



HAZELNUT CLIMATE CHANGE AND ENVIRONMENTAL IMPACTS

TURKEY REPORT

ekologos

Commissioned by



This Report prepared by EKOLOGOS on behalf of the Rainforest Alliance, UTZ Hazelnut Program. September 2020



EKOLOGOS Sürdürülebilirlik Yönetim ve İletişim Hizmetleri Ltd. Şti.
Osmanağa Mahallesi, Kuşdili Caddesi No: 33 D: 2 34714 Kadıköy - İstanbul
Tel: +90 (216) 349 40 97 - 98

Coordinator: Barış Doğru, baris@ekoIQ.com

Researcher: Gülce Demirer, Bulut Bağatır

English Editors: Ayşe Bereket, Mustafa Yükselbaba

Graphic Designer: Özlem Sarar Doğru

Contributors: İdil Ander, Ömer Oktay

Cover Photo: Halit Kahveci

About the Rainforest Alliance, UTZ Hazelnut Program and This Report

UTZ hazelnut program is the first independent, third-party sustainability certification program to be implemented in the hazelnut industry in Turkey. The program is run by the Rainforest Alliance, an international non-profit organization working in more than 60 countries at the intersection of business, agriculture and forests. Next to the hazelnut program, the Rainforest Alliance certifies tea, aromatic plants, and apples in Turkey.

The UTZ hazelnut program, which made its first harvest in 2014, has developed rapidly since then. With 17 certificate holders in the 2019 harvest, the number of UTZ farmers has exceeded over 6800. In this journey since 2014, the UTZ Hazelnut Program has raised awareness on the social, environmental and economic issues of hazelnut farming while implementing the sustainability standard, promoting cooperation among stakeholders and increasing its influence in the field.

Together with many diverse allies, we are working to solve some of the most urgent environmental and social challenges of our day, with the climate crisis being one of the key issues of our focus. While the effects of climate change are felt more and more every day in Turkey, any work to be done on this issue becomes more important than ever. We see the need for more information about the effects of climate change on hazelnut production, which is a very important export product for Turkey. Therefore, before narrowing down the focus to UTZ certified hazelnut scope, this report aims to fill the void of general data and research. Moreover, the report tries to develop an understanding on the relationship between hazelnut and climate change & environmental impacts in general and suggests possible next steps. We hope this study will shed light on the environmental impact of hazelnuts and the relationship between climate change and hazelnuts. Since this is the first study carried out in this context, we wish him to be able to guide the next research and raise awareness among stakeholders.



More information: <https://utz.org/> - <https://www.rainforest-alliance.org/> **Mail:** idede@ra.org

All photos used in this Report belong to Giresun Chamber Of Commerce. We would like to thank the executives of the Chamber for allowing their use in the report.



Photo: Ali Mermertaz

HAZELNUT, CLIMATE CHANGE AND ENVIRONMENTAL IMPACTS

TURKEY REPORT

04 INTRODUCTION

06 A. CLIMATE CHANGE: NOT IN THE FUTURE, HERE AND NOW!

- A1. The Planet's Climate is Changing
- A2. Turkey, Black Sea Region and Climate Change
Turkey and Climate Change
Black Sea and the Climate Change
- A3. Agriculture and Climate Change

12 B. HAZELNUT, CLIMATE CHANGE AND ENVIRONMENTAL IMPACTS

- B1. Ecosystem and Social-Based Structural Problems of Turkish Hazelnut Production
- B2. Hazelnut Production and Climate Change in Turkey
- B3. Impacts of Hazelnut on Environment and Climate Change

28 C. FIELD NOTES, RESULTS AND A ROADMAP FOR SUSTAINABLE HAZELNUT PRODUCTION

- C1. Field Notes
- C2. Conclusions and Recommendations for Sustainable Hazelnut Production
Research Findings
A Roadmap for a Sustainable Hazelnut Production

INTRODUCTION

Hazelnut is one of the most climate-sensitive plants of the world which needs very specific climatic conditions and is not productive when these conditions are not present. Anatolia is considered the motherland of hazelnut, which is only productive and high quality at a certain northern latitude and in certain weather conditions and humidity, precipitation and temperature levels. Optimum growing conditions for hazelnut are found in areas where the average temperature is between 13°C - 16°C, the precipitation level is more than 700mm per year, an elevation is below 1,500 meters. All these ideal features are present in the Black Sea region and particularly the Eastern Black Sea region.

Hazelnut, one of the largest agricultural export items of Turkey, is grown across the entire Black Sea region, although the production is historically concentrated in several districts of Ordu and Giresun in the eastern Black Sea region. Turkey provides approximately 70 percent of the world hazelnut production and earns about 2 billion dollars every year.

Despite its great importance, hazelnut production in Turkey, has long-standing structural problems. Some of these are social problems such as migration because of insufficient household incomes and aging farm population, which are caused by legal and administrative issues. Hazelnut orchards, which are excessively divided by the inheritance law and lost their efficiency scale is one of the problems and area-based public support is another. Many experts suggest that as long as the support is based on area it will not encourage orchard owners to produce more.

Another structural problem, which is interwoven with these social and legal problems, is that the hazelnut orchards were deprived of the necessary care and attention for such a long time that they degenerated and became arid. In the past, hazelnut orchards were kept at a certain level by local farmers who relied on hazelnut production through traditional, labor-intensive methods which eventually became rather poorly implemented and today a significant part of the orchards are increasingly left to the mercy of natural forces. Aging hazelnut trees have not been renewed for a long time and the age of the trees reaches 80 or 100 years in some places. Since the growers are far from the necessary scientific meth-



ods and consider the hazelnut almost like a forest product, the productivity of hazelnut production in Turkey has fallen far behind other producing countries such as the United States and Italy.

However, there is another big and decisive problem above all these structural problems. Climate Change. Human-caused climate change affecting the whole world warmed the planet by an average of 1°C and according to the IPCC reports if the necessary measures are not taken, the critical level of 1.5°C will be exceeded in 20 to 30 years. However, climate change, rather than the average climate rise, manifests itself with extreme climatic events such as drought, heat waves, storms and heavy rainfall and can cause significant fluctuations in agricultural production.



Photo: Ahmet Kılıç

CLIMATE CHANGE ALREADY MANIFESTS ITSELF AS DROUGHT AND TEMPERATURE INCREASE IN THE MIDDLE EAST AND ANATOLIA AND IT CAN BE FELT IN THE BLACK SEA REGION, WHICH IS THE PRIMARY HAZELNUT PRODUCTION AREA OF THE WORLD.

The Mediterranean Basin where Turkey is located, is among the most vulnerable regions that will be most affected by climate change. Climate change already manifests itself as drought and temperature increase in the Middle East and Anatolia and it can be felt in the Black Sea region, which is the primary hazelnut production area of the world. Although there is no major change in the amount of precipitation in the region, scientific research and projections predict significant changes in the seasonal regime and rainfall calendar; early and extreme temperatures in the coastal line and the farmers already feel it through drops in yield and quality. Although the results of a few studies on this issue include certain differences, they make important warnings predicting that the hazelnut production of Turkey will be deeply affected

and there will be decreases in yield and quality. Growing calendar changes, watering in the summer months, which was never before an issue, becomes imperative and there are significant increases in the number of pest and fungal species. While hazelnut is strongly affected by the impacts of climate change, of course hazelnut production also plays a part in environmental degradation. The carbon footprint of hazelnut is at low levels for reasons such as low levels of mechanization, labor-intensive production methods and being a perennial plant. However, hazelnut production results in the pollution of soil and water resources and negatively affects biodiversity.

All of these factors are pushing hazelnut production to a crossroads. Climate resilient hazelnut growing, which keeps its environmental impact under control and is in harmony with its ecosystem, requires a holistic public hazelnut policy. A new hazelnut policy that will be built on the participation of all stakeholders should address both the structural problems of the past from social and biological origins and the present and future problems originating from climate change all together and offer holistic solutions. Otherwise, the future of the hazelnut growing in Turkey, which puts its mark on the economy, culture and social relations of the entire region, will be much more troublesome than predicted. This study explores primarily the impacts of climate both globally and in Turkey and the Black Sea region in particular as well as probable future impacts of climate change. We did a literature review on existing research about the impact of climate change on agriculture and hazelnut production in particular. Through field research and in-depth interviews with experts, we tried to define convergent and diverging aspects of scientific projections and field experiences. We examined the intertwinement between the structural problems from social and biological origins and the impacts of climate change. Finally, we explained the negative and positive effects of hazelnut growing on the climate change and environment.





Photo: Hatice Ayaz

A) CLIMATE CHANGE: NOT IN THE FUTURE, HERE AND NOW!

A1. The Planet's Climate is Changing

Climate change is now undoubtedly the most important threat to human existence on our planet. Reports by the United Nations Intergovernmental Panel on Climate Change (IPCC) which has put its signature on scientific studies and awareness campaigns for many years to raise the problem, have almost conclusively put forward that greenhouse gas emissions released by human activities and production since the Industrial Revolution have caused climate change.¹

The gravity of the situation and the huge threat it poses to human civilization was shared with the global community through IPCC's "Special Report: Global Warming of 1.5°C"². In summary, the report says in a restrained language that "Human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels" (Article A1, Summary for Policymakers, page 4); that if it continues to increase at the current rate, global warming is likely to reach 1.5°C between 2030 and 2052 (Article A1, Summary for Policymakers, page 4) and explains ravaging impacts of global warming of 1.5°C and especially that of more than 2.0°C on the nature and humans (Article A3, Summary for Policymakers, page 8).

However, more important and unfortunately, graver matters come up in the same report's ensuing warnings: "Impacts on natural and human systems from global warming have already been observed. Many land and ocean ecosystems and some of the services they provide have already changed due to global warming." (Article A3.1, Summary for Policymakers, page 8). "Climate models project robust differences in regional climate characteristics between the present day and the day when the global warming would probably reach a level between 1.5°C and 2.0°C. These differences include increases in: mean temperature in most land and ocean regions, hot

extremes in most inhabited regions, heavy precipitation in several regions, and the probability of drought and precipitation deficits in some regions.” (Article B1, Summary for Policymakers, page 8).

All of these statements clearly indicate that climate change is not a catastrophe affecting a far geography such as polar bears in the Arctic, climate change is happening here and now, not in an indefinite future and in far and marginal lands. What is more important is that the findings in the aforementioned IPCC report which includes valuable contributions from more than 6,000 scientific references and thousands of experts and government officials, match exactly with the daily experience and observations of the growers that were interviewed. Moreover, these are happening sooner and quicker than scientists predicted...

This increase may reach much more dangerous levels as long as human civilization continues to burn fossil fuels; and even if we were to cut our reliance on fossil fuels today, it may take centuries for the atmospheric CO₂ concentration to drop to earlier levels. Consequently, humanity has to get used to living with the 1°C of global warming and its outcomes which will become the “new normal”.

Therefore, food production which is expected to become one of the most critical issues of the 21st century, namely agriculture, must be reformed in line with new climate normals. The adaptation of agricultural production to climate change includes a series of work from choosing seed and plant types based on climate models to using efficient watering systems, decarbonized production means and alternatives and changing planting and harvest seasons.

A2. Turkey, Black Sea Region and Climate Change

Turkey and Climate Change

The number of studies on the impacts of the climate change on Turkey’s geography as well as the whole world is rapidly increasing. Prof. Dr. Murat Türkeş from the Climate Change and Policies Application and Research Center at Bosphorus University who has been working on the impacts of the climate change on Turkish geography for many years underlines that Mediterranean basin is among the regions most affected by the climate change



Photo: Yunus Yildiz

for its being in the transition zone.³ Turkey itself has an exclusive location in the Mediterranean basin and the Turkish geography which is a part of the Eastern Mediterranean, Southeast Europe and Caucasia while it is connected with the Middle East and the North Africa, is under the impacts of a drought that emerged in 1970s and the temperature rises that started in 1990s.

The evaluations of the General Directorate of Meteorology confirm these findings.⁴ Accordingly, the average temperature in Turkey, was 14.2 °C in 2017 which means an increase of 1.5°C compared to 1970, and 0.7 °C compared to the average temperature of 13.5°C recorded in the period from 1981 to 2010. Average temperatures have increased steadily since 1998 (excluding 2011).

Another parameter that provides important data on climate change is, of course, the amount and frequency of precipitation. According to the data of MGM, in 2017, the annual average total precipitation was 506.6 mm, 12% below the normal between 1981 and 2010 (574 mm). There has been a decreasing trend in the amount of pre-

The average annual temperature deviations in Turkey (1971-2017)

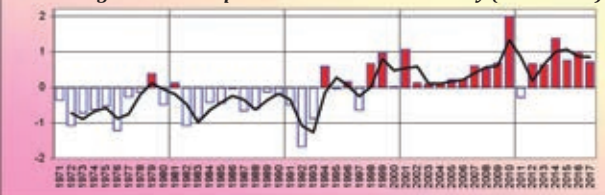




Photo: Mehmet Can Düzgün

“FLOODS ARE INCREASING BUT THERE IS NO CHANGE IN THE TOTAL PRECIPITATION. STANDARD PRECIPITATION AMOUNT DOES NOT CHANGE BUT THE DISTRIBUTION OF THE PRECIPITATION CHANGES. ALL OF THE 1,500 MM FALLS IN ONE DAY; THERE IS IMBALANCE IN THE RAINFALL.”

precipitation from 1990 to today and the third of the annual decreases from 1990 to date took place in 2017. These data clearly suggest that while the temperatures are increasing in Turkey, the precipitation levels are decreasing.

Another data set that reveals the relationship between the climate change and the weather events is the humidity and evaporation ratios. Moisture and evaporation data are related with the long-term drought on the one hand, but they are also related with the short-term meteorological disasters such as excessive rains and storms. MGM data shows that average moisture has decreased in Turkey compared to 1970, while the evaporation also has a downward tendency.

There are many scientific studies indicating that the climate change is also associated with the excessive temperatures. Maximum average temperature during summer months is rising in Turkey, while minimum average temperature during winter months has a decreasing tendency. However, in general terms, we can assert that

Turkey is faced with a climate which is warmer, has less precipitation.

The research puts it that aside from the above-mentioned anomalies in the humidity, temperature and precipitation, the frequency and intensity of the storms, floods and frost in particular are also on the rise in Turkey. The actual meteorological data and the the climate models also unfortunately coincide.

Black Sea and the Climate Change

The common finding of all possible climate change scenarios is that Mediterranean is one of the regions that will be worst affected by this situation. Mediterranean Basin's being an important transition zone has a lot to do with that.

Is this picture also true for the Black Sea, which is the highest rainfall region of Turkey? The researches and climate projections do not predict any fall in the total precipitation in the region. Even some projections predict some increase in the precipitation in the Eastern Black Sea region. However, researchers estimate big changes in the precipitation regime which mean the distribution, calendar and intensity of the precipitation. Unfortunately, we already started seeing these changes which take place in the form of decrease in precipitation in June and July in particular. Hazelnut growers say they have problems in productivity and quality during the last 10 years because the hazelnut plant does not take the precipitation it needs during the summer months, and they can overcome this problem only by irrigation.

