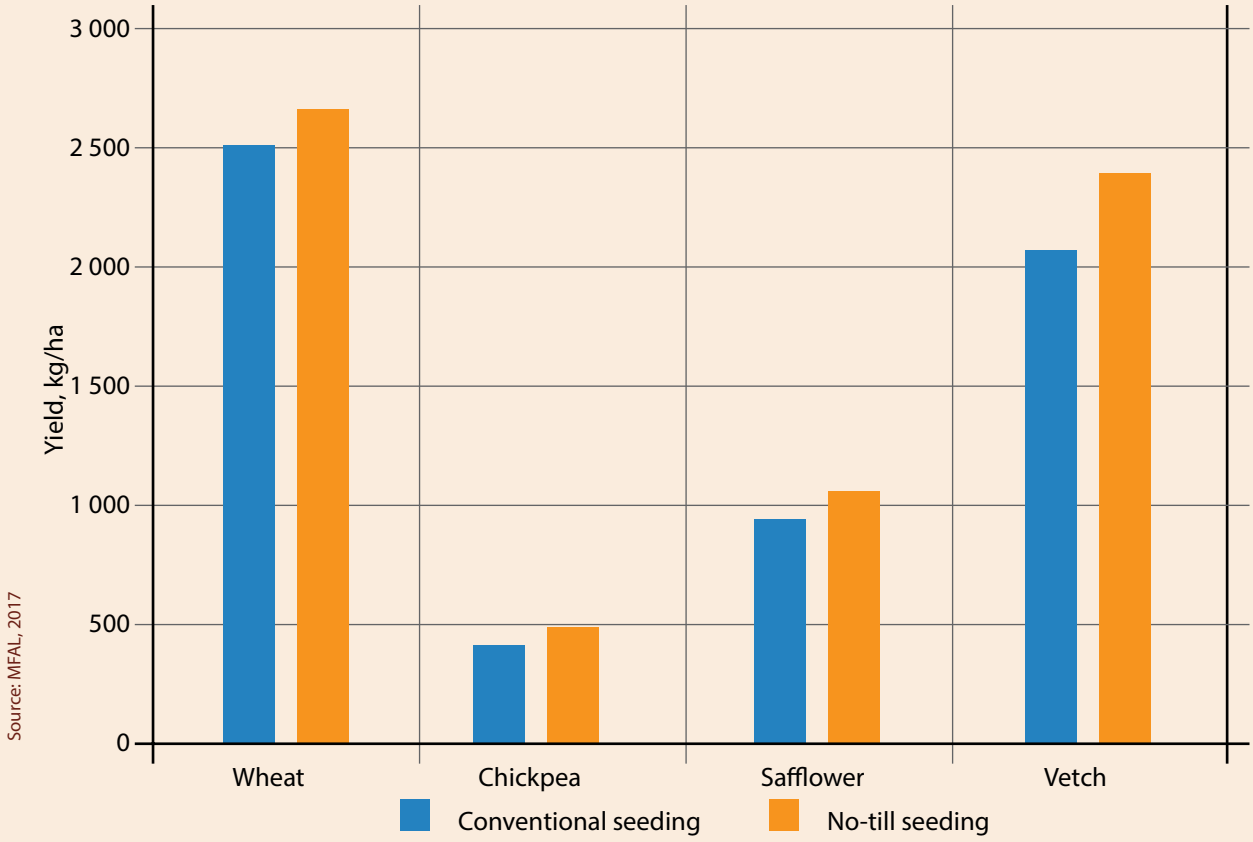

Figure 172. Long term average (13 years) grain yields of wheat, chickpea, safflower and dry matter yield of vetch under conventional and CA systems in Konya Province under rainfed conditions

yields, better use of production inputs and therefore greater profitability while reducing production costs, enhanced crop, soil and ecosystem health as well as the associated ecosystem services, and improved climate change adaptability and mitigation. In essence, CA addresses the missing ecological sustainability or the resilience components in the intensive tillage-based agriculture.

