Organisation for Economic Co-operation and Development
Organisation de Coopération et de Développement Économiques

ENVIRONMENTAL PERFORMANCE OF AGRICULTURE IN OECD COUNTRIES SINCE 1990:

Spain Country Section

This country section is an extract from chapter 3 of the OECD publication (2008) ***Environmental Performance of Agriculture in OECD countries since 1990***, which is available at the OECD website indicated below.

This text should be cited as follows: OECD (2008), *Environmental Performance of Agriculture in OECD countries since 1990*, Paris, France

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

TABLE OF CONTENTS OF THE COMPLETE REPORT

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The review of environmental performance draws on the country responses to the OECD agri-environmental questionnaires (unpublished) provided by countries and the OECD agri-environmental database supporting Chapter 1 (see website above).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.

 ENVIRONMENTAL PERFORMANCE OF AGRICULTURE IN OECD COUNTRIES SINCE 1990 – ISBN 978-92-64-04092-2 – © OECD 2008

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:

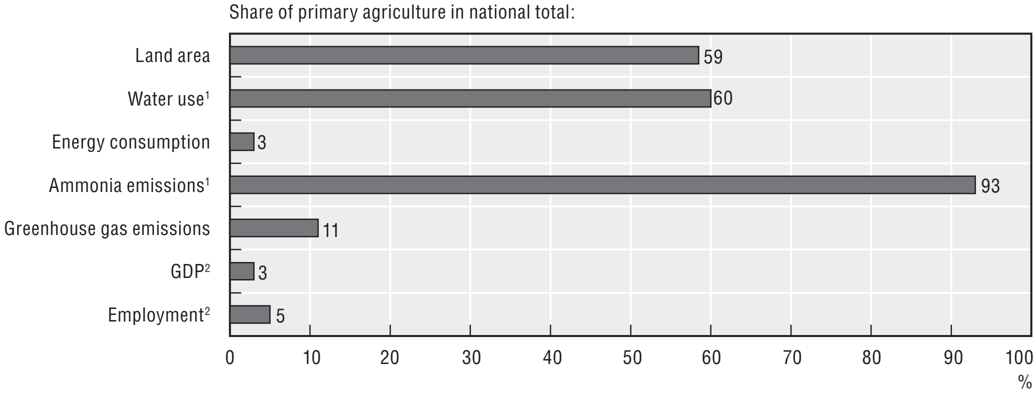
Coverage: The analysis is confined to examination of agri-environmental trends. The influence on these trends of policy and market developments, as well as structural changes in the industry, are outside the scope of these sections. Moreover, the country sections do not examine the impacts of changes 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).

3.25. SPAIN

Figure 3.25.1. **National agri-environmental and economic profile, 2002-04: Spain**



StatLink http://dx.doi.org/10.1787/301026803438

1. Data refer to the period 2001-03.
2. Data refer to the year 2003.

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

3.25.1. Agricultural sector trends and policy context

Growth in agricultural production was among the highest across OECD countries, between 1990-92 and 2002-04 (Figure 3.25.2). But between 1990 and 2003 the share of agriculture in GDP declined from 5% to just over 3% and the share of farm employment in total employment from nearly 10% to 5% [1] (Figure 3.25.1). Agriculture's use of natural resources is significant and accounted for 59% of total land use (2002-04) and 60% of water use (2001-03) [1, 2].

Agricultural production is intensifying on a smaller area of land and is being concentrated in fewer farms [1]. The total area farmed declined by 3.5% between 1990 and 2004, compared to the average for the EU15 of over 5% [1]. During this time the use of farm inputs rose, resulting in higher agricultural productivity and the substitution of labour by purchased inputs since 1990. The rise in the volume of purchased farm inputs over the period 1990-92 to 2002-04 included: nitrogen (5%) and phosphate inorganic fertilisers (13%), pesticides (11%); on-farm energy use (39%) and water use (9%) (Figure 3.25.2). Underlying these changes has been greater regional specialisation in production [3] and a shift from crop to livestock output, with the volume of livestock production rising by nearly 37% (for all livestock types except dairy cows) compared to an increase of 22% in crop production between 1990-92 and 2002-04. Even so, crop production contributes the major share of the total value of agricultural production (over 60% in 2003), and for some crops output has risen more rapidly than for livestock, especially for irrigated crops including olives, vine and horticultural products [1].

Farming is mainly supported under the Common Agricultural Policy (CAP) with support also provided through national expenditure within the CAP framework. Support to EU farmers on average declined from 41% of farm receipts in the mid-1980s to 34% in 2002-04 (as measured by the OECD Producer Support Estimate – PSE) compared to the 31% OECD average. Nearly 70% of EU support to farmers was output and input linked in 2002-04 (compared to over 90% in the mid-1980s), the forms of support that most encourage production [4]. Total budgetary support to Spanish agriculture including EU funding was over EUR 6 (USD 7.5) billion in 2004, of which 25% was nationally financed. Agri-environmental measures in Spain accounted for 4-5% of budgetary support in 2004 [5].

Agri-environmental policies have been strengthened since their introduction in 1992 [5, 6, 7]. During the financial period 2000-06, the agri-environmental measures were included inside a national rural development programme. Their main objectives were targeted to achieve a sustainable agriculture and the protection of biodiversity and landscape. The priorities for agri-environmental policies are divided into five areas which cover: water, soil, natural risks, biodiversity and landscape. There are nine different measures related to these areas, including: extensive production; local varieties threatened with genetic erosion; environmental measures for the rational use of chemical products; prevention of soil erosion; protection of wetlands ecosystems; reducing water abstractions and enhancing extensive production; landscape protection; fire prevention; and livestock farm management for the conservation of natural resources. The expenditure on agri-environmental measures for the 2000-06 period was EUR 1.2 (USD 1.5) billion, of which 70% was EU-funded.