Asst. Prof. Dr. Coşkun Erüz provides data that confirms these findings and states that the floods are increasing but there is no change in the total precipitation⁵. Standard precipitation amount does not change but the distribution of the precipitation changes. All of the 1,500 mm falls in one day; there is imbalance in the rainfall.⁶

Prof. Dr. Türkeş says this intense rain can be interpreted as a part of the extreme weather conditions, a fundamental characteristic of the climate change. “Such rainfall is not a good thing for the agriculture and the plantation; the soil cannot keep the water sufficiently, and it cannot benefit from the water. The soil is dry in the first place. Intense precipitation causes floods only. In regions with strong slopes such as the Eastern Black Sea or Southeast-

ern Anatolia, in particular, it may be more frequent to see intense rainfalls, showers, floods and overflows. Asst. Prof. Dr. Erüz has similar opinions: “There are no longer characteristic mid seasons. We see late summers and late winters. The precipitation went out of the period. This is the case in entire Turkey. This is felt more strongly in Black Sea as it has a mild weather with intense precipitation.”

Of course, one of the direct reasons that leads to this irrigation need is the increase in temperatures. Özer Akbaşlı, a hazelnut producer and consultant with whom we have interviewed, says there has been a temperature increase by about 1°C according to the data of the meteorological observation points established by private institutions in the region.⁷ This coincides with the 1°C increase provided in projections.

In addition to the increase in average temperatures, there are anomalies in the minimum and maximum temperatures which may be more significant than higher average temperatures. Projections say that there will be higher than the normal temperatures during the summer months at the coastal line up to 250 meters of altitude in particular, and onsite data verify presently.

According to the climate change projections⁸ prepared by Prof. Dr. Beyza Ustaoglu, Prof. Dr. Mehmet Karaca in 2014⁹, average temperature in the region will rise by 6°C in the next 90-year period. Although this projection is based on A2, which is accepted as the worst-case scenario, it would not surprise anyone if there will be excessive temperatures in the coastline in particular.

A3. Agriculture and Climate Change

Climate change is often covered by the media mostly from a sensational, massive loss of lives and devastation of property point of view that is extreme weather events, storms and tornados. Countries hit by severe storms, weather most developed or underdeveloped, are quite frequently in media reports. Even by looking at movies¹⁰ on the topic, it is apparent that climate change draws public attention through disasters.

However, in reality climate change is, well beyond all those disasters, an extremely slow moving societal-humanitarian calamity whose effects are therefore more



Photo: Halit Kahveci

difficult to sense. It advances stealthily like a “frog slowly boiled in a pan”, not with sudden impacts. People are very rapidly normalizing even the sudden extreme weather events.¹¹

Yet there is an area where climate change can have a deeper and permanent impact which can be felt far more strongly by people living in urban areas: Agricultural production and food. Today, climate changes experienced in almost all geographies of the World lead to significant fluctuations in yields and quality of many products. This paves the way to huge threats to food stability and availability.

One of the most important studies done in this field is “Climate Change and Sustainability in Agriculture in Turkey” report prepared by Prof. Mikdat Kadioğlu, Prof.

Yurdanur Ünal, Aslı İlhan, Meteorological Engineer, and Cemre Yürük, Meteorological Engineer.¹²

It says widely known climate-related threats to global food production may contain many risks for grain, vegetable and fruit:

- **Decline in yield:** Stress caused by high temperatures and draught may cause yields to decline in crop production and animal farming, including dairy.

- **Increase in water demand for irrigation:** Regions where farming currently depends on natural rainfall may face costly solutions to access water and problems with other industries in sharing water.

- **Changes in timing of planting and harvest:** Changes in precipitation patterns, extreme precipitation and consequent flooding may cause the timing of planting and harvesting to be delayed. Earlier last frost dates due to warmer weather may cause planting to be moved forward.

- **Decline in soil suitability for growing crops:** Rising weather temperatures and decreasing precipitation will reduce soil humidity. Therefore present farming areas may not be suitable for crop development in the future or will definitely require irrigation.

- **More diseases and pests:** Without cold winters to control them anymore, some diseases and pests can survive and/or may produce more generations per year, triggering possible epidemics. Changing temperature and humidity conditions may cause new diseases and pests to harm areas which were previously unaffected. For example, Septoria leaf blotch diseases of wheat is now found in Central Anatolia where it was previously non-existent. Assoc. Prof. Barış Karapınar, Boğaziçi University, also an expert at Istanbul Policy Center, talks about the impacts of climate change in his article titled “Climate Change and Agriculture,” published in the “Principles of Sustainable Agriculture - Good Practices Guide” prepared by the Turkish Business Council for Sustainable Development (BCSD): “When climate projections for Turkey are studied, it can be predicted that soil surface will warm by between 4-6°C in the years 2070-2090, compared with 1960-1990 and humidity, particularly in the Mediterranean region will fall by 35% by the end of this century. Considering that recent impacts resulted from an approximately 1°C increase over the past averages, it is not

difficult to foresee what huge impacts the 4-6°C increases will create”¹³.

“Regarding agricultural production, it is estimated that growing seasons will be longer on the largest and most fertile lands, heat waves will be effective and water shortages will occur. Central Aegean, Central Anatolia and Southeast Anatolia in particular will be the regions to be most impacted by the changes in average climate values” Dr. Karapınar says.¹⁴

At this point, agriculture stands quite apart from all other sectors. When ties to other sectors are taken into account, impacts of unfavorable weather conditions on agricultural production will at the same time influence inflation by means of prices, spending budgets of consumers in rural and urban areas, related industries’ access to raw materials and international trade (trade deficit, foreign exchange rates and related macro balances). Therefore, a sustainable agricultural policy will fundamentally shape the country’s future. The forthcoming period will show how successfully we can achieve that.

1 <http://www.ipcc.ch/report/ar5/>

2 <https://www.birbucukderece.com/>

3 Excerpts from the interview with Prof. Dr. Murat Türkeş, April 2019, Ankara

4 General Directorate of Meteorology, Evaluation of Temperature and Precipitation in 2017, <https://www.mgm.gov.tr/FILES/Haberler/2018/2017SicaklikveYagisDegerlendirmesi.pdf>

5 “Local Implications of the Climate Change” prepared by the TEMA Foundation (Turkish Foundation for Combating Erosion Reforestation and the Protection of Natural Habitats) and WWF-Turkey, Semi-structured Interview Results section, Asst. Prof. Dr. Coşkun Erüz, March 2015,

6 http://www.tema.org.tr/folders/14966/categorial1docs/97/Yerel%20Etikiler%20Analizi_v11.pdf

7 Notes of interview with Özer Akbaşlı, February 2019, Giresun

8 “The Effects of Climate Change on Spatiotemporal Changes of Hazelnut (*Corylus avellana*) Cultivation Areas in the Black Sea Region, Turkey”, Prof. Dr. Beyza Ustaoglu, Sakarya University Faculty of Science and Literature, Department of Geography, Sakarya, Prof. Dr. Mehmet Karaca, Eurasia Institute of Earth Sciences

9 *Ibid.*

10 <http://www.wikizero.net/index.php?q=aHR0cHM6Ly9lbi53aWtpcGVkaWEub3JnL3dpa2kvQ2F0ZWdvcnk6Q2xpbWF0ZV9jaGFuZ2VfZmlsbXNM>

11 <https://www.iklimhaber.org/insanlar-asiri-hava-olaylarini-normallestiriyor/>

12 “Climate Change and Sustainability in Agriculture in Turkey”, Federation of Food & Drink Industry Associations of Turkey, 2017, <http://www.tgdf.org.tr/wp-content/uploads/2017/10/iklim-degisikligi-rapor-elma.compressed.pdf>

13 Principles of Sustainable Agriculture – Good Practices Guide, BCSD Turkey, October 2018, <http://www.skdturkiye.org/yayin/surdurulebilir-tarim-ilkeleri-iyi-uygulamalar-rehberi>

14 *Ibid.*

B) HAZELNUT, CLIMATE CHANGE AND ENVIRONMENTAL IMPACTS OF HAZELNUT PRODUCTION

Among the plants of this planet, there are very few plants which are in such a sensitive relation with climatic conditions as hazelnut. Hazelnut grows productively only in four coastal areas of the world, (Black Sea coasts of Turkey and Georgia, Adriatic coasts of Italy, Catalan region of Spain and US State of Oregon) and this climate specific growing conditions of hazelnut makes it much more sensitive to climate change. Optimum growing conditions for hazelnut are found in areas where average temperature is between 13°C - 16°C, has a precipitation level of more than 700mm per year, below an elevation of 1,500 meters.¹⁵ If the global climate change will result in a rapid and definite change in the climatic conditions of these regions dramatic fluctuations in total yield and quality will not be surprising.

Unfortunately, the problems of the hazelnut production in Turkey is not limited to climate change, environmental problems and their various effects. Even if climate change should be set aside, many problems going back to many years, some originating from biological causes and some from sociological causes are badgering the Turkish hazelnut production to death. Without fully understanding these problems which became complicated and ramified with climate change and eliminating their root causes, it will not be easy for hazelnut production to cope with climate change.

B1. Ecosystem and Social-Based Structural Problems of Turkish Hazelnut Production

Hazelnut is a unique agricultural product for Turkey, having significance well beyond being a farm product, in terms of biological diversity, economic value, and leaving its mark on a whole region with its cultural value and folklore. Turkey is the world's biggest hazelnut producer and exporter and accounts for about 70% of global output and 82% of global exports. In that sense, an average 500,000 tons of the world's 270,000-850,000-tonne hazelnut with shell output is produced in Turkey, particularly in Ordu and Giresun provinces, although significant fluctuations occur from year to year. Hazelnut is known to be produced in 43 provinces





Photo: Emel Taranoglu

of Turkey; however, production for commercial purposes is made along the coast line from Istanbul to Artvin. Ordu and Giresun provinces stand out with their output (their aggregate production exceeds the total of all other provinces) and quality.

Hazelnut cultivation directly concerns 400,000 families or 2-2.5 million people and provides employment opportunities for hundreds of thousands, according to data from the Farmer Registry System, and raises 3 billion dollars in export revenues, thus, cannot easily be compared to any other agricultural product. Since hazelnut is one of the essential inputs for chocolate industry, it is regarded as a closely watched raw material for the food industry not only in Turkey but also in the entire world.

However, hazelnut cultivation which has such an important and dominant place on a local, national and global scale, faces such long-lasting problems that can actually be called structural ones.

Turkey's problems in hazelnut cultivation can be understood just by looking at production figures per hectare are: According to 2013 data by FAO, yield per hectare was 1300 kg in Turkey, 3640 kg in the USA and 1570 kg in Italy. Apparently, Turkey which is regarded as the motherland and major production area of hazelnut, produces at less than half the yield in the USA which started hazelnut cultivation much later and at almost half the yield in Georgia which has almost the same conditions as Turkey.

The main structural problem is that farm lands are divided into smaller and smaller lots because of Turkey's legislation on inheritance. Enterprises' average cultivated land size is 1.4 hectares in Turkey, compared with a minimum of 2.2 hectares required to support a standard family amid sufficient circumstances in hazelnut cultivation, according to related research (*TurkStat 2017*).¹⁶ Furthermore, in most places where field interviews were conducted, the size of hazelnut orchard per family was reported to fall even below 0,4 hectares.

The loss of families' livelihoods in turn triggers migration from rural areas to cities. This situation creates a certain population which does farming only for a specific period. Their primary occupation is no longer hazelnut cultivation, so they are not concerned about the various stages of production (pruning, care, fertilizing, watering, applying pesticides, etc.), consequently yield and quality of hazelnut pro-

duction declines in the hands of these former farmers. Moreover, a vicious cycle is created: Earning fewer and unstable income further pushes farmers to turn away from cultivation and fuels the tendency to migrate.

Another structural problem of hazelnut cultivation stems from regulations, namely Field-Based Subsidy System. Many of the stakeholders we have interviewed are in the opinion that field-based subsidies provided to hazelnut producers recorded under the Farmer Registry System do not support production. Stakeholders say many farmers who have migrated to towns and are no longer involved or are little involved in hazelnut production are benefiting from the field-based subsidies, thus the system is encouraging laziness. They say subsidies should instead be directed to production itself. A vicious cycle also forms here. People who receive field-based subsidies do not take adequate care of their hazelnut orchards, thus yield and quality decline, yet they do not feel the need to act because they continue to get the same subsidies.

In addition to above-mentioned structural problems stemming from regulations, there are also intertwined biological ones. The top ones are old, infertile hazelnut orchards and poor-quality soil. This subject is punctuated at the Hazelnut Report 2018 of the Chamber of the Agricultural Engineers, and it is pointed out that the yield of the hazelnut trees in Trabzon, Giresun and Ordu provinces is less than those in Kocaeli, Sakarya and Düzce provinces due to the old age and thicker-set of the trees in the former three provinces. This proves the fertility of the younger hazelnut orchards. The report also highlights the fact that hazelnut orchards are fast increasing in Sakarya and Düzce provinces because the new plantations in this region have greater size hence higher yield. The report maintains that if proper measures are not implemented, what is commonly called as mismanagement of the agricultural activity and the poor quality of the products will continue to grow further.

Noting that root ages reach 80-100 years in some areas, stakeholders agree that rejuvenating pruning is not the solution and old hazelnut trees must be entirely renewed. However, this requires active farmers. A young generation of farmers hopeful for the future and supported by the government can carry out a juvenescence program which is extremely important for the future of hazelnut production.

B2. Hazelnut Production and Climate Change in Turkey

Raw material gains and radical changes in the conditions of the social life caused by the climate change, and increasingly higher control and pressure on the use of fossil fuels and emissions are no doubt creating significant threats in many industries including mainly energy and manufacturing industry. Similarly, climate change is upsetting the economic balances by causing billions of dollars of losses worldwide each year, and this will increase further in the future. However, one of the areas that will be worst affected is probably the agricultural industry, because many economic activities are performed relatively independently from the natural conditions while agricultural production is totally dependent on the climatic conditions average temperatures, number of sunny days, precipitation regime and intensity, drought and excessive heatwaves.

We should remind here that hazelnut plant is much more sensitive to the climate compared to many other agricultural products. First, hazelnut is a plant produced totally under natural conditions, which means it is almost impossible to grow it in greenhouse unlike many other plants.

Secondly, it needs very fundamental weather conditions as can be understood from the places it grows. Productive ha-

zelnut growing is restricted with certain latitudes only. Fast and fundamental changes in weather conditions in these regions

How does Changing Climate Affect Hazelnut Production?

Local impacts of the global climate change which is happening faster than one might have expected have already become the subject of many research studies. There are pioneering studies - though very little - about how hazelnut production will be affected from the climate change. It is not a surprising that these pioneering studies have taken place in Turkey, which alone accounts for 70% of the world hazelnut production. The study named "The Effects of Climate Change on Spatiotemporal Changes of Hazelnut (*Corylus avellana*) Cultivation Areas in the Black Sea Region, Turkey"¹⁷, prepared by Prof. Dr. Beyza Ustaoglu from Science-Literature Faculty, Sakarya University and Prof. Dr. Mehmet Karaca from Eurasia Institute of Earth Sciences focuses on vertical and horizontal changes of the hazelnut fields in Turkey based on a 90 year projection of climate change. Let's try to cover this comprehensive study, and its conclusion, which is accepted as the first research in the world on this subject.

