Expected Effects of Climate Change on Organic Agriculture in Turkey

U. AKSOY[1] AND *H.Z. CAN*[1]

Abstract

In Turkey, organic agriculture started in mid-1980s with the demand coming from the enlarging European market. This impulse resulted in converting traditional Turkish crops as dried fruit and nuts that were already grown as low-input into organic management. These commodities still play a major role in Turkish organic production and export. Turkey being a Mediterranean country is reported to be severely affected by climate change in all scenarios. The impact will vary according to the regions. High temperatures and water shortages will be the major problems of the west, southwest and southeast. The east will have milder winter climates that will affect the snow melt and river flows. These effects will get stronger towards the second (2041-2070) and third (2071-2100) periods. Organic agriculture is practiced in all regions of Turkey mainly based upon the existing ecological and socio-economic factors. Changes in climate will affect perennials the most whether be cultivated fruit species or harvested from nature. The paper evaluates the expected effects of climate change on Turkish organic agriculture at regional level based upon common findings revealed by different scenarios.

Keywords: *Mediterranean, carbon emission, drought, perennial plants, perennial species.*

Introduction

Agriculture plays a dual role in climate change mitigation: Agriculture is on one hand a source of greenhouse gas emissions and at the same time a reservoir for greenhouses gases. The share of agricultural sector in the annual amount of greenhouse gasses (GHG) is estimated by the Intergovernmental Panel on Climate Change (IPCC) as 10 to 12 % of global emissions. The major share of agricultural emissions is reported to be nitrous oxide (N_2O) and methane (CH_4) on CO_2 equivalent basis. Emissions in agriculture are from 'small, diffuse and non-point sources'. Soil carbon losses caused by agriculture account for a tenth of total CO_2 emissions attributable to human activity since 1850. Despite various reports and publications there is still lack of data, and thus need for measurement, monitoring and verification still exists. However, the steps to be taken in data collection should balance the costs incurred and accuracy (Reed, 2009; IPCC, 2007). In Turkey, Turkish Statistics Institute (TUİK) has the mandate to prepare the inventory for climate change (Anonymous, 2009a). During this period, besides appraising current agricultural practices in terms of GHG emissions and sequestration potential, there is a need to assess possible impact of climate change on production capacity of agriculture at regional, national and transnational levels. Organic agriculture with techniques based upon principles of ecology and care and with a focus on on-farm inputs, exerts positive effects on climate change alleviation through reduction of GHG emissions and increased carbon sequestration capacity (Müller and Davis, 2009; Niggli et al, 2007; Niggli et al, 2009; Jordan et al., 2009; Leu, 2009). Turkey's National Climate Change Adaptation Strategy and Action Plan identified various activities for agriculture however did not assign any role to organic agriculture. The main objective 'Developing and expanding R&D and scientific studies to identify the impacts of climate change on agriculture and to ensure adaptation to climate change' by developing innovative and appropriate agriculture techniques oriented to ensure adaptation to climate change and sustainability of natural resources foreseen for 2011-2015 and to be implemented by the Ministry of Food, Agriculture and Livestock' can embrace organic agriculture (Talu et al, 2010). In Turkey, organic agriculture displays an increasing trend especially during the last 5 years, however, it is more market oriented rather than preserving natural resources. This paper evaluates possible impact of climate change on organic agriculture in Turkey and focuses on how to alleviate possible negative influences by improving organic management techniques and/or by improving planning.

Projections on Climate Change and its Effect over Mediterranean and Turkey

Various reports on climate change and all regional climate models agree on the Mediterranean Basin as the region most severely affected by global change drivers (Anonymous, 2010a; Sala et al., 2000). Agriculture and agri-industry are important influential forces in Mediterranean economies for food security as well as non-food production and persistence of related sectors e.g. tourism, textiles. In addition to the climate change scenarios, the pressure of economic and demographic growth on natural resources and food production have increased concern among the Region leading to changes in awareness for environment and production systems. In the Mediterranean region, environmen-

[1] Ege University Faculty of Agriculture 35100 Bornova-İZMİR/TURKEY.
uygunaksoy@gmail.com; zafcan@gmail.com

tally friendly production systems having agricultural, dietary and environmental variables are promoted. In this regard, an assembly of ministers declared that 'agriculture and food are areas of strategic importance for societies, economies, regions and cultures' (Anonymous, 2010a). World rediscover the importance of agriculture and make it a priority at the local, national and international level.

Starting in 2010, Spain followed by Italy became the two leading countries in Europe in terms of surface area managed and certified as organic. During discussions of how agriculture may contribute to GHG emissions or during developing mitigation strategies, several benefits of organic agriculture have been displayed. Organic agriculture contributes to sequestration of carbon, emits less N_2O from nitrogen application since there are limitations for nitrogen input and thus lessens the emissions. Additionally less N_2O and CH_4 are emitted from biomass waste burning because waste management is a part of on-farm in-put use strategy. It requires less energy due to ban or limited use of synthetic fertilizers and pesticides. Consumption habits are known to focus more on local and seasonal supplies that additionally reduce GHG emissions. Indigenous knowledge is valued more in management for mitigation of adverse climatic conditions (Müller and Davis, 2009; Niggli et al, 2007; Jordan et al., 2009; Leu, 2009). Niggli et al (2009) put forth the huge potential of organic agriculture in fulfilling the recommendations of the IPCC Fourth Assessment Report and future food security. They recommend including this potential in further climate change mitigation strategies in agricultural production. Planning and preparing the future of Mediterranean agriculture is more crucial due to its fragile nature with severe climate change warnings and therefore, planning must consider various factors and the complex interactions among these factors that further affect the decisions on land and water use, the choice of crops, production systems, markets and social dynamics (Anonymous, 2012).