National water policies are important for the agricultural sector. Over the past 20 years water policy has evolved through three key phases: first, the *Water Act* from 1985 to 2001; second, the *National Hydrological Plan (NHP)*, 2001-04 and the *National Irrigation Plan (NIP)*, 2002-08; and third the *AGUA* (Actions for the Management and Use of Water) programme, from 2004 to the present. The ***Water Act*** established the institutional framework for water management by creating 15 *River Basin Authorities* (RBAs), each of which design their own hydrological plans, with the first plans established in 1998 for a 10 to 20-year period [5, 7, 8, 9, 10]. The *NHP and AGUA programmes* were introduced with the main objective of resolving water scarcity and degradation problems through subsidised investments in water infrastructure. The *NHP project* aimed to balance national water abundance and deficits, by transferring water from the "abundant" Ebro water basin in the north to the "deficit" water basins in the south as far as Almería, 700 km from Ebro [5, 11, 12]. The new government in 2004 approved a modification of the *NHP*, under the *AGUA programme* which aims to address water scarcity through mainly constructing desalinisation plants drawing on the brackish coastal aquifers in the south, and abolishing the plan to transfer water from the Ebro to the Segura [13, 14]. The project involves investing up to EUR 3.8 (USD 4.8) billion on desalination facilities, with about a third of the additional freshwater capacity intended for irrigation [13]. *AGUA* will also enforce stricter regulations on over extraction of aquifers [14].

The National Irrigation Plan is seeking by 2008 to reduce irrigation water use by 10% from 2002 levels by upgrading existing irrigation infrastructure and developing new irrigation schemes involving a 7% growth in the total irrigated area from 2002 [5, 13, 15, 16]. This is estimated to cost EUR 5 (USD 6.3) billion between 2002 and 2008, with 50% funded publicly (EU, national regional funds) and 50% by farmers using long term loans [16, 17]. Since the 1999 revisions to the *Water Act* irrigators are in principle required to meter water use with *water charges* covering full costs (operation, maintenance, and amortisation of capital). Where irrigators' water use is above the allocated volume of water, this may lead to higher water prices, whereas use below expected levels can result in lower prices [5]. In practice, however, RBAs collect under 20% of irrigation costs [5].

Agriculture is implicated by other national environmental and taxation policies. Farmers benefit from a ***fuel tax concession*** equivalent to nearly EUR 65 (USD 81) million of tax revenue forgone in 2005. Support was provided in 2004 to compensate for higher oil prices, with a payment per litre of fuel consumed up to a maximum of EUR 3000 (USD 3750) per farmer [4]. Some payments are provided to farmers to renew old machinery with less polluting and more energy efficient machinery [4]. The *Plan for Developing Renewable Energy* (2000-10) and the *Plan for Improving Transport Infrastructure* (2000-07) seek to encourage production and domestic consumption of bioenergy (fuels and power generation), involving the use of some domestically produced agricultural biomass and by-products as a feedstock [5, 17]. Measures include support for the capital costs of bioenergy plants, zero taxation on biofuels and favourable feed-in tariffs for generation of renewable electricity production [17].

International and regional environmental agreements are also important for agriculture. They include those seeking to curb nutrient emissions into the Atlantic (*OSPAR Convention*); lower ammonia emissions (*Gothenburg Protocol*) and eliminate methyl bromide use (*Montreal Protocol*). In addition, Spain is a signatory to the *UN Convention to Combat Desertification*, and has adopted the *National Action Programme to Combat Desertification* that expands efforts to control soil erosion, including EUR 1.2 (USD 1.6) billion for agri-environmental measures and EUR 900 (USD 1 125) million for farm forestry [5]. Under the UN *Convention on Biological Diversity* the national *Biodiversity Strategy* (1998) aims to promote biodiversity by developing sectoral plans, including for agriculture and forestry. Conservation programmes such as the *Specifically Protected Areas* (SPA) and *Sites of Community Interest* (SCI) encompass agricultural land [5]. Spain has a number of environmental co-operation agreements with France and Portugal, notably concerning water resources, with nearly half of Portugal's renewable freshwater resources originating in Spain [4]. The *Convention on the Co-operation for the Protection and Sustainable Use of Waters of Portugal and Spain River Basins* (2000), covers water quality and resource use, and defines minimum flows for transboundary river basins [5, 18, 19].

3.25.2. Environmental performance of agriculture

The key agri-environmental challenges are the management and conservation of soils, water resources, biodiversity and cultural landscape features. Other important agri-environmental issues include controlling agricultural water pollution, and lowering ammonia and greenhouse gas emissions. Spain is characterised by great geographical, climatic and agri-ecosystem variety [1, 5]. Almost 60% of the mainland is above 600m in altitude. About a third of the country has an oceanic climate with frequent rainfall, while much of the rest has a Mediterranean or semi-arid climate, frequently affected by droughts. Nearly 40% of the farming population and 80% of farmland is situated in less-favoured areas among which are the mountainous regions threatened by depopulation, where semi-natural low intensity farming systems and areas with special natural characteristics predominate [1].

A major share of agricultural land is subject to moderate to extreme risk of soil erosion, among the highest share across OECD countries [2, 20]. Nearly 50% of agricultural land during 1987 to 2000 was estimated at moderate to extreme risk to ***water erosion*** (from 12 to > 200 tonnes/hectare/year), with more than 70% of arable and permanent cropland at moderate to extreme risk of erosion. About 15% of arable and permanent cropland is at high to extreme risk of erosion (greater than 50 tonnes/hectare/year), but this is restricted to specific areas with steeper slopes and usually occurs only after ploughing or the abandonment of farmland [20]. It has been estimated that ***wind erosion*** has only been reported in more localised areas, such as in the north-west and southern coastal areas [20]. The high soil erosion risk potential is largely attributed to frequent dry periods followed by outbreaks of heavy rain, particularly in southern regions, where there are also fragile soils and thin vegetation cover. In addition, poor soil management practices and land use changes, including abandonment of farmland and conversion from forests to pasture have contributed to increased rates of soil erosion [20, 21, 22]. But the abandonment of olive groves, vineyards and other crops in areas of low soil fertility, however, has also been shown to enhance soil degradation in some areas [20, 21].

Off-farm erosion effects are considered of greater significance than on-farm. Aside from extreme events, the main consequence of soil erosion off-farm includes silting of reservoirs, lakes and rivers, and exacerbating landslides and flooding [20]. An assessment in 1986 estimated that the off-site costs of soil erosion from all land were about EUR 173 (USD 170) million annually [20]. Erosion control criteria were incorporated into schemes eligible for agri-environmental payments in 2000, such as low or no tillage, summer cover crops and use of seeded fallow [2, 5, 23]. While conservation and no-tillage began in the early 1980s, adoption has been limited, although the practice of stubble burning was banned in 2001.

