Organisation for Economic Co-operation and Development
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ENVIRONMENTAL PERFORMANCE OF AGRICULTURE IN OECD COUNTRIES SINCE 1990:

Korea 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.

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The review of environmental performance draws on the country responses to the OECD agri-environmental questionnaires (unpublished) provided by countries and the OECD agri-environmental database supporting Chapter 1 (see website above).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

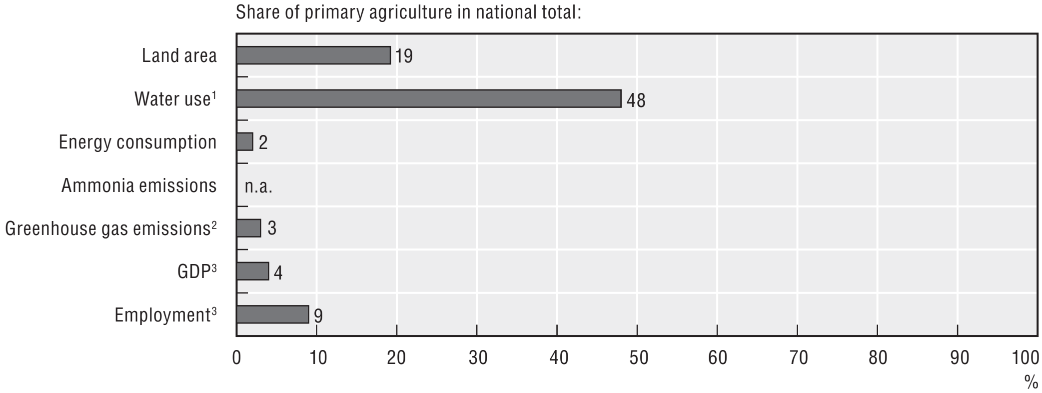
Coverage: The analysis is confined to examination of agri-environmental trends. The influence on these trends of policy and market developments, as well as structural changes in the industry, are outside the scope of these sections. Moreover, the country sections do not examine the impacts of changes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

3.16. KOREA

Figure 3.16.1. **National agri-environmental and economic profile, 2002-04: Korea**



StatLink http://dx.doi.org/10.1787/300588885206

1. Data refer to the year 2002.
2. Data refer to the period 1999-01.
3. Data refer to the year 2004.

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

3.16.1. Agricultural sector trends and policy context

Despite the rapid growth in agricultural production, the acceleration of the Korean economy as a whole has resulted in a decline in the importance of agriculture [1]. Agriculture now accounts for around 4% of GDP and 9% of employment compared to respective figures of 8% and 16% in 1990, while the country is a growing net importer of agricultural products (Figure 3.16.1).

Farming is dominated by rice. The crop accounts for 40% of gross farm receipts and 60% of the total agricultural land area, but livestock, especially pigs and poultry, and fruit and vegetables, are becoming more important [2]. Average farm size is extremely small by OECD standards, less than 1.5 hectares, with a narrow spread around this average. As land and labour are scarce, agriculture makes intensive use of purchased inputs and farm machinery. The use of the latter showed the largest increase, over 180%, across OECD countries between 1990-92 and 2001-03, and has led to a 43% rise in direct on-farm energy consumption (Figure 3.16.2). This compares to an almost 40% reduction in farm employment. There are signs that the intensity of production diminished over the period 1990-92 to 2002-04 with a nearly 7% rise in the volume of farm production: 49% for livestock and 5% for crops. Over the same period the volume of inorganic fertiliser use has declined by –22% for nitrogen fertiliser and –33% for phosphate fertiliser, and pesticide use reduced by –8%, but for water use there was an increase of 7% over this period (Figure 3.16.2).

Support to the agricultural sector is amongst the highest across OECD countries. Support has declined from 70% of farm receipts in the mid-1980s to 63% in 2002-04 (as measured by the OECD's Producer Support Estimate) compared to the OECD average of 30%. Nearly all farm support (93%) is output and input linked, with policies dominated by market price support implemented through trade measures and domestic price stabilisation. Support is focussed on rice, but recent policy priorities have been widened to address environmental, food quality and safety, and rural development issues [3].

