



ENVIRONMENTAL PERFORMANCE OF AGRICULTURE IN OECD COUNTRIES SINCE 1990:

Turkey Country Section

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A summary version of this report is published as *Environmental Performance of Agriculture: At a Glance*, see the OECD website which also contains the agri-environmental indicator time series database at: <http://www.oecd.org/tad/env/indicators>

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Each of the 30 OECD country reviews (plus a summary for the EU) are structured as follows:

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BACKGROUND TO THE COUNTRY SECTIONS

Structure

This chapter provides an analysis of the trends of environmental conditions related to agriculture for each of the 30 OECD member countries since 1990, including an overview of the European Union, and the supporting agri-environmental database can be accessed at www.oecd.org/tad/env/indicators. Valuable input for each country section was provided by member countries, in addition to other sources noted below. The country sections are introduced by a figure showing the national agri-environmental and economic profile over the period 2002-04, followed by the text, structured as follows:

- **Agricultural sector trends and policy context:** The policy description in this section draws on various OECD policy databases, including the *Inventory of Policy Measures Addressing Environmental Issues in Agriculture* (www.oecd.org/tad/env) and the *Producer and Consumer Support Estimates* (www.oecd.org/tad.support/pse).
- **Environmental performance of agriculture:** The review of environmental performance draws on the country responses to the OECD agri-environmental questionnaires (unpublished) provided by countries and the OECD agri-environmental database supporting Chapter 1 (see website above).
- **Overall agri-environmental performance:** This section gives a summary overview and concluding comments.
- **Bibliography:** The OECD Secretariat, with the help of member countries, has made an extensive search of the literature for each country section. While this largely draws on literature available in English and French, in many cases member countries provided translation of relevant literature in other languages.

At the end of each country section a standardised page is provided consisting of three figures. The first figure, which is the same for every country, compares respective national performance against the OECD overall average for the period since 1990. The other two figures focus on specific agri-environmental themes important to each respective country.

Additional information is also provided for each country on the OECD agri-environmental indicator website (see address above) concerning:

- Details of national agri-environmental indicator programmes.
- National databases relevant to agri-environmental indicators.
- Websites relevant to the national agri-environmental indicators (e.g. Ministries of Agriculture)
- A translation of the country section into the respective national language, while all 30 countries are available in English and French.

Coverage, caveats and limitations

A number of issues concerning the coverage, caveats and limitations need to be borne in mind when reading the country sections, especially in relation to making comparisons with other countries:

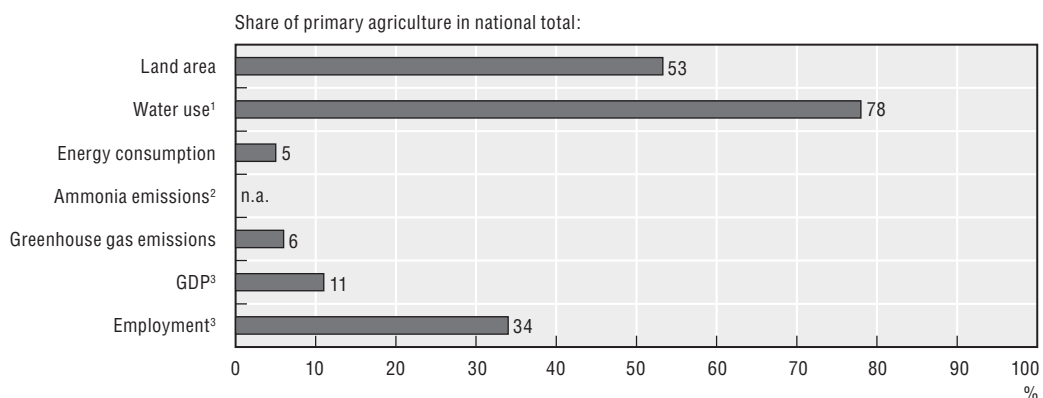
Coverage: The analysis is confined to examination of agri-environmental trends. The influence on these trends of policy and market developments, as well as structural changes in the industry, are outside the scope of these sections. Moreover, the country sections do not examine the impacts of changes in environmental conditions on agriculture (*e.g.* native and non-native wild species, droughts and floods, climate change); the impact of genetically modified organisms on the environment; or human health and welfare consequences of the interaction between agriculture and the environment.


Definitions and methodologies for calculating indicators are standardised in most cases but not all, in particular those for biodiversity and farm management. For some indicators, such as greenhouse gas emissions (GHGs), the OECD and the UNFCCC are working toward further improvement, such as by incorporating agricultural carbon sequestration into a net GHG balance.

- **Data availability, quality and comparability** are as far as possible complete, consistent and harmonised across the various indicators and countries. But deficiencies remain such as the absence of data series (*e.g.* biodiversity), variability in coverage (*e.g.* pesticide use), and differences related to data collection methods (*e.g.* the use of surveys, census and models).
- **Spatial aggregation** of indicators is given at the national level, but for some indicators (*e.g.* water quality) this can mask significant variations at the regional level, although where available the text provides information on regionally disaggregated data.
- **Trends and ranges in indicators**, rather than absolute levels, enable comparisons to be made across countries in many cases, especially as local site specific conditions can vary considerably. But absolute levels are of significance where: limits are defined by governments (*e.g.* nitrates in water); targets agreed under national and international agreements (*e.g.* ammonia emissions); or where the contribution to global pollution is important (*e.g.* greenhouse gases).
- **Agriculture's contribution to specific environmental impacts** is sometimes difficult to isolate, especially for areas such as soil and water quality, where the impact of other economic activities is important (*e.g.* forestry) or the "natural" state of the environment itself contributes to pollutant loadings (*e.g.* water may contain high levels of naturally occurring salts), or invasive species that may have upset the "natural" state of biodiversity.
- **Environmental improvement or deterioration** is in most individual indicator cases clearly revealed by the direction of change in the indicators but is more difficult when considering a set of indicators. For example, the greater uptake of conservation tillage can lower soil erosion rates and energy consumption (from less ploughing), but at the same time may result in an increase in the use of herbicides to combat weeds.
- **Baselines, threshold levels or targets for indicators** are generally not appropriate to assess indicator trends as these may vary between countries and regions due to difference in environmental and climatic conditions, as well as national regulations. But for some indicators threshold levels are used to assess indicator change (*e.g.* drinking water standards) or internationally agreed targets compared against indicators trends (*e.g.* ammonia emissions and methyl bromide use).

3.28. TURKEY

Figure 3.28.1. **National agri-environmental and economic profile, 2002-04: Turkey**



StatLink  <http://dx.doi.org/10.1787/301167028002>

1. Data refer to the year 2001.
2. Data refer to the period 2001-03.
3. Data refer to the year 2004.

Source: OECD Secretariat. For full details of these indicators, see Chapter 1 of the *Main Report*.

3.28.1. Agricultural sector trends and policy context

Agriculture remains the major sector for employment in Turkey, but the sector's role in the economy is declining. Primary agriculture's share in employment decreased from 47% in 1990 to 34% in 2004, but the contribution to GDP is smaller declining over the same period from 17% to 11% [1, 2, 3] Figure 3.28.1. The agricultural labour force, about half of which are women who mainly work as unpaid family labour, experience a high incidence of poverty, poor education, and low provision of public services, although this situation is beginning to improve [2, 3].

