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AGRICULTURE, TRADE AND THE ENVIRONMENT: THE DAIRY SECTOR
MAIN REPORT

JOINT WORKING PARTY ON AGRICULTURE AND THE ENVIRONMENT

Previous versions of this document have been discussed at meetings of the JWP on Agriculture and the Environment in June and November 2003, where it was agreed to be declassified under the written procedure. The process of declassification has been completed and this final version of the document will be combined with the companion paper [COM/AGR/CA/ENV/EPOC(2003)93/FINAL] into one report for publication.

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AGRICULTURE, TRADE AND THE ENVIRONMENT: THE DAIRY SECTOR

MAIN REPORT

Introduction

1. The main purpose of this study is to improve the understanding of the linkages between agriculture, trade and the environment in OECD countries by examining these linkages as they relate to the dairy sector. Three of the main issues are: the environmental impacts of agricultural support measures and the consequences of further trade liberalisation; the trade impacts of policies measures introduced to address environmental issues in agriculture; and the characteristics of policies that can best achieve environmental objectives in ways that are compatible with multilateral trade and environmental agreements. A third group of policies, those dealing with animal welfare, also have an impact on milk producers, but a review of these policies is beyond the scope of this study.

2. This work continues the analysis of these linkages by the OECD Joint Working Party on Agriculture and the Environment (JWP). The JWP has already completed two general studies on these linkages. One examined the domestic and international environmental impacts of agricultural trade liberalisation (OECD, 2000*a*), while the other examined the production and trade effects of agri-environmental measures (OECD, 2000*b*). Both studies provided a conceptual overview of the specific linkages and the issues involved, reported the results from general quantitative studies that had been undertaken, and suggested issues for further analysis.

3. Livestock was highlighted as an area for further examination in both reports. The report on the impact of trade liberalisation on the environment concluded that "subsequent research could also cover in more depth the impact of trade liberalisation on issues like concentration of livestock herds that have been identified in this study as potential environmental 'problem hot-spots'" (OECD, 2000*a*). Similarly, the report on the production and trade effects of agri-environment measures concluded "that the impact of agri-environmental measures on farming costs is more pronounced in livestock production than in crop farming. This issue of potential distortions in international livestock trade could be more extensively explored by drawing on empirical work in OECD countries" (OECD, 2000*b*). Within livestock, the pig sector was chosen for the initial study before progressing to the dairy sector. The first livestock report, *Agriculture, Trade and the Environment: The Pig Sector*, was published in 2003 (OECD, 2003*a*). To provide a broader perspective, the OECD is also examining these linkages as they relate to the arable crop sector (documents COM/AGR/CA/ENV/EPOC(2003)104-109).

4. The dairy sector provides a good opportunity to consider these linkages. The present study provides a good contrast to the pig sector study because there are a greater range of farming systems involved in dairy production, *e.g.* mountain dairy farming, pastoral based systems, indoor facilities, reflecting to some extent different agro-ecological conditions and land availability. Consequently, the environmental impacts of dairy farming are quite diverse. While water and air pollution from dairy farming are of increasing concern for most OECD countries, a number of other environmental issues such as soil erosion, biodiversity and landscape are also considered important in some instances. There is a wide variation in the forms and level of support, including trade measures, provided to dairy producers among OECD countries and over time. In many countries, it is one of the most highly supported sectors. There are also a growing number of agri-environmental policies impacting of dairy farmers. This diversity of policy

experience provides a rich variety of material that can be examined and compared. The study, which does not deal with environmental issues beyond the farm gate, also provides an excellent opportunity to use and progress two tools being developed by the OECD: the agri-environmental indicators and the inventory of policy measures addressing environmental issues in agriculture. The study also presented an opportunity to follow-up on the OECD Workshop on Organic Agriculture by examining in detail some of the environmental, trade and policy issues surrounding organic dairy production (OECD, 2003*b*).

5. The report is organised as follows.

- An overview of the world dairy market is provided in Chapter 1.
- The potential linkages between dairy production and the environment, and recent trends in these impacts are examined in Chapter 2.
- Structural changes in the dairy sector since the mid-1980s that influence these linkages, along with technological and management developments to improve the environmental performance are highlighted in Chapter 3.
- The environmental impact of organic milk production systems are evaluated against conventional production systems in Chapter 4.
- An analysis of agricultural support policy measures affecting milk production is provided in Chapter 5.
- The impact of further trade liberalisation on milk production and the environment, looking particularly at nitrogen and greenhouse gases, are explored in Chapter 6.
- Policy measures introduced to deal with environmental issues in the dairy sector are discussed in Chapter 7.
- Because of their relative and growing importance, policy measures to promote organic dairy farming are examined separately in Chapter 8.
- Finally, the impact of policy measures on trade, in particular, the effect of manure management regulations on competitiveness is studied in Chapter 9.

1. World dairy market

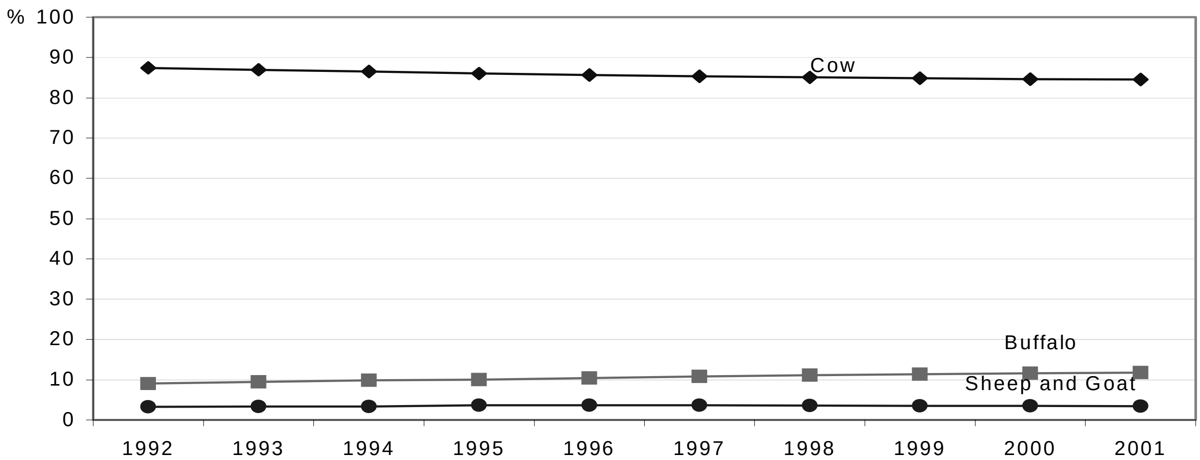
- Cow milk production accounts for the largest share of total world milk production.
- The European Union and the United States are major producers of cow milk, together accounting for 40% of global production. India, Russia and Brazil are important non-OECD producers.
- Since 1980, significant increases in production have occurred in Australia, Korea, Mexico, New Zealand and Portugal, with growth limited in a number of OECD countries by the imposition of production quotas.
- Trade in dairy products has increased at a faster rate than production, particularly during the last half of the 1990s. While only a small proportion of total world production is exported, exports are significant for some European and Oceania countries.

6. This chapter provides a brief overview of the world dairy market, discussing the levels and trends in production, consumption and trade of milk and milk products. Since 1980, there has been a steady increase in world cow milk production, although production in some OECD countries has been constrained by quotas, with some significant increases in others. OECD countries are major producers and consumers of milk and milk products, dominate the export of milk and milk products, and are important markets for imports.