"The Agro-Environmental Policy towards the 21st Century" was launched in 1996 to address environmental issues in agriculture. The initiative seeks to limit harmful impacts of agriculture on the environment and encourage wider use of practices which can reduce environmental pressure, such as Integrated Pest and Nutrient Management and organic farming [4]. Although fertiliser and pesticide inputs are subsidised [5, 6], since 1997 pesticides have been subject to an environmental charge per container of KRW 6 (USD 0.006) (less than 500 ml) to KRW 16 (USD 0.014) (more than 500 ml); while an emission charge on excess livestock pollution has applied since 1991 of KRW 74 (USD 0.06) per cubic metre of waste [5]. Cross compliance and direct payments have been implemented to reinforce existing agri-environmental measures. The *Direct Income Support for Paddy Field* programme provides cross-compliance payments for paddy fields paid on a per hectare basis of between KRW 432 000 and KRW 532 000 (USD 375 and USD 462) per hectare annually, with a programme budget of KRW 481 billion (USD 417 million) in 2004. Payments are conditional on farmers reducing the use of fertilisers and pesticides.

Since 1999 Direct Payments for Environmentally Friendly Farming were introduced, to restrict the use of fertilisers and pesticides in drinking water conservation areas; and also for soil conservation practices. The measure was broadened in 2002 by making payments available nationally, with eligibility based on the amount of chemicals used and, in the case of soil conservation practices, according to local soil fertility and climatic conditions [7]. Expenditure on the programme increased from KRW 3 to 4.5 billion (USD 2.5-4 million) from 2003 to 2004 [3]. From 2003, farmers who set aside rice fields for three consecutive years may receive KRW 2 185 000 (USD 2 600) annually. Under 3% (27 000 hectares) of paddy fields have been set aside so far, accounting for 7% of direct payments in 2004 or KRW 129 billion (USD 104 million) [5]. Since 1991 the government has supported, under dual programmes through the Ministries of Agriculture and Environment, the construction of livestock waste treatment facilities up to nearly KRW 1.4 trillion (USD 1.24 billion) by 2003 [5].

Agriculture is also affected by national environmental and taxation policies. Agriculture is provided support for energy costs covering 48% of electricity delivery costs to farmers and the energy subsidy to agriculture, rural areas and fisheries amounting to an estimated KRW 150 billion (USD 113 million) annually [8]. Irrigation water charges, investment, operation and maintenance costs are subsidised [1, 9], and farmers are not charged for the cost of delivery when receiving water from large government dams [5]. But farmers provide labour for weed elimination, dredging, etc., to maintain irrigation facilities and this is estimated to be 35% of total irrigation operation and maintenance costs. The Government is seeking to address biodiversity concerns related to agriculture, in particular, by halting a number of projects that would have reclaimed wetland and tidal habitats for farm use, and by introducing wetland preservation schemes in co-operation with the Global Environmental Facility. The reclamation of the Saemangeum tidal flats for rice fields is the most notable example of these projects; launched in 1991, by 2004 it has cost KRW 1.7 trillion (USD 1.9 billion) [5]. An ecosystem conservation charge was introduced in 2001 which applies to newly converted paddy fields and other projects. It is set at KRW 250 000 (USD 200) per hectare, with a maximum tax intake per project of nearly KRW 1.0 billion (USD 900 000) from 2006. The tax can be refunded if there is establishment of new green areas or reafforestation [5].

3.16.2. Environmental performance of agriculture

Pressure on water and land resources are the major environmental challenges for agriculture. These challenges are closely linked to high population density and economic growth, with a farming structure characterised by numerous small farms, dominated by rice production. This gives rise to environmental concerns with regard to agriculture's impact on water use, water retention, water pollution, soil quality, biodiversity and air emissions.