Agricultural production has grown rapidly since 1990, among the highest rates of growth across OECD countries (Figures 3.28.2 and 3.28.3). Agriculture is becoming more intensive as the expansion in production and use of purchased variable inputs has grown more rapidly since 1990 than the 1% increase in area cultivated from 1990-92 to 2002-04 (Figures 3.28.2 and 3.28.3). The volume of agricultural production rose by 16% between 1990-92 and 2002-04, with crop production increasing by 19% and livestock 11% (mainly poultry, as grazing livestock numbers have fallen) [4]. Over the same period the use of purchased farm inputs also increased for inorganic nitrogen fertilisers by 11%, by 60% for pesticides (1993-2002), 59% for direct on-farm energy consumption, and by 65% for water use, although the use of inorganic phosphate fertilisers declined by -15% (Figures 3.28.2, 3.28.3 and 3.28.4). Arable farming dominates the agricultural sector, accounting for about 75% of output value, with the value share of fruit and vegetables over 40% [3].

Despite the growth in agricultural production subsistence and semi-subsistence farming is significant. The structure of farming largely remains small, family owned, highly fragmented, lacking capital, and using only basic technologies [2, 3, 5]. Rapid population growth, together with the prevailing inheritance laws, have led to farm fragmentation so that agricultural activities are predominantly of a low intensity, low productivity, subsistence-income type [2]. About 85% of farms (2003) are smaller than 9 hectares, although the remaining 15% of farms of over 10 hectares cultivate almost 60% of the total agricultural land area [2, 5, 6]. As a consequence of changes in farm structures agricultural productivity growth is well below that for other sectors in the economy [2, 3].

Support to agriculture has been highly variable since the mid-1980s but has remained below the OECD average. Support to farmers increased from an average of 16% of farm receipts in 1986-88 to 25% in 2002-04 (as measured by the OECD's Producer Support Estimate) compared to the OECD average of 30% [2, 6, 7]. Traditionally support to farmers was provided through market price support and input subsidies, which are the forms of support that most encourage production intensity and pressure on the environment. The *Agricultural Reform Implementation Project* (ARIP) over 2001-05, however, led to the reduction of these forms of support and their replacement with *Direct Income Support* (DIS) payments not linked to commodity production [3, 8]. Although about 80% of support to farmers was still provided through output-linked support in 2002-04, the share of input subsidies declined from 30% to 2%, while DIS payments represented 18% of support to farmers [7]. The share of total support to agriculture (budgetary plus market price support) in the GDP rose from 3.5% (1986-88) to a high of nearly 7% by 1999, but subsequently fell to around 4% by 2004-06 [2, 9].

Macroeconomic reforms from early 2000 onwards have had a major impact on the agricultural sector with important environmental implications. Following a period of macroeconomic instability over the 1990s (*e.g.* budget deficits, high inflation, volatile exchange rates) the government embarked on a path of disinflation requiring a reduction in government expenditure, including agriculture [2, 10]. This led to the introduction of ARIP in 2001, and later its extension, in time and scope, for the period 2005-07 [8, 9, 11]. From 1990 up to the introduction of ARIP support was provided for purchased farm inputs, including fertilisers, pesticides, irrigation water and energy, with a view to improving productivity [2, 12, 13]. However, subsidies on purchased fertilisers and pesticides (except for sugar beet) were largely abolished under the ARIP from 2001, although some infrastructure subsidies remain with the objective of improving farm production capacity, such as soil conservation, drainage, field levelling, and land consolidation [7, 9, 10]. The reduction in the fertiliser subsidy began in 1997, resulting in the lowering of the unit subsidy from 45% of the total price in 1997 to 15% by 2001 [6]. Support for use of diesel fuel is provided as budgetary expenditure rather than a tax concession, of TRY 23.9 (USD 18) per hectare (up to a maximum of 50 hectares in 2005 [9]. For some agricultural producers (*e.g.* poultry, greenhouses) support is given to lower energy costs at rates ranging from 20-50% of the cost of electricity provided to other consumers, while support is also provided to cover irrigation electricity costs [9, 14].

The development of agri-environmental policies has been limited since 1990, although recently more policy initiatives have been undertaken. As part of the amended (2005) ARIP, the *Environmentally Based Agricultural Land Protection* (CATAK) programme aims to protect environmentally fragile areas subject to severe erosion CATAK is initially implemented in four pilot provinces covering 5 000 hectares with annual transition payments (5 to 10 years) of TRY 560-1 260 (USD 400-900) per hectare [9, 11, 15]. Measures under CATAK include taking land

out of production (“set aside”) and adoption of environmentally beneficial practices, such as contour tillage, pasture rehabilitation, and reduced flow irrigation [9, 15]. The *National Regulation on Organic Agriculture* (1994) defines the standards, definitions, certification and regulations covering organic farming, developed in harmony with the EU regulations, and up to 2006 there were no support payments for organic farming [16, 17, 18, 19]. The *Farmer Transition Program* (2001), which pays farmers for diverting from over-produced commodities to alternative commodities, provides an opportunity for the introduction of environmentally beneficial management practices, reinforced by the *Regulation of Good Agricultural Practices* (2004).

The costs of irrigation systems are being transferred from the government to local water user associations. With the progressive transfer of the operation and maintenance (O&M) of irrigation networks from the government General Directorate of State Hydraulic Works (DSI) and the now abolished General Directorate of Rural Services (GDRS) to self financing local water user associations, farmers are supporting a higher share of the costs of maintaining irrigation systems [2, 20]. The DSI is mainly responsible for the development and maintenance of large irrigation infrastructure (e.g. dams, drilling wells), while the now abolished GDRS largely developed small scale on-farm irrigation works [20]. Farmers partially cover O&M costs of irrigation water through annual crop and area based charges [3, 9]. While collection rates of water charges in publicly operated schemes are low and never exceed 54%, those in farmer operated schemes are almost 90% [7]. The DSI expenditure on irrigation O&M costs (net of farmer’s fees) averaged TRY 103 (USD 75) million over 2004 and 2005 [9]. Currently farmers investing in drip irrigation are granted credit with 0% interest rate for a 5 year period or a 50% lump-sum of the costs of adopting this technology.

Some regional development projects have significant implications for agriculture and the environment. Many of these projects are financed by international development agencies and donors (e.g. the World Bank), as national funding is limited [3]. The World Bank supported *South-Eastern Anatolian Project* (GAP) (1983-2001) is the largest regional development project in Turkey covering 10% of the total land at an estimated cost of TRY 50 (USD 32) billion. GAP involves, among other objectives, to expand agricultural production in the region through building 22 dams and providing irrigation infrastructure for 1.7 million hectares of land by 2015 [3, 4, 13, 15, 21, 22, 23]. In the jointly EU and World Bank funded *Anatolian Watershed Rehabilitation Project* (AWRP), with funding of TRY 65 (USD 45) million over 2004 to 2012, the aim is to restore degraded soils to increase farm and forestry production [3, 11, 15].

Economy-wide environmental policies also affect agriculture. The *National Environmental Action Plan* (NEAP, 1998) provides for national and regional plans to generate information to combat land desertification and reduce discharges of nutrients, and a number of regulations control water and soil pollution, and protect biodiversity [9, 24]. Under the *National Action Programme for Combating Desertification*, strategies and information are developed to address problems of soil degradation, combat desertification, and evolve sustainable land use [24, 25]. The *Regulation on Water Pollution Control* (1988) defines water quality criteria according to the purpose for which the water is used, including treated waste water used for irrigation. A *Nitrate Directive* was adopted in February 2004, as part of the goal to harmonise with EU policies, but there is still the need to define the responsibilities of the organisations defined under the Directive [7].