Ordu, Giresun, Trabzon, Samsun, Düzce and Sakarya provinces all in the Black Sea region have been selected as the research areas in the study, average temperatures and precipi-



HAZELNUT, CLIMATE CHANGE AND ENVIRONMENTAL IMPACTS

tation measured between 1975 and 2009 were calculated as 13-16 °C and 700 mm respectively, and these figures were accepted as optimal values in hazelnut production.

Temperature and precipitation were presupposed as the foremost two climate parameters for the hazelnut, and temperatures and precipitation data were examined for the years 2011-2100 according to A2 scenario obtained via RegCM2 climate model.

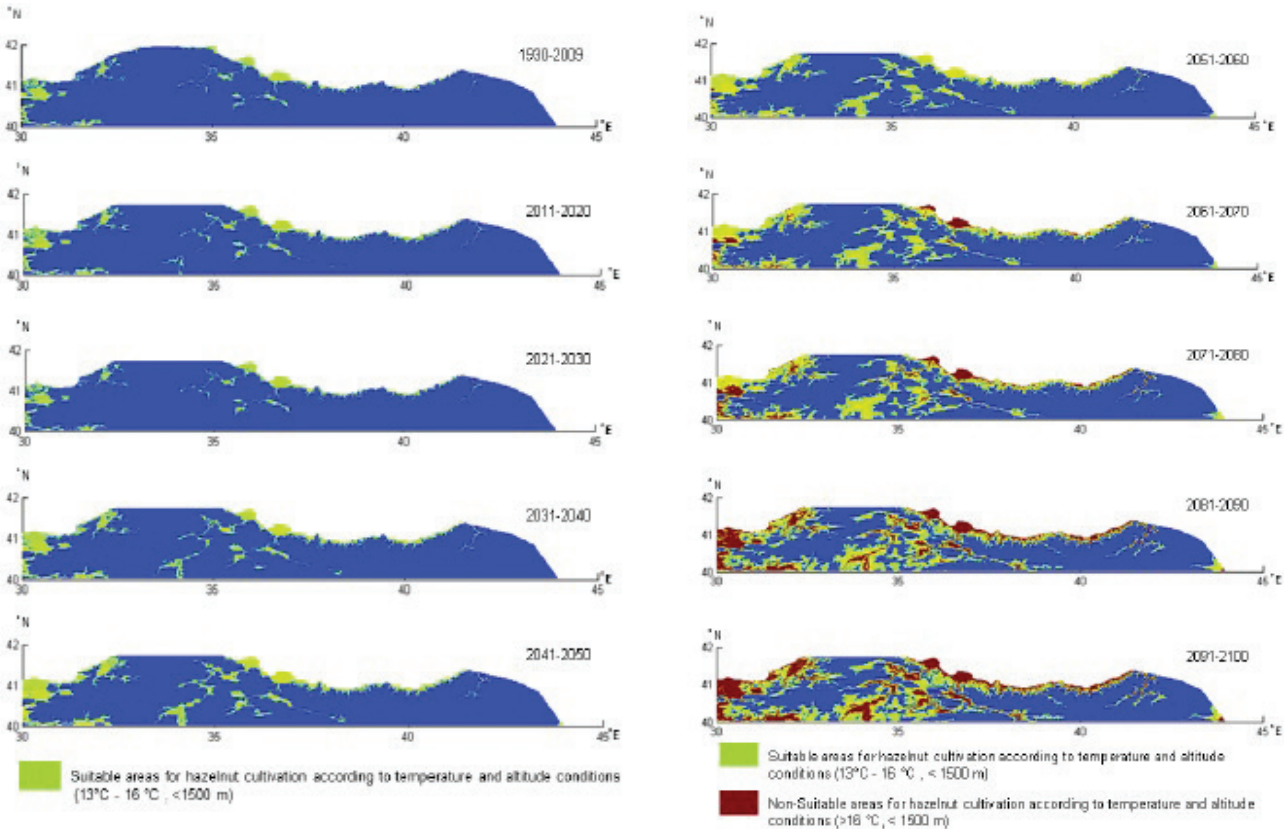
According to the results of the analysis, the rise in temperature during the 90 years between 2011 and 2100 were found as 6°C. In addition, it was estimated that, due to the change in temperature, there would be a shift in areas with appropriate temperature values of 13-16°C as needed for the hazelnut production, and this shift will be vertical because of the structure of the terrain. It was also estimated that precipitation would also increase from the present amounts. Increase in the amount of rainfall above the current amount of 700 mm, appropriate amount for hazelnut growing, is forecasted to have positive impacts, and the increase in the rainfall will

affect Eastern Black Sea region, where hazelnut production is particularly widespread.

However, forecasted rise in temperatures for the period 2011-2100 is more prominent than the forecasted increase in rainfall. That is why it was predicted that there would be a certain vertical shift (7a, 7b) in hazelnut growing areas starting from 2050.

The study predicts that the forecasted temperature changes up to 6°C in the next 90 years will cause horizontal and vertical shifts in hazelnut growing. The findings indicate that hazelnut growing in the coastline up to an altitude of 250 meters which has historically been home to the most productive and quality hazelnut orchards might be affected negatively from this change in temperature, while the areas above 1,500 meters which are by no means appropriate for hazelnut growing at present will become so in the future.

It seems the projection of Ustaoğlu and Karaca pointing out to the fact that the coastline up to 250 meters of altitude, which was so far accepted as the most quality and produc-



tive hazelnut production area, would increasingly become non-fertile is becoming much faster than all estimations. Chambers of agriculture, commerce exchanges, Turkish Hazelnut Cooperative (Fiskobirlik), as well as the industrialists and farmers all say that productivity dropped, rate of wastage rose in coastal regions in the last 4 to 5 years, while the types of hazelnut which grow at higher altitudes and durable against harsher conditions with lesser soil described as gravelly by now has come to the forefront.

This rise in altitude in the near future may pose a threat to the forestlands above an altitude of 1,500 meters where it was so far believed that hazelnut cultivation was almost impossible, and this may end up with an environmental destruction. Cutting of the forests to make hazelnut orchards that is currently said to have been prevented totally through careful observation via satellite may come to our agenda once again.

Another study dealing with the effects of the climate change on the hazelnut cultivation which is yet unpublished has been conducted by Prof. Dr. Levent Kurnaz and postgraduate students Nazan An and Mustafa Tufan Turp from the Climate Change and Policies Application and Research Center, Boğaziçi University. The study named "Assessment of Hazelnut Yield in a Changing Climate for Turkey"¹⁸ tried to find the hazelnut yield in the period 2021-2050 based on the RCP 8,5 climate scenario which predicts what will happen in the future if everything goes on with the current trend and no radical measures are implemented (business as usual). According to the interview with the postgraduate students An and Turp, climate change will cause 5% drop in hazelnut yield in the next 30 years on average. An and Turp say that, in their projection that took the period 1991-2012 as reference, they took precipitation regime and irregularities, evaporation (soil moisture), relative humidity, growing degree days, duration of sunshine and difference of temperature, i.e. the difference between the minimum and maximum temperatures during the rest and subsequent blossoming periods, as the main parameters. The researchers say that they dealt with the entire Black Sea region (West, Central and East Black Sea) as well as the East of Marmara, and they witnessed the effects of the climate change that cause drop in the hazelnut yields in 65 out of 105 areas they studied. This drop becomes more pronounced towards the eastern parts, i.e. in Giresun-Ordu region where hazelnut is produced



DR. ARZU SEZER, WHOSE DOCTORAL THESIS WAS ON HAZELNUT FUNGAL DISEASES, THINKS THAT THE ERYSIPE CORYLACEARUM POWDERY MILDEW, WHICH WAS SUDDENLY INTRODUCED IN 2013 AND HAD SERIOUS IMPACTS ON HAZELNUT PRODUCTION, IS ASSOCIATED WITH CLIMATE CHANGE.

intensely at present. The research puts it that the yield may increase at some parts of the Western Black Sea, but drop in the yield will be more prominent in general. The researchers say these results may further deteriorate provided that the global struggle against the climate change not gain a stronger momentum, while they may be abated or prevented with the help of the changes in technology or administrative organization.¹⁹

Asst. Prof. Dr. Erüz from the Black Sea Technical University believes that there may be significant falls in hazelnut yield due to the climate change: "The soil in slopes is shallow in Black Sea region. Lack of rain for one month in the yearlong precipitation regime leads to serious drought in Black Sea region. The species dependent on high rainfall and moisture

are drying out. Trees dry out or they experience water stress (loss of product, failure to thrive) and villagers see this very clearly. Quality is dropping; prices are climbing in the market. Hazelnut's shell gets thicker; failure to thrive becomes apparent in the quality of the product. Hazelnut yield falls down immediately should there be no rain in July and August."²⁰

Climate change has important impacts on agricultural production through direct climate parameters. There are also indirect impacts such the increase in the pests, emergence new pests, etc., because radical changes in climatic conditions cause the migration of many living creatures and their settlement in different geographies. These changes may end up with far more and stronger impacts, because the new environment may have no "counter-pests" or "counter-organisms" to control their number, or it may cause epidemics or there may be a boom in their population.

Experts agree that there is a similar expansion of the hazelnut pests at present. At the top of the list comes powdery mildew which suddenly emerged in early 2013 and spread rapidly to all trees leading to significant falls in the yield and quality of the hazelnut. Powdery mildew is indeed a disease that existed for a long time with a great prevalence in our country and in the world. It can infest all shelled fruits as well as various wood-like plants and herbaceous plants. Until recently, it was known that the disease in the hazelnut was caused by a fungus named "*Phyllactinia guttata*", and this fungus triggered the disease only on the leaves without any wide-scale economic loss in the hazelnut. However, the symptoms of the disease have changed starting from 2013 and the symptoms spread to the husk and the shoots in addition to the flowers, leading to drying and fugacity. Dr. Arzu Sezer, Teaching Assistant at Plant Protection Department, Agricultural Faculty, Ordu University, with whom we interviewed under this research, found out that the new disease was caused by *Erysiphe corylacearum*, contrary to what was known before, and she wrote articles on the subject. As a former employee of Giresun Hazelnut Research Center who studied the fungus types that led to diseases in hazelnut during her postgraduate courses and conducted many researches on the subject subsequently, Sezer believes that powdery mildew caused by *Erysiphe corylacearum* is related with the climate change. Although there are no direct studies on the subject, she says that the outbreak of this disease can

be associated with the climate conditions because, during the years of its emergence and spread, there was less rain than the seasonal averages and the weather was relatively warm and arid: "When we look at the impacts of the climate change on diseases like powdery mildew in general, one can conclude that the powdery mildew disease would be exacerbated and there will be more problems in plants during periods of lesser rain and higher temperature. In general, fungal diseases like moisture, however, the outbreak potential of powdery mildew disease has a potential to become a problem in relatively warmer and dryer conditions. This is not only my opinion; all authorities think the same way. Powdery mildew is expected to increase in plants together with the climate change".

Prof. Dr. Sebahat K. Ozman-Sullivan, who has been working on the hazelnut pests for 38 years, is more cautious on the relationship between the climate change and increase in the pests. Ozman-Sullivan underlines that the pest population varies from one period to another, and more research needs to be conducted to associate this with the climate change, and points out at the recently-emerged green shield bug (*Palomena prasina* L.): "Aspergillus type fungus are located at the spot sucked by this bug, leading to the emergence of poisonous and carcinogenic materials which we call aflatoxin".²¹

"It is not easy to associate the increase and decrease in the pest populations with climate change only, but it is clear that the climate is being destabilized. This may vary from one pest species to another; we are in no position of saying that there has been a definite increase or decrease in all of them; but it is clear that some things have changed," says Ozman-Sullivan, adding that the imminent danger was the brown marmorated stink bug (*Halyomorpha halys* (Stal.)), which is very similar to green shield bug (*Palomena prasina* L.). Motherland of this bug which entered Turkey via Georgia is China, Korea, Taiwan and Japan; it spread to the United States and Europe, and to Georgia from Europe. Although we do not know for certain whether or not the migration route of the bug is associated with the climate change, we know that there are invasive species in many parts of the planet due to the climate change. It is clear that monitoring the changes in the flora and fauna that move due to the global warming will also be one of the significant work areas from the viewpoint of hazelnut production in the near future.



Photo: Zeliha Begöz

B3. Impacts of Hazelnut on Environment and Climate Change

Today, all scientific studies say with about 100% certainty that man-induced climate change keeps disrupting all norms of our planet. The climate change which is being felt in all corners of our planet in the form of weather events such as drought, storms, heat waves and intense rains, and disasters caused by these events such as floods, overflows and forest fires has its impacts on each industry taking its toll from the mankind in general.

It is noteworthy that the economic activities that are inflicted losses due to climate change are greatly responsible from the climate change itself. Power production leads the industries causing greenhouse gas emissions, while the agricultural industry including the husbandry has as big a share as 20%. The impact of the agriculture on environment is not restricted with the greenhouse emissions. Agricultural activities cause important environmental problems in many

fronts such as soil degradation, erosion, deforestation, excessive water use and water pollution.

Then does the hazelnut production which is affected by the climate change to a great extent have negative impacts on climate change, environmental degradation, pollution and water resources. “Turkish Hazelnut Industry’s Carbon Footprint Study” conducted by Dr. Pınar Özuyar from Energy, Environment and Economy Center, Özyeğin University comes to the forefront as the most important study on this subject.²² By using this important study, let us now have a quick look at the impacts of the hazelnut cultivation on climate change.

a. Impacts of Hazelnut Cultivation on Climate Change

“Turkish Hazelnut Industry’s Carbon Footprint Study” by Dr. Pınar Özuyar, Energy, Environment and Economy Center, Özyeğin University deals with the hazelnut industry information under two separate main chapters as production and logistics, and it analyzes the production from the orchard

until the end of the processing plant. Logistics covers both the entire transportation activity throughout the production stage and the transportation activity until the buyer and mostly includes the export.

Carbon Footprint due to Hazelnut Production

The study deals with carbon footprint induced by hazelnut production under four separate headings: Fertilization and other chemical processes, energy use during production-harvest period, waste during and after the harvest period, processing plant energy use, Packaging.

Let's see these stages shortly:

Fertilization and other chemical procedures: Summer and winter fertilization is made in order to ensure the hazelnut plant's normal development, its giving ample and quality products, and provide it for the nutrition it needs. The ideal fertilization is to determine the situation of the hazelnut plant through the soil and leave analysis and apply appropriate amount of fertilizer according to the needs. The fact that the producers do not inhabit nearby the hazelnut orchard obstruct these procedures and cause the fertilization procedure realized at random.

Liming is also conducted in hazelnut orchards depending on the need. In liming, materials such as limestone, hydrated and un-hydrated lime are used. Additionally, disinfestation is also made against the pests such as hazelnut worm, may bug, etc. at certain periods.

Power use during production-harvest period: Hazelnut species are ripened for harvest at different times. However, August and September are generally the proper months for harvest. The hazelnut either falls down the tree by itself, shaken off by hand or hand-picked from trees. No device is required at this stage using electricity or fuel. However, at flat grounds, harvesting by machine is also becoming more popular. After the harvest, the hazelnuts taken to the blending location inside their stem are laid on ground.

A machine named hazelnut thresher is used for obtaining shelled hazelnut by separating the hazelnut from its stems. Hazelnut thresher separates 1 ton of hazelnut per hour on average depending on the productivity of the machine. Hazelnut thresher consumes an average of 6-7 liters of diesel oil per hour.