Agriculture accounts for nearly 50% of total water use and 20% of land use (2004). With over 60% of the country forested and mountainous, continued population growth, and a population density the highest in the OECD, there is intense pressure to convert farmland to other uses, but in some cases also convert land to agricultural use. Soils are "naturally" low in fertility as they originate from granite and granite-gneiss, with heavy summer rains leading, in the absence of conservation practices, to high levels of erosion on steep land, especially in mountainous cultivated areas [10]. The Asian monsoonal climate is suited to rice production but encourages pests, diseases and weeds resulting in intensive use of pesticides, and also rapid decomposition of soil organic matter.

The area of agricultural land at moderate to severe risk of erosion (greater than 10 tonnes/hectare/year) declined by 3% between 1990-94 and 2000-02. The share of agricultural land affected by moderate to severe rates of erosion rose slightly from 21% to 22% over this period, but mainly because of the much larger decrease in agricultural land area over the period [11, 12]. But with over three-quarters of farmland little affected by erosion, soil degradation from erosion does not pose an immediate threat to agricultural production. Even so, erosion is impairing the long term productivity on some steeper marginal land [13]. Moreover, while soil fertility, as measured by soil organic carbon content, deteriorated between 1990 to 1999, but by 2003 it had increased because of the greater use of compost and soil supplements with adequate application of fertilisers (Figure 3.16.3) [14].

Trends in water quality indicate that agriculture is an important source of pollutants. Agricultural water pollution has been identified as one of the most serious environmental issue that farmers need to address [5, 15]. While the estimated biological oxygen demand (BOD) discharges from agriculture have more than halved between the mid-1990s and 2004, other BOD sources decreased even more rapidly, such that agriculture's share in total BOD loadings (tonnes/day) rose from 9% to 24% over this period [5]. The principal pollutants are nitrates and phosphates, especially from livestock operations and, to a lesser extent, fertilisers, with concentrations increasing in some rivers, lakes and reservoirs [16]. However, there is more recent evidence that nitrate pollution of groundwater has decreased [17]. "Red tides" of decomposing algae, resulting from nutrient pollution (eutrophication) from agricultural and other sources, is also occurring in some coastal waters [18, 19], imposing high economic costs on fisheries and aquaculture [20].

The elevated levels of water pollution from agricultural sources are associated with rising levels of nutrient surpluses, being amongst the highest across OECD countries (Figure 3.16.2). Surpluses of both nitrogen and phosphate from agriculture have grown rapidly, mainly due to rising pig and poultry numbers [15, 21], although this is partly offset by a reduction in inorganic fertiliser use over the period 1990-92 to 2002-04 [15]. There is an accumulation of phosphorus, heavy metals and other toxic elements in agricultural soils [13]. The build-up of phosphorus in agricultural soils from the overuse of fertilisers and livestock manure is more than twice that required for the optimal level of growth in some vegetable producing areas [22], however, overall agricultural use of phosphorus fertilisers declined by 33% between 1990-92 and 2002-04. Aside from natural processes, the chemical degradation of soils stems from inappropriate soil conservation practices and excessive use of fertilisers and manure [13]. Over 90% of livestock waste from larger livestock operations is returned to the land, with about 8% treated [5]. While the area of farmland and the number of farms adopting nutrient management plans have grown rapidly over the 1990s only about 20% of farms had adopted plans by 2000-03, and nutrient use efficiency (output/input) is among the lowest across OECD countries.

The 8% decline in pesticide use (1990 to 2003) has eased its potential pressure as a water pollutant (Figure 3.16.2). However, the intensity of pesticide use per hectare of land, among the highest across OECD countries, is still a concern reflecting the need to lower the loading of pesticides in water bodies [5, 23]. The use of pest management practices is extremely limited, with under 0.1% of the total arable and permanent crop area under integrated pest management in 2000-03 and under 1% of farms under organic management [11].

With growing competition for water resources nationally, agriculture is under pressure to manage water more efficiently [24]. Total water demand is expected to increase by 10% between 2001 and 2020, although the demand from agriculture is variously projected to expand by less than 2% [15, 25] or change little up to 2020 [24]. Agricultural water use increased by 7% over the period 1990 to 2002, compared to a 33% increase in total national water use (Figure 3.16.2). With farming accounting for 48% of water use, a 10% improvement in agricultural water use efficiency would be sufficient to provide 21% of current national water needs [15]. Upgrading existing irrigation facilities and infrastructure (*e.g.* about 30% of pumping stations are over 20 years old) has been identified as a key issue in improving water use efficiency by agriculture [9], especially in the context of resolving problems between competing users and of growing water scarcity [24]. Agriculture accounted for 40% of groundwater use (2002), but whether this water resource is being used beyond recharge rates is unknown.