For Europe, projected rainfall changes are quite complex however in general, for all scenarios, mean annual precipitation increase is projected for northern Europe and decreases in the south. Besides, the change in precipitation will vary significantly from season to season and across regions. Climate change will pose two major water management challenges in Europe: increasing water stress mainly in southeastern Europe, and increasing risk of floods throughout most of the continent. Summer precipitation would decrease substantially (in some areas up to 70% in the SRES A2 scenario) in southern and central Europe. Presence of enhanced anticyclonic circulation in summer over the north-eastern Atlantic creating a low pressure area over eastern Europe. This structure redirects storms northward, causing a considerable and widespread decrease of precipitation (up to 30–45%) over the Mediterranean Basin and western and central Europe. Reduction in rainfall frequency projected for some Mediterranean regions will worsen drought conditions, and has been observed in the eastern Mediterranean (IPPC, 2007).

It is projected that climate change will have a range of impacts on water resources. Annual runoff decreases in central, Mediterranean and eastern Europe are projected. In southern Europe (south of 47°N), runoff is projected to decrease by 0–23% up to the 2020s and by 6–36% up to the 2070s. Groundwater recharge is likely to be reduced in central and eastern Europe (Eitzinger et al., 2003), with a larger reduction in valleys and lowlands with differential effects on reduced productivity of Mediterranean Basin shrub and tree species (Ogaya and Peñuelas, 2003). Drought may also act indirectly on plants by reducing the availability of soil phosphorus (Sardans and Peñuelas, 2004). With global mean temperature increase of 1.8°C, between 60 and 80% of current species are projected not to persist in the southern European Mediterranean region (Bakkenes et al., 2002). The Fourth Evaluation Report indicated 1°C - 2°C increase in temperatures in the Mediterranean basin thus aridity and reduction in biodiversity will be a problem of wider areas. Heat waves and the number of very hot days will increase especially in inland regions. In Turkey, temperature increases are estimated around 2.5°C - 4°C, reaching up to 5°C in inner regions and up to 4°C in the Aegean and Eastern Anatolia (IPCC, 2007). In the Mediterranean Basin, mountain species show high risk (Thuiller et al., 2005). Delayed flowering and reduced flower production of Mediterranean Basin shrub species are also projected under drying scenarios (Ogaya and Peñuelas, 2005). Increased summer temperatures affect fruit set negatively. Irregular and longer rainfall if coincide with flowering period will reduce fruit set in many fruit species that bloom during spring season.

Turkey as an eastern Mediterranean country is among the countries that will be most impacted by climate change. Turkey's First National Communication on Climate Change prepared in 2007 foresees, increasing summer temperatures, decreasing winter precipitation in western provinces, loss of surface water, increased frequency of droughts, land degradation, coastal erosion and floods. Summer temperatures are expected to increase especially in the West. Winter and spring precipitation are foreseen to decrease in South and West (40 %) and only 5 % in other regions. The precipitation levels will increase in the North. In Turkey, temperature increases are estimated around 2.5°C - 4°C, reaching up to 5°C in inner regions and up to 4°C in the Aegean and Eastern Anatolia (IPCC, 2007).

Talu et al (2010) summarize various studies that simulate climate change scenarios for Turkey or the wider region. The findings show that surface temperature will increase slightly all over Turkey for the 2011-2040 period as less than 0.5 °C in winter and 1.0 °C in summer. Significant increases will appear in the second period (2041-2070) as 1.5 °C in winter and 2.4 °C in summer. The increases will be elevated towards the end of the century. The Eastern region will have more rises in temperatures in winter, and Southern and South-Eastern parts in summer. For the last period

(2071-2100), the summer temperature will increase around 6 °C in south-eastern and south-western Turkey whereas around 3°C in the Black Sea and Marmara regions.

Demir et al (2008) using Regional Climate Model, PRECIS (**P**roviding **RE**gional **C**limates for **I**mpacts **S**tudies) report that the expected climate change for Turkey in 2071-2100 would be:

- Similar increases in both maximum and minimum temperatures,
- 5-6 °C increases in mean temperatures in coastal regions,
- 4-6 °C increases in winter temperatures in the east,
- 6-7 °C increases during summer in the Aegean and 7-8 °C in the more continental parts,
- The precipitation decrease up to 40 % in the West and only 5% in the east and north-east,
- Major decrease in winter precipitation in the West and South,
- Snow depth lessen in the Eastern and the Eastern Black Sea regions,
- Water loss to be more significant in Southern Marmara, Aegean, Eastern Black Sea, North of Southeastern Anatolia regions and along the Taurus Mountains,

Changes in snow melt regimes will affect river flows. The main threats are expected as drying out of Gediz and Big Meander rivers in west Turkey (Talu et al., 2010). The expected shift in climatic conditions will not only affect the crop choice, biodiversity, farming system and land and water use preferences but will significantly affect food production and socio-economic conditions including tourism in Turkey (Şen et al., 2012).