Turkey also has commitments under various international environmental agreements, with implications for agriculture. An important driving force for the participation in these agreements has been linked to the goal of joining the EU [3]. As part its commitments under the UN Convention to Combat Desertification, the *National Action Programme for Combating Desertification* is addressing soil degradation issues (see above) [26]. Agriculture is also affected by Turkey's international commitment to limit emissions of methyl bromide (*Montreal Protocol*). The *National Biodiversity Strategy and Action Plan* (1998) seeks to meet commitments under the *Convention on Biological Diversity*. The Plan has provisions for: establishing protected areas, along with management plans; creation of wildlife sanctuaries; preservation of agricultural genetic resources; and levies a charge for grazing beyond common pastureland to reduce pressure on fragile ecosystems [3, 7, 24, 26]. With the signature to the *Ramsar Convention* to protect wetlands, the 2003-08 *National Wetlands Strategy Plan* sets general principles on the protection of wetlands, provides provisions for defining protected areas and preparing management plans, under the guidance of the National Wetland Commission [3, 26]. Turkey is also involved in addressing a number of environmental issues with neighbouring countries with implications for agriculture. This mainly concerns the diversion of water for irrigation, flood control and the pollution of trans-boundary rivers, and also pollution of the Mediterranean and Black Sea [13]. The transboundary rivers include the Meriç (Bulgaria and Greece), Arpaçay and Aras (Armenia, Azerbaijan and Iran), Çoruh (Georgia), Kura (Georgia, Azerbaijan, Armenia and Iran), Asi (Syria) and the Tigris and Euphrates (Syria and Iraq) [13, 23].

3.28.2. Environmental performance of agriculture

Overall agricultural pressure on the environment has risen since 1990, but the intensity of the farming system in terms of the use of purchased variable inputs, despite their rapid growth, is considerably lower than many other OECD countries [3, 13]. However, with the reduction in cattle, sheep and goat numbers relative to an increase in permanent pasture over the same period, this has eased pressure on land susceptible to erosion, but in some areas overgrazing remains a problem [27]. The key environmental concerns relate to: soil degradation, especially from erosion; overexploitation of water resources; water pollution, including salinisation from poor irrigation management practices; and adverse impacts of farming on biodiversity [3, 13, 27, 28].

Degradation of agricultural soils is a major and widespread environmental problem. One of the most acute forms of soil degradation is erosion, with 73% of total agricultural land and 68% of prime farmland prone to risk of erosion, mainly water erosion (71%) but also wind erosion (2%) [3, 24, 25]. Elevated rates of erosion have been induced, in particular, by: natural conditions, especially the climate and steep topography (over half the total land area is above 1 000 metres in elevation); unsuitable tillage and irrigation management practices; as well as overgrazing and stubble burning in some regions [3, 25, 27]. The eastern part of the country is less prone to erosion as pasture is dominant, however, overgrazing and other inappropriate pasture management practices have left about 60% of rangelands prone to erosion, especially in the Aegean and Marmara regions [3, 13, 25, 27]. Off-farm sediment flows have reduced the efficiency of dams through siltation and impacted adversely on aquatic ecosystems, despite abatement programmes initiated 25 years ago [3, 13, 25].

Other forms of soil degradation are more limited, with an estimated 6% of arable land suffering yield limitation due to salinisation and a further 12% affected by waterlogging [3, 25]. A study of the impact of salinisation and waterlogging on cotton production in the Menemen

region of the Gediz Delta, for example, revealed that yields were reduced by over 30% [29]. Inappropriate irrigation and fertiliser management practices, as well as excess extraction of water have been important causes of soil salinity in some areas [3, 25], with this problem growing rapidly in parts of the area under *South-Eastern Anatolian Project (GAP)* [30]. **The uptake of soil conservation practices is poor**, with only around 4% of the area prone to risk of erosion subject to soil erosion prevention programmes, mainly caused by inadequate resources, technical skills and knowledge to address the problem [24, 25]. But the afforestation of some agricultural land has helped to combat erosion, especially since 1993 under the *National Tree Improvement Plan* [13, 30].

Overall pollution of water from agricultural activities is low compared to many other OECD countries, but in some regions the pressure on water quality from farming is high, especially certain irrigated areas [3, 13, 27]. But it is difficult to determine the extent and trends in water pollution due to agriculture, as monitoring data of agricultural pollution of rivers, lakes or marine waters is poor although the DSI does have a national network of monitoring sites [27]. Moreover, the trends in the main agricultural pollutants have diverged over the period 1990 to 2004. While there has been an almost continuous decline in the nutrient balance surpluses over this period (both nitrogen and phosphorus), at the same time pesticide use has increased.

There have been substantial reductions in agricultural nutrient surpluses, with a steady decline in both nitrogen (N) and phosphorus (P) surpluses (in tonnes) between 1990-92 to 2002-04, leaving aside occasional annual fluctuations (Figures 3.28.2 and 3.28.3). This largely reflects the reduction in livestock numbers except for poultry (less manure inputs), which has more than offset fluctuations in inorganic fertiliser use (see below) and the large rise in crop production (leading to higher nutrient uptake, hence, lower surpluses). The intensity of nutrient surpluses (expressed as kg N per ha) have been considerably lower than the EU15 and OECD averages, and by 2002-04 for nitrogen surpluses was about a third of the EU15 average and almost a half for phosphorus (Figure 3.28.2).

Trends in inorganic fertiliser use have fluctuated considerably since 1990 and influenced the overall development in nutrient surpluses. As agricultural support levels (including for fertilisers) rose over the period 1994 to 1999, fertiliser use also increased. During the policy reform period of 2000-02, however, when support for fertilisers was lowered, use fell substantially by around 25-30% (in volume terms), but recovered over 2003 and 2004 although remained below the peak of the late 1990s [2, 3, 10]. The application of inorganic fertilisers also appears to be below plant requirements, with an estimate for 2000 indicating that national nitrogen fertiliser use was 65% below soil requirements and 45% below requirements for phosphorus [3, 10]. Even so, while fertilisers are used in excess for some commercial farms, especially in the Marmara and Mediterranean regions, for smaller poorer holdings very little fertiliser is used in relation to soil requirements [10].

Agricultural pollution of water bodies from nutrients is in general low compared to other OECD countries since 1990, although in some localities pollution is a concern, especially the Aegean and Mediterranean regions [13, 27]. But drawing firm conclusions are difficult due to the lack of water monitoring stations in agricultural areas. Data over the period 1995 to 2005, however, estimates that 2.5% of monitoring sites in agricultural areas exceed recommended drinking water standards for nitrates in groundwater [31]. There is also some regional evidence of cadmium accumulation in soils where phosphorus application rates have been high, such as in tomato and sugar beet growing areas, which is of concern

for human health as cadmium can be taken up by plants [32]. There is no information on the adoption of nutrient management practices, including soil nutrient testing and development of manure storage facilities. It is likely, however, that uptake rates of these practices are low as many farmers have poor access to capital to invest in manure storage and other manure treatment technologies, and also have inadequate knowledge of nutrient management practices.