Agriculture's water retaining capacity has declined in volume terms by around 15% over the period 1990 to 2004 (Figure 3.16.4) [26]. Korea considers that water retaining capacity (WRC) is a key environmental benefit associated with its agriculture, especially in view of the increasing incidence, severity and cost of national flood damage [25, 27]. Paddy rice fields account for 70% of agricultural WRC and are considered to provide other benefits, such as reducing soil erosion and enhancing biodiversity [22]. The key reason for the decline in WRC has been the 13% reduction in area farmed from 1990-92 to 2002-04, partly offset by an increase in the volume of on-farm water retaining facilities (*e.g.* small dams, reservoirs) by more than 50% over the 1990s [11].

Korea experienced the highest increase in ammonia emissions among OECD countries, but has phased out the use of methyl bromide. The main reason for the 27% increase in ammonia emissions, over the period 1990 to 1998 (Figure 3.16.2), was due to the expansion in total livestock production resulting in elevated levels of emissions [28], partly offset by the decline in fertiliser use for rice production (25% of agricultural ammonia emissions are derived from fertiliser use) [29]. The rapid increase in the number of farms adopting nutrient management plans over the 1990s may have slowed the rate of ammonia

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emissions, but only about 20% of farms had adopted such plans by 2000-03. The use of ***methyl bromide*** (an ozone depleting substance) was phased out in the early 1990s, well in advance of the *Montreal Protocol* 2005 deadline.

There was a small reduction in agricultural greenhouse gas (GHGs) emissions over the period 1990 to 1999-2001. While total GHG emissions rose over this period by around 5%, they declined for agriculture by 6%, with farming contributing 3% to total emissions in 2001 (Figure 3.16.2) [30]. Much of the reduction in agricultural GHGs was due to the reduction in rice production, leading to lower methane emissions and nitrous oxide from the decline in fertiliser use, partly offset by an increase in livestock numbers [30]. The role of agriculture in ***carbon sequestration*** diminished over the period 1990 to 2003 (Figure 3.16.3), especially because of the conversion of farmland for urban and transport uses, but improvements in soil management practices and the conversion of some farmland for forestry has helped to increase carbon sinks.

Agricultural land reclamation and water pollution are damaging wild species not dependent on agriculture. The reclamation of tidal flats and wetlands for agricultural and industrial uses is an important threat to biodiversity, particularly for some migratory birds [5, 31]. Agricultural reclamation of these habitats over the past 10 years declined from a peak of 4 000 hectares annually to 2 000 hectares in 2000-01 [12]. This is significant for biodiversity as more than 50 internationally important bird species have been identified as migrating through these habitats [32]. A notable example is the Saemangeum tidal flat, which was included under a project in 1991 to be converted to rice fields, although, the future of this project in 2005 was uncertain. This habitat is a breeding ground for many aquatic species (*e.g.* fish, crabs) and a crucial feeding site for 50 000 shorebirds, including a number of species of international importance [5]. Additional threats to the decline and extinction of certain wildlife species from farming include: pollution of aquatic ecosystems from pesticides and nutrients [31, 33, 34]; and deforestation for agricultural development, nearly 17 000 hectares in 2000-01, although 7 000 hectares of this area was converted from agricultural to use for forestry [11].

At the same time the reduction and change in use of agricultural land is having an adverse impact on some wild species dependent on agriculture. Paddy rice fields together with rivers, tidal flats and lakes, provide habitat for more than a million migrant water birds [5]. The change in use of farmland, notably from paddy rice fields to urban use and to use for the vinyl-mulched or greenhouse culture of upland or vegetable crops, is reducing the foraging habitat available to some waterbirds [32, 35]. For example, numbers of Hooded Cranes (*Grus monacha*), which use paddy fields as a primary wintering habitat, have declined sharply due to the conversion of paddy rice fields [31, 35]. Paddy rice fields also provide a more species rich environment for birds compared to forest and mountain habitats, probably because they offer a more varied habitat. Even so, the reverse is true for mammals, possibly linked to the lack of suitable breeding sites on paddy rice fields compared to forest and mountain habitats [32].