Overall pollution of water bodies by agriculture is widespread and growing [5, 24]. The agri-food industry was an important but not the major source of direct water pollution across the economy in 1997, accounting for 7% for nitrogen, 7% for phosphorus and 2% for metal pollutants [24]. The potential risk of water pollution from run-off and leaching of agricultural nutrients, pesticides, and heavy metals is increasing with the rise in nutrient surpluses and pesticide use. The growth in irrigation is leading to greater return flows containing pollutants and higher salinity through the over extraction of aquifers [25]. Farm pollution of rivers is less severe than for lakes, reservoirs (many of which are eutrophic) and groundwater where quality is continuing to decline in some areas, particularly caused by nitrates, salts and pesticides.

Agricultural nutrient surpluses increased between 1990-92 and 2002-04 (surpluses are the quantity of nutrient inputs minus outputs of nutrients, nitrogen – N – and phosphorus – P). Over this period the quantity of N surplus increased slightly by 1% compared to a decline of 21% for the EU15, while the P surplus increased by 18%, but for the EU15 decreased by 43% (Figure 3.25.2). Despite the rise in nutrient surpluses, the quantity of surplus per hectare of agricultural land was considerably lower than the EU15 and OECD averages. There was little change in nutrient use efficiency (the ratio of N/P output to N/P input) over the period 1990-92 to 2002-04. The increase in nutrient surpluses is mainly due to higher growth in inorganic fertiliser use and manure (from higher livestock numbers, especially, cattle, pigs and poultry).

Agriculture's nitrate pollution of groundwater is a serious concern. Nitrate pollution of groundwater is widespread and is mainly caused by the agricultural sector, which accounts for 80% of total groundwater use. Around 21% of monitored aquifers have nitrate concentrations above the *EU Drinking Water* standard (> 50 mg/l) compared to less than 1% for surface water in 2002-03 [2]. Over the 1990s concentrations of nitrates were stable in about 30% of aquifers, decreased in around 30% and increased for the remaining 40% [5].

Agricultural pollution of groundwater is more significant in Mediterranean areas where nitrate concentrations above 100 mg/l are not uncommon [26, 27]. It was reported in 2003 that only one coastal area was potentially subject to eutrophication from nitrogen and phosphorus [5]. There has been some improvement in nutrient management with effluent that was formerly discharged directly into water courses now being diverted to settling ponds and then spread onto farmland and forest soils.

The growth in pesticide use on farms is increasing groundwater pollution pressures. Pesticide use (tonnes of active ingredients) declined from the mid-1980s to the mid-1990s but steadily grew up to 2004 (Figure 3.25.2), in part due to the 22% growth in the volume of crop production between 1990-92 and 2002-04. The rise in pesticide use was in comparison to a reduction for the EU15 and OECD averages over the same period. There is no systematic regular monitoring of pesticides in water bodies, but various studies report their increasing presence in groundwater largely as a direct result of farming activities [5, 26, 28]. Irrigation has resulted in the contamination of aquifers, in some cases in excess of *EU Drinking Water Standards*, such as the water basins of Tajo, Guadiana, Guadalquivir, Sur, Júcar and Catalonia [5, 26]. In addition, some organochlorine pesticides, which have been restricted or prohibited since the late 1970s/ mid-1980s (*e.g.* DDT, dieldrin, lindane), were still being detected in soils, water, foods and people up to the early 2000s, due to their persistence in the environment [28, 29].

Recent trends in farming practices and systems could lower pesticide use. The share of arable and permanent crops under ***non-chemical pest control methods*** (*e.g.* crop rotation, manual weeding) and integrated pest management (*e.g.* using pest resistant crops, enhancing natural enemies) rose from 3% in 1990 to 8% by 2000 [1, 2]. The area under ***organic management*** has expanded rapidly from a very few farms in the early 1990s to 8% of total agricultural land by 2005 (Figure 3.25.3) [1, 2, 30]. The main organic crops (by area) include cereals, olives, and horticultural crops, while there has also been an increase in organic livestock production, especially cattle, sheep and goats [1]. The growth in the use of insecticides could also be reduced with the expansion in ***transgenic Bt maize production*** [31]. Since its introduction in 1998 the area under Bt maize rose to over 10% of the total maize area by 2005, the largest area of transgenic crops across the EU15 in 2005 [31, 32].

Agricultural water use grew twice as rapidly as total water use across the economy between 1990-92 and 2001-03 (Figure 3.25.2). As a result, farming accounted for 60% of total water use in 2001-03 [2]. Much of the increasing use of water by agriculture has arisen because of the 8% growth in area irrigated from 1990-92 to 2001-03, contributing to over a quarter of the EU15 total irrigated area by 2001-03. By 2001-03 the irrigated area accounted for 9% of farmland, almost 100% of total farm water use, between 50-60% of the final value of agricultural production and 80% of farm exports [1, 16, 33]. The expansion of the olive, vine and horticulture sectors has been a key driving force in demand for irrigation. On average about 80% of the irrigable area (*i.e.* area with irrigation infrastructure) is irrigated annually [16, 34]. The main source of water for irrigation is surface water (75-80%), with groundwater accounting for much of the remainder, while the share of irrigation in total groundwater use is about 75-80% [8, 16]. In some eastern coastal areas and the Spanish islands, however, recycled water and desalinisation are becoming important ways to meet the demand for water by irrigators and other users [14, 16].

There is widespread over-exploitation of aquifers from irrigation and other users, especially the tourist industry and urban centres along the Mediterranean coast [5, 18]. Around 13% of the irrigated area extracts water from aquifers that are over-exploited or in danger of saltwater intrusion [16, 35]. The over extraction from aquifers has led to problems of increasing salinity and reduced river flows to the detriment of aquatic ecosystems, especially in southern river basins [5, 9, 13, 33, 36]. Water abstractions by irrigators not registered have contributed considerably to the problem of the over-exploitation of aquifers [5, 9, 13, 37]. It has been estimated that around 45% of water pumped from aquifers is extracted without registration mainly for irrigation, but also for urban use and the tourist industry [35, 37], with up to 90% of private wells not correctly registered [9]. Irrigation water application rates (litres per hectare of irrigated land) decreased by 5% between 1990-92 and 2001-03, compared to the decrease of 9% for the OECD on average. This improvement in irrigation water use efficiency is in part explained by the increase in the share of irrigated area under the more efficient drip-emitter water application technologies, which rose from 9% in 1989 to 31% in 2001-03 [2]. In 2002 about 20% of the irrigated area was supplied water through earth ditches, while under 30% of the irrigation infrastructure is less than 20 years old [34, 38].