The growth in pesticide use has been among the most rapid across OECD countries, over the period 1993 to 2002 (volume of active ingredients) (Figures 3.28.2 and 3.28.3). The growth in pesticide use has been closely linked to the increase in crop production, in particular, horticultural production in the irrigated areas of the Marmara, Aegean and Mediterranean regions which account for over 70% of pesticide use [10, 25]. As with fertilisers, the trend in pesticide use grew rapidly from 1993 to 1997, declined over the policy reform period but has subsequently recovered [2, 3, 10]. To a limited extent the growth in **organic farming** has restricted the growth in pesticide use. But despite the rapid increase in organic farming since 1990 its share in total agricultural land area was the lowest in the OECD at under 0.5% in 2002-04, compared to the OECD average of nearly 2% and the EU15 average of almost 4%, although unlike many OECD countries no support is provided to organic producers [3, 16, 17, 18, 19]. Organic farming is largely geared toward export markets, mainly horticultural crops, but also cotton [16, 17, 18].

The overall intensity of pesticide use is low by comparison with other Mediterranean OECD countries, but there are concerns over adverse impacts on human health and the environment in some localities [3, 33]. A study of the Adana region estimated that nearly 13% of farmers reported ill-effects from pesticide use, while aerial spraying has raised concerns with pesticide drift [33, 34, 35]. It is unclear the extent to which integrated pesticide management practices are being used by farmers. There is no regular monitoring of pesticides in water bodies, but some studies report their presence in rivers, lakes, irrigation canals, and also on greenhouse vegetables [13, 34]. Some pesticides prohibited since the 1980s have also been detected (*e.g.* DDT, aldrin, dieldrin and other organochlorine pesticides), but below toxic levels for human health, although of some concern for their adverse impacts on aquatic ecosystems [36, 37, 38].

Agricultural water use grew by 65% between 1990-92 and 2001, among the highest rate of growth across OECD countries, and compares to the growth in water use for the economy as a whole of nearly 30% (Figures 3.28.2 and 3.28.4). As a result agriculture accounted for nearly 80% of water use by 2001. Much of the growth in water use is because of a 5% increase in the area irrigated from 1990-92 to 2001-03, with 9% of farmland under irrigation by 2001-03 (Figure 3.28.3). By 2005 nearly 5 million hectares were being irrigated, while over 8 million hectares are irrigable and up to 26 million hectares of land is suitable for irrigation (not taking economic considerations into account) which is about 60% of the total agricultural land area [2, 3, 15]. Most irrigation water is delivered by gravity flow and only 5% by pumping [39]. Larger farms tend to be irrigated from dams and reservoirs mainly subsidised by the government, with 1% of farmers using 15% of the irrigated land, while smaller farmers are more likely to irrigate from wells constructed at their own expense [40]. Recent government budget constraints have limited growth in the area irrigated, notably under the GAP [2].

With the rise in demand for water by the agricultural sector there is growing competition for water resources with other users and increasing environmental concerns. Much of the

water for irrigation is derived from reservoirs, but around 35% is pumped from groundwater. Many aquifers, however, are being exploited beyond their natural recharge rate, especially in the Mediterranean region, which is a concern as two-thirds of drinking water in the region is supplied from groundwater [3, 41]. The over extraction of groundwater in regions such as the Mediterranean is also a concern both because of the intrusion of sea water into aquifers, and also the growing competition for water resources with the tourism industry which, similarly to agriculture, has its peak demand period in the summer [13]. Some major irrigation projects have also been undertaken with little consideration of environmental management or impacts, with the loss of valuable ecosystems (e.g. steppe, wetlands) and increasing problems of salinity and agro-chemical run-off becoming widespread [3, 21, 27]. Even so, the GAP project is increasing the supply of domestically produced hydroelectricity and has brought socio-economic welfare gains to villagers [21, 41].

There has been a modest improvement in irrigation management practices. The use of the more efficient low pressure sprinklers and drip emitters technology has risen from a share of 4% to 8% of irrigation water, largely used on horticultural crops, but by 2000 nearly 92% of irrigation water was applied through the less efficient method of flooding [20, 31]. Despite the greater uptake by irrigators of more efficient water application technologies, partly induced by low interest credit for the purchase of drip irrigation technology, irrigation water application rates per hectare increased (i.e. a declining trend of irrigation water efficiency) by 56% between 1990-92 and 2001, compared to a decrease of -9% for the OECD on average. This might be explained not only by the high water losses from irrigation infrastructure (many canals are open so losses from evaporation are high), and lack of capital, but also by technical inefficiency in managing irrigation systems due to, for example, lack of technical knowledge and weak advisory services [1, 2, 11, 15, 27].

Low water charges have not been sufficient to cover irrigation infrastructure operation and maintenance (O&M) costs [2, 20]. It was estimated by the DSI in the late 1990s that water charges to cover O&M costs for gravity cotton irrigation systems should be 6 times above that actually paid by producers, and 31 times above the charge to producers to cover O&M plus fixed capital costs [42]. For irrigation systems requiring pumped water these differences would be appreciably greater [42]. But in recent years water charges have risen, as a result of the transfer of irrigated areas operated by the DSI to water user associations [39, 42]. A study of cotton and grape production in the Gediz Basin, for example, showed that where these transfers have occurred and water charges increased, irrigation water productivity showed significant gains [39].

Air pollution trends linked to farming have shown mixed results since 1990. Agricultural ammonia emissions probably increased between 1990 and 2004, but ammonia emission data are not regularly collected. The main sources of agricultural ammonia emissions are from nitrogen fertiliser use and livestock (manure and housing), which increased in the period since 1990. For methyl bromide use (an ozone depleting substance) Turkey along with most OECD countries has substantially reduced its use over the 1990s as agreed by the phase-out schedule under the Montreal Protocol, which seeks to reduce use by 20% in 2005 from the 1995-98 base period for Article 5 countries (i.e. developing countries), and complete phase out by 2015. Methyl bromide is largely used by the horticultural sector, especially as a soil fumigant [3, 34]. Turkey has exceeded this target with methyl bromide use reduced by 81% by 2004. The phase out of methyl bromide is being jointly planned and assisted by the UNEP, UNIDO and the World Bank [3].

Agricultural greenhouse gas (GHG) emissions declined by 21% between 1990-92 and 2002-04 (Figure 3.28.2). This compares to a 43% rise in economy wide GHG emissions and the reduction in EU15 agricultural GHG emissions of 7% [11]. Farming accounted for 6% of total national GHG emissions by 2002-04, but only 1% of total OECD agricultural GHG emissions. Agricultural emissions reductions are largely explained by the decrease in cattle, sheep and goat numbers, lowering methane emissions, partly offset by higher fertiliser use and crop production [11]. With the projected expansion of agricultural production up to 2016 and rising direct on-farm energy consumption, it can be expected that agricultural GHG emissions may rise [11].