3.16.3. Overall agri-environmental performance

Agri-environmental challenges for Korea are dominated by the impacts of rice cultivation on water and land resources, and increasingly the livestock sector. Agriculture is the major water user, in particular because of the dominance of rice cultivation, but demand for water by urban and industrial consumers is growing rapidly. Intense competition for land – Korea is the most densely populated OECD country – is also raising concerns, with the loss of agricultural land to other uses offsetting certain environmental benefits considered to be associated with agriculture, principally flood mitigation and biodiversity.

Since the mid-1990s an effort is being made to establish environmental monitoring, including for agriculture [5]. The current lack of regularly collected data is impeding the capacity to accurately track the state and trends of Korean agri-environmental performance, most importantly in the areas concerning water use efficiency, water and soil quality, air emissions and biodiversity. The costs and benefits of using agricultural land and water retention facilities compared to non-agricultural land and water retention facilities to help mitigate flood damage are also unknown.

The net burden on the environment from agriculture is significant, but recent policy developments are beginning to address the issue. Policy initiatives are seeking to stimulate the adoption of sustainable farming practices, raise the efficiency of resource use, cut chemical input use, encourage the adoption of soil conservation practices, and address biodiversity concerns. There are also indications that farmers are becoming more receptive to adopting sustainable practices [4, 5, 7]. While fertiliser and pesticide inputs are subsidised, Government plans are to reduce their use by 30% from 1999 levels by 2005 [6]. In addition, the Ministries of Agriculture and Environment have jointly adopted a 10 year plan (2004 to 2013) to reduce pollution from livestock waste, after concluding that their separate programmes since 1991 have not been effective or efficient [5].

A new Direct Payment for Environmentally Friendly Livestock Practice was introduced in 2004 with a budget of KRW 5.8 billion (USD 5 million), for which cattle farmers are eligible if they recycle more than 60% of manure; and poultry and pig farmers if they reduce stocking densities by 20-30% below "normal" standards. Livestock producers can each receive KRW 13 million (USD 11 282) under the programme and an additional KRW 2 million (USD 1 736) if they apply stricter standards [3]. More broadly, the Prime Minister's office initiated a plan in 2005 for the comprehensive management of agricultural pollution in the country's four major river basins over the period 2006 to 2020 [5].

With the overall expansion of the agricultural sector, especially livestock, the pressure on the environment has increased over the past decade. This trend may continue over the next 10 years mainly because of the projected growth in livestock production, partly offset by the anticipated contraction in rice production. With the projected expansion in livestock output, except beef [36], this could lead to a further rise in nutrient surpluses with adverse impacts for water and air pollution. Nevertheless, the expected reduction in rice production could result in the continued decrease in fertiliser and pesticide use [36]. But continued use of high output-related policy support measures and subsidies for fertilisers, pesticides, energy and water, discourage farmers from reducing inputs or using them more efficiently, including, in the case of energy use helping to reduce greenhouse gas emissions [1, 5, 8, 9]. The need for greater efficiency in water use by agriculture is also important in view of problems arising from water scarcity and conflicts between competing users, especially as agriculture is the major water user, and the sector's use of water increased between 1990 and 2002. The continued loss of wetland and tidal habitats to agricultural development is having a damaging impact on internationally important wildlife habitats, in particular the Saemangeum tidal flats project for conversion to rice fields, although the future of this project in 2005 was uncertain [5].