Air pollution trends linked to farming have shown mixed trends. Agricultural ***ammonia emissions*** rose by 21% between 1990-92 and 2001-03, among the highest rates of growth across OECD countries, mainly as a result of the increase in livestock numbers and nitrogen fertiliser use. Farming accounted for 93% of total ammonia emissions in 2002-04 (Figure 3.25.2). Spain has agreed to cut total ammonia emissions to 353 000 tonnes by 2010 under the *Gothenburg Protocol*. By 2001-03 total ammonia emissions were 389 000 tonnes, so a further 10% cut will be required to meet the target under the Protocol. While it is likely that the growth in farm ammonia emissions has contributed to an overall rise in acidifying pollutants, increasing pressure on ecosystems (terrestrial and aquatic) sensitive to excess acidity, there is little research or data available. For ***methyl bromide*** use (an ozone depleting substance) Spain, along with other EU15 countries, reduced its use over the 1990s as agreed by the phase-out schedule under the *Montreal Protocol*, which sought to eliminate all use by 2005. Since 2005 Spain has agreed to reduce annually "*Critical Use Exemption*" (CUE), which under the *Protocol* allows farmers additional time to find substitutes, with CUEs reaching 252 tonnes in 2007, (ozone depleting potential), or about a half of the EU15's CUEs. Methyl bromide is permitted in strawberry and flower crop production, as well as research, especially as a soil fumigant.

Growth in agricultural greenhouse gas (GHG) emissions was the highest across OECD countries, rising by 18% between 1990-92 and 2002-04 (Figure 3.25.2). This compares to a reduction of –7% in agricultural GHG emissions for the EU15, and a 41% rise in total GHG emissions for the Spanish economy as a whole [39]. Under the *Kyoto Protocol* and the EU *Burden Sharing Agreement* Spain can increase its total GHG emissions up to 15% by 2008-12 from the 1990 base year [39]. The share of farming in national GHG emissions was 11% in 2002-04 with the main sources and growth of agricultural GHGs from methane (from livestock) and nitrous oxide (from fertilisers and manure applied on soils) [39]. As a result of the policy measures taken in order to control GHGs, agricultural GHGs are projected to decline by 2% from 2005 to 2010 [39]. Over the period 1990 to 2008-12 estimates suggest that changes in farm management practices and farmland use could lead to an increase in ***carbon sequestration*** equivalent to about 25% of agricultural GHGs in 2000-02 [2]. Almost 60% of the carbon sequestration is expected to occur from afforestation of farmland, with a further 10% from the change to conservation tillage [2].

The rise in direct on-farm energy consumption of 39% was below the 54% rise across the economy, over the period 1990-92 to 2002-04 (Figure 3.25.2). Rising energy consumption has contributed to higher GHG emissions. Farming accounted for about 3% of total energy consumption in 2002-04 and projected growth in farm production could see energy consumption rise unless energy efficiency gains are realised. Much of the rise in direct on-farm energy consumption, the highest rate of growth across OECD countries, is explained by the expansion in use and size of machinery as a substitute for labour over the past 15 years.

A central element of the Plan for Developing Renewable Energy (2000-10) is the expansion of biomass to produce bioenergy (electricity and biogas) from agricultural, forestry, industrial and other feedstock sources [17]. Biogas production has been expanding and biofuel production capacity almost met 50% of the 2010 target by 2004, with Spain now one of the major bioethanol producers in the EU [17], although the production of biomass to generate power has fallen behind the government's target [17].

Overall the adverse pressure from agriculture on biodiversity has increased since 1990, but disentangling the impacts due to farming activities and related land use changes is complex and hampered by a lack of data. However, there are two diverging trends. On the one hand, the intensification of production with an increase of pollutants into the environment, especially nutrients, pesticides and ammonia emissions, has increased pressure on terrestrial and aquatic ecosystems, and degradation of habitats through soil erosion, flooding for irrigation, and the reduction of water flows in rivers. On the other hand the conversion of semi-natural farmed habitats mainly to shrub, forestry, and urban development has also led to adverse effects on biodiversity. The abandonment of low intensity grazing in some semi-natural habitats, for example, has caused the loss of more than 60% of grassland species [40]. Some farmland use changes, however, may have a beneficial impact for biodiversity, including the increase in farm fallow land and farm woodland, which together accounted for 22% of total farmland by 2000-02 compared to 19% in 1990-92 [2].

Agricultural crop and livestock genetic resource diversity increased between 1990 and 2002, suggesting greater environmental resilience of farming systems. The diversity of most ***crop varieties*** used in production rose during this period, but maize was a notable exception although some local varieties of maize were not included in the statistics [2]. Similarly for ***livestock breeds*** there was an increase in the numbers (diversity) of officially recognised breeds, domestic and foreign breeds, used in marketed production, from 88 in 1979 to 169 in 2007. *In situ* conservation of local breeds is growing in importance, with most breeds having recognised breeding associations, supported by a regional network, largely government-funded, of *ex situ* collections of animal genetic material. Despite these changes there was an increase in the number of officially recognised critical and endangered livestock endogenous breeds from 19 to 117 breeds between 1979 and 2007, with most of them under conservation programmes [2]. In some cases the conservation of certain breeds, notably the protection of the Iberian Pig (*Cerdo Ibérico*) and several domestic ruminant breeds, has brought with it not only a source of income through the sale of high quality cured hams, meats and cheese, but has also formed an integral part of ecosystem diversity conservation. The Iberian pig has adapted over the centuries to feed on the acorns from the oak trees in the semi-natural grazed Dehesa habitats [41, 42].

Converting agricultural land to other uses puts pressure on biodiversity conservation, especially in the case of semi-natural farmed habitats [6]. Relative to other EU15 countries Spain has a high proportion of farmland designated as ***semi-natural habitat*** subject to extensive management practices, including: lowland Steppes (where poor soils have constrained more intensive cultivation); mountain areas, ranging from terraced olive groves in the south to hay meadows in the Pyrenees to the north; and some lowland rivers and wetlands [15]. An important farmed semi-natural habitat in Spain is the ***Dehesa***, a habitat system common to Mediterranean Iberia (Figure 3.25.4). The Dehesa is a system created by human land use and management, mainly based on extensive stockbreeding farming in an area of mixed pastures and Mediterranean forest vegetation. More than 20% of the area has to be covered with leafy species, with a rate of tree cover of between 5% and 60%. These characteristics lead to an ecosystem with high environmental value, sustainable use of land, and a balance between landscape and the diversity from the integration due to agriculture and forestry management.