Direct on-farm energy consumption rose by nearly 60% between 1990-92 to 2002-04, among the largest increase across OECD countries, contributing to agricultural GHG emissions (Figures 3.28.2 and 3.28.4) [43]. The growth in on-farm energy consumption was more rapid than for the national economy, 44% over the same period, although by 2002-04 agriculture accounted for only 5% of total energy consumption. Much of the rise in on-farm energy consumption is explained by the expansion in use and size of machinery, as a substitute for labour over the past 15 years, and greater demand for energy from pumping irrigation water [44]. While farm employment declined by around 13% between 1990-92 and 2001-03, the numbers of tractors and harvesters in use rose by 40% over the same period. The share of on-farm energy consumption from animal manure declined relative to an increase in use of diesel and electricity since 1990, part of a longer term trend [43]. Also the efficiency of agricultural energy use, as measured by the energy input-output ratio, has been declining since the mid-1970s as Turkish agriculture has become more energy intensive. A study of cotton production, however, has shown that energy efficiency could be improved [43, 45]. Projections indicate that agricultural energy consumption will continue to grow by nearly 5% annually (tons of oil equivalent) between 2003 and 2020 [11].

Renewable energy production from agricultural biomass feedstocks has been declining, from around 7% of total primary energy supply in 1990 to less than 5% by 2000 [14, 46, 47]. This is largely explained by the replacement of non-commercial fuel sources (i.e. mainly livestock manure) by commercial non-renewable energy sources, such as electricity and other fuels, with this trend projected to continue up to 2020 [46]. By the late 1990s almost 60% of livestock manure was burned for heating [48]. Numerous studies indicate, however, that there is considerable physical capacity to expand the use of agricultural biomass for renewable energy production, especially for heat and electricity generation and biogas, drawing on agricultural wastes, such as cereal straw and livestock waste [14, 47, 49, 50, 51]. There are no power plants in operation using biomass, and only two facilities producing biogas with a combined capacity of 5 Megawatts [46].

Carbon sequestration associated with agriculture has most likely increased since 1990, contributing to a reduction in GHG emissions. There are not, however, any national estimates of agricultural carbon sequestration although some regional studies have been completed [52]. The rise in carbon sequestration is most likely due to the 13% rise in permanent pasture area, decrease in area under arable crops, and to a lesser extent the conversion of farmland to use for forestry, although overall the total agricultural land area increased between 1990 and 2004. With improved management the potential of pasture to act as a GHG sink could be improved [11].

Turkey has a highly rich biodiversity which is under growing pressure from agriculture, although the impacts of farming on biodiversity are diverse, complex and poorly monitored [3, 11, 13]. The biological richness of Turkey is a consequence of a highly varied

biogeography, climate and different types of farming systems, with around three quarters of the European flora and fauna species found in the country [3, 13, 53]. But there is increasing pressure on biodiversity mainly due to: intensification in fertile areas with greater use of agro-chemicals; construction of large rural development projects altering the ecology of entire regions; and diversion of water for irrigation to the detriment of wetlands [3, 11, 13, 54]. At the same time there is the loss of some farmed habitats from the conversion to urban use, and in some marginal farming areas from the afforestation and abandonment of semi-natural farmed habitats to overgrowth, although overall the area of agricultural land increased since 1990 (Figures 3.28.2 and 3.28.3).

In terms of agricultural genetic resources Turkey has a role of global importance. The country is recognised as a “Vavilov” centre, which is an area where **crops**, such as Wheat (*Triticum spp.*), Barley (*Hordeum spp.*), Oats (*Avena spp.*), Peas (*Pisum sativum*) and Lentils (*Lens culinaris*) were first domesticated. Use of these crops have evolved over several thousand years providing progenitor species used in Mediterranean and temperate agricultural systems [53, 55, 56]. Under the *National Plant Genetic Resources Programme* 15 endangered species are under *in situ* conservation programmes (including wild relatives, for example, of wheat and lentils). *Ex situ* conservation involves a seed bank containing around 53 000 accessions and a vegetative gene bank having collected nearly 6 000 accessions, with these efforts supported through the World Bank and International Plant Genetic Resource Institute [31, 53, 56]. While high levels of plant genetic diversity exist *in situ*, both in the wild and in more marginal mountainous and semi-natural farming areas, substantial genetic erosion has occurred because of the abandonment of farming in these areas and where farming continues because of the introduction of high-yielding varieties [55, 57]. Moreover, there is insufficient resources, monitoring and institutional capacity to fully support *in situ* conservation across large areas, so informal approaches relying on farming communities are the primary form of plant conservation [26, 55, 56, 57]. For **livestock breeds** there was a reduction in the numbers of breeds used in marketed production between 1990 and 2000, especially for cattle, sheep and goats [31, 48]. There are *in situ* programmes for the conservation of local breeds, covering cattle, sheep, goats, poultry and other native breeds [31]. There is little information on *ex situ* collections or the conservation of endangered livestock breeds, although a study for sheep and goats indicates a number of breeds are at risk of extinction [58].

Agricultural land use and management practices are adversely impacting natural and semi-natural habitats, and as a consequence damaging wild flora and fauna species [3]. The 1% increase in the area under agriculture between 1990-92 to 2002-04 (Figures 3.28.2 and 3.28.3), has led to land clearing for farming, mainly involving the ploughing of steppe land and conversion of forests, coupled with intensification through greater use of agro-chemicals has had adverse impacts on wild species both direct and indirect [3, 53]. With the lowering of stocking densities on pasture, especially semi-natural grassland steppe areas, this has helped to ease the pressure on these habitats. Overgrazing, however, remains a problem in some regions, notably the grazing of forests and pasture near the Black Sea and in the Mediterranean where overgrazing has reduced the number of pastoral vegetation species during the 1990s from about 25 to 5-6 [13, 34].

Nationally there are some 200 wetlands, nine of which have been classified as sites of international importance under the Ramsar Convention, which Turkey signed in 1994 [3, 11]. Agriculture has been one of the major causes of **wetland degradation**, including from the adverse impacts of constructing irrigation projects and diversion of water causing changes

in water flows to wetlands; excessive extraction of aquifers reducing water flows to wetlands; agricultural pollutant run-off, especially the eutrophication of inland and coastal wetlands; and the expansion of the area cultivated in some areas leading to a loss of wetlands [3]. But the drainage of wetlands was largely halted in the mid-1990s, although some reclamation for agricultural use has continued, such as the Çukurova-Akyatan delta and Sultan marshes [11, 13, 27]. The impact of farming on bird populations measured by the BirdLife International **Important Bird Areas** (IBAs) indicator, defined as prime bird habitat, shows that around 40% of the most significant threats to Turkish IBAs originates from farming [41, 59]. The main threats include: intensification of production from greater use of agro-chemicals; loss of semi-natural farmed habitat to other uses; and construction of irrigation projects [3].

3.28.3. Overall agri-environmental performance

Overall the expansion in agricultural production has exerted greater pressure on the environment since 1990. This is in part because of the increased area farmed and greater use of purchased variable inputs including fertilisers (except phosphate fertiliser) pesticides, water and energy, although there has been a lowering of agricultural air pollution emissions (methyl bromide and greenhouse gases). Soil erosion remains a major problem and irrigation water application rates (litres per hectare) increased significantly, compared to a declining trend for most other OECD countries where irrigation is important. There are also concerns for biodiversity, both the erosion of agricultural genetic resources (notably plant species) and also harmful impacts of land use changes and farming practices on natural and semi-natural habitats and as a consequence harmful impacts on wild flora and fauna.

The agri-environmental monitoring system needs to be considerably improved, to help enhance the quality of information for policy makers to evaluate the environmental effectiveness of newly introduced agri-environmental and environmental policy measures [3, 27, 54]. Some areas of agri-environmental monitoring are now well established, especially related to irrigation water use and management, and greenhouse gas emissions. But for most agri-environmental issues monitoring is weak or, where data do exist, their quality and reliability are poor [3, 27]. Support from international groups, such as the World Bank, however, is helping to develop a base for tracking environmental performance.