1.1 Production

7. Cow milk production accounts for the largest share of world milk production by animal species (Figure 1.1). This report focuses on milk production from cows, and references to "milk production" without reference to animal type are referring to milk produced from cows and not from other animals. Although, its share has declined, world cow milk production increased by just under 1% per annum during the period 1992 to 2001, to reach a total of 495 million tonnes.

Figure 1.1. Share of world milk production by species of animal, 1992-2001

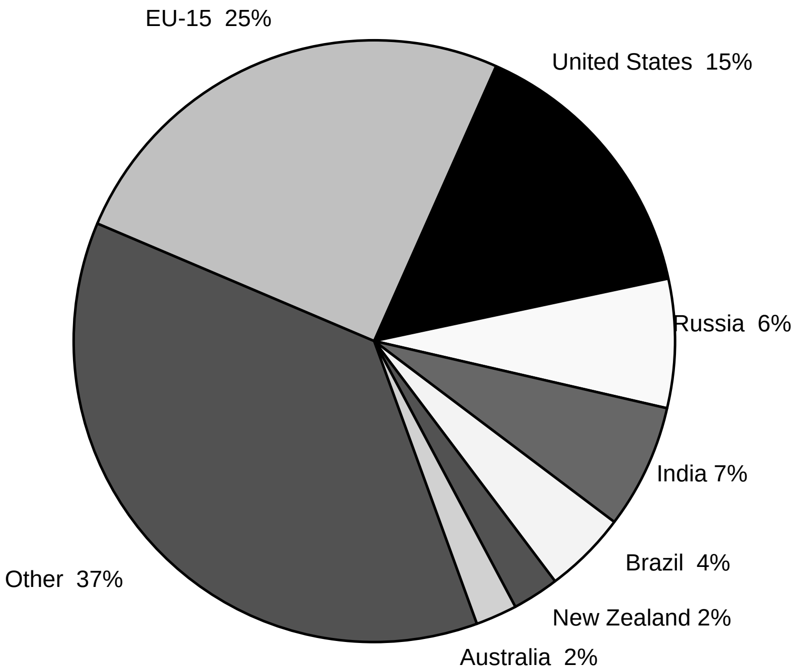


Source: IDF (2003).

8. The **European Union** is the world's largest producer of cow's milk, producing around 122 million tonnes of milk in 2001 and accounting for around 25% of total world production in the period 1997-2001 (Figure 1.2). Throughout this report the EU is defined by the 15 member states prior to the accession of 10 additional members on 1 May 2004. Within the EU, the top five producers are **Germany**, **France**, the **United Kingdom**, the **Netherlands** and **Italy**, together accounting for about three-quarters of total EU production. Excluding the Netherlands, the other four countries contain 67% of the useable agricultural land and 63% of the population.

9. Outside the EU, the largest producer is the **United States**, along with non-OECD countries such as Brazil, India and Russia. While countries such as Brazil, India and Russia have very large cow populations, milk yields in these countries are very low. India is the world's largest producer if buffalo milk is included. In total, OECD countries account for around 60% of cow milk production.

Figure 1.2. Share of world cow milk production, 1997-2001 average



Source: OECD Secretariat.

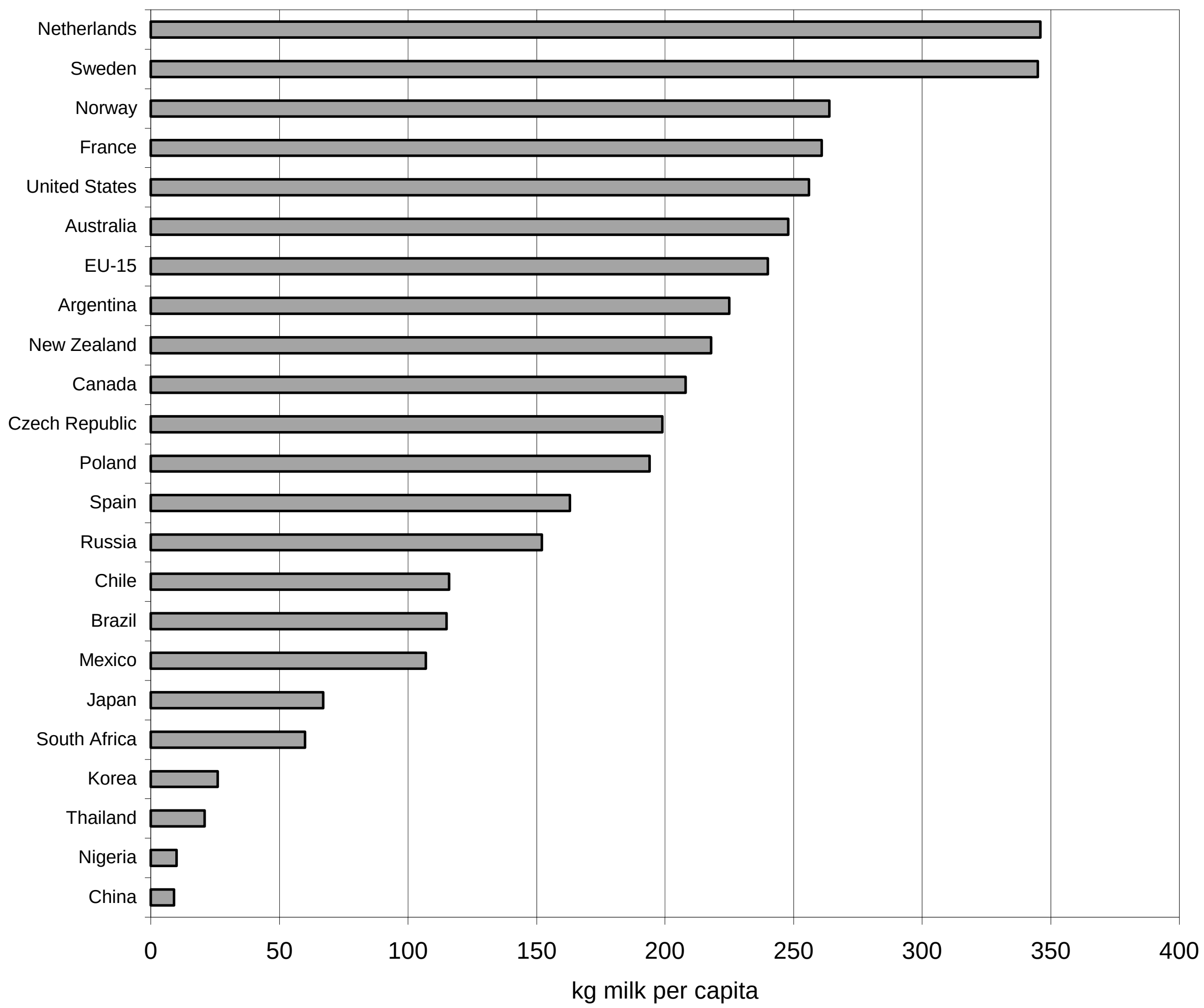
10. Since 1980, production has been relatively stable or slightly falling in most OECD countries, due in many cases to the existence or establishment of production quotas during this period (Annex Table 1.1). There are a few notable exceptions to this trend. During the 1980s there was a large expansion of milk production in percentage terms in **Korea** and to a lesser extent **Portugal**. Then, during the 1990s, milk production increased significantly in **Australia** and **New Zealand**, and continued to grow steadily in Korea, **Mexico** and Portugal. Production has expanded in the **United States** at a fairly constant rate of about 1% over the period 1980-2001, translating into the largest increase in volume terms. Production in the **European Union** has been limited by the imposition of production quotas since 1984.