CA favours root growth, whereas water transmission is maintained through the activity of soil organisms sufficiently provisioned with organic matter, water and nutrients. A consequence of their activity is soil aggregation interspersed with voids (pores), depending on organisms' production of roots, exudates, gums, hyphae and on their proliferative burrowing and distributive activities. Multiple attributes of organic matter in soil – dynamised by the soil biota – therefore make it a key factor for improving and maintaining yields (of plants and of water).

As benefits on soil fauna affect directly above ground fauna, the impact of CA on biodiversity is very high. CA represents a fundamental change in production system thinking and is counterintuitive, novel and knowledge intensive. The roots of the origins of CA lie in the farming communities, and its spread has been largely farmer-driven. Experience and empirical evidence across many countries has shown that the rapid adoption and spread of CA requires a change in commitment and behaviour of all concerned stakeholders. For the farmers, a mechanism to experiment, learn and adapt is a prerequisite.

For the policy-makers and institutional leaders, transformation of tillage systems to CA systems requires that they fully understand the large and longer-term economic, social and environmental benefits CA paradigm offers to the producers and the society at large. Further, the transformation calls for a sustained policy and institutional

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Figure 173. Local no-till grain drill in Central Anatolian Region

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Figure 174. Women Farmer Field School (FFS) members practicing no-till planting in Konya Province

support role that can provide incentives and required services to farmers to adopt CA practices and improve them over time.

CA as a paradigm to underpin "sustainable production intensification" recognizes the need for a productive and remunerative agriculture that at the same time conserves the natural resource base and environment, and positively contributes to harnessing the environmental services. Sustainable crop production intensification must not only reduce the impact of climate change on crop production but also mitigate the factors that cause climate change by reducing emissions and by contributing to carbon sequestration in soils. It should enhance biodiversity in crop production systems above and below the ground, to improve ecosystem services for better productivity and healthier environment.

CA delivers on all of these goals. It saves on energy use in farming and thus reduces emissions. And, it enhances biological activity in the soils, resulting in long-term yield increase. In fact, CA represents a practical concept to achieve and sustain improved soil health and better soil-crop-nutrient-water management in agricultural landscapes leading to ecologically and economically sustainable agriculture.

Certainly, the progress towards global sustainability greatly depends on each of the landowners of over 570 million farms distributed worldwide, who in the end, are the principal agents making decisions and adopting different farming practices. CA is now practiced globally on about 180 million ha in all continents and all agricultural ecologies, including in the various temperate environments. During the last decade, cropland under CA has been increasing at the rate of some 10 million ha per annum. Turkey reported 45 000 ha in CA to FAO in 2016, and is a country with high potential for adopting this system.

In the last few years a number of projects have addressed the topic, especially taking into consideration the need to mitigate and adapt to climate change, whilst improving sustainability of agriculture through the diffusion and adoption of low-carbon technologies with win-win benefits for farmers and the environment, including biodiversity and ecosystem based adaptation. Even though no project can restore the ecological structure and function of a complex ecosystem, within a few years, results are starting to be tangible. Lessons-learned at global level, has been implemented in Turkey with the support of FAO, GEF, EU and other international organization. The results are promising, as CA based projects have demonstrated that it could be the right path to follow leading to the recovery of ecological processes and habitat quality within a reasonable period. Among other technical interventions, such as windbreakers and water boxes, the introduction of climate smart agriculture practices, as CA (no-tillage, permanent soil cover, crop rotations) in annual and permanent crops, together with a rational irrigation scheme are considered key elements to achieve a biodiversity friendly and sustainable agricultural system in Turkey.

Agricultural implications of Ecosystem Based Adaptation (EBA) on climate change in steppe ecosystems

Steppe Ecosystems in Central Anatolia represent an important part of natural resources providing the basis to support agricultural activities and livelihoods. Unsustainable land use increases the exposure of humans, plants and animals to climatic challenges, posing new risks for food security, food safety and human health.

Human intervention and land use management represent an additional driver for habitat degradation. Vegetation clearing and use of non-native species for monoculture forestry plantations have simplified the system. Within farming systems, agricultural intensification poses a threat to the survival of wild fauna and flora.