Farmed semi-natural habitats are rich in biodiversity and are associated with several of Spain's emblematic endangered species, such as the Iberian Lynx (*Lynx pardinus*), Spanish Imperial Eagle (*Aquila adalberti*), Black Vulture (*Aegypius monachus*) and Black Stork (*Ciconianigra*) [15, 40]. But these habitats are subject to a variety of threats, including: their abandonment to shrub reducing their value for many species of flora and fauna [22, 40, 43]; conversion to use for forestry; greater use of chemical inputs in some cases (such as mountain olive groves); overstocking of livestock in certain areas,; and pollution of rivers.

The expansion of irrigation has had adverse impacts on ecosystems. In southern regions semi-natural farmed habitat has been converted to areas of intensive irrigation with adverse consequences for terrestrial species [44]. The rising demand for water in newly irrigated areas has also led to the diversion of water for irrigation lowering flows in rivers and wetlands, and chemical run-off polluting aquatic ecosystems [5, 15, 36, 37, 44, 45]. But some research has shown that under certain management conditions irrigation pools for holding water for drip irrigation (*e.g.* using sand and gravel instead of plastic as construction materials), can provide habitats for some species, including aquatic plants, water birds, fish and amphibians [44, 46].

The change and loss of semi-natural farmed habitats has been detrimental to bird populations. Although data are limited, trends in farmland bird populations declined between 1997 and 2002. Moreover, the importance of farming practices on bird populations is also revealed by the BirdLife International Important Bird Areas (IBAs) indicator, defined as prime bird habitat. The indicator shows that around 35% of the most significant threats to Spanish IBAs originates from farming, including not only production intensification but also the loss of semi-natural farmed habitat to other uses, while the construction of irrigation projects threatens around 40% of IBAs [47]. Winter stubble maintenance is included as a compulsory commitment under some agri-environmental programmes, in part to help reduce soil erosion.

The conversion of semi-natural farming systems to other uses threatens cultural landscape conservation. The abandonment of semi-natural farmed areas to garrigue or shrub or their conversion to other uses (*e.g.* irrigation or forestry) is also a concern for cultural landscape conservation, including the neglect and damage to features such as stone walls, terraces and historic farm buildings [15]. The changing spatial characteristics of semi-natural landscapes through abandonment are also considered to have reduced the structure and heterogeneity of landscapes and hence diminished their aesthetic value [22, 48]. Socio-economic changes also alter cultural landscapes in agricultural areas, especially through changes in farming practices, such as the reduction in transhumance leading to the disappearance of drovers' tracks and loss of farmer knowledge related to hedge and terrace maintenance [48, 49]. The Ministry of Environment together with regional governments is beginning to establish an inventory of drovers' tracks in recognition of their value to some livestock systems, biodiversity and cultural landscapes [5].

3.25.3. Overall agri-environmental performance

Overall the pressure on the environment from agriculture has increased since 1990. This largely results from both the rapid growth in agricultural production (among the most rapid in the OECD area), and the greater use of purchased inputs on a declining farmed area. As a result, the intensity of farming is growing with increasing use of nutrient fertilisers, pesticides, water, and energy. Compared to many other EU15 countries, however, Spanish agriculture is in general more extensive. However, soil erosion and water scarcity and pollution are the main environmental problems caused by agriculture. The conservation of biodiversity and cultural landscapes in agriculture and the increase in ammonia and greenhouse gas emissions are also growing environmental challenges related to agriculture.

There is a lack of data and indicators to adequately monitor and evaluate agri-environmental performance and policies. Improving the collection and maintenance of databases would provide information for policy makers to better monitor agri-environmental policy measures and evaluate their environmental effectiveness. The government, however, is beginning to establish databases. For example, in 2002 the Ministry of the Environment embarked on a 10 year project to establish a new national soil erosion inventory to improve national estimates of ***soil erosion*** risks [2, 20]. The knowledge base on ***biodiversity*** is also being strengthened with recently published inventories of flora and fauna and their habitats [5]. But River Basin Authorities' task of managing and regulating water, especially extractions not registred from groundwater, is being impeded by a lack of reliable information of how much ***water***, where, and at what rate it is being abstracted and recharged by agriculture, and what the long term environmental implications might be [8, 14, 50]. Moreover, there is no systematic monitoring of agricultural ***pesticide*** pollution of water bodies, and there is little information on the impact of agricultural ***ammonia*** emissions on ecosystems.

The government has begun the task of addressing environmental problems in agriculture with the introduction of agri-environmental policies in 1992. But there has been a relatively low uptake of agri-environmental schemes in Spain compared to many other EU15 countries. For example, in 2002 less than 10% of agricultural land was included under such schemes compared to over 20% for the EU15 on average [51]. This is partly explained by budgetary restrictions; the predominant attitude among farmers to raise production without attention to environmental stewardship; and high transaction costs [7]. By the end of 2004, however, over 50% of the target under the 2000-08 *National Irrigation Plan* to upgrade the irrigation infrastructure had been achieved with water savings estimated at 4% of the total irrigation water used in 2001-03 [16, 34].

The projected growth of farm production up to 2008-12 may further increase environmental pressure, in particular, from the anticipated rise in livestock numbers, fertiliser use and irrigated area [52]. ***Soil erosion*** is a key agri-environmental problem, to address this issue a number of measures are being taken, such as agri-environmental measures, cropland afforestation and forest fire prevention [53]. Concerning curbs on the growing ***pollution from agricultural nutrients*** under the *EU Nitrates Directive*, only a relatively small share of farms (about 15%) and farmland (nearly 10%) were under agri-environmental measures that include nutrient management commitments in 2001-03 [2, 5]. ***Fuel tax concessions*** and support provided to compensate for higher oil prices for farmers undermine incentives to more efficiently use energy and may lead to higher GHG emissions, which is of particular significance as agricultural GHGs have been increasing.