11. In terms of the major dairy products, there has been a decline in skim milk powder (SMP) and butter production since the mid-1980s. This has been offset by a steady increase in the quantity of cheese and whole milk powder (WMP) production.

1.2 Consumption

12. For most countries, a large proportion of milk production is consumed domestically in various forms including fluid milk and other fresh products such as yoghurts, or in processed products such as butter, cheese and milk powders. Per capita milk consumption rates in OECD countries are relatively high and stable, with the exception of **Japan** and **Korea** where consumption rates are lower but increasing (Figure 1.3).

Figure 1.3. Per capita milk and milk product consumption in selected countries, 1998-2000



Source: AFFA (2003).

13. Approximately one-quarter of world cow milk production is consumed in the form of fluid products, although the share of production consumed as fluid product and per capita consumption rates vary from country to country. In some OECD countries per capita consumption rates of fluid milk are

falling, with milk increasingly utilised only as a beverage and being substituted for fermented milk, milk drinks and dairy desserts. In contrast the volume of liquid milk sales in developing countries is steadily rising because of improved distribution systems and increased income per household.

1.3 Trade

14. Because a large share of milk production is consumed domestically, and despite technological developments in refrigeration and transportation, international trade in milk and milk products represents only about 8% of world production, excluding intra-EU trade (14% including intra-EU trade). Most dairy product trade is in bulk commodities, with butter, cheese, SMP and WMP accounting for around 80% of the value of trade (Jesse, 2003).

15. The share of production traded varies considerably between milk products. At one extreme, approximately 50% of WMP production is exported. At the other, exports of retail packed liquid milk account for less than 0.5% of production. In between, approximately 30% of SMP, 10-15% of butter and retail packed condensed milk, and 7% of cheese production is exported (Vavra, 2002). While trade has traditionally been dominated by butter and SMP products, during the 1990s the main growth was in WMP and cheeses.

16. OECD countries are the major exporters of dairy products (Annex Table 1.2). Together they accounted for 82% of world exports in the 1997-2001 period, excluding intra-EU trade (90% if included), a reduction from the early 1980s when 94% of world exports originated in OECD countries. The **European Union** is the largest exporter of dairy products, although its share of total exports (excluding intra-EU trade) has fallen from about 55% of world exports in the first half of the 1980s to approximately one-third during the last half of the 1990s. In contrast, exports from **Australia** and **New Zealand** have risen substantially, particularly in the form of WMP and cheese, and also from **Mexico** and the **United States** but from a much lower base. The world's largest traders in terms of exports as a percentage of production are New Zealand (70%), the **Netherlands** (61%), **Ireland** (55%), **Denmark** (50%) and Australia (49%). **Belgium** is a major processor of milk within the EU and is now exporting more than it produces domestically. While the United States is a major milk producer, only 3% of its production is exported.

17. Imports of milk and milk products are less concentrated among countries than exports. While dominating the export of dairy products, the OECD as a whole is not as significant in terms of imports, accounting for only 30% of total imports in the 1997-2001 period, excluding intra-EU trade (around 60% if included). The major markets in terms of volume of product are the **European Union**, **Japan**, **Mexico** and the **United States**. In almost all countries, the volume of imports has increased during the 1990s, with significant increases in **Canada**, **Hungary**, **Korea** and **Poland**. The importance of individual countries varies from product to product. For example, the major import markets for cheese are the EU, Japan, Russia and the United States. For milk powders, developing markets are important with Algeria, Brazil and Malaysia major importers of WMP, and Algeria, Mexico and the Philippines significant importers of SMP. For butter and butteroil, the EU and Russia are the most important import markets (IDF, 2003).

2. Dairy farming and the environment

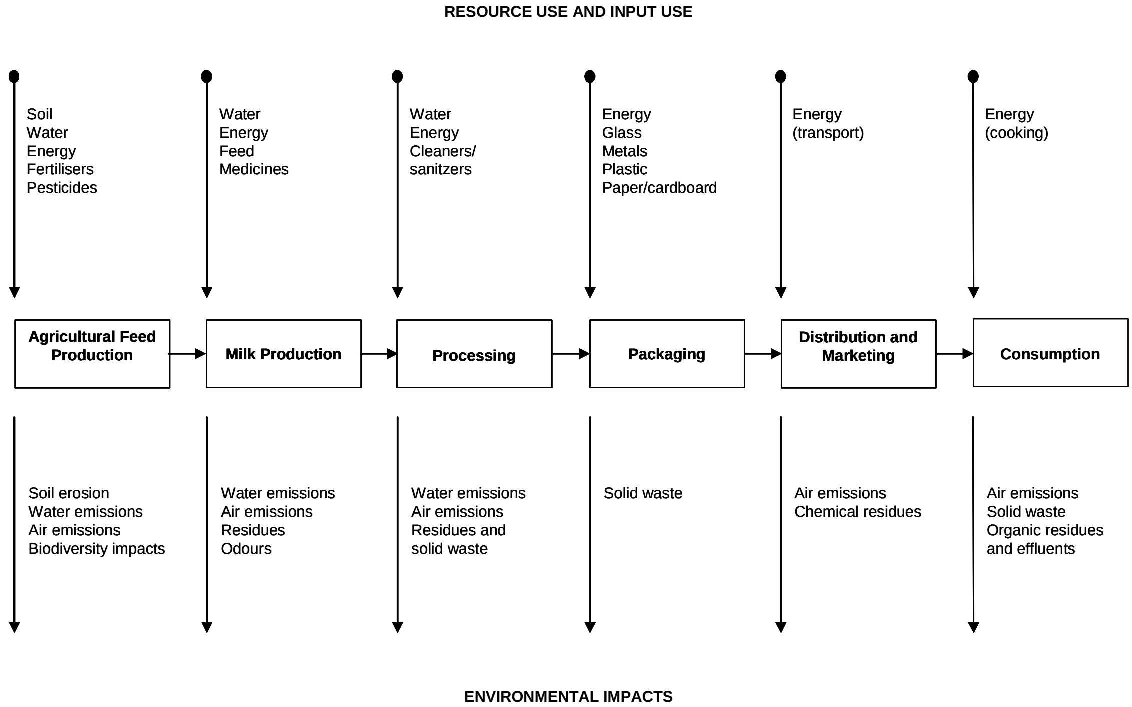
- The key environmental issues associated with dairy farming concern water pollution (mainly nitrogen and phosphorus), air emissions (principally greenhouse gases (GHG) and ammonia), and the links between dairy farming and biodiversity.
- The environmental risks of dairy manure disposal in certain regions have increased as production units have grown fewer, larger, and more specialised. The level of *risk* to water pollution from nitrogen in dairy manure is highest in Japan and several European countries, with the risk increasing in Australia, Korea and New Zealand as production has expanded.
- Greenhouse gas emissions from dairy farming have decreased in almost all OECD countries, and generally represent a low share of overall GHG emissions. Only in New Zealand are dairy cows a significant source of GHG emissions.
- While there are some risks to the genetic stock associated with widespread adoption of the Holstein breed for milk production, most OECD governments have in place programmes to protect the genetic diversity of native cattle populations.
- The impact of milk production on ecosystems is diverse. While increasing the intensity of milk production generally reduces biodiversity, some intensive systems are valued for their contribution to migratory birds and landscape value.
- Evidence suggests that milk production has grown more rapidly than the output of nitrogen in manure and GHG emissions *i.e.* some decoupling has occurred. This is probably due to increased productivity, and the adoption of environmentally friendly technologies and management practices.