Agri-environmental policies are being strengthened and many environmental measures have been introduced since the mid-1990s. Under the 2006 Agricultural Policy Strategy 2006-10 the share of budgetary support for agri-environmental purposes will be 5% [15]. As part of the amended (2005) ARIP, the *Environmentally Based Agricultural Land Protection* (CATAK) programme, support will be provided for environmental cross compliance and organic farming, as well as combating soil erosion and developing irrigation systems that use less water [9]. The government is also in the process of introducing measures to encourage greater production and use of renewable energy, including energy and biofuels produced from agricultural biomass feedstocks [43]. These measures could be important in providing incentives for using the considerable potential of agricultural biomass as a feedstock for energy and fuel production that exists in Turkey [43]. Measures to address overgrazing, under the Grazing and Pasture Law of 1998, are attempting to restrict stocking levels on state owned grasslands [41].

Despite the introduction of policies to address agri-environmental issues many problems persist, although overall the intensity of agriculture is much lower than across most OECD

European countries. While in part soil degradation (particularly erosion) is naturally occurring, the absence of widespread adoption of soil conservation practices has failed to improve soil quality, in particular, as a result of overgrazing and ploughing grassland. Subsidies for purchased variable inputs while increasing farm output as intended, has kept agriculture on a technically suboptimal trend and led to unintended environmental damage [2, 13]. Continued subsidies for water charges and electricity for pumping (and diesel for machinery) are undermining the efforts to achieve sustainable agricultural water use, especially groundwater, and in the case of energy and diesel reduce greenhouse gas emissions. The operation and management responsibilities for local irrigation networks (previously run by a national monopoly), however, have been transferred to self-financing water user associations. This has led to an increase in water charges in order to cover operating costs and is helping toward more effective use of scarce water resources [2, 39, 42].

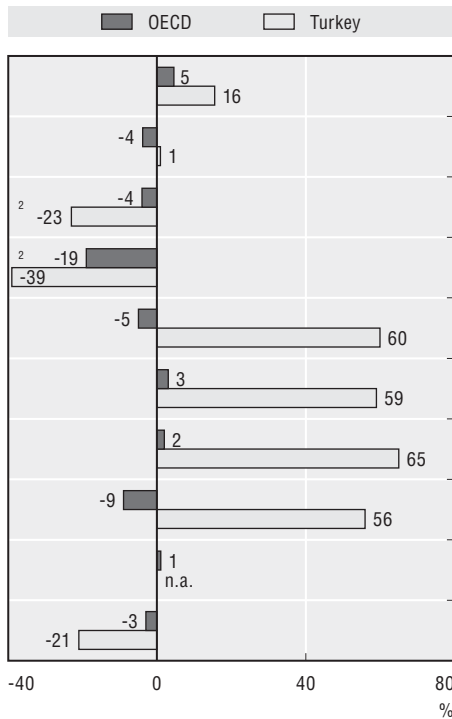
Projections suggest that agricultural production is likely to expand up to 2016, and that agricultural pressure on the environment may continue [60]. While most of the growth in production will derive from higher yields, the area cultivated for some crops may also increase, such as for cereals [60]. The future rise in agricultural production implies higher demand for water, with projections of water demand from other users (e.g. industry, households tourism) expected to be more rapid than for agriculture up to 2030, as national population, incomes and foreign tourism increase the demand for water [4, 42].

An important part of the government strategy toward expanding agricultural production are a number of large scale irrigation projects, in particular, the South-Eastern Anatolian Project (GAP). The GAP requires the utilisation of some of the water potential of the Dicle (Tigris) and Firat (Euphrates) to irrigate the 1.7 million hectares in the GAP region. This has raised concerns not only for the ecology of the GAP region, but also for water flows for neighbouring countries downstream, namely Iraq and Syria. At present there is some progress in addressing the environmental impacts of the GAP project and agreement between Turkey and these countries on the equitable allocation of water from the Dicle – Firat basin. These rivers comprise less than a half of Turkey's and most of Iraq's and Syria's water supply [23].

The agricultural sector is also undergoing structural changes with environmental implications. A key aspect to structural change in agriculture, which may impact on agri-environmental performance, is the extent to which small semi-subsistence farms can escape the vicious circle of low technical efficiency and technological and educational backwardness. Only 24% of the agricultural labour force had completed primary education (eight years) and 14% had completed secondary education or above by 2004 [1]. Improvements in human capital are clearly crucial to the future of Turkish farming and in raising agri-environmental performance. This needs to involve both increasing employment opportunities for farmers to leave the sector and improving the efficiency of those remaining in agriculture by upgrading the training and advisory services to assist farmers to adopt new, efficient and environmentally friendly farming practices. This may in turn help farmers address the key agri-environmental issues in Turkey by improving soil quality, increasing the efficiency of water use management, and conserving biodiversity.

Figure 3.28.2. **National agri-environmental performance compared to the OECD average**

Percentage change 1990-92 to 2002-04¹



Absolute and economy-wide change/level

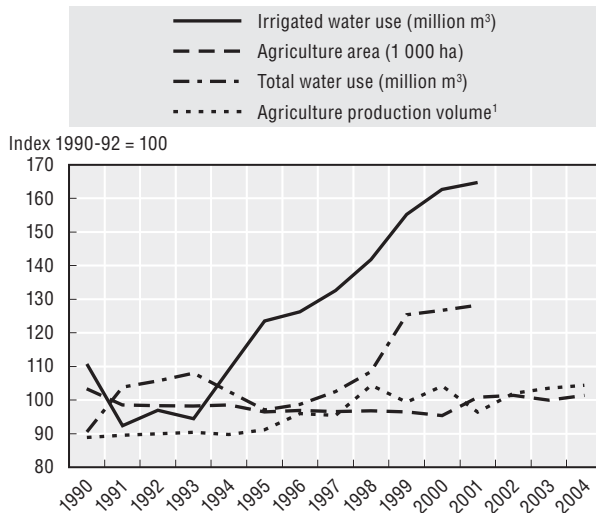
Variable	Unit	Turkey	OECD
Agricultural production volume	Index (1999-01 = 100) to 2002-04	116	105
Agricultural land area	000 hectares to 2002-04	352	-48 901
Agricultural nitrogen (N) balance	Kg N/hectare 2002-04	28	74
Agricultural phosphorus (P) balance	Kg P/hectare 2002-04	5	10
Agricultural pesticide use	Tonnes to 2001-03	+7 161	-46 762
Direct on-farm energy consumption	000 tonnes of oil equivalent to 2002-04	+1 170	+1 997
Agricultural water use	Million m ³ to 2001-03	+12 188	+8 102
Irrigation water application rates	Megalitres/ha of irrigated land 2001-03	8.8	8.4
Agricultural ammonia emissions	000 tonnes to 2001-03	n.a.	+115
Agricultural greenhouse gas emissions	000 tonnes CO ₂ equivalent to 2002-04	-3 930	-30 462

n.a.: Data not available. Zero equals value between -0.5% to < +0.5%.

1. For agricultural water use, pesticide use, irrigation water application rates, and agricultural ammonia emissions the % change is over the period 1990-92 to 2001-03.
2. Percentage change in nitrogen and phosphorus balances in tonnes.