According to 2008 figures, the total GHG emissions of Turkey total to 336.5 million tons of CO_2 equivalent. Agriculture contributes to 7 % of total emissions. The share of GHG emissions in Turkey are reported as 81.5 % CO_2, 15.6 % CH_4, 1.9 % N_2O, and 1 % F. 59 % of CH_4 emissions result from waste burning and 31 % from agriculture. 72 % of N_2O emissions come from agricultural activities (Anonymous, 2009b). According to the European Environment Agency (2011) emissions of GHG almost doubled in Turkey between 1990 and 2007, increasing in all sectors except agriculture. The increase resulted mainly due to high economic and population growth that resulted in increasing energy demand and energy production. Turkey responded to Kyoto protocol rather late due to its specificities. The law related to Kyoto Protocol was accepted in the Turkish Parliament on 5 February 2009, and Turkey became officially a party on 26 August 2009, however a number of sectoral policies on mitigation have been initiated even before ratification (Anonymous, 2009a).

Turkey and Current Status of Organic Agriculture

Turkey has a surface area of 783 562 km^2 about 280 000 km^2 devoted to agriculture and 230 000 km^2 to forests. Grassland and rangeland occupy 18 % and the remaining 20 % is used for other purposes. 31 % is cultivated however nearly ¾ are threatened by erosion risk. The overall average altitude is 1100 m asl. Turkey is affected also by pressure systems originating from polar and tropical regions. The diverse geography results in different agro-climatic zones, rich biodiversity, and variable socio-economic conditions (Anonymous, 2007). Anatolian peninsula, the Asian and major part of Turkey is surrounded by sea from three sides. The coastal areas and river basins in the west and south have typical Mediterranean climate. North-eastern Black Sea region is characterized with mild climate and heavy rainfall whereas central and eastern Anatolia have continental cold temperate climate. Seven main agro-climatic zones with various microclimates promote natural and agro biodiversity and plant production. Agriculture consumes 75 and 30% of total and renewable water resources, respectively, and the efficiency is low. The share of agriculture in water use is expected to increase to 72 % by 2023. The annual per capita water availability was 1430 m^3 in 2008, based on the 2008 population figure of about 72 million, availability is estimated to decline to 1000 m^3 per capita per year by 2030 for an expected population of 100 million, which means that Turkey will face 'water scarcity' (Kibaroğlu et al., 2011). More than 30 million live around the sea coasts thus any negative change will have direct impact on regional economy and everyday lives. Agriculture and agri-industry (textiles, food) has a significant share in Turkish national economy. Tourism as an end user of agri-food production is a leading sector in Turkey.

Organic agriculture developed in Turkey since mid-1980s based upon the demand of the enlarging European market. At the initial stage, low-input systems of traditional crops (e.g. grapes, figs, apricots, hazelnut and cotton) were converted to organic management to supply the demand. Since 1994, competent authority is the Ministry of Food, Agriculture and Livestock, and organic agriculture is practiced according to legislation which is harmonized with the European Union legislation e.g. EC 2092/91 and later with EC 834/2007 and further amendments. Till today, major organic products continue to come from plant production, traditional dried fruit, nuts and olive ranking in the first places (Table 1). Organic certification of animals and their products except organic bee keeping started to enhance only during the last years (Table 2). Organic medicinal and aromatic plants are collected mainly from the mountain series in the south and west of Turkey (Table 3). Among perennials, apple, pomegranate and sour cherry are used for processing namely juice extraction (Table 4). Parallel to the development of the domestic market, product range is widening including fresh fruit and vegetables, animal products and non-food commodities e.g. textiles and cosmetics.

Expected Effects of Climate Change on Turkish Organic Agriculture

The impact of climate change on organic agriculture will vary significantly according to the regions. During the 2011-2040 period, water availability with slight tempera-

Table 1 - *Organic Plant Production in Turkey (2010).*

Parameters	Certified as Organic	In Transition
Number of farms	11 179	30 918
Cultivated area (ha)	63 040	295 140
Wild harvest (ha)	126 251	0.0
Fallow (ha)	2 495	23 107
Total area (ha)	191 785	318 248
Production (amount in tons)	331 361*	1 012 375*

Source: www.tarim.gov.tr * Fresh + Dry produce.