18. The dairy sector plays an important part in the agricultural activity of many OECD countries, with global demand for dairy products expected to continue to rise. Milk is produced through a range of different farming systems, *e.g.* indoor facilities, pastoral based systems and mountain dairy farming, reflecting to some extent different agro-ecological conditions and land availability. Consequently, the potential environmental impacts of dairy farming are many and complex. While water and air pollution from dairy farming are of increasing concern for most OECD countries, a number of other environmental issues such as soil erosion, preservation of biodiversity and landscape are also considered important in some countries. Along with other agricultural sectors, growing public awareness of the environmental impact of dairy farming has raised concerns for farmers, processors and policy makers. This chapter provides an overview of the environmental impacts of dairy farming and comments on the trends in these impacts in OECD countries.

2.1 An overview of the linkages

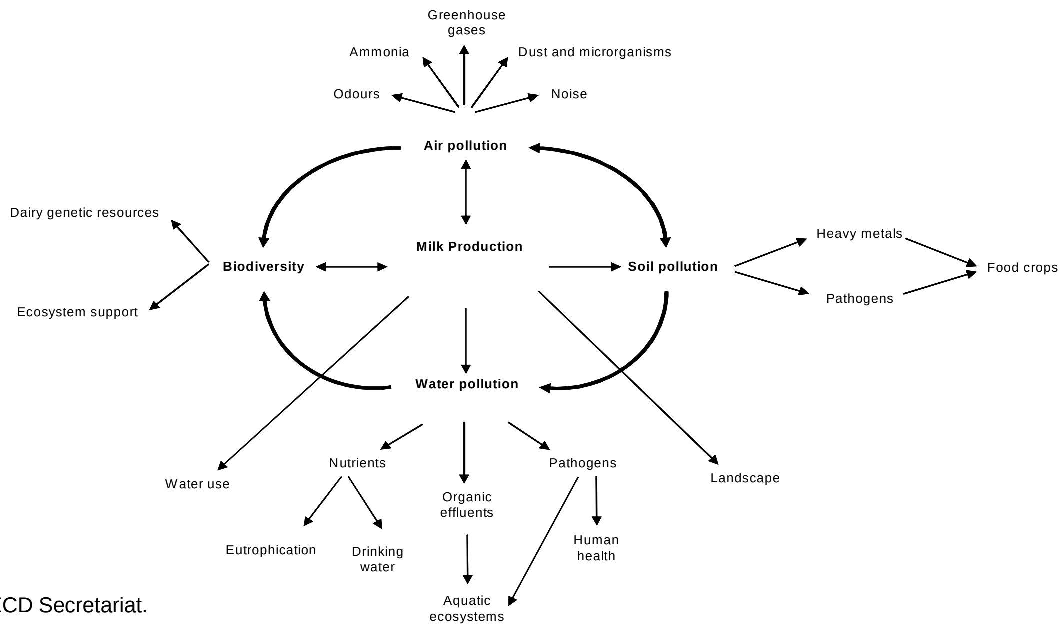
19. A broad view of the dairy industry can be taken by considering the entire agro-food chain, extending from feed production through to the final consumption of dairy products. The “life-cycle approach” illustrates the range and diversity of environmental inputs and outputs resulting from the actions of dairy producers, processors, marketers and consumers along the food chain (Figure 2.1). However, it is not the objective of this study to examine the entire range of impacts along the milk “life cycle”; instead the focus is on the direct impacts on the environment of the milk production stage of the chain. One consistent finding of the “life cycle” assessments that have been done in the dairy sector is that production at the farm level has the greatest environmental impact of all the stages (Berlin, 2002).

Figure 2.1. Resource and input use and environmental impacts through the dairy supply chain
"Life cycle approach"



Source: OECD Secretariat, adapted from Pagan and Lake (1999).

Figure 2.2. Linkages between milk production and the environment



Source: OECD Secretariat.

20. The scope of the direct linkages between milk production and the environment cover a wide range of issues (Figure 2.2). The most important of these issues concern the contribution to water and air

pollution, although other environmental issues need to be recognised, including soil quality, water use, biodiversity and landscape.

2.2 Water pollution

21. The contamination of water bodies with pollutants from dairy production can occur through a variety of pathways, from both point or diffuse (non-point) sources of pollution, and transported as nutrient particles into soil and water or as organic effluents in the form of faecal waste directly into waterways.

22. In dairy farming areas the disposal of excess ***nutrients***, principally nitrogen (N) and phosphorus (P), from dairy manure are among the principal causes of pollution of surface water (rivers and lakes), groundwater, and marine waters. Excess nutrients can damage aquatic ecosystems, including coastal marine ecosystems, through eutrophication (*i.e.* algae growth and depletion of oxygen in water) and degrade their use for recreational purposes, such as fishing (OECD, 2001*a*). Nutrients in surface water and groundwater can also impair drinking water quality and increase purification costs, and in high enough concentrations lead to human health problems.

23. Nutrient pollution from dairy production mainly occurs because producers do not, or are not required to, take into account the environmental costs resulting from point sources of pollution, such as slurry/manure storage facilities and dairy housing units, and non-point pollution sources, principally from fertiliser application and spreading manure on fields. Dairy cows grazing in open fields, depending on the stocking density and local conditions (*e.g.* soil, weather), are also a non-point source of pollution resulting in surface run-off and leaching of manure excreted in the field.

24. Given the many sources of nutrients from agriculture into water bodies (*e.g.* fertilisers from crop production and manure from other livestock farming), there is little data available that identifies the specific contribution of dairy to water pollution. However, given the prominence of the dairy sectors in the livestock industry of many OECD countries it could be significant in some cases.

25. In the **United Kingdom**, dairy cattle were responsible for 700 water pollution incidents in 1998 where source was classified, representing almost one-third of all incidents of water pollution from agriculture (Williams and Bough, 2001). Similarly, one-third of water pollution complaints regarding livestock production in **Japan** in 1997 (totally 851) were caused by dairy farms (Nagamura, 1998).

26. Trends in the nutrient content of dairy manure production and nutrient soil surface balance can be used as a proxy to reveal the potential risks to water quality from dairy farming. It is important to note that this does not include other sources of nutrients such as fertilisers and atmospheric deposition, or the uptake of nutrients by crops. Further, it is an indirect measure of the potential risk of water pollution as other factors, in particular soil types, precipitation levels and farm management practices such as stocking rates and manure management procedures, influence the level of nutrient leaching that actually occurs. However, it is worth considering because the appropriate disposal of nutrients from dairy cow manure has become a major environmental issue in many countries as a result of the trend towards larger production units. Many agri-environmental policy measures, particularly regulations, specifically address manure management.

27. The OECD nitrogen soil balance indicator measures the difference between the nitrogen available to an agricultural system (inputs, mainly from livestock manure and inorganic fertilisers) and the uptake of nitrogen by agriculture (outputs, largely crops and pasture), with a persistent surplus indicating potential environmental pollution of water (indicated by kilograms of nitrogen per hectare of agricultural land), as the volatilisation of ammonia from livestock is excluded from the balance (OECD, 2001*a*). While the baseline to assess the risk of nitrogen surplus can vary according to local conditions (*e.g.* soil types,

climate), some studies suggest that above 50 kg nitrogen per hectare (kgN/ha) annually indicates a high risk of soil surface run-off or leaching of nitrate into water bodies.