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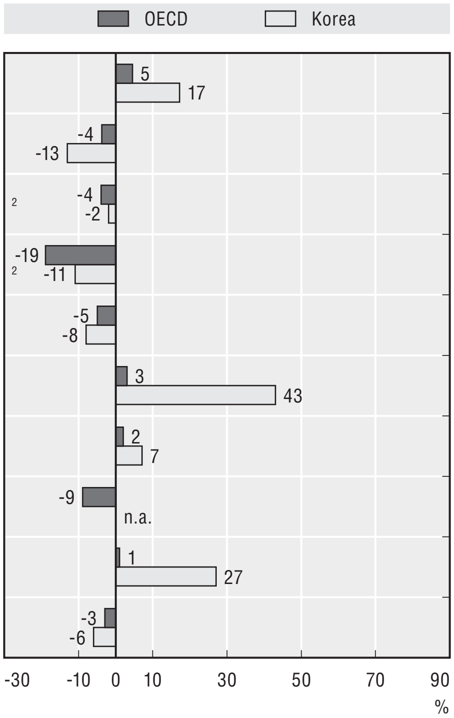
Figure 3.16.2. **National agri-environmental performance compared to the OECD average**

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



Absolute and economy-wide change/level

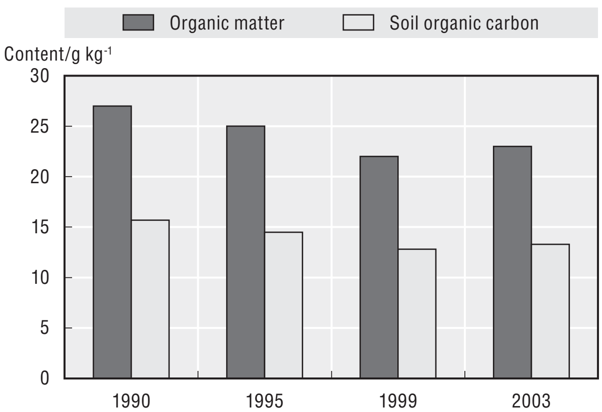
Variable	Unit		Korea	**OECD**
Agricultural production volume	Index (1999-01 = 100)	1990-92 to 2002-04	117	105
Agricultural land area	000 hectares	1990-92 to 2002-04	–284	–48 901
Agricultural nitrogen (N) balance	Kg N/hectare	2002-04	240	74
Agricultural phosphorus (P) balance	Kg P/hectare	2002-04	48	10
Agricultural pesticide use	Tonnes	1990-92 to 2001-03	–2 276	–46 762
Direct on-farm energy consumption	000 tonnes of oil equivalent	1990-92 to 2002-04	+805	+1 997
Agricultural water use	Million m^3	1990-92 to 2001-03	+1 100	+8 102
Irrigation water application rates	Megalitres/ha of irrigated land	2001-03	n.a.	8.4
Agricultural ammonia emissions	000 tonnes	1990-92 to 2001-03	+38	+115
Agricultural greenhouse gas emissions	000 tonnes CO_2 equivalent	1990-92 to 2002-04	–271	–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.

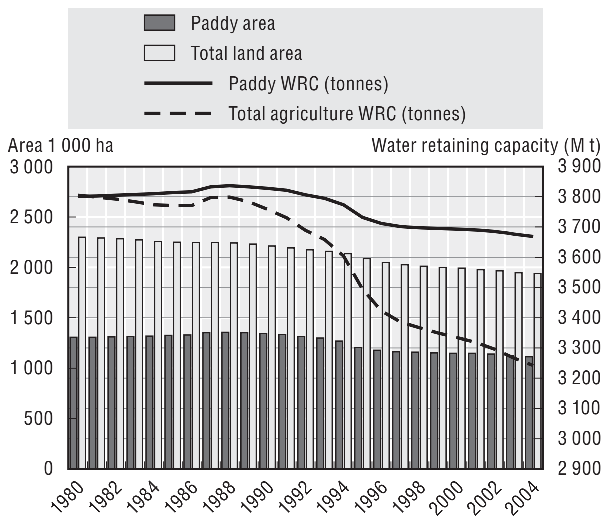
Source: OECD Secretariat. For full details of these indicators, see Chapter 1 of the *Main Report*.

Figure 3.16.3. **Composition of soils**



Source: Rural Development Administration, Republic of Korea.

Figure 3.16.4. **National water retaining capacity of agriculture**



Source: Rural Development Administration, Republic of Korea.

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