Photo: Emel Taranoglu

Waste during and after the harvest season: The hazelnut inside its stem is passed through the hazelnut thresher and the stems should be laid down on the orchard as fertilizer. However, a very small portion of the stems is used as a fuel and unfortunately; a significant portion of it is practically thrown on the roadsides and causes environmental pollution. Aside from the stems, the shells of the processed hazelnut are another source of waste. At present, there are different applications on waste material.

Power use at processing plants: Once separated from the stems, shelled hazelnuts are partly sent to the end-users without being unshelled depending on the demand of that year. More frequently, the hazelnut is sent to the buyers as natural hazelnut, roasted hazelnut, fine-cut hazelnut, and hazelnut puree and hazelnut oil after being processed at the small local plants. Recently, we see modern hazelnut processing plants with international standards being established in Turkey. However, small-scale preliminary processing plants are still more prevalent across the country.

Packaging: Jute sacks are used as hazelnut package. Plastic package is also used, but to a much lesser extent. Jute is a tropical plant from Tiliaceae family. This plant is predominantly used to obtain the fiber with the same name. Jute sacks are very cheap and can be used by the farmers for 10-15 years.

Occasional holes and ruptures are easily patched. Scrapped jute sacks are also used as doormats. In short, jute sacks rarely become waste; the waste ratio is not more than 10-15 percent.

Carbon Footprint due to Hazelnut Logistics

Logistical activities in hazelnut industry are separated into two. The first group is transportation from the orchard to the plants. The second group of logistical activity is the delivery of the hazelnut which is in various intermediary and end-product to the buyers. This delivery is divided into two: domestic and international.

About 450,000 to 600,000 tons of hazelnuts are exported annually in the entire world in total, and Turkey has the largest share in these exports while this share may change from one year to another. Turkey sells hazelnuts to about 100 countries with Italy and Germany taking the lead.

On average, 80% of Turkey's hazelnut exports are delivered via trucks. About 70% of these land exports are supplemented via sea transportation. While the remaining 20% are exported through sea. Air cargo is not widespread because of its high costs. Similarly, railway is not also preferred due to its low feasibility.

Carbon Sink Due to Hazelnut Growing

Unlike many other economic production activity, hazelnut growing is a carbon sink at the same time because hazelnut tree is a perennial plant.

There are studies about this characteristic of the hazelnut tree. Compared to other agricultural products, hazelnut tree is considered to be more advantageous in terms of its carbon sink capacity thanks to its long roots and high photosynthesis ability. Therefore, while calculating the total carbon footprint of the hazelnut, this carbon sink characteristic should be definitely taken into account and deducted from the total value.

Hazelnut: Only 2% of Turkey's Agriculturally Induced Carbon Emissions

Under the study, carbon emissions were calculated for the fertilization and other chemical procedures, energy use during production-harvest period, waste during and after the harvest, energy use by the processing plants, packaging and logistical activities in hazelnut industry. On the other hand, carbon sink capacity of the hazelnut trees reduces the total negative impacts of the hazelnut industry though only a little. According to the research findings of Dr. Özüyar, approximate carbon emission caused by these activities of the Turkish hazelnut industry is equivalent to 1.421 million tons of CO₂. Sixty-four percent of this figure is caused by logistic ac-

tivities (post-production-process) and 36% covers all activities performed after the production and for processing prior to the end-user plant. 512,000 tons of CO₂ equivalent which accounts for 36% is only 2% of the carbon emissions stemming from the whole agricultural activities in Turkey, as calculated based on the data of the Turkish Statistical Institute. Carbon emission stemming from the total logistic activity, international transport in particular, makes 909,000 tons. Given the fact that global logistic values make 14-15 percent of the entire global carbon emission, logistic activities stemming from the Turkish hazelnut industry account for only 0.1 percent of the entire carbon emissions.

Another important study from Turkey on the impacts of the hazelnut on climate change and environmental problems is the report named "Life Cycle Assessment of Roasted and Bleached Hazelnut Kernels" prepared by myclimate Turkey in 2013 for a private hazelnut company.²³

The lifecycle assessment conducted on three separate categories of global warming, acidification and eutrophication²⁴ revealed that the hazelnut's growing process was the process that had the biggest impacts in each of the three categories. The ratio of the impacts of the growing process on global warming, acidification and eutrophication were calculated as 69%, 76% and 84% respectively. The biggest effect stemmed from the emissions caused by the use of ammonium nitrate and other fertilizers during the growing process. The second biggest effect was revealed during the distribution of the products, i.e. the logistic activities. The effect of the logistic process on global warming, acidification and eutrophication were 21%, 17% and 10% respectively. The share of the international transportation in these areas of effect range between 79% and 87%. The main determinant in this process is the consumption of electricity, which accounts for about 70 percent of the total effects on each category. The use of natural gas provides the second biggest impact on global warming and acidification. Packaging materials also create 4% of the total impact for each category. The use of corrugated cardboard comes out as the main determinant of this impact.

When we assess the results of the two studies that deal with the impact of the hazelnut on environment and climate change, we can comfortably say that the production processes of the hazelnut have far less direct emissions than the other industries and other agricultural production categories. However, this result is driven not by the choice of

low-carbon options and good planning, but by the intrinsic characteristics of the hazelnut (its being a perennial tree; its exclusion of modern production techniques during its sowing, planting, and harvesting processes; its having a labor-intensive production process, etc.)

Therefore, there are a great number of improvement steps that should be taken in these fields including the logistics.

b. About the Impacts of Hazelnut on Environment

It is evident that, just like all activities of the humankind, agricultural production also has serious impacts on environment. We can examine the impacts of the agricultural activities under five main headings: The first is the transformation of the natural habitats into agricultural areas and breaking up of the ecosystems from one another which is more generally studied under the subject of deforestation. The second is the degeneration of the untouched, virgin ecosystems. The third is the uniform production due to industrialization, hence reduction of the genetic variability of all products, and consequent loss of biodiversity. The fourth is the pollution of the water and soil due to the use of fertilizers and agricultural pesticides. The fifth and last is the loss of soil (erosion) due to various effects. Now, let us try to trail the environmental impact of the hazelnut cultivation on the

ecosystem of the region on these headings.

At the top of the list of major impacts of the agricultural activities on natural habitats comes the deterioration of the habitats that have become highly rich and complex through their evolution in millions of years as a result of the monotype and extremely interfering agricultural applications. Natural flora breaks up, becomes smaller or disappears completely as a result of this radical agricultural intervention. Hazelnut cultivation thus led, and continues to lead to significant impacts on the natural habitat of the Mediterranean Region. Almost all of the hazelnut orchards in Giresun and Ordu, the most important hazelnut cultivation areas in the world, were created by deforestation of the natural forests in the region. Regional Directorates of Forestry say that the pressure of the hazelnut cultivation on forests were heavily experienced between 1975 and 1985 and continued during 1990s at a lesser degree thanks to the domestic migration that took place during 1990s.

Transformation of the vast forests into hazelnut orchards led to the loss and degradation of the soil because the hazelnut's root is less deep compared with the forest trees. It is a common knowledge that transformation of the vast forest areas into hazelnut orchards has led to loss of soil and erosion by degrading the resilience of the soil.



Photo: Erhan Aydın

The data provided by the Directorate of Fight with the Desertification and Erosion (ÇEM) put it that 90% of the soil in Turkey is exposed to the water erosion risks, while only 1% is exposed to wind erosion risks. According to the estimations by the Turkish Foundation for Combating Erosion, Reforestation and the Protection of Natural Habitats (TEMA) based on the data of the General Directorate of Electrical Power Resources Survey and Development Administration, 743 million tons of soil is lost each due to the erosion. Erosion takes place on 59% of the agricultural areas, 64% of the pastures, and 54% of the forest assets.²⁵

The global “Vulnerability to Water Erosion” map prepared by the United States Agricultural Ministry shows a considerable portion of the Turkish soil as “highly vulnerable” and “vulnerable” to water erosion.²⁶

One of the major causes of the erosion problem of Turkey is its rough terrain. In Turkey, 59% of the terrain has a slope of more than 12%, and intense and very intense erosion is experienced in 11.5% of such terrains.²⁷ Similarly, 6.5% of the terrain in Turkey has a slope of more than 60%, and 1.3% of such terrain undergoes intense and very intense erosion.²⁸

A survey has shown that more than 90% of the total terrain in the province of Giresun, one of the two most prevalent hazelnut cultivation provinces in Turkey, has a slope of more than 12%.²⁹ (The situation in the province of Ordu is more or less the same, although there is no concrete data.)

Another major proof for the rising problems caused by the rough and highly sloppy terrain of the Black Sea together with the heavy rains triggered by the climate change is provided by the Black Sea Action Plan announced by the Environment and Urban Affairs Minister Murat Kurum in July 2019.³⁰ This document which is the first climate action plan prepared on a regional basis in Turkey and consisted of 14 headings primarily stresses the high landslide risks caused by the rains. This plan which concentrates on 19,000 running waters and 131,000 wadis in the provinces of Trabzon, Rize, Ordu, Giresun and Artvin which account for almost the entire hazelnut production of the country reveals the great risks caused by the floods for the region. The document which mainly concentrates on the buildings constructed on the stream beds makes no mention of the impacts of the agricultural lands created on forest lands, while the impact of the hazelnut orchards that increases the landslide risks should also be definitely covered in this context.

According to the report, “Towards Sustainable Hazelnut Cultivation in Giresun”³¹ the amount of soil lost by the erosion increases significantly as the slope of the hazelnut orchards increases. While the forest cover provides a very nice protection against erosion even in a high slope. “There is a definite and urgent need for soil protection measures given the fact that a significant portion of the hazelnut orchards in Giresun is located on a high slope”³². According to the data of the Republic of Turkey Agriculture and Forestry Ministry Hazelnut Research Institute Directorate, the erosion increases by 1.5 times when the slope of the terrain increases to 28% from 15%, and by 2.5 times to 45%.³³

We know that another major environmental impact of the hazelnut cultivation takes place by the use of chemical fertilizers and pesticides; however, the screening of the existing literature shows that there is a complete lack of researches about the soil and water pollution caused by the hazelnut agriculture in Turkey. Annual Environmental Impact Reports for the provinces of Ordu and Giresun having a dense hazelnut cultivation provide the amounts of the chemical fertilizers and pesticides used in each province under the heading of “Soil Pollution Caused by the Agricultural Activity”, but these reports fail to bear any data concerning the underground water pollution and the pollution caused by the chemical fertilizers and pesticides under its chapter named “The Pollution of the Surface and Underground Waters”. However, a survey conducted on tea cultivation in a very similar and nearby geography shows that the fertilizers and the pesticides cause a serious pollution on water resources. The research conducted by WWF-Turkey in Firtina Valley of the neighboring province of Rize reveals that 28-40 percent of the fertilizers used in the tea orchards lead to the pollution of the water.³⁴

In this regard, when we consider the lands where hazelnut is cultivated in Turkey, we see that a great majority of the hazelnut orchards are sloppy topographically, vulnerable against the erosion and has got a very thin soil.³⁵ Random and intense use of fertilizers and pesticides without any soil analysis increases the acidity of the soil which is already high enough, and reduces the resilience of the soil against erosion.

Another practice in hazelnut cultivation that reduces the resilience and quality of the soil is the use of herbicides for the cleaning of the weeds that grow in the hazelnut orchard. Herbicides are applied intensely and unconsciously in the

weeding which is needed to facilitate the collection of the hazelnuts falling to the ground during the harvest and to enhance the nutrition and water taking capacity of the hazelnut plant from the found. The damage of the soil as caused by other chemicals including the insecticides used in the fight against the insects that increase their population depending on the changing climate conditions are also among the topics that are needed to be replied. Although there is not sufficient information on this subject either, a projection made based on the pesticides purchased in Giresun showed that a total of 106.5-128.0 grams of herbicides are estimated to be used per hectare.³⁶ It is worrying for the health of the soil-water resources and the sustainable hazelnut cultivation that 125-150 thousand kg herbicides are used in Giresun in total. It is voiced by the hazelnut farmers and specialists of the subject that the “nettle-pesticide” as it is popularly-named and which is the most frequently-used herbicide, loosens and dries the soil causing strong erosion in sloppy ground in particular.³⁷

One of the major factors is the awareness and knowledge of the hazelnut growers on environmental matters. A research article published in 2018 in the “Turkish Natural Sciences Review” (Türk Doğa Bilimleri Dergisi) with title of “An Examination of Use of Pesticide in Hazelnut Production from the Viewpoint of Environmental Sensitivity Example of Giresun Province”³⁸ yields significant results related to this issue. According to this study which examines the environmental sensitivity during the use of pesticides in the hazelnut producers at Bulancak, Espiye, Görele, Keşap and Tirebolu towns and the Central district of Giresun Province; a great majority (83%) of the farmers have said that the agricultural pesticides remaining on the plants are hazardous for the human health, but they also said they did not have sufficient information on the subject. The methods and their percentage used by the farmers in the disposal of the pesticide packages are as follows: 66% burn the package of the pesticides after the application, 24% put in the waste basket inside the rubbish bag, 8% burry in the soil, and 2% throw it away irregularly. Each of these methods has negative methods on the environment and the natural habitat.

According to the findings of the research, 76% of the enterprises examined in Giresun province apply pesticides. The persons consulted the most for fighting with the diseases, pests and weeds are pesticide dealers and agricultural en-



Photo: Engin Ayıldız

gineers. Sixty-six percent of the farmers in the province of Giresun get the information on which pesticide to use for the weeds, pests and diseases from the pesticide dealers and 18% from the consultant agricultural engineer. Seventy percent of the farmers see the label of the pesticide in arranging the application dose, 11% ask the pesticide dealer, 9% do it according to his past experience, while 10% act according to the technical instructions, agricultural engineer and suggestion of his neighbor. This means that a great part of the producers consult with the pesticide dealers in their choice of the pesticide, and they see the package insert in deciding the application dose. Hence, the study suggests that activities should be held in the region to ensure that the pesticide dealers and consultant agricultural engineers have sufficient information on the use of agricultural pesticides.

Another problem voiced exclusively in this region on the subject of the environmental impacts of the hazelnut production is the environmental pollution caused by the agricultural pesticide boxes and packages. The damages of the hazardous waste left in the open areas or disposed by burn-

ing on the health of the people and animals should be definitely taken into consideration.

Another topic that associates hazelnut growing with the environmental pollution is to throw the stems of the hazelnut following the harvest randomly and without any order. This waste should be definitely transformed into fertilizer by using the compost method. The works and experiences of some of the corporate companies should be quickly generalized.