Table 2 - *Organic animal production (2010).*

	Number of farms	Total number of animals	Production
Bee keeping (Organic)	191	14 699 bee hives	208.15 tons honey
Bee keeping (in transition)	225	13 258 bee hives	
Poultry (eggs+meat)	14	342 129 birds	17 889 808 eggs
Poultry (In transition)	1	200	
Cattle	90	45 855 heads	11 604 tons of milk
Cattle (In transition)	69	13 031	

Source: www.tarim.gov.tr.

ture increases will be a major problem especially in the western and southwestern part of Turkey where many perennial fruit crops are grown either as rain-fed or under irrigation (e.g. grape, mandarins, plum) as organic (Table 4). Yield and to a certain extent quality decreases may be expected in rain-fed organic production of olives, figs, chestnut, pine nut, and grapes due to drier conditions in the west. Beekeeping and organic honey production displays an increasing trend in the southwest of Turkey and will be affected with the changing climate and consequent loss of biodiversity. The southwestern Turkey has a significant share in medicinal and aromatic plants harvested from wild. The species that will be prone most are carob and daphne (bay) leaves collected from this region. On the other hand, irrigated organic vineyards will be exposed to severe drought conditions as a consequence of reduced flow in Gediz river and lower underground water tables. These effects will tend to worsen during the second half of the 21st century (Figure 1). The irregularities in spring rainfall regimes will affect pollination and fertilization negatively which in return may reduce fruit set in case precautions are not placed properly. There are various other agronomic or economic issues to be analyzed as sudden temperature shocks, changes in UV fractions or the costs incurred with proposed techniques while planning researchwork to mitigate expected changes.

The current organic management of above mentioned species mainly rely more on low or no-input systems where soil management does not receive special attention. To overcome the expected effects of climate change there is a need to adopt new rootstocks and scions resistant to the changing climate. One advantage of the traditional agriculture is the presence of varieties that are well adapted to the local conditions. A study on fig varieties revealed that Sarılop (syn. Calimyrna), variety used for commercial sun-drying in western Aegean Region for centuries has higher water use efficiency compared to other fig cultigens adapted to other climatic conditions (Can et al., 2000). The management skills developed through centuries by the fig farmers in the Aegean Region allow mitigation of drought by regulating fruit set through the number of male figs hung onto female trees. If the winter rains are not adequate for optimal development of the seasonal shoot, the farmers reduce fruit set in order to obtain less number of fruit but bigger in size. The expected climatic changes will have more impact on perennial species whether cultivated or harvested from wild since annuals may adapt within short terms through changing the vegetation periods (e.g. early or late production) and/or the species/varieties (e.g. with high water use efficiency, shorter vegetation).

The South east (GAP) Region is expected to be the second-most affected region, especially towards east (Figures 2, 3). The Region has been subject to intensive irrigation projects and thus a change in land-use and crop pattern. Organic agriculture is seen as an opportunity to preserve the natural resources namely land and water. The GAP administration carries out a project to promote an organic food and textile cluster. Irrigated organic cotton production has increased during the last decade mainly in a short-term rotation with cereals/legumes. The shortages in water reserves will affect the production patterns. Pistachio nut and pomegranate are the two fruit species that are grown mostly as rain-fed and thus will be affected the most with the

Table 3. *Organic products from wild harvest (2010).*

Products Name	Production (tons)
Linden	5 006.51
Carob	2 306.08
Daphne (Bay)	575.04
Wild apple	394.40
Raspberry	302.37
Rose hips	269.58
Cornelian cherry	221.98
Blackberry	181.28
Bilberry	155.73
Hawthorn	150.26
Myrtle	90.20
Sour orange	87.55
Wild apricot	51.03
Wild plum	36.00
Japanese persimmon	26.83
Jujube	19.33
Wild strawberry	7.50
Common medlar	4.73
Wild pear	2.02

Source: www.tarim.gov.tr.

Table 4 - *Organic fruit production (2010).*

Species	Production (tons)	Species	Production (tons)
Apple	35 804.50	**Plum**	1 230.37
Grape	25 664.47	**Mandarin**	1 163.09
Olive	17 833.69	**Grapefruit**	1 000.75
Apricot	13 564.30	**Chestnut**	926.61
Fig	9 643.98	**Walnut**	818.55
Hazelnut	7 944.68	**Mulberry**	803.80
Pomegranate	6 149.24	**Pistachio**	754.64
Sour Cherry	3 935.70	**Peach**	751.11
Orange	2 267.93	**Pine nut**	559.06
Lemon	1 972.17	**Almond**	103.41
Tea	1 971.85	**Kiwi**	52.70
Banana	1 881.53	**Nectarin**	7.45
Pear	1 716.87	**Avocado**	5.68
Cherry	1 275.83		
Total	**139 803.98**		

Source: www.tarim.gov.tr

changing climate. In establishing new orchards, varieties need to be selected according to the expected climate scenarios. Selection of the appropriate rootstock will also become an important issue for pistachio besides management techniques.

Central Anatolia which is known as the 'cereal store of Turkey' will be also under high risk due to lowered water tables and reduced river flows. Even if the share of the Region in national organic production is low, there are new large-scale organic projects foreseen in Konya under irrigation that needs to consider climate change effect during planning the future activities. On the other hand, Marmara Region is expected to be the least affected with the current climate change scenarios.