Livestock practices have shifted from using local breeds and small ruminants to large ruminants and more productive breeds. In pasturelands, drought-resistant perennials may decline, while annuals may find more suitable conditions, affecting forage availability and quality. Drought resistant crop varieties are seen as an important resource to ensure stable yields and food security.

A number of approaches have been implemented to mitigate these negative impacts. Illustrative examples, such as Ecosystem Based Adaptation (EBA) approach include CA and biodiversity, holistic rangeland management, sustainable agriculture, agro-ecological practices, participatory sustainable land management approaches and agro-forestry.

The project, "Agricultural Implications for Ecosystem Based Adaptation to Climate Change in Steppe Ecosystems (GCP/TUR/063-EC)", implemented by FAO and funded by the EU and the Republic of Turkey aimed to reduce vulnerability to the impacts of climate change in Anatolian Steppe Ecosystems. The project promoted the integration of the EBA approach into relevant policies, programs and activities, as a tool to combat the effects of climate change in Turkey, by developing planning processes and strategies within the relevant sectors promoting CA at different levels.

The benefits of CA suggest that management decisions that improve soil fertility, water conservation, foster carbon sequestration and reduce greenhouse gas emissions contribute to the resilience of soils and cropping systems, all of which will be needed to respond to climate change and related challenges such as food security.

EBA strategies to Anatolian Steppe Ecosystems considers the local implementation with inclusive approach. This participatory process was provided by the development of a pilot study in Konya Province, with demonstration sites in Ilgın and Kadınhanı Districts to develop a rational for integrating EBA at a local scale.

In order to increase the resilience of societies and steppe ecosystems to the impacts of climate change, the EBA fostered the use of biodiversity and ecosystem services as part of an overall strategy to help people adapt to the adverse effects of climate change.

The adoption of the EBA in Turkey represents an opportunity to support national, regional, local institutions, civil society and the private sector, enhancing their resilience to climate change by integrating climate change adaptation into their activities and to take actions in the sustainable management of biodiversity, livelihood and ecosystem services.

Integrated Pest Management: an environment friendly strategy to control pests

Agricultural production and productivity are continuously under the risk of loss due to pests. The most straightforward way to eliminate these risks in most cases is the use of chemicals. Changes in environmental conditions and/or farming systems create new forms of pests and diseases every day, therefore new and more effective chemicals are developed and applied to cope with such newly emerging pests. Yet, agricultural chemicals are one of the most serious threats to both humans and the environment. The amounts of pesticides consumed to save the crops is increasing due to intensification of agricultural practices responding to higher demands than before and to the increasing resistance of pests to agrichemicals. Table 32 gives a summary of the main pesticides used in Turkey between 2006 and 2017.

Thanks to integrated pest management (IPM) as a safe and environmentally sound approach, we do not need to solely rely on chemicals to control pests. As the preliminary approach, IPM offers biological and cultural methods that reduces chemical use in agricultural production. IPM however does not totally exclude use of chemicals but reduces it by means of complementary processes. The implementation of IPM requires comprehensive knowledge of life cycle and environmental requirements of pests, associated flora/fauna and their interactions with pests, main pests of specific environments and weakness/resistance to those pests and diseases, sound cultural methods to avoid pests and many others. As an effective and sensitive approach to manage pests, IPM is applied in several branches and stages of agriculture from production to retail. Any IPM practices follow a four-ranked approach namely:

1. Set threshold,
2. Monitor and identify pests,
3. Prevent and
4. Control.

The main approach is prevention. Appearance of a single pest does not always mean that a control is needed. Incidence of the pest should be at a critical threshold level to apply control measures. Plant protection specialists should monitor pests throughout their life time. When the pest prevalence and damage reaches the set threshold then it is time for implementing control measures. Prevention steps include using cultural

Table 32. The amount of pesticides used in Turkey between 2006 and 2017 (in tonnes)