Biodiversity

Environmental impacts of the hazelnut cultivation are inflicted ultimately seen on the biological diversity. The fact that the majority of the hazelnut orchards are opened out of the forests is a serious handicap for the biodiversity and the wild life. The foremost asset of the nature and culture of the Black Sea is the forest ecosystems³⁹, and these ecosystems are directly influenced by the hazelnut cultivation. A survey conducted in 2016 in Piraziz, a township of Giresun with a significant hazelnut cultivation activity, provide important results on this subject.⁴⁰ At spots where herbicide ((Korfosat-Glyphosate Acid) was applied against euphorbia about three weeks before screening conducted at a hazelnut orchard, it was observed that no plants grew near euphorbia sp. and rumex. The lower part of the same orchard where no chemical drugs were used, several natural plant species were spotted, including the endemic (*Iris lazica*). Although encountering such dense herbaceous plants at a hazelnut orchard of around 0.25 hectares during a day of fieldwork is positive, not seeing any of them in parts where herbicide was applied is equally worrying in terms of ecological sustainability and biological diversity.⁴¹

No scientific research was found on this subject during the literature review, however local people and growers have reported their observations that *similax excelsa*, *cantharellus cibarius*, *lactarius piperatus*, blackberry and wild strawberry and several kinds of mushrooms have decreased sharply since herbicides have been in use to control weeds in hazelnuts.⁴² There is a widespread public opinion that together with the decline in the population of these species, edaphons such as snakes and earthworms have disappeared and birds like blackbird, starling, finch as well as mammals like rabbits cannot be seen anymore, whereas the numbers of mice and weasels have risen.⁴³

Similarly, both experts and local producers believe that fish

in streams have died out due to nitrate pollution and they demand that serious research be done on the effects of drugs, particularly on humans, water, soil, plants and wild animals including birds. According to some sources, even under ideal conditions, 2 to 10 percent of nitrogen-based fertilizers applied to the soil contaminate surface and ground water.⁴⁴

Excessive use of chemical drugs does not only harm the ecosystem, it is also thought to directly affect hazelnut yields in a negative way. As frequently mentioned in this study amid problems which are voiced by all producers and partners, it is suggested that when fungicides are heavily used for ashing, brown cochineals, an important pest, increase because fungicides naturally destroy not only the pests, but also the fungi which kill the cochineals.⁴⁵

In the report headlined "Toward Sustainable Hazelnut Production in Giresun," it is underlined that an *Allothrombium* type parasite and wild mite type from the *Trombidiidae* family, acknowledged as one of the most important indicators of a healthy ecosystem or absence of chemical contamination, is never spotted in hazelnut orchards where drugs are used. This predator used in biological control and attracting interest in the science world in recent years, was found in an area where no drugs were applied and no intensive intervention was made in the past five years, clearly indicating the negative effects of agricultural drugs on biological diversity and hazelnut production.

Another important area which must be studied in terms of the region's agricultural production and uncontrolled fertilization and application of drugs is the sea ecosystem where all Black Sea rivers run to in the end. The fishing industry which has always been an important source of income for the Black Sea Region and a major influence on the local people's nutrition habits, is also thought to be under pressure from agricultural activities. Many sources say that agriculture, sea transportation and artificial activities related to tourism have created a major constraint especially in the northern part of the Black Sea and have limited fish stocks by affecting biodiversity.⁴⁶

In conclusion, it is evident that there is a need to conduct comprehensive research on the relation between hazelnut farming and biological diversity and wildlife, their interactions or the benefits of their coexistence for hazelnut farming and develop sustainable applications from an ecological point of view.

HAZELNUT, CLIMATE CHANGE AND ENVIRONMENTAL IMPACTS

“The most important asset of the nature and culture of the Black Sea is the forest ecosystem.” Streams and high mountain ecosystems are also dominant in the region after the forest ecosystem. Conservation and sustainable management of natural habitats in this region should be considered within the framework of utilization and management of forests. Forests must be planned together with all their products and services. Integrated Forest Management approach will be an important tool in order to be prepared for processes like the climate change which will negatively affect the region and for the continuation of benefits from the forests. Under this approach, benefiting from functions and services harbored by the forests, processes of conservation and adaptation to climate change are evaluated from social, economic and ecological perspectives and management decisions are made with the participation of different industries”.

“The most important problems in the region are two major processes of change: Change in the region’s social and economic structure due to climate change Unfortunately, we do not fully know the effects of these two changes. As a result of these, we face problems like land deformation, erosion,

flood and high waters, loss of forest ecosystem, destruction of habitat and economic losses”.

“Processes related to these changes must be studied and the process of change must be managed with social, ecological and economic dimensions. One of the best tools is to design Integrated Forest Management plans. It should be an approach that includes applications to manage the process of change without the classical approaches”.

“The effects of climate change in the Black Sea region will be observed mostly in agriculture through irregular and extreme weather events and the changing of seasonal trends. Increases in the frequency and severity of extreme weather events leading to decline in the number of types and populations of species and to serious drops in agricultural yields of the region whose main source of livelihood is hazelnut and tea, may cause the agricultural population to move to other industries because of the loss in yields. Climate change sourced fluctuations are known to hurt tea farming through population explosion in pests which previously did not create any problems for the tea plant. We witness increases in flood disasters as a result of climate anomalies. We observe



Photo: Turgay Dündar

the effects of socioeconomic change particularly at plateaus where livestock is not kept and some endemic plant types and butterflies have decreased because grass is no longer sown. There is disintegration of habitat and buildup of concrete due to infrastructure construction at plateaus which have been opened to tourism. Risk of moving tea and hazelnut farming to higher altitudes in the future as a result of climate change may trigger deforestation”.

Finally, we know that the hazelnut tree is a perennial tree and it is a natural carbon sink. However, one should remember that the hazelnut orchards are mostly acquired from the forest lands that have much bigger carbon sink capacity than them. Acquiring forest lands to plant hazelnut trees is strictly prohibited at the moment and this is closely monitored by the au-

thorities. However, it may be possible to raise the altitude for growing hazelnut or shift the region entirely due to the climate change. It is highly important to continue the controls strictly in order to prevent that any competition between the hazelnut plant and the natural forests leads to a possible deforestation. We have some research as listed above regarding the carbon footprint and environmental impacts of the hazelnut, but it is clear that we need much more research and information on this subject. Both universities and the research institutions need to generate much more information on the subject. The existing studies should be definitely updated and occasionally renewed with new data sets, and the environmental problems that have not been studied until now should be dealt with the help of the further scientific research.

15 The Effects of Climate Change on Spatiotemporal Changes of Hazelnut (*Corylus avellana*) Cultivation Areas in the Black Sea Region, Turkey, Prof. Dr. Beyza Ustaoglu and Prof. Dr. Mehmet Karaca, 2014 http://aloki.hu/pdf/1202_309324.pdf

16 Chamber of Agriculture Engineers, HAZELNUT REPORT – 2018 http://www.zmo.org.tr/genel/bizden_detay.php?kod=30070&tipi=17&sube=0

17 The Effects of Climate Change on Spatiotemporal Changes of Hazelnut (*Corylus avellana*) Cultivation Areas in the Black Sea Region, Turkey, Prof. Dr. Beyza Ustaoglu and Prof. Dr. Mehmet Karaca, 2014 http://aloki.hu/pdf/1202_309324.pdf

18 Assessment of Hazelnut Yield in a Changing Climate for Turkey), Prof. Dr. Levent Kurnaz, Nazan An ve Mustafa Tufan Turp, Climate Change and Policies Application and Research Center of Boğaziçi University.

19 Excerpts from an interview with Nazan An and Mustafa Tufan Turp of Climate Change and Policies Application and Research Center of Boğaziçi University, 27 March 2019.

20 “Climate Change and Local Effects Report”, semi-structured interview results, prepared by TEMA Foundation and WWF-Turkey, March 2015

21 Excerpts from a private interview with Prof. Dr. Sebahat K. Ozman-Sulivan, Ondokuz Mayıs University, Faculty of Agriculture, Department of Plant Conservation, February 2019, Samsun

22 “Turkish Hazelnut Industry's Carbon Footprint Study”, Dr. Pınar Özuyar from Energy, Environment and Economy Center, Özyeğin University, 2012, <https://www.ozyegin.edu.tr/tr/enerji-cevre-ve-ekonomi-merkezi>

23 “Life Cycle Assessment Of Roasted And Bleached Hazelnut Kernels”, NOOR Fındık, November 2013

24 Eutrophication is a serious problem that affects the ecosystem of large masses of water, and it is the explosion of algae and plankton as a result of increase of their food stuffs such as azote and phosphor. <http://www.cevrevesaglik.com/otrofikasyon-nedir/>

25 Climate Change and Erosion Report, TEMA,

26 Ibid.

27 Directorate of Fight with the Desertification and Erosion (ÇEM) of the Republic of Turkey Agriculture and Forestry Ministry, http://www.cem.gov.tr/erozyon/AnaSayfa/Erozyonyeni/Genel_Bilgi.aspx?sflang=tr

28 Ibid.

29 Giresun Province Environmental Status Report, 2009

30 <https://www.iklimhaber.org/cevre-ve-sehircilik-bakanligi-karadeniz-iklim-degisikligi-eylem-planini-yayimladi/>

31 “Giresun’da Sürdürülebilir Fındık Üretimine Doğru” (Towards Sustainable Hazelnut Cultivation in Giresun) WWF-Turkey, 2017, https://www.wwf.org.tr/basin_bultenleri/raporlar/?9060/Giresunda-Surdurulebilir-Findik-uretimine-Dogru

32 Ibid.

33 The impact of the slope of the terrain in different agricultural applications, (Değişik tarım uygulamalarında arazi eğiminin erozyon üzerindeki etkisi), <http://arastirma.tarim.gov.tr/findik/Sayfalar/Detay.aspx?Sayfald=22>

34 WWF-Turkey, 2011, Monitoring the Implementation of Integrated Basin Management in Firtina Valley, Istanbul.

35 Karadeniz Bölgesinde fındık yetiştirilen toprakların bazı fizikokimyasal özellikleri, (Some Physicochemical properties of the soil where hazelnut is grown in Black Sea region) Coşkun Gülsel, Rıdvan Kızılkaya, Abdurrahman Ay, Caner Gökçe, Elif Toptan, https://www.researchgate.net/publication/329962716_The_2nd_International_UNIDOKAP_BOOK_OF_PROCEEDING

36 “Giresun’da Sürdürülebilir Fındık Üretimine Doğru” (Towards Sustainable Hazelnut Cultivation in Giresun) WWF-Turkey, 2017, https://www.wwf.org.tr/basin_bultenleri/raporlar/?9060/Giresunda-Surdurulebilir-Findik-uretimine-Dogru

37 Ibid.

38 “Fındık Üretiminde Kimyasal İlaç Kullanımının Çevresel Duyarlılık Yönünden İncelenmesi: Giresun İli Örneği”, (“A Study of the Use of Agricultural Pesticides in Hazelnut Production from the Viewpoint of Environmental Sensitivity: Giresun Province Example”) by Burhan KILIÇ, A. Semih UZUNDUMLU, Göksel TOZLU, 2018 <http://dergipark.gov.tr/download/article-file/555008>

39 Private information, Nature Conservation Centre, Dr. Uğur Zeydanlı, Yıldırım Lise, July 2019.

40 “Giresun’da Sürdürülebilir Fındık Üretimine Doğru” (Towards Sustainable Hazelnut Cultivation in Giresun) WWF-Turkey, 2017, https://www.wwf.org.tr/basin_bultenleri/raporlar/?9060/Giresunda-Surdurulebilir-Findik-uretimine-Dogru

41 Ibid.

42 Ibid.

43 Ibid.

44 Korkmaz, K., 2007, Nitrogen and Nitrogen Pollution in Agricultural Input System; http://www.ziraat.ktu.edu.tr/tarim_girdi.html

45 Excerpts from the interview with Prof. Sebahat K. Ozman-Sullivan of Ondokuz Mayıs University, Faculty of Agriculture, Department of Plant Conservation, February 2019, Samsun.

46 <http://www.coastlearn.org/tr/bio/introduction.htm>

C) FIELD NOTES, RESULTS AND A ROADMAP FOR SUSTAINABLE HAZELNUT PRODUCTION

C1. Field Notes

“Climate change can transform areas above 1,500 meters into lands suitable for hazelnut cultivation”

Professor Beyza Ustaoglu, Department of Geography, Faculty of Science and Literature, Sakarya University.

The first leading study on the impacts of climate change on hazelnut cultivation in Turkey and in the world conducted by **Professor Dr. Beyza Ustaoglu** from the Department of Geography at Sakarya University was completed in 2012 and includes important assessments regarding the future of hazelnut in Turkey.

“This study puts emphasis on the ecological characteristics of the hazelnut (**altitude, exposure, soil and climatic conditions**), “**special climatic requirements**” and “**elevation**”. Temperature and precipitation are two important climatic properties that determine hazelnut cultivation. Regions with annual mean temperature of 13-16°C with total annual precipitation over 700 mm have the most favorable conditions for hazelnut cultivation. Altitude is a factor that limits hazelnut production economically. The most favorable conditions are found in coastal zones (0-250 meters). Low temperatures and frost at higher altitudes limit hazelnut yield. Since hazelnut is seen in broad-leaved forests (*Quercus*, *Carpinus*, *Fagus*) and coniferous-broad-leaved (*Fagus - Abies*) forests in the Black Sea region at 20-1500 meters, the literature sets the upper limit for hazelnut cultivation 1500 meters.”

“In this study, the current conditions models were based on the special climatic requirements of hazelnut during each phenological period and **data sets from 273 meteorological stations** of the Turkish General Directorate of Meteorology were used for this purpose. The special climatic conditions required by the hazelnut during its phenological

periods of the hazelnut (flower bud formation, loss of leaves, dormancy, flowering/pollination, fertilization/fruit development/ripening, harvest) and their impacts on cultivation and yield were analyzed. The results were used, for example, to determine that a frost that occurs during the flowering period leads to decreased yield by causing loss of flowers.”

“Using global climate change scenario A2, future hazelnut cultivation areas in Turkey have been investigated at 10-year intervals using simulations to estimate the spatiotemporal change. The simulation results showed an increase up to 6 °C in average temperature for the upcoming 90 years. The changes in temperature conditions are expected to **cause horizontal and vertical zone shifts of hazelnut cultivation areas**. Rising temperatures will have negative impacts on hazelnut cultivation, particularly in the coastal zone (0-250 meters). On the other hand, areas above 1500 meters that are not currently suitable for hazelnut production will become arable lands with vertical change. The cultivators need for new hazelnut cultivation areas as a consequence of climate change may result in deforestation. The development of alternative crops that are suited to warmer conditions and their introduction to farmers should already begin as temperatures in the coastal zone are expected to increase. If these efforts are delayed, the impacts of climate change on hazelnut cultivation as the most important crop and source of income in the region, will also bring about socioeconomic issues. This should be of particular concern particularly in regards to the densely populated coastal zone.”



Photo: Toyfan Öztürk

“Climate change-caused increases in temperature have reached the Black Sea region”

Professor Dr. Murat Türkes, Center for Climate Change and Policy Studies, Boğaziçi University

“**Mediterranean** countries hold a unique place in the observation of climate change and its impacts. The countries that are the most impacted by climate change are located in the Mediterranean basin because it is an important transition belt. And Turkey holds a special place in the Mediterranean basin because it spreads over the Eastern Mediterranean, Southeast Europe and the Caucasus and has connections with the Middle East and North Africa.”

Mediterranean climate has its own problems aside from climate change; summers are very long, hot and dry. Most of the precipitation falls in winter and spring. Therefore, the delays and shifts in precipitations pose a serious drought risks. This has an important impact on agriculture, water resources and ecosystems.”