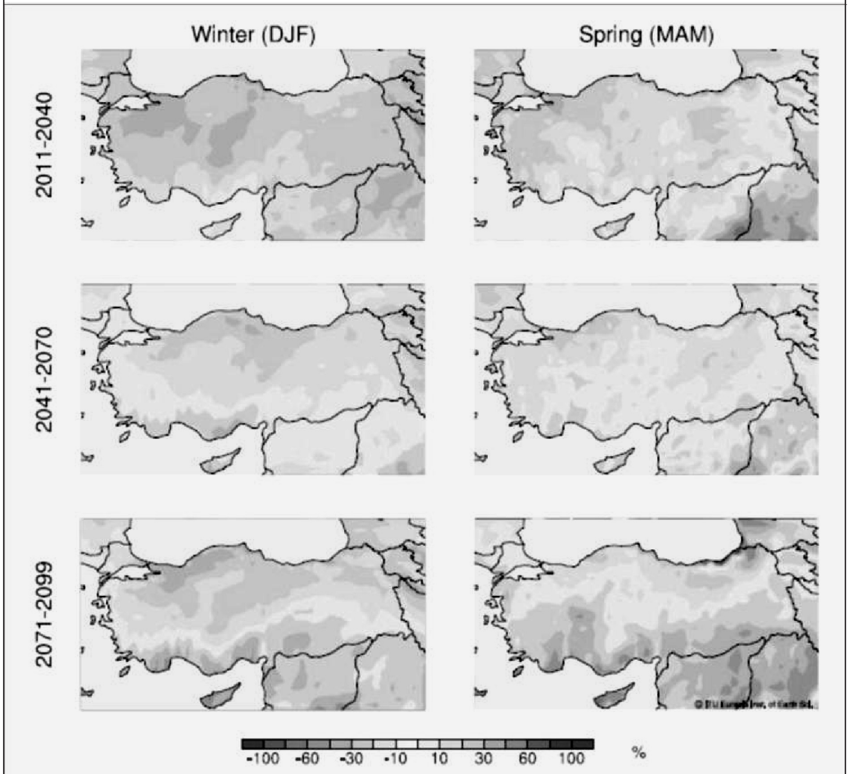
The Black Sea Region which lies along the Black Sea coast shows variations in respect to climate change. The projections show that Central Black Sea Region will receive lower rainfall and the river flows will be reduced (Şen et al, 2012) (Figures 3 and 4) posing drought risk especially for summer vegetables and hazelnut production. The North- Eastern Black Sea Region will bring more favorable conditions with no significant threats especially for organic hazelnut or tea production. Risks are foreseen due to off-season, sudden and heavy rainfall leading to floods increasing erosion and loss of nutrients especially on the slopes. The soil properties in the region display low soil N levels and low soil pH therefore there will be a need for better soil fertility management. Organic honey production is going to be a major activity and the changes should be monitored closely.

East Anatolia that possess cold temperate climate is expected to get milder with increasing temperatures therefore organic fodder and cereal production, extensive animal husbandry and beekeeping may profit with the changing climate. The grazing period may be extended leading to the challenge of better manage of meadows. The major risk in the Region could be on sun-dried apricots especially grown as rain-fed on slopes in Malatya or neighboring provinces.

Recommendations and Conclusion

The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) made important recommendations on how agri-

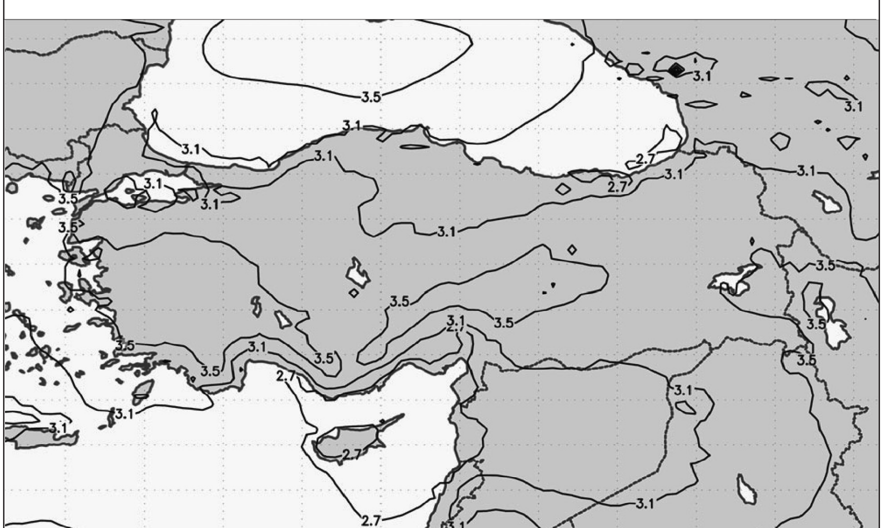
Figure 1 - *Projected changes (over 1961-1990 period) in precipitation (%) for winter (left column) and summer (right column). The projections are based on the A2 scenario simulation of the ECHAM5 general circulation model (Talu et al., 2010).*



culture could mitigate GHG emissions (IPPC, 2007). These recommendations include: 'crop rotations and farming system design; nutrient and manure management; livestock management; pasture and fodder supply improvement; fertile soil maintenance and restoration of degraded land'. Organic practices are well suited to enhance plant and animal productivity and efficiency especially if practiced with a focus on reduced reliance on external inputs. Through implementation of these practices, organic agriculture increases the ability of the farming system to function even when faced with the adverse effects of climate change by increasing resilience within the agro-ecosystem to temperature extremes, drought and soil erosion. (Niggli et al, 2009). The current need in Turkish organic agriculture appears to be changing the concept of 'replacing inputs from conventional to organic' present in many farmers or even technical staff to a smarter organic management system. Such good practices should include an efficient design of the farm and its environment and on-farm inputs. Mitigation of climate change is primarily achieved through long established and locally optimized organic farming practices. Locally adapted species/varieties, diversification, integrated plant-animal production, multifunctionality, short market channels and integration of local knowledge in practices seem to be the keywords and concepts that require more attention in Turkey.