Table 2.1. Milk production and water pollution risk indicators, 1985-87 and 1995-97[1]

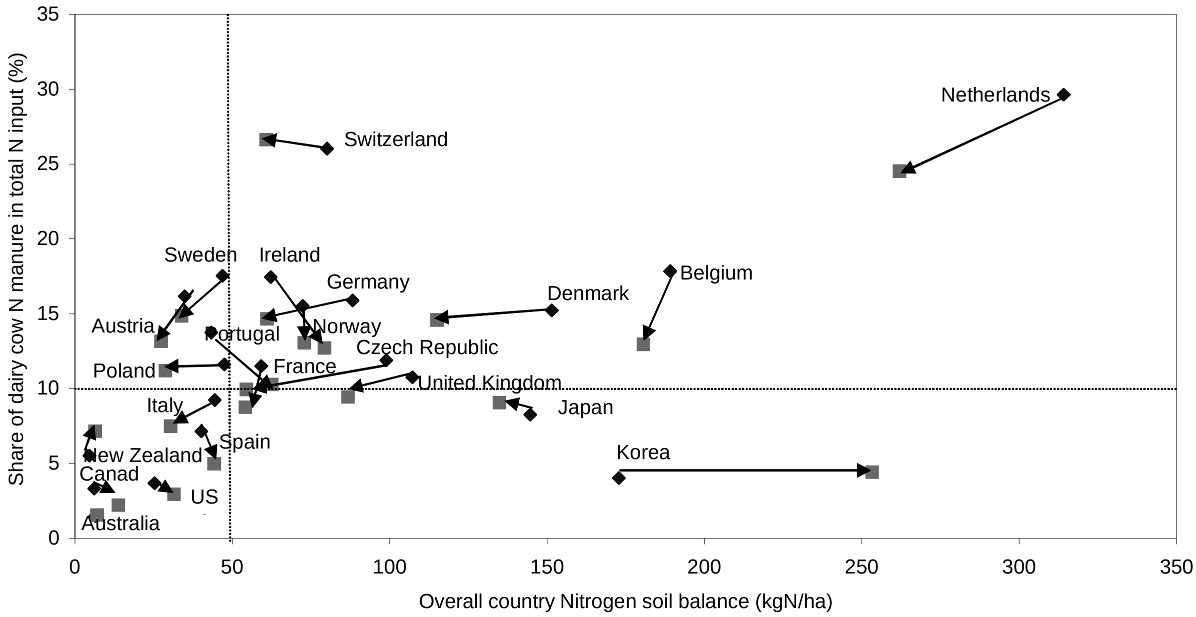
	Milk production		Dairy cow N manure[2]		Share of dairy cow N manure in total N input		Overall country N balance	
	000 t		000 t		%		kgN/ha	
	1985-87	1995-97	1985-87	1995-97	1985-87	1995-97	1985-87	1995-97
Milk production and dairy cow N manure increasing								
Share of dairy cow N manure in total N input increasing								
Nitrogen balance increasing								
Korea	1 762	2 005	26	34	4	4	173	253
Australia	6 279	8 888	125	133	1	2	7	7
New Zealand	7 782	10 530	198	247	6	7	5	6
Milk production increasing but dairy cow N manure decreasing								
Share of dairy cow N manure in total N input increasing								
Nitrogen balance decreasing								
Japan	7 390	8 560	121	115	8	9	145	135
Share of dairy cow N manure in total N input decreasing								
Nitrogen balance increasing								
Portugal	1 296	1 786	42	38	14	10	43	63
United States	64 900	70 366	1 027	896	4	3	25	32
Canada	7 934	7 970	104	85	3	2	6	14
Nitrogen balance decreasing								
Germany	25 487	28 696	699	505	16	15	88	61
Greece	710	752	25	19	3	3	58	33
Milk production and dairy N manure decreasing								
Share of dairy cow N manure in total N input increasing								
Nitrogen balance decreasing								
Switzerland	3 819	2 597	72	67	26	27	80	61
Share of dairy cow N manure in total N input decreasing								
Nitrogen balance increasing								
Ireland	5 653	5 336	134	111	17	13	62	79
Norway	1 962	1 843	31	27	16	13	72	73
Spain	6 071	3 967	154	109	7	5	40	44
Nitrogen balance decreasing								
Netherlands	12 306	11 076	321	235	30	25	314	262
Belgium	4 128	3 601	82	57	18	13	189	181
Denmark	5 023	4 624	108	88	15	15	152	115
United Kingdom	16 007	14 737	337	270	11	9	107	87
Finland	3 031	2 454	61	39	19	14	78	64
Czech Republic	6 940	6 487	99	55	12	10	99	54
France	27 670	25 130	546	401	11	9	59	54
Sweden	3 568	3 318	71	55	18	15	47	34
Italy	10 824	10 724	207	143	9	7	44	30
Poland	15 933	11 697	313	211	12	11	48	29
Austria	3 729	2 973	66	48	16	13	35	27
Turkey	3 400	3 200	310	291	11	11	17	12

Notes:

1. Countries are listed within each grouping according to their 1995-97 nitrogen balances.
2. Based on nitrogen manure production from dairy cows.

Source: OECD Nitrogen Soil Balance Indicator, www.oecd.org/agr/env/indicators.htm.

Figure 2.3. Risk to water pollution from nitrogen (N) in dairy manure, 1985-87 and 1995-97[1]



Note:

1. Each point in the graph shows the combination of the overall nitrogen soil balance and the share of dairy cow N manure in total N input. The point at the tail of an arrow refers to 1985-87 and the point at the head of an arrow refers to 1995-97.

Source: OECD Nitrogen Soil Balance Indicator, www.oecd.org/agr/env/indicators.htm.

28. Using the information contained in the OECD nitrogen soil balance indicator, it is possible to identify changes in the level of risk associated with milk production. Countries can be classified according to the level of dairy cow nitrogen manure production, the share of this in total nitrogen input, and the overall country nitrogen soil balance (Table 2.1 and Figure 2.3). This is likely to underestimate the contribution of dairy to nitrogen input because it does not take into account nitrogen manure from other dairy animals (calves, heifers and bulls), nitrogen fertilizer applied on dairy farms, nor the biological nitrogen fixation by legumes such as clover used in certain dairy grazing systems.

29. It is possible to identify four groups of countries in terms of the *level* of risk to water pollution from nitrogen in manure produced by dairy cows at the national level

- Countries where the risk is higher as measured by the overall nitrogen balance (*i.e.* 50 kgN/ha or greater) and the importance of dairy cow manure as a source of nitrogen (*i.e.* contributing 10% or more to the total nitrogen input) include **Belgium**, **Czech Republic**, **Denmark**, **Germany**, **Ireland**, **Japan**, the **Netherlands**, **Norway, Portugal**, **Switzerland** and the **United Kingdom**. These countries are located in the top right hand quadrant of Figure 2.3.

- In **France** and **Korea**, while the overall nitrogen balance is high, the contribution of nitrogen from dairy cow manure is less than 10%.

- In **Austria**, **Poland** and **Sweden**, the reverse is true; the overall nitrogen balance is low but the contribution of nitrogen from dairy cow manure is greater than 10%.

– In **Australia**, **Canada**, **Italy**, **New Zealand**, **Spain** and the **United States**, the risk is lower, as indicated by an overall nutrient balance below 50 kgN/ha and with dairy contributing less than 10% to total livestock nitrogen manure production. These countries are located in the bottom left-hand quadrant of Figure 2.3.

30. Changes in the OECD nitrogen balance indicator between 1985-87 and 1995-97 reveal different *trends* in the potential risk to water pollution from nitrogen in dairy manure. Again, four groupings of OECD countries can be identified.