Year	Insecticides	Fungicides	Herbicides	Acaricides	Rodenticides	Other	Total
2006	7 628	19 900	6 956	902	3	9 987	45 376
2007	21 046	16 707	6 669	966	51	3 277	48 716
2008	9 251	16 707	6 177	737	351	5 613	38 836
2009	9 914	17 863	5 961	1 533	78	2 302	37 651
2010	7 176	17 396	7 452	1 040	147	5 344	38 555
2011	6 120	17 546	7 407	1 062	421	6 978	39 534
2012	7 264	18 124	7 351	859	247	8 766	42 611
2013	7 741	16 248	7 336	858	129	7 128	39 440
2014	7 586	16 674	7 794	1 513	149	6 007	39 723
2015	8 117	15 984	7 825	1 576	197	5 327	39 026
2016	10 425	20 485	10 025	2 025	259	6 835	50 054
2017	11 436	22 006	11 759	2 452	236	6 209	54 098

Source: TÜİK, 2018

methods, such as crop rotation, selecting pest resistant/tolerant varieties, selecting crop varieties suitable for specific environmental conditions, and using healthy pest-free rootstock or other propagation material.

These methods present no risk to people or the environment and generally can be very effective and cost efficient. When the above-mentioned steps prove to be ineffective, then IPM programs evaluate the proper control method not only for efficacy but also for risk. Effective and less risky pest control methods are chosen first. These may include using traps or less risky chemicals, such as pheromone lures to disrupt pest mating. If such measures indicate that pest is not controlled, then use of pesticides is inevitable.

MAF runs a Plant Protection Central Research Institute (in Ankara Province), two Plant Protection Research Institutes (in İzmir and Diyarbakır provinces) and a Biological Control Research Institute (in Adana Province). In addition to that, all the local extension agencies are involved in pest control. MAF specialists continuously monitor the pests regularly based on a plan. In addition, integrated management of certain pests such as sunn pest (*Eurygaster integriceps*), grasshoppers and Mediterranean fruit fly (*Ceratitis capitata*) are performed at national level. Airplanes for spraying chemicals is no longer allowed. Establishment of green belts to keep the pests away from farming areas is another approach practiced in Turkey. In the meantime, use of predators and parasitoids are becoming widespread.

The Plant Protection Research Institutes in Ankara and İzmir Provinces, and the Biological Control Institute are responsible for rearing predators and parasitoids. In 2017, the amount of parasitoid insects released into nature is 1.8 billion. Forecasting and early warning systems are integral parts of IPM.

This system predicts proper time for intervention of pest control measures by using climatic data. These systems are generally used against horticultural crop pests as apple scab (*Venturia inaequalis*) and apple codling moth (*Cydia pomonella*), grape berry moth (*Lobesia botrana*) and grapevine downy mildew (*Plasmopora viticola*).

Figure 175. Light traps used to control the population of pests

Complementary to the national efforts, FAO supports Turkey on capacity development on IPM by training extension staff and farmers; promoting biological control methods to reduce pesticide risks in food; and disseminating the project achievements through different forms of outreach events, field days, workshops and conferences. Under the auspices of a completed project, many activities were carried out to promote IPM in Mersin, İzmir, Muğla, Antalya, and Aydın provinces in 2012 and 2013, along with efforts for safe and efficient usage of conventional pesticides if usage is unavoidable.

FAO also provides support at policy level when it is needed. In 2012, Turkish national legislation on plant health and IPM was reviewed, and a legal action road map for IPM programmes in the country was produced, which was further used to review plant health legislation and to compare it with the EU regulations to align with those of the EU. A document was also prepared entitled "Study and evaluation of the provisions of Turkish legislation concerning plant protection and phytosanitary issues, pesticides and IPM".

Good Agricultural Practices embracing IPM

In Turkey, Good Agricultural Practices (GAP), which is based on integrated crop and pest management is regulated and subsidized in primary production of plant, animal and aquaculture food products. The MAF issued the regulation in October 2010 and later the implementing guidelines setting up the duties of the responsible departments, authorization of control bodies, conformity criteria and control points.