Source: OECD Secretariat. For full details of these indicators, see Chapter 1 of the Main Report.

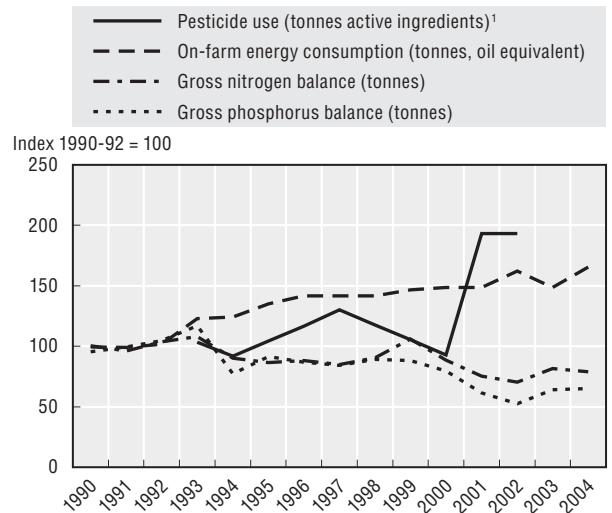
Figure 3.28.3. **Trends in key agri-environmental indicators**



1. Index 1999-2001 = 100.

Source: OECD Secretariat.

Figure 3.28.4. **Trends in key agri-environmental indicators**



1. Index 1993-95 = 100.

Source: OECD Secretariat.

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Bibliography

- [1] State Planning Organisation (2006), *National Rural Development Strategy*, Republic of Turkey Prime Ministry State Planning Organisation, Ankara, Turkey, <http://ekutup.dpt.gov.tr/bolgesel/strateji/kirsali.pdf>.
- [2] OECD (2006), *OECD Economic Surveys – Turkey*, Vol. 2006/15, October, Paris, France, www.oecd.org/eco.
- [3] A. Burrell and A. Oskam (eds.) (2005), *Turkey in the European Union: Implications for Agriculture, Food, and Structural Policy*, CABI, Wageningen University, Wageningen, the Netherlands.
- [4] Sayan, S. and N. Demir (2003), “Structural change in agriculture and water requirements in Turkey”, *Research in Middle East Economics*, Vol. 5, pp. 289-315.
- [5] Berkum, S. van (2005), *Is the Turkish Agri-food sector ready for EU entry?*, paper presented to the European Association of Agricultural Economists, 24-27 August, Copenhagen, Denmark.
- [6] Cakmak, E.H. (2004), *Structural change and market opening in agriculture: Turkey towards EU Accession*, Economic Research Center Working Papers in Economics 04/10, September, Middle East Technical University, Ankara, Turkey.
- [7] OECD (2005), *Agricultural Policies in OECD Countries: Monitoring and Evaluation 2005*, Paris, France, www.oecd.org/agr/policy.
- [8] OECD (2002), *Agricultural Policies in OECD Countries: Monitoring and Evaluation 2002*, Paris, France, www.oecd.org/agr/policy.
- [9] OECD (2007), *Agricultural Policies in OECD Countries: Monitoring and Evaluation 2007*, Paris, France, www.oecd.org/agr/policy.
- [10] World Bank (2004), *Turkey: A review of the impact of the reform of agricultural sector subsidisation, Europe and Central Asia Region, Environmentally and Socially Sustainable Development Unit*, Washington DC, United States, www.worldbank.org.tr.
- [11] Ministry of Environment and Forestry (2007), *First national communication on Climate Change: Republic of Turkey under the UN Framework Convention on Climate Change*, see the UNFCCC website at http://unfccc.int/national_reports/annex_i_natcom/submitted_natcom/items/3625.php.
- [12] Dogruel, F., A.S. Dogruel and E. Yeldan (2003), “Macroeconomics of Turkey’s agricultural reforms: an intertemporal computable general equilibrium analysis”, *Journal of Policy Modeling*, Vol. 25, pp. 617-637.
- [13] OECD (1999), *Environmental Performance Reviews – Turkey*, Paris, France, www.oecd.org/env.
- [14] Sayin, C., M.N. Mencet and B. Ozkan (2005), “Assessing of energy policies based on Turkish agriculture: current status and some implications”, *Energy Policy*, Vol. 33, pp. 2361-2373.
- [15] Ministry of Agriculture and Rural Affairs (2006), *Rural Development Report in Turkey*, paper presented to the International Conference on Agrarian Reform and Rural Development, 7-10 March, Porto Alegre, Brazil.
- [16] Özkan, M. (2003), “Organic Agriculture and National Legislation in Turkey”, pp. 289-294, in OECD, *Organic Agriculture: Sustainability, Markets and Policies*, Paris, France, www.oecd.org/tad/env.
- [17] Yazgan, M. and A. Tanik (2004), “Ecological agriculture and food production in Turkey”, Chapter 10 in W.L. Filho (ed.), *Ecological Agriculture and Rural Development in Central and Eastern European Countries*, NATO Science Series, Series V: Science and Technology Policy – Vol. 44, IOS Press.
- [18] Sayan, Y. and M. Polat (2005), “Development of organic animal production in Turkey”, pp. 153-159 in Hovi, M., J. Zastawny and S. Patel (eds.) (2005), *Sustaining Animal Health and Food Safety in Organic Farming*, Proceedings of the 3rd Workshop, September, Falenty, Poland, www.safonet.org/publications/ws3/index.html.
- [19] Kenanoğlu, Z. and O. Karahan (2002), “Policy implementation for organic agriculture in Turkey”, *British Food Journal*, Vol. 104, Part3/4/5, pp. 300-318.
- [20] Çakmak, B., M. Beyribey and S. Kodal (2004), “Irrigation water pricing in water user associations, Turkey”, *Water Resources Development*, Vol. 20, No. 1, pp. 113-124.
- [21] Miyata, S. and T. Fujii (2007), “Examining the socioeconomic impacts of irrigation in the Southeast Anatolia Region of Turkey”, *Agricultural Water Management*, Vol. 88, pp. 247-252.
- [22] Ozdogan, M., C.E. Woodcock, G.D. Salvucci and H. Demir (2006), “Changes in summer irrigated crop area and water use in Southeastern Turkey from 1993 to 2002: Implications for current and future water resources”, *Water Resources Management*, Vol. 20, pp. 467-488.