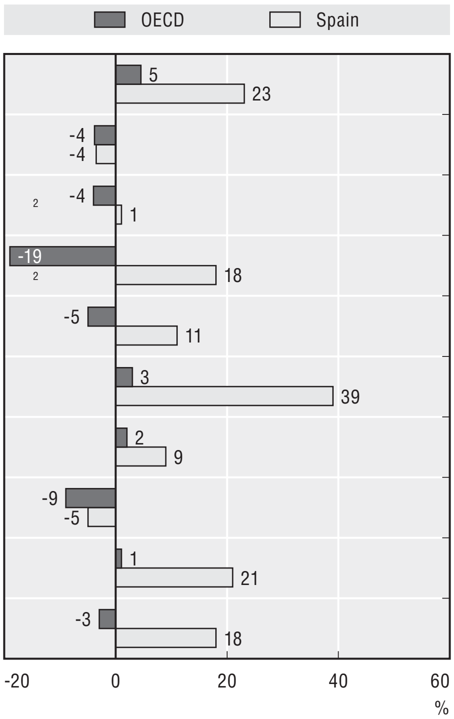
The expansion of biomass (including from agricultural feedstock) has fallen behind the targets set for 2010 under the Plan for Developing Renewable Energy, with the collection and transport of biomass thus far poorly developed [17]. With the increase in ammonia emissions, which are produced mainly by agriculture, Spain will have to make substantial reductions in agricultural emissions to meet both commitments under the Gothenburg Protocol by 2010 and the more stringent target under the EU *National Emission Ceilings* [5]. There has been some success in reducing ***methyl bromide*** use to meet commitments under the *Montreal Protocol*, while since 2005 an annual reduction of Critical Use Exemption (CUEs) has been agreed for Spain. CUEs have been assigned to strawberry and flower crops, and for research activities. Biodiversity is under serious threat from agriculture, and agri-environmental measures could be strengthened to address this problem [5]. Examples include altering management practices for irrigation pools [45], and limiting herbicide application on winter fallow [54].

Farmers have little incentive to conserve water resources given the support provided to water charges and irrigation infrastructure costs. In addition, the cost of water for irrigators has typically represented only a small share of their annual variable costs (*e.g.* labour, fertilisers, pesticides, seeds and plants), limiting the use water more efficiently [14, 55]. But the control of water charges by largely regional authorities instead of by water users, also leads to excessive use. While the expansion in the area irrigated has been a key driving force in the socio-economic expansion of many areas, especially in the south-east, the pace of development has led to water demand exceeding availability leading to water scarcity, over-exploitation of groundwater and increasing salinisation, and damage to aquatic ecosystems by from reduced water flows to wetlands and rivers [14, 33]. The competition for water resources has been exacerbated by growing demand not only from farming but also from tourism and urban development, particularly along the Mediterranean coast [14, 35].

The AGUA programme brings with it potential environmental problems, as it seeks to address water scarcity by focusing on supply (mainly through desalinisation) rather than demand (price of water). This stems from the fact that farmers are pumping water from aquifers at prices that are as much as 3-5 times lower than the cost of desalinated water [13]. As a result of this, and in the absence of subsidies to farmers to purchase the higher priced desalinated water, better quality desalinated water could be mixed with lower quality water from coastal aquifers (that are often brackish), further exploiting aquifers. This may also encourage further illegal extraction of groundwater unless the use of aquifers is strictly enforced [13, 14]. Desalinisation also requires considerable quantities of energy. In the Canary Islands, for example, 14% of all energy demands were for seawater desalinisation in the early 2000s period [14]. Moreover, the environmental impacts from desalinisation on aquatic ecosystems are unclear [14].

Figure 3.25.2. **National agri-environmental performance compared to the OECD average**

Percentage change 1990-92 to 2002-04[1]



Absolute and economy-wide change/level

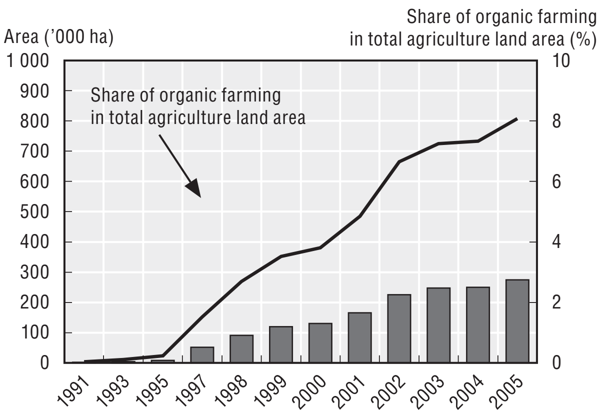
Variable	Unit		Spain	**OECD**
Agricultural production volume	Index (1999-01 = 100)	1990-92 to 2002-04	123	105
Agricultural land area	000 hectares	1990-92 to 2002-04	–1 054	–48 901
Agricultural nitrogen (N) balance	Kg N/hectare	2002-04	33	74
Agricultural phosphorus (P) balance	Kg P/hectare	2002-04	8	10
Agricultural pesticide use	Tonnes	1990-92 to 2001-03	+3 933	–46 762
Direct on-farm energy consumption	000 tonnes of oil equivalent	1990-92 to 2002-04	+707	+1 997
Agricultural water use	Million m^3	1990-92 to 2001-03	+1 740	+8 102
Irrigation water application rates	Megalitres/ha of irrigated land	2001-03	7.0	8.4
Agricultural ammonia emissions	000 tonnes	1990-92 to 2001-03	+67	+115
Agricultural greenhouse gas emissions	000 tonnes CO_2 equivalent	1990-92 to 2002-04	+7 265	–30 642

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*.

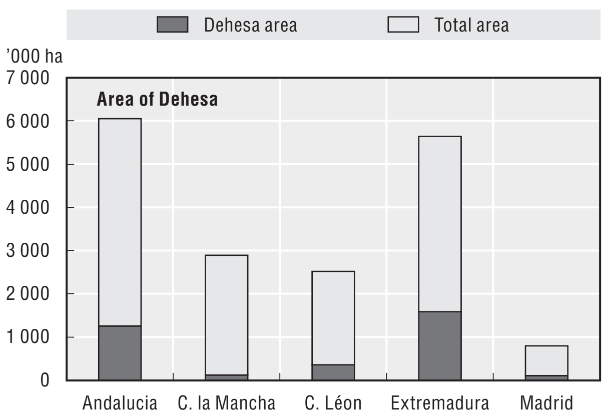
Figure 3.25.3. **Area of organic farming**



Source: Ministry of Agriculture, Fisheries and Food, Spain.

Figure 3.25.4. **Share of Dehesa area in total land area for five regions**

2006



Note: The dehesa is mainly located on traditional agricultural areas such as the Castilian plateau or the Southern part of Spain.