“With climate change, there has been a decrease as well as a change in the form of precipitations, particularly in winter-time. Precipitations do not fall as snow. There is a decrease in precipitations as well as a shift to other seasons. And, of course, when precipitations shift to the beginning of autumn or summer, they fall as heavy rain whereby the soil is not able to hold sufficient water and cannot benefit from it. Since the soil is already dry, heavy rains cause floods and inundations. In areas such as the Eastern Black Sea region and Southwest Anatolia, where sea-effect and orographic precipitations interact and orographic precipitations are strong, disasters like heavy rains, rainstorms, floods, inundations, landslides, etc., can occur.”

“Temperature increases caused by climate change seem to be higher in the western and southern parts of Turkey. These are the areas where climate is the most volatile; however, volatility is also increasing in the Black Sea and Northeast Anatolian regions. In other words, in Northeast Anatolia and the East Black Sea region, which used to have calm and consistent climate regimes, climatic variability increases as temperatures rise and this causes inundations, floods and landslides. There is also a substantial decrease in soil humidity, which is also very important. The soil’s capac-

ity to hold organic matter, and particularly organic carbon matter, decreases and the soil becomes less fertile. The desertification processes intensify and you have to use more fertilizers and pesticides in agriculture, thereby increasing fossil fuel consumption and polluting the air, water and soil with these chemicals. The impacts of climate change in Turkey are not only observed through decreasing precipitation, temperature increases and strong weather events; there are also many sociological and ecological interactions. When you add improper land use and general land degradation to climate change, when the climate and ecosystem that awaits you is similar to North Africa’s, the future of agriculture could be a less fertile, low-yield ecosystem or agricultural ecosystem.”

Projections based on homogenized global and regional models of future climate and climatic variability for Turkey and its surrounding regions indicate that in Turkey, temperatures and the number of annual heat waves will increase dramatically by the end of the 21st century. This shows that the conditions that we currently define as heat waves will become normal (common) conditions by the end of the century. The circulation model over the Eastern Mediterranean, particularly in the summer, will play an important role in this increase. With warm air currents arriving from the Persian Gulf during the warm time of the year and Mediterranean seawater temperatures rising with atmospheric circulation patterns such as atmospheric stability, an increase in the number and intensity of heat waves seems inevitable. The results of climate models indicate that rising temperatures will be accompanied by a decrease in rainfall and snow and an increase in the frequency and duration of droughts. By the end of the 21st century, in the Eastern Mediterranean and particularly in semi-arid areas, many sectors -notably agriculture, tourism and energy- will be negatively impacted in relation to the combined effect of declining precipitations and rising temperatures and the increase in the frequency of extreme weather/climate events.”

“Powdery mildew on hazelnut caused by *Erysiphe corylacearum* is most probably associated with climate change”

Dr. Arzu Sezer, Department of Plant Protection, Faculty of Agriculture, Ordu University, and former Giresun Hazelnut Research Institute employee.

Arzu Sezer, whose doctoral thesis was on hazelnut fungal diseases, thinks that the *Erysiphe corylacearum* powdery mildew, which was suddenly introduced in 2013 and had serious impacts on hazelnut production, is associated with climate change. Sezer states that even though this issue has not been directly researched, the introduction of *Erysiphe corylacearum* powdery mildew can be associated with climatic conditions given the fact that conditions during the years it was introduced and developed the weather was hot and dry, with below normal seasonal precipitation levels.

“As for the effects of changes in climatic conditions on diseases such as powdery mildew, an increase in powdery mildew occurrence can be expected during periods of decreased precipitation and increased temperatures. In general, fungal disease thrives in humid conditions however, powdery mildews have the potential to develop in relatively warmer and dry conditions. This is not just my opinion, all experts agree on this issue. Powdery mildew is expected to increase with changes in climatic conditions.”

A widespread disease in Turkey and in the world, powdery mildew in hazelnut has been known for long time. Powdery mildew occurs in hazelnut as well as in all nut types, fruits various woody and herbaceous plants. Until recently, the causing agent was identified as the “*Phyllactinia guttata*” fungus and known to only affect leaves and not cause extensive economic loss, and cultural measures were sufficient to fight the disease. However, the symptoms of the disease changed began to change in 2013, powdery mildew symptoms were observed on husks and offshoots as well as leaves, together with drying and premature leaf drops were observed. Dr. Arzu Sezer determined that disease was caused by a different and new agent, the *Erysiphe corylacearum*.



“We have published the results of our study on determining the causing agent of powdery mildew. In 2015-2016, we worked on the chemical control of the disease and developed a control program. In 2017, we conducted experiences with various plant protection products that were alternatives to chemicals. One of these products contained a biological plant protection agent (a parasite fungus that interacts with powdery mildew fungus). Even though the results were not highly successful, more studies need to be conducted on these methods that cause less harm to the environment. Applying the products to every cultivation area is challenging and expensive, and can cause further problems if the products are chemicals. Therefore, environment-friendly plant protection products that contain biological preparations can be much more effective in fighting powdery mildew.”

“We need to have a better knowledge of farmers in order to fight climate change”

Özer Akbaşlı, Hazelnut Producer, Agricultural Consultant, Giresun

“Turkish hazelnut production has very serious structural problems and to solve these we first need to understand the general sociological situation. We cannot solve these problems by considering the economic activities alone, we need to address these problems.”

“In the 1970s, the average hazelnut cultivation area measured 50 hectares, today it has decreased to 0.5 hectares. An area of this size is too small to feed the producer. The Ministry of Agriculture’s farmer database (ÇKS) shows that the average age of hazelnut producers is 58,5-59. We need to act right away because these farmers will be 68 to 69 years old in ten years and will not be able to cultivate hazelnuts by themselves. This is what happened in Spain and had heavy repercussions.”

“First of all, sociologists need to do field studies and publish. They need to look at people who live in the hazelnut region, at their perception of agriculture, their relationship to their children, their family structure, their income level. They need to determine the percentage of people who reside in cities and the time allocated to hazelnut cultivation. We need to look at all of these factors and understand who the hazelnut produc-

er is and develop policies accordingly.”

“The same holds true for climate change. How does and how will climate change affect us? We need to understand this through scientific research. The main reason for last year’s low hazelnut yield in the Black Sea region appears to be a temperature increase 1°C. Why? Because Giresun’s Tombul hazelnut requires 600 hours of cold a year. The Çakıldak hazelnut that grows at higher altitudes requires 1,600 hours of cold a year. In other words, hazelnut trees require an average of 1,000 hours of cold. They need to fulfill their chilling requirements. If this is not possible because of climate change, do we need to direct producers to hazelnut cultivars that have lower chilling requirements? And if there is a need to switch cultivars, which producers are going to do it. What do producers think about this? Will the Ministry of Agriculture undertake the switch through subsidies? If it will, will it take care of them for five years? We do not know the answers to these questions, but we need to know them because we need data in order to fight climate change. We need to know the producer to know which solutions can be applied.”

“Our greatest disadvantage is not having enough scientific research on the hazelnut”

Dr. Hüseyin İrfan Balık, Agricultural Engineer, Giresun Hazelnut Research Institute

Agricultural Engineer Dr. Hüseyin İrfan Balık who works on hazelnut growing at the Giresun Hazelnut Research Institute states that they personally see the impacts of climate change during field work. “We observe the plants everyday all year around and try to see the impacts of climate change on the hazelnut. This is, of course, a very extensive issue and you need to look at all the parts of the issue to understand it. We have to assess the current situation. However, our projections are much direr.” Balık says that according to data that he obtained from the General Directorate of Meteorology for a report that will be published by the end of summer, highest temperature, lowest temperature, average temperature and precipitation data of the last 5 years display the most extreme values since the 1950s. “Although the Black Sea region is Turkey’s wettest region, we began experiencing drought. The issue is not the amount of total precipitation; annual to-

tal precipitation is above 1,000 mm, however precipitation in the months of June and July, when the hazelnut requires rainfall the most, is decreasing. During these two months of development, which follow fertilization, the hazelnut is stressed for water and this leads to yield and quality problems.”

Balık states that the impacts of climate change on the various phenological stages have a serious effect on the hazelnut. “We are observing that the degree of dichogamy has been increasing in the last 3 years. This is caused by the temporal separation between male and female flowers and since there is no pollination, the hazelnut does not produce fruits.” Hüseyin İrfan Balık underlines that the greatest disadvantage is the fact that the hazelnut is not a very well known species. “There are very few scientific researches on the hazelnut. We absolutely need more research.”





Photo: Berna Yösmoğlu

“Further research is needed on the impacts of climate change on pests”

Professor Dr. Sebahat K. Ozman-Sullivan, Department of Plant Protection, Department of Agriculture, Ondokuz Mayıs University

“The main pests of hazelnut cultivars are nut weevil (*Curculio nucum* L.) and big bud mites (*Phytoptus avellanae* Nal. and *Cecidophyopsis vermiformis* Nal.). However, in recent years a sucking type bug we call the green shield bug (*Palomena prasina* L.) was introduced and has become a problem for hazelnut export. The *Aspergillus* fungi settle in the area sucked by the bug and produces the poisonous carcinogen aflatoxin.”

“I have been working in this area for 38 years. Pest population increases and decreases. We cannot assert that this happens entirely in relation to climatic conditions but climatic conditions, which we call non-living abiotic factors, greatly impact pest population. All species live under different climatic conditions and have different optimum requirements. The living conditions of the pests will change with changes in climatic conditions. Even plants species will change. Existing plants will perhaps stop growing and pests will die with them, or they will shift to higher altitudes. Climate change will certainly cause vertical and horizontal shifts of plant and pest habitat.”

“It is not easy to say pest populations increase and decrease

only in relation to climatic changes, however it is very clear that climate has become instable. We cannot affirm that all pest populations increase or decrease as it depends on the species, but we see very clearly that there are some changes happening.”

“Now the real danger is the brown marmorated stink bug (*Halyomorpha halys* Stal) that is coming over here from Georgia. This bug, which had a tremendous impact of hazelnut cultivation in Georgia and could not be eradicated despite extensive chemical use, has crossed our borders. This a polyphagous pest that lives not only on hazelnut cultivars but over 100 host plants. It will cause tremendous damage once it reaches hazelnut cultivation areas. And perhaps, the bugs we currently classify as main pests will become secondary pests.”

“This bug is native to China, Korea, Taiwan and Japan. It spread to the USA and Europe, and from Europe to Georgia. It is not clear whether this migration is related to climate change, increases in temperature or to our changing conditions. We need further research to provide clearer answers to this issue and many others.”

“Black Sea region needs integrated forest management plans”

Dr. Uğur Zeydan and Yıldırım Lise, Nature Conservation Centre

“The most important asset of the nature and culture of the Black Sea is the forest ecosystem.” Streams and high mountain ecosystems are also dominant in the region after the forest ecosystem. Conservation and sustainable management of natural habitats in this region should be considered within the framework of utilization and management of forests. Forests must be planned together with all their products and services. Integrated Forest Management approach will be an important tool in order to be prepared for processes like the climate change which will negatively affect the region and for the continuation of benefits from the forests. Under this approach, benefiting from functions and services harbored by the forests, processes of conservation and adaptation to climate change are evaluated from social, economic and ecological perspectives and management decisions are made with the participation of different industries”.

“The most important problems in the region are two major processes of change: Change in the region’s social and economic structure due to climate change Unfortunately, we do not fully know the effects of these two changes. As a result of these, we face problems like land deformation, erosion, flood and high waters, loss of forest ecosystem, destruction of habitat and economic losses”.

“Processes related to these changes must be studied and the process of change must be managed with social, ecological and economic dimensions. One of the best tools is to design Integrated Forest Management plans. It should be an approach that includes applications to manage the process of change without the classical approaches”.

“The effects of climate change in the Black Sea region will be

observed mostly in agriculture through irregular and extreme weather events and the changing of seasonal trends. Increases in the frequency and severity of extreme weather events leading to decline in the number of types and populations of species and to serious drops in agricultural yields of the region whose main source of livelihood is hazelnut and tea, may cause the agricultural population to move to other industries because of the loss in yields.

Climate change sourced fluctuations are known to hurt tea farming through population explosion in pests which previously did not create any problems for the tea plant. We witness increases in flood disasters as a result of climate anomalies. We observe the effects of socioeconomic change particularly at plateaus where livestock is not kept and some endemic plant types and butterflies have decreased because grass is no longer sown. There is disintegration of habitat and buildup of concrete due to infrastructure construction at plateaus which have been opened to tourism. Risk of moving tea and hazelnut farming to higher altitudes in the future as a result of climate change may trigger deforestation”.



Photo: Mehmet Can Düzgün

“The true impact of climate change is reflected on the precipitation regime”

Professor Dr. Saim Zeki Bostan, Department of Horticulture, Faculty of Agriculture, Ordu University.

“We have been looking at climate parameters and wondering how hazelnut production would be affected and we are seeing some changes. This can sometimes be misunderstood. People say things such as “precipitation has increased”, but we think that the change in the precipitation regime has a bigger impact.”

“Climate scientists predict that Turkey will face serious threats in the 2050s. We even see that some of the events that were predicted for the 2030s are already occurring in Turkey. We live in a high-risk area for groundwater reserves. Everyone thinks that the Black Sea region has abundant groundwater reserves, but that is not true. We are located in the most high-risk area. Experts state that the risk of water shortage in this region is higher than before, and that the Black Sea region faces higher risk than the Mediterranean region.”

“We have studied the relationships between climate parameters and hazelnut yield in the region we saw that

indeed some changes occur in relation to the climate. Thereafter we prepared a project for TÜBİTAK (Scientific and Technological Research Council of Turkey) and several university-funded projects. Using data from published final reports, we researched hazelnut yield values of different irrigation applications for hazelnut and the change in yield parameters. Our research results showed that irrigation increases hazelnut yield by there 200 to 250 percent. In the past, hazelnut cultivation did not need irrigation. Why? Because the trees water requirements were met by rainfall.”

“The period following the fruit set period, in other words the period between the second week of May and July is critical for fruit development. We determined that hazelnut’s unmet water requirement must be compensated through irrigation during this critical period for fruit development and plumpness. Nowadays, it is almost impossible for hazelnut producers in the Black Sea region to obtain high yield and high-quality fruit without irrigation.”

“With climate change, the cold-resistant hazelnut has become the highest-quality hazelnut”

Levent Ağca, Chairman of FİSKOBİRLİK Integrated Hazelnut Processing Industry and Trade Inc. (Efit A.Ş.)

Chairman of FİSKOBİRLİK Integrated Hazelnut Processing Industry and Trade Inc. (Efit) Levent Ağca states that the quality of hazelnuts from the coastal zone has been deteriorating for the last 3 to 4 years. As the chairman of Fiskobirlik Integrated Processing Facilities he receives hazelnuts from all regions. He says that hazelnuts from the coastal zone exhibit mold and rot. Ağca says, “Therefore, the cold-hardy Çakıldak, which was not a favored cultivar in the 1960s and 1970s, has become the best quality hazelnut.”

Therefore, the price of the hazelnut that is cultivated at high altitudes with cold winters has gone up. These field data concur with scientific projections. Ağca states that it is going to become increasingly difficult to cultivate hazelnut

in the coastal regions, and that hazelnut cultivation is going to shift to high altitudes, and that this is going to happen in the near future. Ağca attributes this shift to climate change and says that even though everything has changed, the hazelnut cultivation calendar remained the same because of some old habits. He states that this causes serious damage and adds, “We have to re-establish the dates of pesticide application, fertilization and pruning. In other words, we have to determine a new calendar.”