– In **Australia**, **Korea** and **New Zealand**, the risk has increased as measured by an increase in both the contribution of dairy cows to total nitrogen input and the overall nitrogen balance between the two periods. In all three countries there has been a significant increase in milk production and a corresponding increase in the quantity of dairy cow nitrogen manure. These trends indicate that the expansion of dairy production in these countries is exerting a growing risk to the environment in terms of the potential release of nitrates from dairy farming into water bodies.

– In **Canada**, **Ireland**, **Norway**, **Portugal** and **Spain** and the **United States**, the contribution of dairy cow nitrogen manure has fallen but the overall nitrogen balance has increased. Of these six countries, milk production has expanded in Canada, Portugal and the United States but the amount of nitrogen from dairy cow manure has decreased. This can be explained by a fall in cow numbers but an increase in milk yield per cow. In the other countries, both milk production and dairy cow nitrogen manure production has decreased. In all six countries it is likely that the overall risk has decreased.

– In **Japan and Switzerland**, the contribution of dairy cows to total nitrogen input has increased but the nitrogen balance has fallen. It is difficult to conclude the net overall effect, but the importance of dairy cows as a potential source of nitrogen pollution could well have decreased, but remains a significant source at least in Switzerland.

– In all other countries the risk has decreased as both the nitrogen balance and the contribution of dairy cow nitrogen manure have decreased. For most of these countries, **Austria**, **Belgium**, the **Czech Republic**, **Denmark**, **Finland**, **France**, **Italy**, the **Netherlands**, **Poland**, **Sweden**, **Turkey** and the **United Kingdom**, a reduction in the level of milk production and in the quantity of nitrogen manure from dairy cows has contributed to this decline in national risk. Factors driving these developments include a reduction in milk quotas in many European Union countries and increases in milk yield, requiring less cows to achieve the production limit set by quota. **Germany** and **Greece** have been able to expand production while reducing the quantity of nitrogen manure produced. Overall, it can be concluded that for this group of countries the risk of nitrogen water pollution from dairy production has decreased, although it continues to remain a significant source in some (*e.g.* the Netherlands).

31. In addition to trends in the level of nutrient production, a number of other factors are also likely to be changing the risk of water pollution. Importantly, the above analysis does not take into account the nitrogen input from fertilizers that is also applied to pasture and fodder crops. With a shift towards fewer but larger dairy operations the production of recoverable manure nutrients is exceeding the assimilative capacity of the cropland and pasture on these farms (Chapter 3.1). Further, changes in the geographic location of dairy production may also raise the risk if production becomes spatially concentrated to the extent that the quantity of manure from farms in these regions exceeds the assimilative capacity of surrounding farmland to absorb dairy manure nutrients at agronomic rates (Chapter 3.2). A major

limitation of the proceeding analysis is that it only considers the level and change in risk at the national level.

32. In the **United States**, data from the 1997 Census of Agriculture indicate that dairy, beef, poultry, and swine operations all produce nutrients in excess of on-farm requirements, with more than half the total excess coming from poultry operations. It is estimated that 60% of the recoverable nitrogen produced from manure is in excess of the on-farm crop needs. Of this excess (735 000 tonnes N), 64% is from poultry, with dairy contributing 9%. For phosphorus, over 70% of recoverable phosphorus is in excess (462 000 tonnes P_2O_5), 52% is from poultry with dairy again contributing 9% (Gollehon *et al*., 2001). However, while the overall quantity of manure from dairy cows has been decreasing, the quantity in excess of on-farm crop needs has been increasing, more than doubling between 1982 and 1997 (Kellogg *et al*., 2000).

33. In addition to nutrients, ***organic effluents*** usually contain a high proportion of solids, and can be transported into waterways direct from dairy slurry or manure storage. Organic pollution of water causes rapid growth in micro-organisms resulting in a high biochemical oxygen demand (BOD), and as a result reduces the available oxygen to support aquatic life. Direct discharge of organic effluents is capable of causing fish kills or severe disruptions to aquatic ecosystems by increasing BOD levels (Hooda *et al*., 2000). While dairy slurry has a lower BOD concentration compared to other forms of waste (Table 2.2), its impact can still be significant on water bodies. In addition to manure, the inappropriate storage of grass silage for animal feed can be a significance source of BOD pollution if not managed correctly.

Table 2.2. Ranges of biochemical oxygen demand (BOD) concentrations from various wastes

Waste Source	BOD Value (mg/l)
Silage effluents	30 000 – 80 000
Pig slurry	20 000 – 30 000
Cattle slurry	**10 000 – 20 000**
Liquid effluents draining from slurry stores	1 000 – 12 000
Treated domestic sewage	20 – 60
Clean river water	< 5

Source: MAFF, United Kingdom (1998).

34. A third source of water pollution concerns ***pathogens*** in dairy manure (*e.g.* bacterial, parasites, and medicines) which can also be transmitted in waterways (and the air) directly from faecal discharges and leaking slurry/manure stores, and from field application of manure. These pathogens can damage fish and shellfish in aquatic ecosystems, and cause human health problems through impairing drinking water quality. Little is currently known about the fate, transport and overall potential human health and environmental effects that may occur from complex mixtures of pathogens released from livestock manure, although considerable research is now underway in this area (*e.g.* Kolpin *et al.*, 2002). A study in the **United States** found that 9% of farm-associated streams were cryptosporidium positive, with the frequency of manure spreading being the key influencing factor (Sischo *et al*., 2000).

2.3 Air pollution

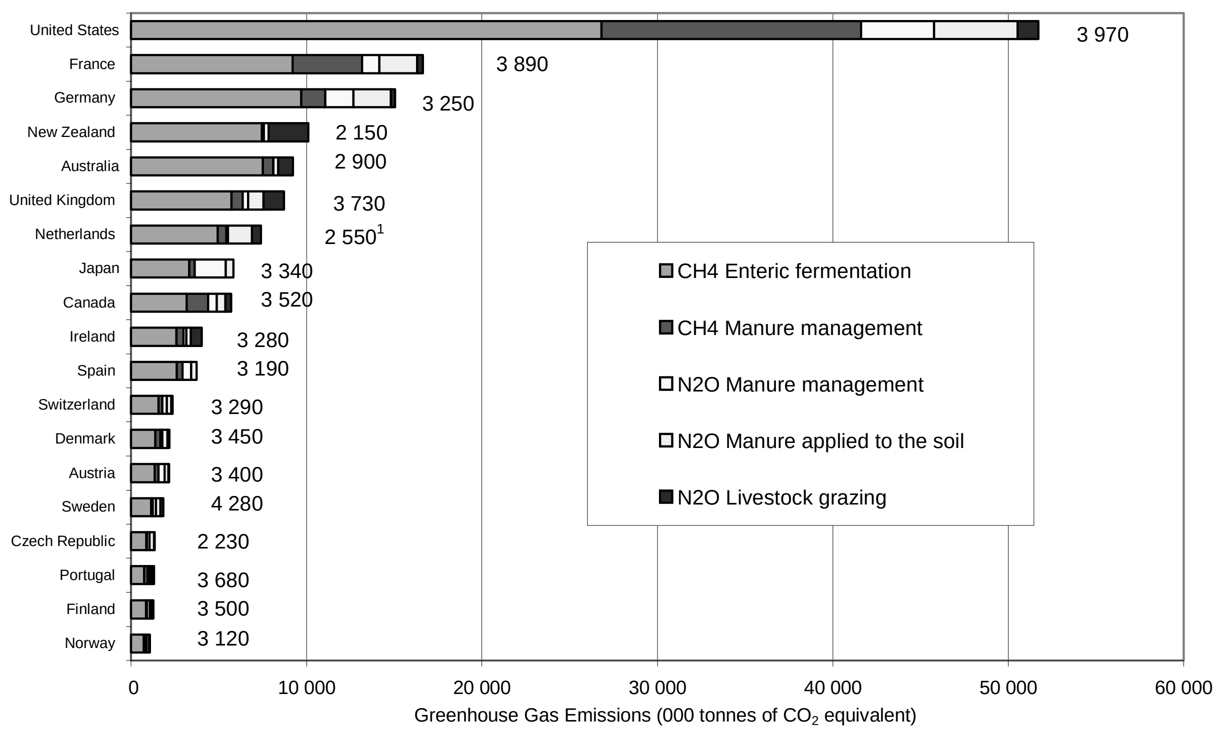
35. Milk production can contribute to air pollution and cause harm to the environment and human health in several ways (Figure 2.2). The major airborne emissions from dairy farming concern greenhouse gases (methane and nitrous oxide) affecting climate change, and ammonia which can lead to soil