Source: Ministry of Agriculture, Fisheries and Food, Spain.

StatLink http://dx.doi.org/10.1787/301076525861

Bibliography

[1] Ministry of Agriculture, Fisheries and Food (2004), *Facts and Figures of Agriculture, Fisheries and Food in Spain*, 7th edition, Madrid, Spain, *www.mapa.es/portada_en.htm*.

[2] The Spanish response to the OECD Agri-environmental Indicators Questionnaire, unpublished.

[3] Mora, R. and C. San Juan (2004), "Geographical specialisation in Spanish agriculture before and after integration in the European Union", *Regional Science and Urban Economics*, Vol. 34, pp. 309-320.

[4] OECD (2005), *Agricultural Policies in OECD countries: Monitoring and Evaluation 2005*, Paris, France, *www.oecd.org/agr/policy*.

[5] OECD (2004), *Environmental Performance Reviews: Spain*, Paris, France, *www.oecd.org/env*.

[6] Mazorra, A.P. (2001), "Agri-environmental policy in Spain. The agenda of socio-political developments at the national, regional and local levels", *Journal of Rural Studies*, Vol. 17, pp. 81-97.

[7] Oñate, J.J. and B. Peco (2005), "Policy impact on desertification: Stakeholders' perceptions in southeast Spain", *Land Use Policy*, Vol. 22, pp. 103-114.

[8] Fornés, J.M., A. de la Hera and M.R. Llmas (2005), "The silent revolution in groundwater intensive use and its influence in Spain", *Water Policy*, Vol. 7, pp. 253-268.

[9] Cortina, L.M. and N. Hernández-Mora (2003), "The role of groundwater in Spain's water policy", *Water International*, Vol. 28, No. 3, pp. 313-320.

[10] Barreira, A. (2003), "The participatory regime of water governance in the Iberian Peninsula", *Water International*, Vol. 28, No. 3, pp. 350-357.

[11] Embid, A. and A.K. Biswas (2003) (eds.), "Special Issue: The Spanish National Hydrological Plan", *International Journal of Water Resources Development*, Vol. 19, No. 3, September.

[12] Arrojo, P. (2003), "Spanish National Hydrological Plan: Reasons for its failure and arguments for the future", *Water International*, Vol. 28, No. 3, pp. 295-302.

[13] Albiac, J., Y. Martínez and J. Tapia (2006), "Water Quantity and Quality Issues in Mediterranean Agriculture", in OECD, *Water and Agriculture: Sustainability, Markets and Policies*, Paris, France, *www.oecd.org/tad/env*.

[14] Downward, S.R. and R. Taylor (2007), "An assessment of Spain's Programa AGUA and its implications for sustainable water management in the province of Almería, southeast Spain", *Journal of Environmental Management*, Vol. 82, pp. 277-289.

[15] Beaufoy, G., S. Jennings, E. Hernandez, C. Peiteado and F. Fuentelsaz (2005), *The Spain National Report: Europe's Living Countryside, promoting policies for sustainable rural development*, joint publication by WWF, UK Land Use Policy Group and the Netherlands Stichting Natuur en Milieu, *www.panda.org/europe/agriculture*.

[16] Pindado, P. (2006), "The Spanish programme of improvement and modernisation of traditional irrigation systems", in OECD, *Water and Agriculture: Sustainability, Markets and Policies*, Paris, France, *www.oecd.org/tad/env*.

[17] International Energy Agency (2005), *Energy Policies of IEA Countries: Spain 2005 Review*, Paris, France, *www.iea.org*.

[18] Santafé Martinez, J.M. (2003), "The Spanish-Portuguese Transboundary Water Agreement: Historic Perspective", *Water International*, Vol. 28, No. 3, pp. 379-388.

[19] Maia, R. (2003), "The Iberian Peninsula's shared harmonisation of use: A Portuguese perspective", *Water International*, Vol. 28, No. 3, pp. 389-397.

[20] Solé Benet, A. (2006), "Soil Erosion in Spain", in Boardman, J. and J. Poesen (eds.), *Soil Erosion in Europe*, John Wiley, London, United Kingdom.

[21] Dunjó, G., G. Pardini and M. Gispert (2003), "Land use change effects on abandoned terraced soil in a Mediterranean catchment, NE Spain", *Catena*, Vol. 52, pp. 23-37. *www.elsevier.com/locate/catena*.

[22] Bielsa, I., X. Pons and B. Bunce (2005), "Agricultural abandonment in the North Eastern Iberian Peninsula: The use of basic landscape metrics to support planning", *Journal of Environmental Planning and Management*, Vol. 48, No. 1, pp. 85-102.

[23] Boellstroff, D. and G. Benito (2005), "Impacts of set-aside policy on the risk of soil erosion in central Spain", *Agriculture, Ecosystems and Environment*, Vol. 107, pp. 231-243.

[24] Sánchez-Chóliz, J. and R. Duarte (2005), "Water pollution in the Spanish economy: analysis of sensitivity to production and environmental constraints", *Ecological Economics*, Vol. 53, pp. 325-338.

[25] Causapé, J., D. Quílez and R. Aragüés (2004), "Assessment of irrigation and environmental quality at the hydrological basin level: I. Irrigation quality", *Agriculture Water Management*, Vol. 70, pp. 195-209.

[26] Sánchez, A. (2003), "Major challenges to future groundwater policy in Spain", *Water International*, Vol. 28, No. 3, pp. 321-325.

[27] Causapé, J., D. Quílez and R. Aragüés (2005), "Groundwater quality in CR-V irrigation district (Bardenas I, Spain): Alternative scenarios to reduce off-site salt and nitrate contamination", *Agriculture Water Management*, Vol. 84, pp. 281-289.

[28] Sánchez-Camazano, M., L.F. Lorenzo and M.J. Sánchez-Martín (2005), "Atrazine and alachlor inputs to surface and ground waters in irrigated corn cultivation areas of Castilla-Leon region, Spain", *Environmental Monitoring and Assessment*, Vol. 105, pp. 11-24.

[29] Carreño, J., A. Rivas, A. Granada, M.J. Lopez-Espinosa, M. Mariscal, N. Olea and F. Loea-Serrano (2007), "Exposure of young men to organochlorine pesticides in Southern Spain", *Environmental Research*, Vol. 103, Issue 1, pp 55-61.