Due to the prevailing climatic conditions and long history of conventional practices, low soil organic matter content is a problem in many regions of Turkey. Thus, enhancing soil biological processes, the proportion of vegetation cover and soil fertility and structure, and creating organic matter in forms that are more effective at producing soil carbon will become more important. Research on developing good/best practices in organic agriculture to mitigate effect of climate change is necessary. Drought resistant species/varieties (higher WUE, higher PUE) of both cultivated and wild plants and new more adaptive minor species must be developed. More precise scientific findings should be put forth based upon long-term evaluations under organic management. Land abandonment can be a problem in some regions which may further facilitate forest recovery and natural flora. Changes in land use need to be monitored closely, as well.

Figure 2 - *Annual maximum temperature change (°C) over Turkey (Şen et al., 2012).*



The Turkish State Meteorological Service (www.mgm.gov.tr; www.meteor.gov.tr) of the Ministry of Forestry and Water Works collect and disseminate agro-climatic data including impact of seasonal climatic conditions which may guide future research however more detailed, sound, and up-to date data and easily accessible monitoring system need to be developed. The strategies for climate change mitigation should be developed at regional level with a priority on major crops. To widen knowledge base, interdisciplinary courses must be initiated at different levels. Training of trainers and farmers for possible effects of climate change and pro-

Figure 3 - *Annual total precipitation change over Turkey (Circles inserted by authors show possible areas that will be affected by drought, straights at first and broken lines at the second rank)* (Şen et al., 2012).