Farmers applying GAP do not have to go through a transition period and are inspected by control bodies authorized by the MAF. In case of conformity with the criteria, products are certified and consumer packages are labelled with the national GAP logo. The farmers participating GAP system are subsidized per unit area varying according to the type of the product. Farmers targeting export markets especially fresh fruit and vegetable producers also get the private GLOBALGAP certification to have access to the supermarkets.

Figure 176. Planting nectar plants in the crop field is favourable for propagation of beneficial insects

Promotion of organic agriculture to conserve the biodiversity

Organic agriculture is a farming system aimed at preserving diversity, maintaining healthy agroecosystems and inspection and certification of the value chain according to valid standards. Organic agriculture started in Turkey with the demand of importers due to enlarging European organic markets in mid 1980's. Organic farming was supported as a policy since 2009 and developed rapidly, engaging more farmers. Dried fruits, nuts, medicinal and aromatic plants, cotton and olive oil, which are produced under low input conditions are among the major organically produced agricultural export commodities since the initial stage of organic farming. Until the last five years, Europe led by Germany was the main destination for Turkish organic products however with the growth of the North American organic market, it is now equally important as European market. Additionally, Turkish products are produced according to the international standards demanded by the markets and exported at world-wide level. The number of countries where Turkish organic products are exported was about 44 in 2016, among those, the US and the EU Member States are the major destinations. The United Kingdom, Japan, Canada, Australia, China and the Turkish Republic of Northern Cyprus are the other countries where Turkish organic products are exported.

The development of organic agriculture was top down as in many developing countries targeting the export markets. Despite the local demands, domestic markets developed rather late only after the efforts of the NGOs and the subsidies. Another bottleneck was that export driven organic farming was carried out as contracted farming where the companies provided initial know-how, inputs, certification cost and guaranteed the market. This system did not exist in the domestic market so farmers hesitated to convert to organic since they had no market information and were resource poor to cover the cost of certification.

In Turkey, organic agriculture system was initiated officially with the regulation adopted in 1994. The Law was enforced in 2004 and the regulation is revised in 2010. The

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Figure 177. Logo of Organic Products in labels certifying that the product is produced according to the Turkish Organic Agriculture Law

legislation on organic farming is very similar to that of the EU and amended to align with the changes. The legislation includes the general principles of organic farming, administrative and legal arrangements including duties and responsibilities of institutions and organizations related to organic farming and their fields of activity, list of allowed inputs, and non-conformities or violations. In Turkey, competent authority is MAF. A special Department on Organic Agriculture was established in 2003, since then organic farming related work has been carried out by this Department.

There is a central data collection system functioning through the authorized inspection and certification bodies and comparable to the Turkish statistics on agriculture. All data on organic farming, exports, imports and authorized inspection and certification bodies can be accessed at the MAF webpage (www.tarim.gov.tr). The MAF has carried out and today still implements various projects for expanding organic farming practices throughout the country. The framework project entitled "Project on Expansion and Control of Organic Farming" is implemented by MAF since 2011 under the coordination of the Good Agricultural Practices and Organic Farming Department of the Directorate General of Plant Production of the Ministry. Within the scope of this project, as of 2017, research, development, training and awareness raising activities and studies on organic vegetable, animal and wild harvested products are being carried out both at the Central Organization of the Ministry and at 54 Provincial Directorates and 12 research institutes. Every provincial directorate of MAF in 81 provinces has a unit on organic agriculture functioning with trained experts that carry out mainly extension and monitoring tasks.

Organic farming was performed in 75 067 holdings from all regions in 2017. Major activity is plant production including annual and perennial crops and grassland. On raw material basis, 214 crops are produced as wheat, olive, hazelnut, walnut, pistachio, dried fig, dried apricot, raisins, legumes, medical aromatic plants, cotton, berries and fresh fruits and vegetables. As processed products, fruit juices and concentrates, frozen fruits and vegetables, milk and dairy products,

Table 33. Production of top 15 crops in 2016 (Organic products and products in conversion period)