[30] Robles, R.R., L. Vannini, T. De la Puente and J.J. Fernández-Revuelta (2005), *Consumer attitudes behind organic foods perception: An illustration in a Spanish area*, paper presented to the European Association of Agricultural Economists, August 24-27, Copenhagen, Denmark.

[31] Demont, M. and E. Tollens (2003), *Impact of biotechnology in Europe: The first four years of Bt maize adoption in Spain*, Department of Agricultural and Environmental Economics, Kathlieke Universiteit Leuven, Leuven, Belgium, *www.biw.kuleuven.be/aee/clo/wp/demont2003b.pdf*.

[32] ISAAA (2005), *Global Status of Biotech/GM Crops in 2005*, International Service for the Acquisition of Agri-biotech Applications (ISAAA), ISAAA Briefs No. 34-2005, Executive Summary, *www.isaaa.org/*.

[33] Varela-Ortega, C. (2003), "Assessment of agricultural policy options for sustainable ground-water management: a case study of wetland conservation in Spain", *Options Méditerranéenes*, Séries, A/52, pp. 183-197.

[34] Barbero, A. (2006), "The Spanish National Irrigation Plan", in OECD, *Water and Agriculture: Sustainability, Markets and Policies*, Paris, France, *www.oecd.org/tad/env*.

[35] Velázquez, E. (2006), "An input-output model of water consumption: Analysing intersectoral water relationships in Andalusia", *Ecological Economics*, Vol. 56, pp. 226-240.

[36] WWW International (2005), *One Europe More Nature: European Challenges Natural Solutions*, Gland, Switzerland, *www.panda.org/about_wwf/where_we_work/europe/what_we_do/epo/initiatives/agriculture/common_ag_policy/cap/news/index.cfm*.

[37] WWF Spain (2006), *Illegal water use in Spain: Causes, effects and solutions*, Madrid, Spain, *www.panda.org/about_wwf/where_we_work/europe/what_we_do/epo/initiatives/agriculture/common_ag_policy/cap/news/index.cfm*.

[38] Lorite, I.J., L.Mateos and E. Fereres (2004), "Evaluating irrigation performance in a Mediterranean environment: I. Model and general assessment of an irrigation scheme", *Irrigation Science*, Vol. 23, pp. 77-84.

[39] Ministry of Environment (2006), *Cuarta Comunicación Nacional de España* (in Spanish only, Spain's fourth national communication on Climate Change under the United Nations Framework Convention on Climate Change), see the UNFCCC website at *http://unfccc.int/national_reports/annex_i_natcom/submitted_natcom/items/3625.php*.

[40] Peco, B., A.M. Sánchez and F.M. Azcárate (2006), "Abandonment in grazing systems: Consequences for vegetation and soil", *Agriculture, Ecosystems and Environment*, Vol. 113, pp. 284-294.

[41] Lopez-Bote, C. (1998), "Sustained utilisation of the Iberian Pig Breed", *Meat Science*, Vol. 49, Supplement 1, pp. 517-527.

[42] Aparicio Tovar, M.A. and J.D. Vargas Giraldo (2006), "Considerations on ethics and animal welfare in extensive pig production: Breeding and fattening Iberian pigs", *Livestock Science*, Vol. 103, pp. 237-242.

[43] Suárez-Seoane, S., P.E. Osborne and J. Baudry (2002), "Responses of birds of different biogeographic origins and habitat requirements to agricultural land abandonment in northern Spain", *Biological Conservation*, Vol. 105, pp. 333-344.

[44] Abellán, P., D. Sanchéz-Fernández, A. Millán, F. Botella, J.A. Sánchez-Zapata and A. Giménez (2006), "Irrigation pools as macroinvertebrate habitat in a semi-arid agricultural landscape (SE Spain)", *Journal of Arid Environments*, Vol. 67, Issue 2, pp. 255-269.

[45] Ibanez, C. and N. Prat (2003), "The environmental; impact of the Spanish National Hydrological Plan on the Lower Ebro River and Delta", *International Journal of Water Resources Development*, Vol. 19, No. 3, pp. 485-500.

[46] Sánchez-Zapata, J.A., J.D. Anadón, M. Carrete, A. Giménez, J. Navarro, C. Villacorta and F. Botella (2005), "Breeding waterbirds in relation to artificial pond attributes: implications for the design of irrigation facilities", *Biodiversity and Conservation*, Vol. 14, pp. 1627-1639.

[47] 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*.

[48] Schmitz, M.F., I. De Aranzabal, P. Aguilera, A. Rescia and F.D. Pineda (2003), "Relationship between landscape typology and socioeconomic structure: Scenarios of change in Spanish cultural landscapes", *Ecological Modelling*, Vol. 168, pp. 343-356.

[49] Calvo-Iglesias, M.S., R. Crecente-Maseda and U. Fra-Paleo (2006), "Exploring farmers' knowledge as a source of information on past and present cultural landscapes: A case study from NW Spain", *Landscape and Urban Planning*, Vol. 78, pp. 334-343.

[50] Lopez-Gunn, E. (2003), "The role of collective action in water governance: A comparative study of groundwater user associations in La Mancha aquifers in Spain", *Water International*, Vol. 28, No. 3, pp. 367-378.

[51] European Environment Agency (2005), *Agriculture and Environment in EU15: The IRENA Indicator Report*, EEA, Copenhagen, Denmark, *http://webpubs.eea.europa.eu/content/irena/Latestproducts.htm*.

[52] Solbes, R.V. (2003), "Economic and social profitability of water use for irrigation in Andalucia", *Water International*, Vol. 28, No. 3, pp. 326-333.

[53] United Nations Convention to Combat Desertification (2006), *Summary of the Third Spanish Report on the National Action Programme to Combat Desertification*, UNCCC Secretariat, *www.unccd.int/php/countryinfo.php?country=ESP*.

[54] Suárez, F., V. Garza, J.J. Oñate, E.L. García de la Morena, A. Ramírez and M.B. Morales (2004), "Adequacy of winter stubble maintenance for steppe passerine conservation in central Spain", *Agriculture, Ecosystems and Environment*, Vol. 104, pp. 667-671.

[55] Albiac, J., J. Uche, A. Valero, L. Serra, A. Meyer and J. Tapia (2003), "The economic unsustainability of the Spanish National Hydrological Plan", *International Journal of Water Resources Development*, Vol. 19, No. 3, pp. 437-458.