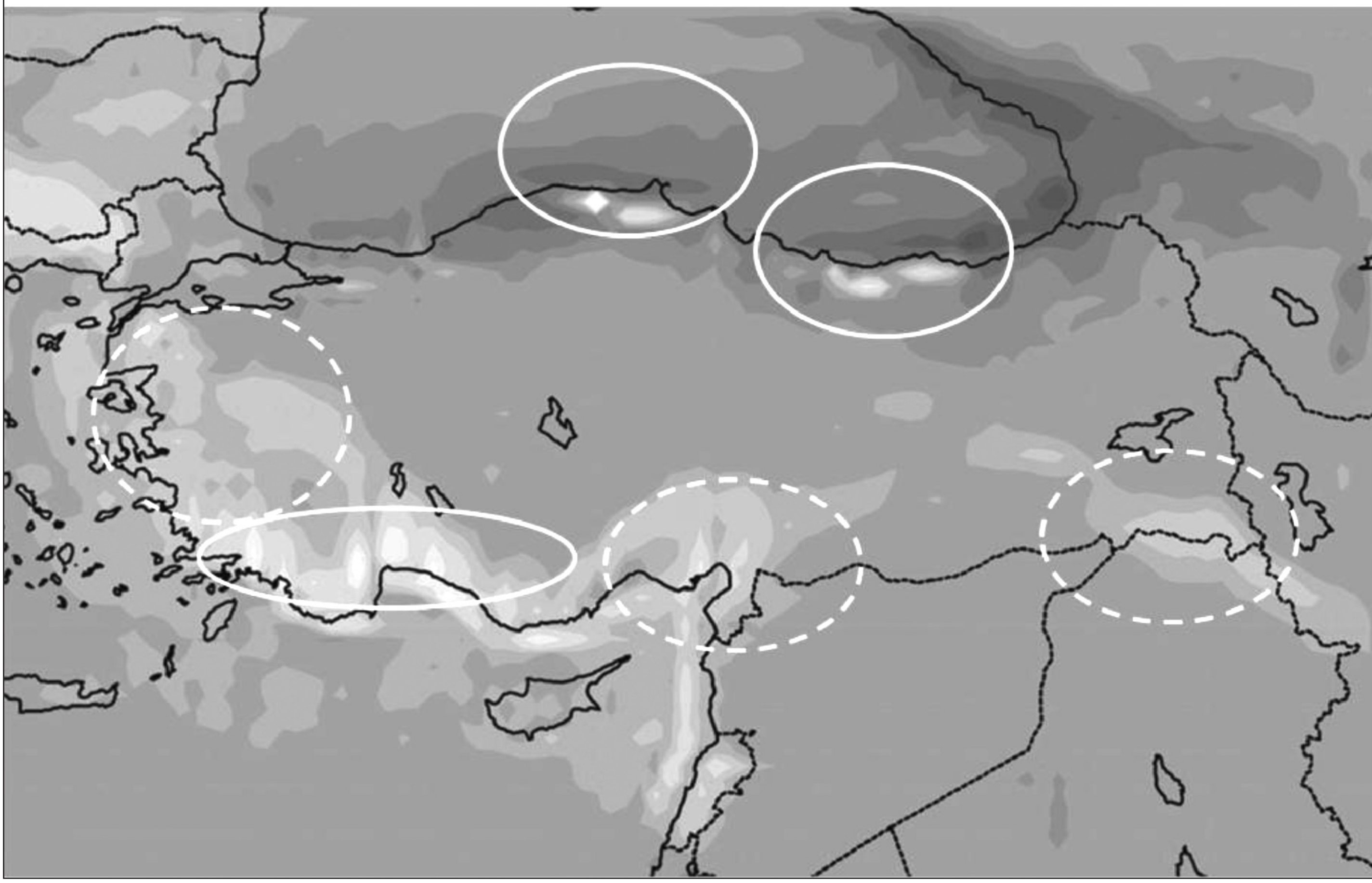
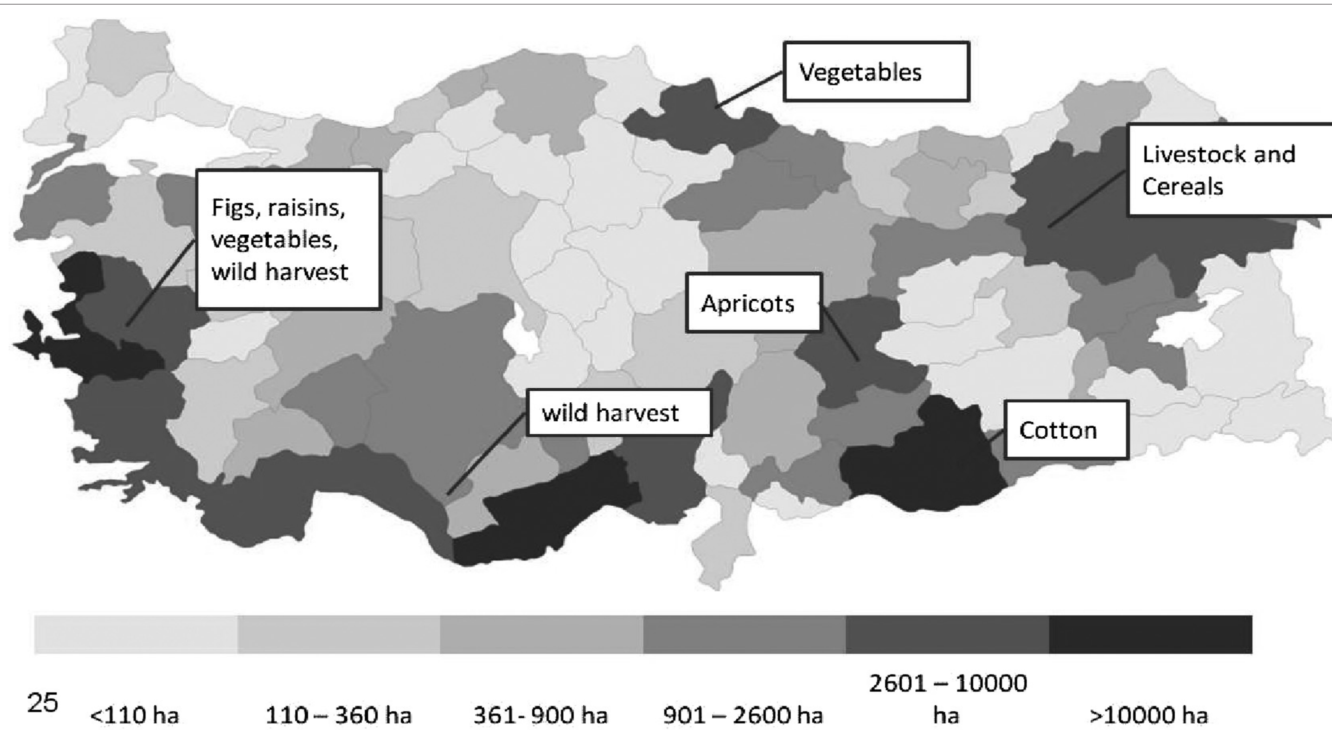


Figure 4 - *Share of provinces based on organic certified land (ha) (2008).*



moting exchange of knowledge and information among similar agroecological zones are also recommended to increase mitigation capacity of organic agriculture.

References

Anonymous (2007): First National Communication on Climate Change, Republic of Turkey, Arpak, G. and Ubay, B. (Edited by), Ministry of Environment and Forestry, 276 p. (www.iklimnet.org).

Anonymous (2009a): Birleşmiş Milletler İklim Değişikliği Çerçeve Sözleşmesi Kapsamında Türkiye'nin Durumunu Değerlendirmeye Yönelik Rapor (Report for Evaluation of Turkey's Case for UN Climate Change Framework Agreement, Ankara, 32 p. (www.iklim.cob.gov.tr).

Anonymous (2009b): Information Sheet for GHG Inventory, Ministry of Environment and Forestry. 1 p.