Ağca also refers to micro-weather events and explains that a variety of climate conditions can occur within short distances and underlines that extreme weather events, storms, frost and extreme heat have negative impacts on hazelnut cultivation.



Photo: Kemal Özkılıç

“Unfortunately, due to climate change hazelnut’s future looks troublesome”

Nazan An, Researcher, Center for Climate Change and Policy Studies, Boğaziçi University

M. Tufan Turp, Researcher, Center for Climate Change and Policy Studies, Boğaziçi University

Professor M. Levent Kurnaz, Director, Center for Climate Change and Policy Studies, Boğaziçi University

“Our research paper titled Assessment of Hazelnut Yield in a Changing Climate for Turkey, which is in the process of being published, we tried to foresee hazelnut yield for the next 30 years in Turkey.”

“We based our research on the pessimistic RCP8.5 climate change scenario that depicts a business as usual scenario where no radical measures are taken. Nevertheless, we can say that in reality the current global trajectory is even worse”. “We designed a statistical model using regional climate modelling outputs. Using this statistical model and 1992-2012 as the reference period, we tried to predict hazelnut yields for 2021-2050, and used. We initially wanted to use a larger reference period however we could only access 1992-2012 data through the Turkish Statistical Institute.”

“With this model, we determined the parameters that were important for hazelnut yield and quality and tried to foresee the changes they would undergo.”

“The hazelnut is a fruit that requires regular rainfall and therefore precipitation is an important parameter for hazelnut. Almost the entire Black Sea region and the east of the Marmara region receive regular precipitation and thus constitute a natural habitat for the hazelnut.”

“According to projections, there will be no substantial decrease in seasonal precipitation in the Black Sea region, and winter precipitation is expected to increase in the eastern part of the Black Sea region. The important thing here is the expectation that the variability of precipitation will increase. Therefore, the fact that higher amounts of precipitation will fall in shorter time scales (such as a monthly precipitation falling in just three days) is an important problem. In other words, we expect an increase in extreme precipitation intensity and frequency in the future.”

“Transpiration is an important parameter to determine a plant’s water stress during low precipitation months. At the end of the fruit development period or at the beginning of

the ripening period, the hazelnut requires approximately 60 percent relative humidity, therefore relative humidity is an important factor for the hazelnut. The model also takes into account the duration of sunshine parameter, which is important for the hazelnut during the shoot growth period from April to July. The other parameter that was taken into consideration was growing degree days, an important parameter for all agricultural products. The analysis concluded that all of these parameters have impacts on yield depending on the phenological stage of the hazelnut.”

“However, we can state that the most important parameter is change in temperature, in other words the difference between minimum and maximum temperatures during the hazelnut’s dormancy period and the later blooming period. Even though, compared to average temperatures, temperature difference provides wider information on the impacts of climate change on the hazelnut (frost), it has only been taken into consideration in a just a few academic papers. Temperature differences are important for a better understanding of extreme heat and our model supports this. We can assert that an increase in temperature difference during the flower development stage has a negative impact on the hazelnut.”

“Our research covers the entire Black Sea region (West, Middle and East Black Sea) and Eastern Marmara. We included 105 hazelnut producer sub-provinces that had a statistical significance level over 80 percent. We saw that hazelnut yield is expected to decrease in more than 60 sub-provinces. The decrease rate becomes higher from east to west, namely as we get closer to the Giresun-Ordu region, where hazelnut industry is the most concentrated. Yields are expected to fall in areas with highest yields. Out of the 60 sub-provinces where yields are expected to decrease, approximately 30 are located in the Eastern Black Sea region and approximately 20 in the Middle Black Sea region.

“In terms of yield, the Eastern Marmara and the Western



Photo: Erhan Aydin

Black Sea regions are in better shape than the Middle and Eastern Black Sea regions. Therefore, it seems that unless we change our perception of agricultural, take certain measures and do some changes in agricultural applications, yields will continue to fall. We observe a 5 percent decrease in average yield when all of the locations included in the research are taken into account. However, yield decreases are highly variable across locations. Findings varied from 25

percent decrease to 15 percent increase. In conclusion, hazelnut yield, which is already low, is expected to further decrease in relation to climate change. As the world leader in hazelnut production and export, Turkey could lose its competitive edge in the international market and since Turkey supplies 75 percent of the global hazelnut demand, there is a risk that supply might be insufficient to meet global demand."

“Hazelnut cultivation will shift to higher altitudes”

Bülent Yavuz, CEO, Yavuz Fındık, Giresun

“Changes in climate conditions and a one-degree warming can have very serious consequences. A body temperature of 37.5°C might not affect you, but it can affect me. Stamina is important here. You might be strong and young, and this fever will not affect you. But I might be old and frail and a fever of 37.5°C will weaken me”

“Climate change has a similar impact on hazelnut. We see that climate change has a bigger impact in areas populated with older trees. Younger trees are more resilient to change. For example, we observe that the Akçakoca area is more resilient because trees are young.”

“Powdery mildew is the most important problem we’ve been encountering in recent years is entirely caused by climatic conditions. It is not something that is spread or carried by an external factor. It is entirely related to climatic conditions, differences between night and day and humidity. It was first introduced in the Eastern Black Sea region, spread to the west. During the first few years, we realized that winters were not cold. Temperatures hit 25°C in November. Of course, nature has its own way of doing things. If you go out with just a T-shirt in winter, you get sick. There is a winter rhythm we are used to, weather conditions have changed, they are out of the ordinary.”

“Very warm winters, in other words no chilling period, erratic weather in March, April and May, increased humidity and difference between night and day temperatures, they all have an impact on the hazelnut. Just think of it, the temperature increases from 5°C at night to 25°C the following day. This is something that oc-

curs in continental climates, it is out of the ordinary for our region.”

“In the Black Sea region weather is always relatively mild. This has completely changed. And we see that this reflects on the yield and quality of the product. Even if the yield is high, there is a big drop in quality. The Black Sea hazelnut’s quality dropped because the trees are old, but climatic conditions also play an important part here.”

“There is no problem if the hazelnut undergoes a good chilling period and normal summer weather conditions with weekly or bi-weekly rain and normal humidity levels. The Black Sea hazelnut yield depends on weather conditions. The yield varied according to weather conditions but at least the quality of the product was not affected. But now, it began to affect quality.”

“It is clear that hazelnut cultivation will shift to higher altitudes. The cultivation altitude range used to be 0 to 200 meters, now it has increased to 400 meters. And this will shift further. There are no hazelnuts in 1,000-meter altitude, maybe one day there will be. In other words, hazelnut cultivation will shift vertically and yield in the coastal area will decrease.”

“We always preferred to purchase our hazelnuts from the coastal area because they have a higher oil content and they are high-quality. Now, we prefer to purchase hazelnuts that are cultivated at higher altitudes. The yield and quality is very good at higher altitudes. We prefer the Çakıldak hazelnut from Ordu in particular, a cultivar from higher altitudes because it is more resilient and is resistant to the heat and late frosts.”

“The Black Sea climate is changing and this impacts hazelnut production”

Nurittin Karan, Head of Giresun Chamber of Agriculture

Head of the Giresun Chamber of Agriculture Nurittin Karan reflects on information he acquired through direct contact with hazelnut producers and his personal observations and says “The Black Sea climate has begun to change, global warming is causing severe changes. During some winters we experience autumn or even spring temperatures. This is quite detrimental to the hazelnut, as it requires a certain chilling period during winter, and even requires temperatures below 0°C for clove formation. And then it requires a certain period of warm temperatures. But last year, there was no chilling period and there was an important decrease in yield. For example, while average hazelnut yield in Giresun is usually 1,100 to 1,200 kilograms/hectare, last year it dropped down to 300 kilograms/hectare and the reason for this was that we did not experience winter temperatures. In July and August temperatures hit 37°C. The plant was already stressed.”

Karan also draws attention to unusually severe windstorms. According to Karan, these severe storms used to occur every 10 to 7 years and their frequency and severity increased with climate change. Karan says, “We have seen very severe storms in the last 4 years. In January, a 80-90 km/h storm caused 110 km/h winds in the city center blowing off roofs, and it also damaged hazelnuts.” Another issue that is underlined by all interviewees is the relationship between climate change and powdery mildew. Karan says that he has never seen this disease before and adds, “It was introduced in April 2015. There was constant rainfall in the region up until the month of August and the disease spread. A disease that we had not seen since the 1950s has now become a permanent disease. Hazelnut branches cannot get rid of this disease and this is related to climate. For example, if the humidity level had dropped, the disease could have not become permanent.”



Photo: Engin Ayıldız

“We will face serious challenges with this model that has been entirely abandoned to natural conditions.”

Sabahattin Arslantürk, Head of National Hazelnut Council (UFK), CEO of Arslantürk Hazelnuts, Araklı, Trabzon.

“For the last three years, pest damage has been increasing in relation with climate change. In our region, the green shield bug population is increasing and bacterial diseases are causing more damage. We do not know the exact damages caused by powdery mildew, as it is relatively new. The damage caused by these bacteria and pests in the region has peaked and exceeds 50 percent in the coastal zone.”

“Pests cause less damage in higher altitudes, therefore coastal zones are under greater risk. Revenue from hazelnut cultivation has seriously decreased in recent years. Hazelnut cultivation is not a principal source of income anymore; it has become a source of side income. This is why interest in hazelnut cultivation continues to decrease. We see this by looking at yield data. Turkey’s average yield has dropped below 1000 kilograms/hectare. In addition to climate change, the other challenge we are facing is the division of inherited land. The divided land is not able to feed families any longer.”

“In reality, many people are aware of the situation but we often look at it from a price-oriented perspective. Yes, price is a very important issue for all products, but there are many factors that determine price. We need to increase the yield of existing hazelnut cultivation areas, but the current trajectory we are on is heading towards the opposite direction. We need to avert this

trajectory. We need to approach the issue holistically, compensate for the shortcomings and take measures to achieve a more sustainable hazelnut production. The government has many responsibilities to assume in this matter. Cultivation land needs to be of adequate size in order to be economically feasible. There are many models such as land consolidation, leasing and co-op models and they need to be subsidized. The State is paying farmers for loss of income, however the subsidy system needs to be yield and production-oriented.

“The fact that trees are old decreases their resistance to pests. Young trees are more resistant to all kinds of impacts. We are talking about 70 or 100 years in terms of root age. The important part is root age. Rejuvenating pruning is not real rejuvenation. The trees are very old in terms of root age, and this also impacts yield.”

“When we look at countries that practice organized agriculture and we see, for example, that they cut down almond trees over 30-years of age. Why? Because yield drops and they cut these trees to prevent yield decrease and plant new ones. This allows them to keep average yield at a certain level. But, we are facing and will face serious challenges because we are cultivating within a model that has been entirely abandoned to natural conditions.”

C2. Conclusions and Recommendations for Sustainable Hazelnut Production

a. Research Findings

In this chapter, we will sum up the findings of the literature review and comprehensive interviews with the stakeholders. Research findings show that hazelnut production faces important structural problems stemming from laws and regulations. It can be asserted that these legal-regulatory problems caused by the inheritance and subsidy mechanisms also lead to important sociological, economic, and biological-eco-systemic problems. This interaction results with poorly managed, infertile and low-resistant hazelnut orchards and poor farming practices.

Second important source of problem is a new development that leads to further accentuation of the existing sociological, economic and biological problems: Climate change and environmental problems. The climate change having its impacts on the entire globe, causes changes in Black Sea region, already influencing the hazelnut production. Poorly managed old hazelnut orchards have far less resistance against the new conditions caused by the climate change. As in all spheres, the climate change presses for the introduction of new policies supported by the technology and information in hazelnut production, but to do that, a powerful and conscious hazelnut producer and strong public policies to guide them are needed.

Let us now proceed by telling each of these findings in detail.

a.1. Structural Problems Stemming from Laws and Regulations

Fragmentation of Land due to Inheritance Law One source of the problems is the inheritance law. Despite the enforcement of the “Law for Prevention of the Fragmentation of the Agricultural lands due to inheritance”⁴⁷ as supplemented in 2014 to the Law No. 5403 on Protection of the Soil and Use of the Land”⁴⁸, the hazelnut orchards which were fragmented into scales lower than the scale required for a productive agriculture in the past are voiced as one of the major problems on the subject by all stakeholders. The results of the research on this field puts it that an average household needs a hazelnut orchard at the size of 2,2 hectares to provide its livelihood from hazelnut agriculture alone, while av-

erage size of the agricultural enterprises in Turkey presently stands at 1,4 hectares (TurkStat 2017).⁴⁹

Drifting Away from Production Fragmented land which fails to provide livelihood for a household cause the migration of the rural population involved with farming to cities. This leads to deterioration of the quality and yield of the hazelnut production at the hands of a population whose primary work and job is not hazelnut or agriculture and therefore who do not carry out the basic farming practices (such as pruning, fertilization, irrigation, agricultural pesticide application, etc.), and this in turn creates a vicious cycle: As these people’s revenue becomes less and more instable, they tend to further fall away from production hence rural-to-urban migration.

Increase in producers’ average age. Migration of the young population to cities due to fall below the efficient plant size pulls the average age of the producers higher. Average of the farmers rose as high as to 58 according to the farmer register system (FRS). This makes hazelnut production which is a labor-intensive occupation increasingly more of a product that sees less and less interest creating problems in implementation of the modern techniques.

Area-based Agricultural Support System. Another important problem stemming from the laws and regulations and further deteriorating the structural problems is driven by the subsidy system. Most of the stakeholders we interviewed say the subsidies offered to the farmers on area-basis fail to support production activity of the hazelnut farmers registered to the FRS or updated. The stakeholders say that there were many people who migrated to the city and no longer produce hazelnuts but benefit from the subsidies, adding that this system makes people lazy so the subsidies should be given to the product.

Old Hazelnut Orchards - Arid Land. All these structural problems of the hazelnut production in Turkey are resulted with further infertility in orchards. If we keep the climate change outside this equation for now, the main culprit in this picture of lower yield and quality is singled out as the old age of the hazelnut trees. This problem of old age provided in Hazelnut Report 2018 of the Chamber of Agricultural Engineers is also voiced by all stakeholders interviewed. Stake-

holders provide that the age of the roots reach 80-100 years at some places, and they agree that grafting is not a solution, as the trees need to be renewed with some time intervals. It is further maintained that aside from the hazelnut trees which are wrongly fertilized, pruned, and applied pesticides, another problem was the soil that was not fed accurately for years. The soil which has difficulty to get the right amount of nutrition due to the frequent and intense rainfalls in the Black Sea region has serious adverse effects from the erosion due to the sloppy land. Producers and experts point out that the terraces established long years ago to resist the erosion prompted by the sloppy terrain were mostly ruined, so they need to be definitely renewed. This subject is punctuated at the Hazelnut Report 2018 of the Chamber of the Agricultural Engineers, and it is pointed out that the yield of the hazelnut trees in Trabzon, Giresun and Ordu provinces is less than those in Kocaeli, Sakarya and Düzce provinces due to the old age and thicker-set of the trees in the former three provinces. This proves the fertility of the younger hazelnut orchards. This takes us back to our first determination about the structural problems, i.e. the obligation of the government to develop and introduce a new and holistic hazelnut production policy in cooperation and communication with all stakeholders. A holistic hazelnut policy managed by the public with subsidies and sanctions and supported by the scientific data and researches is needed to overcome the structural problems.

a.2. Climate Change and Environmental Problems

Global Climate Change; Now and Here. Man-made climate change has already started to affect the entire planet. The temperatures increased by 1°C and this warming may pass the critical threshold value of 1.5 °C in the next 30 years. The Mediterranean Basin where Turkey is also located, is among the most vulnerable regions affected/to be affected most by climate change due to the fragile weather conditions in this geography.