acidification, eutrophication and particles. There are also issues of odours and, for some dairy systems, dusts and micro-organisms.

36. The main ***greenhouse gases*** (GHG) from dairy production are methane (CH_4) and nitrous oxide (N_2O), contributing to the process of climate change and global warming, Methane emissions are derived from the digestive processes in dairy cows and other ruminants (enteric fermentation), and the decomposition of manure. Ruminants fed on fibrous diets associated with extensive farming systems have a higher output of methane emissions from enteric fermentation than those in more intensively managed systems that use feed supplements. Nitrous oxide is emitted from stored manure, and from manure spread on soils, either spread from storage or deposited by livestock during grazing. Carbon dioxide (CO_2), another GHG, results from the use of machinery in dairy production, *e.g.* tractors, heating/ventilation systems for housing units and dairy milking machines, but emissions are usually in small quantities compared to CH_4 and N_2O.

Figure 2.4. Gross emissions of greenhouse gases from dairy cows in selected countries, 1999-2001

Total (000 tonnes CO_2) and average emissions per dairy cow (kg CO_2)



Note:

1. The per head estimate for the Netherlands is relatively lower because they include all dairy cattle, not just cows in milk.

Source: OECD Secretariat, based on information contained in 2003 country submissions to the UNFCCC Greenhouse Gas inventory, http://unfccc.int/program/mis/ghg/submis2003.html.

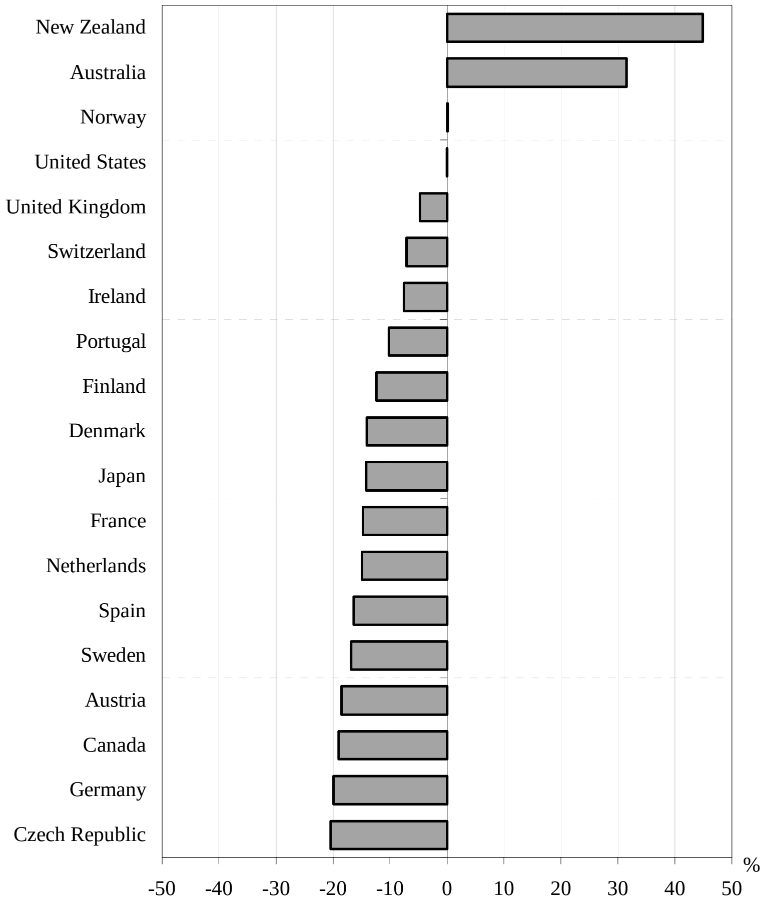
37. The overall level of GHG emissions from dairy farming varies quite significantly between OECD countries, reflecting the size of the dairy cow population in each country (Figure 2.4). Emissions from five sources are included in this calculation: methane (CH_4) emissions from enteric fermentation and manure management; and nitrous oxide (N_2O) emissions from manure management, the application of manure to the soil and from manure deposited during livestock grazing. Emissions that result from fertiliser applied

on dairy farms, ammonia volatilisation, nitrate leaching and energy use in machinery and tractors etc are not included. The five included in the calculation are the most significant with only minor variations in the analysis expected if data on the other emissions were included.

38. Methane production from enteric fermentation in dairy cows is the most significant source of GHG emissions in all OECD countries, accounting for between 50% (**United States**) and 80% (**Australia**) of total dairy farming GHG emissions. Variations in the share of methane and nitrous oxide emissions from manure management and manure applied to the soil reflect differences in farming systems between countries, in particular the amount of time animals spend grazing on pasture, and the types of manure management systems used to store manure collected in housing facilities and milking parlours.

Figure 2.5. Gross emissions of greenhouse gases from dairy cows, 1990-92 to 1999-2001

Change in gross emissions of greenhouse gases from dairy cows



1999-2001
Percentage share of GHG emissions from dairy cows

	in total agricultural GHG emissions	in total GHG emissions
New Zealand	28.6	21.3
Australia	9.0	1.7
Norway	20.9	2.8
United States	10.9	0.8
United Kingdom	48.5	1.5
Switzerland	43.5	4.6
Ireland	20.6	6.0
Portugal	11.1	1.6
Finland	16.9	2.0
Denmark	18.5	3.3
Japan	17.1	0.4
France	16.8	3.3
Netherlands	46.0	3.4
Spain	8.7	1.1
Sweden	20.8	4.5
Austria	28.2	2.9
Canada	9.4	0.8
Germany	22.8	1.6
Czech Republic	14.2	0.9

Source: OECD Secretariat, based on information contained in 2003 country submissions to the UNFCCC Greenhouse Gas inventory, http://unfccc.int/program/mis/ghg/submis2003.html

39. Since 1990 there has been a decline in GHG emissions from milk production in almost all OECD countries, increasing only in **Australia** and **New Zealand** and remaining fairly stable in **Norway** and the **United States** (Figure 2.5). The most significant decreases have occurred in the **Czech Republic** and **Germany**. The main factor driving changes in country GHG emissions over time is changes in animal numbers. At the same time, GHG emissions per head have been rising in response to the increased feeding requirements of dairy cows as they have got larger, leading to greater quantities of methane emitted from enteric fermentation and greater quantities of nitrogen excreted in manure (increasing emissions from manure management and the soil). Data for a few countries also indicates that some change in emission factors arising from changes in the importance of different manure management storage facilities but these changes are minor.