Anonymous (2010a): Impact of climate change on food security and safety in the Mediterranean region and actions to be taken, Proceedings of the 8th Meeting of the Ministers of Agriculture Food and Fisheries of the CIHEAM member countries pp. 25-43.

Anonymous (2010b): Republic of Turkey National Strategy Document on Climate Change. Ministry of Environment and Forestry, 8 p. (www.iklim.gov.tr).

Anonymous (2012): CIHEAM Press Release, Mediterra, The Mediterranean Diet and Sustainable Regional Development (www.arabinnova.com).

Bakkenes, M., Alkemade, JRM., Ihle, F.,Leemans, R., Latour, JB. (2002): Assessing effects of forecasted climate change on the diversity and distribution of European higher plants for 2050. Global Change Biol 8:390–407.

Can, H.Z., Hepaksoy, S., Aksoy U. and Kutlu, E. (2000): Leaf Characteristics and Net Gas Exchange of Fig Cultigens Adapted to Different Climatic Conditions. Acta Horticulturae 516: 131-138.

Demir, İ., Kılıç, G., and Coşkun, M. (2008): PRECIS Bölgesel İklim Modeli ile Türkiye İçin İklim Öngörüleri: HadAMP3 SRES A2 Senaryosu, IV. Atmosfer Bilimleri Sempozyumu, Bildiriler Kitabı, pp. 365-373.

Eitzinger, J., Stastna, M., Zalud, Z., Dubrovsky, M. (2003): A simulation study of the effect of soil water balance and water stress on winter wheat production under different climate change scenarios. Agricultural Water Management, 61 (3): 195-217.

IPPC (2007): Climate Change 2007: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Fourth Assessment Report of the IPCC, 978 0521 88010-7 (www.ippc.ch/pdf/assessment-report).

Jordan, R., Müller, A. and Oudes, A. (2009): High Sequestration, Low Emission, Food Secure Farming. Organic Agriculture - a Guide to Climate Change and Food Security. International Federation of Organic Agriculture Movements (IFOAM), 28 p.

Kibaroğlu, A., Kramer, A. and Scheumann, W. (2011): Turkey's Water Policy: National Frameworks and International Cooperation, Springer Heidelberg Dordrecht, 440 p.

Leu, A. (2009): Ameliorating the effects of climate change with organic systems. Journal of Organic Systems, Vol. 4 No. 1. p. 4-7.

Müller, A. and Davis, J. (2009): Reducing Global Warming: The Potential of Organic Agriculture, Policy Brief. FIBL, Rodale Press. 4 p.

Niggli, U., Schmid, H., and Fliessbach, A. (2007): Organic Farming and Climate Change. Technical Paper, ITC UNCTAD WTO, Doc. No. MDS-08-152.E, 27 p.

Niggli, U., Fliessbach, A., Hepperly, P. and Scialabba, N. (2009): Low Greenhouse Gas Agriculture: Mitigation and Adaptation Potential of Sustainable Farming Systems. FAO, April 2009, Rev. 2 – 2009.

Ogaya, R., Peñuelas, J. (2003): Comparative field study of Quercus ilex and Phillyrea latifolia: photosynthetic response to experimental drought conditions. Environ. Exp. Bot. 50: 137-148.

Reed, D. (2009): Climate Change and Agriculture: Agriculture's Role in Cap-and-Trade, Feeding a Hot and Hungry Planet: The Challange of Making More Food Fewer GHG. www.princeton.edu.

Sala, OE., Chapin, F.S., Armesto, J.J., Berlow, E., Bloomfield, J., Dirzo, R., Huber-Sanwald, E., Huenneke, LF., Jackson, RB., Kinzig, A., Leemans, R., Lodge, DM., Mooney, HA., Oesterheld, M., Poff, NL., Sykes, MT., Walker, BH., Walker, M, Wall, DH. (2000): Global Biodiversity Scenarios for the Year 2100, Science, 287 (5459): 1770-1774.

Sardans, J. and Penuelas, J. (2004): Increasing Drought Decreases Phosphorus Availability in an Evergreen Mediterranean Forest, Plant and Soil, 267: 367-377. Kluwer Publishers, Netherlands.

Şen, B., Topçu, S., Türkeş, M., Sen, B., and Warner, J.F. (2012): Projecting climate change, drought conditions and crop productivity in Turkey, Climate Research, Vol. 52, 175-191.

www.eae.europa.eu/ghg...2011 cp/turkey_tp2011_country_profile.pdf

Talu, N., Özden, M. S., Özgün, S., Dougherty, W., and Fencl, A. (2010): Turkey's National Climate Change Adaptation Strategy and Action Plan (Draft), (Edited by D. Şillil-ler Tapan), T.R. Ministry of Environment and Urbanization, Ankara. 142 p. (www.iklim.gov.tr).

Thuiller, W., Lavorel, S., Arau, M.J., Sykes, M.T. and Prentice, I.C. (2005): Climate change threats to plant diversity in Europe. PNAS, 102: 23, 6 p. www.pnas.org_cgi_doi_10.1073_pnas.0409902102.