Black Sea and Hazelnut are affected by the Climate Change. All scientific data, field observations and surveys testify to the same point. Black Sea is undergoing a serious change in climate sense. This change causes rises in temperature and important irregularities starting from the coastal strip. Total amount of precipitation may be unchanged, but serious problems are experienced in regular rainfall which is

more important for the hazelnut. Sudden and intense rains are seen at certain periods, while rain reduces and even reaches the drought levels in some other periods (in June, July, and August). These changes in climate deeply affect the hazelnut plant which need very special and sensitive weather conditions. Hazelnut is a dichogamic plant, i.e. it has both male and female flowers. Therefore, the male and female flowers should blossom one after the other, otherwise pollination is not possible. Climate change however, disrupt the blossoming sequence of the male and female flowers, hence pollination.

Turkey's Hazelnut Map to Change. Hazelnut is among the most climate-sensitive plants in the world. The foremost proof of this is the fact that it can be grown productively only in three or four regions in the entire world all in the same latitudes. Another geographical impasse of this highly climate sensitive plant of hazelnut in Black Sea region is that there is no land to the North as it is covered with the Black Sea. Almost all plants, mushrooms and animal species, i.e. all flora and fauna, migrate to the North due to the climate change. Unfortunately, just like the polar bears, hazelnut has got no place to go to the North. The hazelnut should adopt to the existing conditions and/or the plant should switch to higher altitudes not to pour to the sea. Another possibility found out by the research is shifting of the production areas of the hazelnut further towards the West of the Black Sea region.

Long Term and Scientific Planning Needs. Since the hazelnut is a perennial plant, unlike the other annual plants, it is not possible to change it with species that are durable against the climate change, drought or frost on yearly basis. This requires long-term planning and land management, and of course a strong adaptation program.

Powdery Mildew Threat Growing. Another result of the climate change is the increase in the diseases, fungus and pests. Excessive increase in temperatures in the coastline up to an altitude of 250 meters in particular helps these pests produce in a couple of times more than normal. The powdery mildew disease which emerged in 2013 and is understood to be caused by the fungus named *Erysiphe corylacearum* has so far caused great falls in harvest and in quality, and has become persistent in the region.

New Diseases and Pests. Powdery mildew is of course not the only threat. The damages caused by the green marmorated stink bug in the hazelnut production and quality increased with the increase in temperatures. The newest threat is brown marmorated stink bug (*Halyomorpha halys* (Stal.)), another type of bug similar to the green marmorated stinkbug. Although the relationship between the increase in the pests and the climate change is not certain yet, the increase in the invasive species is common in many parts of the world and is associated with the climate change.

Increase in the Rate of Wastage In the long run; falls not only in yield but also in quality are noteworthy due to the change in pests-diseases and in the climate. The high increase in the waste products for what is called as spoiled, moldy and rotten products is noteworthy due to the pests even in periods when yield seems to have been the same.

Footprint Small, But Environmental Impact Big. Hazelnut's carbon footprint and its impacts on the climate change are not high due to the structure of the hazelnut plant and the production methods employed. However, it has significant impacts on water resources, soil, bio-diversity and ecosystem. However, there are not sufficient research on the subject. For sure, there is a need for further comprehensive and perpetual research on this subject.

Hazelnut Plant is a Carbon Sink Due To its Tree-Like Structure. Elaborate work is needed on this subject. Enhancing the carbon sink capacity of the hazelnut orchards will have favorable effects in terms of fight with the climate change. However, another problem in this context is the destruction of the forests to make hazelnut orchard. This subject is under complete control thanks to the strict supervision of the public authorities. However in the future, it may be necessary to change the hazelnut production areas and carry them to more elevated areas due to the climate change. Moreover, this may bring with it the risk of starting another wave of forest destruction to make hazelnut orchards.

a.3. General Issues

Social-biological problems rooted in history have their impacts on newly emerging climate change problems as well

as Turkey's unique administrative and management problems. That is why there are delays in formulation of the existing problems and finding solutions to these problems. Let us sum up these general problems in short:

Lack of Scientific Research. There are serious problems on scientific production in Turkey. Universities fail to produce sufficient knowledge and research on many fields. Hazelnut orchards have their own share of this deficiency of information. There is a need for much more information on a variety of fields including the sociological, agricultural, climatic, economic and environmental fields for a healthy hazelnut production. On the contrary to its importance for the country, very little is known about the hazelnut plant.

Deficiency of Data. As a general problem of our country, data deficiency is an important problem for the hazelnut industry too. As provided by many stakeholders in our interviews, one needs healthy and meaningful data to conduct research; however, there are no sufficient and reliable resources on this subject.

Lack of Communication and Coordination. Although there are many institutions working on hazelnut, we cannot say that these institutions have a good communication and coordination with one another. There is a need for information channels made up of reliable structures that will convey the right information both to the public and to the hazelnut producers.

Deficiency of a Holistic Public Policy on Hazelnut. Although hazelnut is a highly important agricultural export item and a source of foreign exchange for Turkey, the country has got no generally accepted public policy that grasps and finds solutions to the structural problems and the newly-emerging problems like climate change. At this point, it is extremely important that new public policies should be implemented in order to supervise the use of pesticides and fertilizers which have been used completely unconsciously until today, raise the awareness of farmers on these issues and encourage good agricultural and organic production practices that will protect the health of the producer and the hazelnut plant as well as the water resources, soil and ecosystem.

b. Recommendations for a Sustainable Hazelnut Production

In the previous sections, we tried to identify problem areas in hazelnut production. We have seen that there is a balls-up where some of the problems are arising from legislation, some from the biological nature of the hazelnut and ecosystem and others from climate change and the environmental conditions; and while some of these problems can be resolved in the short term, some of can be resolved only in the medium or long term. In this section, we will state our suggestions for solving these interwoven problems. Undoubtedly, these suggestions, which we have created through interviews with stakeholders, need to be developed using more participatory methods. A real roadmap should be drawn up by conducting a much more participatory discussion process involving public administrators, representatives of the non-governmental organizations, academics and growers. It may be plausible to use this draft and our suggestions as a basis for such work. For these purposes, we can summarize our basic suggestions as follows.

Information-Document-Communication Center. One of the first things to do for this purpose is to strengthen the communication between all stakeholders related with hazelnut production. It is extremely important also to include the universities, research institutions, non-governmental organizations, independent researchers due to the importance of the scientific information. Information-document-communication center should be established for the purpose of producing and sharing this information. This center should ensure the participation of all stakeholders through a strong communication, and share the information and data it obtains transparently and efficiently.

Determination of the Research Areas. There is a need for much more information on hazelnut. Some of this information is related with the economic, social, cultural and demographic state of the producers and local people. It is difficult to formulate solution proposals without first preparing an elaborate portrait of the hazelnut producer. Another important research area is related to the hazelnut plant itself. Contrary to what one might expect, many researchers say that little is known about hazelnut as a plant scientifically. One way of getting to know the hazelnut better is to become

familiar with this unique geography and ecosystem. And finally, the changes that took place and probable changes that are expected to take place in this sensitive geography due to the climate change in particular should be identified. There is a need for the portrayal of these areas elaborately, identification and prioritization of the research areas, and establishment of a regular and healthy communication with the universities, research centers and independent researchers in order to realize these intended researches. An important requirement for carrying out these researches is the creation of resources. Providing scholarship and support to the researchers starting from the graduate, post-graduate and doctorate level stands out as one of the important tasks to do.

Efficiently Announcing and Sharing the Information Obtained. There is a need for creating various instruments to keep the public, relevant institutions and science people informed about the research conducted and the information obtained. For this purpose, a “hazelnut portal” may be founded where all developments on hazelnut are to be shared. interviews, news, research printouts should be held and broadcasted in this media which will be constantly updated. The main goal here should be to nurture a culture for the people involved with hazelnut which left its mark on the life of the region with its economy, sociology and folklore. Conference calls should be organized with the participation of the anthropologists, historians and sociologists for further developing this culture. It will be very beneficial to organize an international hazelnut conference at certain intervals where opinions will be exchanged and scientific facts will be shared.

New Production Forms and Demonstration Orchards. Small enterprises model created as a result of the fragmentation of the hazelnut orchards which cannot feed the producers should be changed through various methods. In this regard, it is highly important to encourage the foundation of the farmer companies, producer associations and cooperatives. It seems impossible for the economically weak producer in the present setting to cope with the major problems such as climate change. At this point, it may be considered to provide agricultural support system only to the producer groups having production only in such collective structures above a certain scale. Hazelnut orchards may be rejuvenated via structures that will employ economically stronger and

scientific agricultural methods, and hazelnut species resistant to the climate change may be planted in accordance with the modern planting methods (at certain distance and sequential order). Pilot hazelnut orchards to be planted by the pioneering farmers and cooperatives or by the farmer, companies may change the viewpoint of the hazelnut producers.

Developing Added Value Hazelnut Products. Local people and producers should definitely be able to provide their living from hazelnut orchards in order to create a solid ground for the hazelnut production in Turkey. An important step to ensure this is to foster new hazelnut products with high added value. subsidy mechanisms and entrepreneurship opportunities may be created for this purpose.

Efficient Public Communication. There is a need for sharing all information to be thus generated with the relevant public organizations; various legal arrangements and pertinent regulatory changes should be enacted for that purpose. Public authorities may be provided guidance to develop a comprehensive hazelnut policy based on positive suggestions and supported by the scientific data and findings with the help of all stakeholders.

A Sustainable Public Policy on Hazelnut. A new sustainable public policy on hazelnut should be established with the help of the suggestions and practical works to be developed together with all stakeholders; and this policy should have short-, medium- and long-term plans, concentrate on a subsidy mechanism about hazelnut production and on long term plans of the region and consider the hazelnut production and producer together. The future of the agricultural sector which is accepted as one of the most strategic sectors of the 21st century but which is under a global risk such as climate change, and the future of hazelnut industry in particular, hinges on policies created with long-term and participatory processes based on scientific and social processes.

47 <http://www.resmigazete.gov.tr/eskiler/2014/05/20140515-1.htm>

48 <http://www.resmigazete.gov.tr/eskiler/2005/07/20050719-2.htm>

49 Chamber of Agriculture Engineers, Hazelnut Report – 2018 http://www.zmo.org.tr/genel/bizden_detay.php?kod=30070&tipi=17&sube=0

SUGGESTIONS FOR RESEARCH

Sociological structure

- Demographic information such as the average age, family size and education of the hazelnut producers
- Average field size
- Migration maps

Researches about the Black Sea geography, hazelnut production, climate change and environmental impacts:

- Impacts of the climate change on hazelnut
Changes in hazelnut plantations in terms of altitude and region
- New hazelnut production maps according to various climate projection
- Ecosystem changes
- Comprehensive investigation on hazelnut species worldwide
- Hazelnut species resistant to climate change
- Carbon sink capacity and improvement works of the hazelnut tree
- Estimation of the ecosystem services of the hazelnut based on economic data in the context of its impacts on environment
- Green logistic works to reduce the carbon footprint of the hazelnut increased due to exports
- Growing conditions, changes in pests
- New biological methods of fighting with pests
- New hazelnut production calendars for regions
- Possible changes in the product design

Research Methodology:

For this research an extensive literature review was carried out, several studies on climate change, environmental impacts and their relationship with hazelnut production were examined and evaluated. Interviews were conducted with stakeholders including academicians, researchers, growers, traders and industrialists as partners representing different areas as part of a trip in January, February and March 2019, covering Samsun, Ordu, Giresun and Trabzon provinces and their districts in East Black Sea region which is home to almost 90% of Turkey's hazelnut production. A few final interviews were conducted in Istanbul and Ankara. Semi-structured deep interview techniques were used for obtaining the views of the stakeholders. By using the snowball sampling technique, we reached a variety of other stakeholders with whom we were not in contact before and we increased the number and diversity of the interviewees. The opinions, comments and evaluations of 24 stakeholders in both their own field of expertise and other hazelnut related areas were analyzed and used in the report.

Interviewees were:

Özer Akbaşlı, hazelnut grower, agriculture consultant, Giresun

Prof. Dr. Sebahat Keçeci Ozman-Sullivan, Ondokuz Mayıs University, Faculty of Agriculture, Department of Plant Conservation, Samsun

Tuğba Er, Food Engineer, Giresun Institute of Hazelnut Research, Giresun

Dr. Hüseyin İrfan Balık, Agriculture Engineer, Giresun Institute of Hazelnut Research, Giresun

Nurittin Karan, Chairman of Giresun Chamber of Agriculture, Giresun

Mustafa Şahin, Chairman of Keşap Union of Hazelnut Growers, Giresun

Levent Ağca, Chairman of the Board of Directors, Union of Hazelnut Agricultural Sales Cooperatives - FİSKOBİRLİK Integrated Hazelnut Processing Industry and Trading A.S. (Efit A.Ş) , Giresun

Eren Nizamoglu, Secretary General of Giresun Chamber of Commerce, Giresun

Erdal Suat Başkan, Director of EU Project Development and Implementation Office, Giresun Commodity Exchange, Giresun

Bülent Yavuz, hazelnut industrialist, General Manager of Yavuz Fındık, Giresun

Sabahattin Arslantürk, Chairman of National Hazelnut Council (UFK), hazelnut industrialist, General Manager of Arslantürk Fındık, Trabzon, Araklı

Doç. Dr. Zafer Yücesan, KTU Faculty of Forestry, Department of Forest Engineering, Director of Hazelnut-Tea Application and Research Center, Trabzon

Edip Sevinç, Union of Black Sea Hazelnut and Products Exporters (KFMIB), Trabzon

Dr. Arzu Sezer, Ordu University Faculty of Agriculture, Instructor at Department of Plant Conservation, former employee of Giresun Institute of Hazelnut Research, Ordu

Ömür Duyar, Agriculture Engineer, Altınordu Province Agriculture Directorate, former employee of Giresun Institute of Hazelnut Research, Ordu

Prof. Dr. Zeki Bostan, Ordu University Faculty of Agriculture, Lecturer at Department of Horticulture, Ordu

Prof. Dr. Beyza Ustaoglu, Sakarya University Faculty of Science and Literature, Department of Geography, Sakarya

Ersin Arısoy, Ferrero FFV Director, Istanbul

Prof. Dr. Murat Türkes, Boğaziçi University Climate Change and Policies Application and Research Center

Prof. Dr. Levent Kurnaz, Boğaziçi University Climate Change and Policies Application and Research Center, Istanbul

Nazan An, Researcher, Boğaziçi University Climate Change and Policies Application and Research Center, Istanbul

Mustafa Tufan Turp, Researcher, Boğaziçi University Climate Change and Policies Application and Research Center, Istanbul

Dr. Uğur Zeydan and Yıldırım Lise, Nature Conservation Center, Ankara