- [23] Burlleson, E. (2005), "Equitable and reasonable use of water within the Euphrates-Tigris river basin", *Environmental Law Reporter News and Analysis*, Vol. 35, pp. 10041-10054.
- [24] UN Convention to Combat Desertification (2006), *Turkey's National Report on the Implementation Processes of the Convention*, UNCCD, 5th Session of Committee for the Review of the Implementation of the Convention, October, Buenos Aires, Argentina, see UNCCD, www.unccd.int/.
- [25] UN Convention to Combat Desertification (2006), *Turkey's National Action Program on Combating Desertification*, see UNCCD, www.unccd.int/.
- [26] Ministry of Environment and Forestry (2005), *Third National Report of Turkey to the Convention on Biological Diversity*, Secretariat to the Convention on Biological Diversity, Montreal, Canada, www.biodiv.org/reports/list.aspx?menu=chm.
- [27] Yuksel, E. (2002), *Background Study on the Link between Agriculture and Environment in Accession Countries – National Report for Turkey*, Authority for the Protection of Special Areas, Turkey and the Institute for European Environmental Policy, London, www.ieep.eu/.
- [28] Kilic, S., F. Evrendilek, S. Şenol and I. Çelik (2005), "Developing a suitability index for land uses and agricultural land covers: A case study in Turkey", *Environmental Monitoring and Assessment*, Vol. 102, pp. 323-335.
- [29] Atis, E. (2006), "Economic impacts on cotton production due to land degradation in the Gediz Delta, Turkey", *Land Use Policy*, Vol. 23, pp. 181-186.
- [30] Çetin, S., A. Karaca, K. Haktanir and H. Yildiz (2007), "Global attention to Turkey due to desertification", *Environmental Monitoring and Assessment*, Vol. 128, pp. 489-493.
- [31] The Turkish response to the OECD Agri-environmental Indicator Questionnaire, unpublished.
- [32] Saltali, K., H. Sari, D. Mendil and S. Altin (2004), "Cadmium and phosphorus accumulates in soil under intensive cultivation in Turkey", *Acta Agriculturae Scandinavica: Section B, Soil and Plant Science*, Vol. 54, pp. 267-272.
- [33] Budak, F. and D.B. Budak (2006), "Farm level analysis of pesticide use in cotton production in East Mediterranean region of Turkey", *Journal of Environmental Biology*, Vol. 27, No. 2, pp. 299-303.
- [34] Tanrivermis, H. (2003), "Agricultural land use change and sustainable use of land resources in the Mediterranean region of Turkey", *Journal of Arid Environments*, Vol. 54, pp. 553-564.
- [35] Ergonen, A.T., S. Salacin and M.H. Ozdemir (2005), "Pesticide use among greenhouse workers in Turkey", *Journal of Clinical Forensic Medicine*, Vol. 12, pp. 205-208.
- [36] Kolankaya, D. (2006), "Organochlorine pesticide residues and their toxic effects on the environment and organisms in Turkey", *International Journal of Environmental Analytical Chemistry*, Vol. 86, No. 1-2, pp. 147-160.
- [37] Barlas, N., I. Çok and N. Akbulut (2006), "The contamination levels of organochlorine pesticides in water and sediment samples in Uluabat Lake, Turkey", *Environmental Monitoring and Assessment*, Vol. 118, pp. 383-391.
- [38] Erdogru, O., A. Covaci and P. Schepens (2005), "Levels of organochlorine pesticides, polychlorinated biphenyls and polybrominated diphenyl ethers in fish species from Kahramanmaraş, Turkey", *Environment International*, Vol. 31, pp. 703-711.
- [39] Ersoy Yildirim, Y. and B. Çakmak (2004), "Participatory irrigation management in Turkey", *Water Resources Development*, Vol. 20, No. 2, pp. 219-228.
- [40] Çakmak, E.H. (2003), "Evaluation of the past and future agricultural policies in Turkey: are they capable to achieve sustainability?", *Options Méditerranéennes, Séries A*, No. 52, pp. 155-165.
- [41] European Environment Agency (2004), *Agriculture and the environment in the EU accession countries*, Environmental issue report, No. 37, Copenhagen, Denmark, www.eea.eu.int.
- [42] Unver, O. and R.K. Gupta (2003), "Water pricing: Issues and options in Turkey", *Water Resources Development*, Vol. 19, No. 2, pp. 311-330.
- [43] Hatirli, S.A., B. Ozkan, and C. Fert (2004), "An Econometric Analysis of Energy Input-Output in Turkish Agriculture", *Renewable and Sustainable Energy Reviews*, Vol. 9, pp. 608-623.
- [44] Karkacier, O., Z.G. Goktolga and A. Cicek (2006), "A regression analysis of the effect of energy use in agriculture", *Energy Policy*, Vol. 34, pp. 3796-3800.
- [45] Yilmaz, I., H. Akcaoz and B. Ozkan (2005), "An analysis of energy use and input costs for cotton production in Turkey", *Renewable Energy*, Vol. 30, pp. 145-155.

- [46] IEA (2005), *Energy Policies of IEA Countries – Turkey 2005 Review*, Paris, France, www.iea.org.
- [47] Kaygusuz, K. (2002), “Sustainable development of hydropower and biomass energy in Turkey”, *Energy Conversion and Management*, Vol. 43, pp. 1099-1120.
- [48] Goncagul, T. (2003), “Farm Animal Diversity in Turkey”, in *OECD Agriculture and Biodiversity: Developing Indicators for Policy Analysis*, Paris, France, www.oecd.org/tad/env/indicators.
- [49] Kaya, D. (2006), “Renewable energy policies in Turkey”, *Renewable and Sustainable Energy Reviews*, Vol. 10, pp. 152-163.
- [50] Balat, M. (2005), “Use of biomass sources for energy in Turkey and a view to biomass potential”, *Biomass and Bioenergy*, Vol. 29, pp. 32-41.
- [51] Taner, F., I. Ardic, B. Halisdemir and E. Pehlivan (2004), “Biomass Use and Potential in Turkey”, in *OECD, Biomass and Agriculture: Sustainability, Markets and Policies*, Paris, France, www.oecd.org/tad/env.
- [52] Evrendilek, F., I. Celik and S. Kilic (2004), “Changes in soil organic carbon and other physical soil properties along adjacent Mediterranean forest, grassland, and cropland ecosystems in Turkey”, *Journal of Arid Environments*, Vol. 59, pp. 743-752.
- [53] Tan, A. (2003), “Agricultural Plant Diversity in Turkey”, in *OECD, Agriculture and Biodiversity: Developing Indicators for Policy Analysis*, Paris, France, www.oecd.org/tad/env/indicators.
- [54] Okumus, K. (2002), *Turkey’s environment: A review and evaluation of Turkey’s environment and its stakeholders*, The Regional Environmental Center for Central and Eastern Europe, Szentendre, Hungary, www.rec.org.
- [55] Bardsley, D. and I. Thomas (2006), “In situ agrobiodiversity conservation: Examples from Nepal, Turkey and Switzerland in the first decade of the Convention on Biological Diversity”, *Journal of Environmental Planning and Management*, Vol. 49, No. 5, pp. 653-674.
- [56] Bardsley, D. and I. Thomas (2005), “Valuing local wheat landraces for agrobiodiversity conservation: in Northeast Turkey”, *Agriculture, Ecosystems and Environment*, Vol. 106, pp. 407-412.
- [57] Kruzich, T.J. and E.C.H. Meng (2006), *Wheat landrace cultivation in Turkey: Household land-use determinants and implications for on-farm conservation of crop genetic resources*, paper presented to the International Association of Agricultural Economists Conference, 12-18 August, Gold Coast, Australia.
- [58] Gürsoy, O. (2006), “Economics and profitability of sheep and goat production in Turkey under new support regimes and market conditions”, *Small Ruminant Research*, Vol. 62, pp. 181-191.
- [59] BirdLife International (2004), *Biodiversity indicator for Europe: population trends of wild birds*, The Pan-European Common Bird Monitoring Database, Birdlife International and European Bird Census Council, www.rspb.org.uk/Images/Biodiversity%20indicators%20for%20Europe%2023.2.04_tcm5-46451.pdf.
- [60] OECD (2007), *Agricultural Commodities Outlook Database*, Paris, France.