Product Name	Number of Holdings	Area, ha	Production, t*
Olive	21 635	81 048	261 814
Wheat	16 614	124 285	334 352
Tea	10 060	4 149	73 085
Alfalfa	9 106	42 106	338 569
Fig	7 472	15 783	111 035
Clover	6 004	29 257	113 565
Barley	5 920	30 452	84 263
Grapes	5 826	13 198	301 903
Vetch	4 603	29 815	78 948
Meadow Fodder	4 188	15 478	49 934
Apple	2 779	3 748	123 896
Apricot	2 283	7 437	122 032
Maize	609	3 183	39 571
Pomegranate	567	1 265	29 708
Cotton	421	6 585	29 476

*on fresh basis as estimates

Source: MFAL 2017

meat and meat products, baby food and olive oil are among the main organic processed products. Information about the top 15 organic crops produced in Turkey is presented in Table 33.

Except beekeeping, organic animal production started only during the last years due to limited demand from the domestic markets and availability of organic grazing land and feed. According to the 2016 data, Turkey produced 8 340 big ruminants including fully organic and in transition, 26 326 small ruminants, 1 212 542 poultry birds, and 76 242 organically managed beehives.

Around 2% of the total agricultural area is certified as organic. This figure is 1.2% above the world average. Organic certified land for wild harvest is around 300 000 ha. Organic agriculture promotes sustainable collecting from nature and help preserving biodiversity. If prerequisites are met, there is no transition period therefore the market demand, especially crop price, determines the size of natural to be devoted and certified for wild harvest. Such areas also support additional activities, such as organic beekeeping.

Organic farming is mainly practiced for food and beverage production; however, it is not limited with those. Organic textiles, cosmetics, fertilizers and pharmaceutical sectors are developing as complementary new opportunities. Organic agriculture with rapidly increasing world and Turkish markets can be seen as a tool for safe and healthy food and non-food production, and preservation of natural resources, land, water and biodiversity in agro and natural ecosystems.

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ORGANİK SERTİFİKALI ÜRETİM ÇİFTLİĞİ
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Turkey and FAO: Strong Collaboration

Partnering for food security and sustainable management of natural resources

Partnership between FAO and Turkey has thrived since the establishment of the country office in 1982 and the Sub-regional Office for Central Asia in 2006 in Ankara.

Through FAO-Turkey Partnership Programme (FTPP) and FAO-Turkey Forestry Programme (FTFP), the collaboration between the Organization and Turkey continues to prosper as the country is a recipient of FAO's assistance in various areas as well as an active resource partner, providing indispensable support technically and financially for FAO activities in the sub-region and beyond.

The Government of Turkey has promoted regional initiatives, developments and collaborations to create much resilient future in the region and address today's challenges with overall USD 30 million contributions to FAO's interventions through FTPP and FTFP from 2006 to 2019.

Turkey's technical and funding support to the countries in the sub-region

- **FAO-Turkey Partnership Programme**

  The overarching objective of the FTPP is to provide assistance on food security and rural poverty reduction in Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkey, Turkmenistan and Uzbekistan.

  The first phase of the programme which was established in 2006 and benefitted from trust fund contributions totaling USD 10 million, was financed by the Government of Turkey, represented by the MoFAL for 28 projects.

  Following six priorities – food security, agricultural and rural development, natural resources management including forestry and fisheries, agricultural policies, food safety, and animal and plant genetic resources were the main concerns during the first phase of the Programme.

  The second phase of FTPP (2015-2019) continues to bring Turkey-FAO collaboration and expertise to Central Asia, the Caucasus and beyond to address food security and nutrition, agricultural and rural development, protection and management of natural resources, agricultural policies, and food safety.

  The overall contribution of the Government of Turkey through MAF for the second phase of FTPP will be USD 10 million by 2019.

- **FAO-Turkey Forestry Programme**

  Another partnership agreement between Turkey and FAO on forestry is financed with a trust fund contribution of USD 10 million from MAF, over an initial period of five years (2015-2019).

  Areas covered by the agreement include sustainable forest management, plantations and rehabilitation, forest products and ecosystem services, forests and the environment, community and forests, governance, assessments and monitoring, combating desertification and interdisciplinary issues. FTFP addresses those issues in Central Asia, the Caucasus and beyond through joint interventions of FAO and Turkey.

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