40. Greenhouse gas emissions from dairy farming generally represent between 1-2% of total net emissions in most OECD countries. The most notable exception is **New Zealand**, where milk production contributes just over 20% of total net GHG emissions in 1999-2001. It represents less that 1% of total net GHG emissions in **Canada**, the **Czech Republic**, **Japan** and the **United States**.

41. Dairy manure is also abundant with ***ammonia*** (NH_3), which is released into the air from dairy housing, stored manure and the land application of manure (Sommer and Hutchings, 2001). Dairy cows are potentially a source of ammonia pollution, but emissions per animal are not as significant as other livestock production systems (Table 2.3). Estimates of ammonia emission rates can vary according to housing conditions, the season, and other factors.

42. A higher risk of volatilisation occurs after manure application. Usually ammonia tends to be deposited in the area surrounding the dairy operation (up to several kilometres) and can be harmful to ecosystems through acidification (*i.e.* by acidifying soils and limiting plant growth) and eutrophication of the environment with prolonged exposure to ammonia. But the distance travelled by ammonia emissions will depend on the concentration of dairy cows and prevailing weather conditions (*e.g.* wind, rain) in a particular region. Ammonia emissions from the application of manure to grassland are 1.5 times higher than from arable land (CEAS, 2000).

Table 2.3. Average ammonia (NH_3) emission rates per type of animal

Animal	Emission rate of NH_3	
	mg/hour/animal	mg/hour/500 kg liveweight
Poultry (laying hens, broilers)	2 – 39	602 – 10 892
Pigs (sow, weaner, finisher)	22 – 1 298	649 – 3 751
Cattle (dairy cows, beef calves)	**80 – 2 001**	**315 – 1 798**

Source: OECD Secretariat, adapted from Hartung, 1999.

43. Data on ammonia emissions from dairy production are not available for many OECD countries. A recent study concluded that ammonia emissions from a representative dairy farm in the **United Kingdom** was equivalent to 57 kgN/ha, compared to 24 kgN/ha on a representative **New Zealand** farm, and remained twice as high when expressed on a per livestock unit or per unit of milk basis (Jarvis and Ledgard, 2002). The difference was mainly due to the housing requirements associated with United Kingdom dairy farming.

44. From the information that is available agricultural ammonia emissions contribute about 90% to total ammonia emissions from all sources. Livestock ammonia emissions account for over 80% of agricultural emissions. The share of dairy in total livestock ammonia emissions varies across OECD countries according to the relative importance of the dairy sector in national livestock production, although the shares broadly reflect those of dairy in total livestock nitrogen manure.

45. Dairy housing units generate ***dust and micro-organisms***, of particular concern to those working in these units and people living in the vicinity of dairy farms. The predominate sources include feed and faecal material, and possibly bedding. Most of the measurements of particulate matter (PM) relating to livestock farming have been performed on poultry and pig farms which are considered to be a more important source (Klimont *et al.*, 2000). Values from Takai *et al.* (1998) in Table 2.4 represent averages derived from measurements done in **Denmark**, the **Netherlands**, **Germany** and the **United Kingdom**. Variations were observed between countries, for example, estimated inhalable dust (TSP) emissions from cattle in Germany (1.2 kg/animal) were nearly twice as high as in England (0.65 kg/animal). Ventilation and feeding practices are among the main factors explaining different emission rates.

Table 2.4. Average particulate matter (PM) emission rates per type of animal

Animal	PM_5	TSP
	Kg/animal/year	
Poultry	0.018	0.105
Pigs	0.123	0.922
Cattle	**0.166**	**0.964**

Source: Takai *et al.* (1998).

46. ***Odours*** are an important environmental nuisance to those living close to production units, and have been implicated as a cause of decreased quality of life, with additional possible negative consequences on human health and welfare (Schiffman, 1998) Rural-urban encroachment is leading to greater conflict between farmers and non-farm residents over issues such as odours from livestock operations.

47. Studies show that the characteristic odour of dairy cattle facilities is a result of a complex mixture of many different compounds and of selective human sensitivity towards these compounds. They also indicate that higher observed concentrations of compounds are related to higher cattle populations within a given area (Sunesson *et al.*, 2001; Rabaud *et al.*, 2003).

2.4 Soil quality

48. Damage to ***soil quality*** from dairy production can occur from heavy metals present in manure, in particular copper and zinc, which are added to concentrate feeds and cadmium, a pollutant resulting from the inclusion of phosphate in feed. Soils on which manure is applied can accumulate heavy metals impairing soil functions and contaminating crops, leading to possible human health impacts (Haan *et al.*, 1998).

49. Overgrazing of pasture by dairy cows may also result in the removal of vegetation cover beyond the level required for protecting soil which exacerbates soil erosion and reduces soil fertility. Some 87% of dairy farms in **Australia** now use strip grazing or small paddocks to manage stock (LWRRDC, 1998), and a similar figure would be found in **New Zealand**. A recent survey in Australia found that most of the

irrigated and high rainfall dairy districts, especially those with medium to heavy texture soils, water logging and deteriorating soil structure are common problems (NLWRA, 2002). These problems can be exacerbated by excessive irrigation, poor drainage, salinity, high stocking rates or grazing of wet pastures (plugging). Research in Southland, New Zealand has demonstrated that current dairy cow grazing practices reduce macroporosity, air permeability and hydraulic conductivity dramatically (Drewry and Paton, 2000).

2.5 Water use

50. Milk production involves both the direct and indirect use of water. The first relates to the quantity of water consumed by the cow. It is estimated that cows need to drink approximately 0.9 litre of water for every 1 litre of milk they produce *i.e.* to produce 15 kg of milk per day a cow will require about 13.5 litres of water (National Academy of Science, 2001). The indirect use relates to the use of water for forage production, whether pasture or fodder crops, and varies according to the geographic and climatic conditions.

51. Despite a reduction in livestock numbers it is likely that the quantity of direct water consumed by cows has closely followed the pattern of milk production, *i.e.* it has remained stable in most OECD countries, increasing in just a few. In both **Australia** and **New Zealand**, the issue of water use in dairy production has become a major issue as a result of increased production and the expansion of the sector in water-scare areas. Irrigation is estimated to account for about 40% of Australian milk production, with the total area irrigates per farm increasing at about 4.5% per year (LWRRDC, 1998).

2.6 Biodiversity

52. The relationship between dairy production and biodiversity can be summarised in terms of its links at the genetic stock and ecosystem levels. The utilisation of the ***genetic stock*** of cattle breeds, domesticated (native and exotic breeds) and wild variants, is essential in maintaining production. The dairy industry requires genetic variants and improvements in order to: upgrade the productivity of commercial lines of dairy production; meet changing demand from dairy processors for protein and fat content in milk; develop breeds less susceptible to disease and health problems; and meet environmental demands, such as developing dairy breeds that can lower pollutant emission levels per kilogram of milk produced. Given the cost of maintaining rare and endangered breeds, a key challenge for animal production is to maintain the minimum number of genotypes for optimal future genetic improvement (Haan *et al.*, 1998). In dairy cattle, the Holstein breed dominates production. Intensive sire selection is leading to relatively rapid inbreeding rates and raises questions about long-term effects of genetic concentration (Notter, 1999).

53. Information on genetic erosion or loss is incomplete, particularly regarding wild variants. For domesticated (farmed) breeds, it is difficult to quantify the level and change in dairy breeds because cattle breeds are often used for more than one form of production (*e.g.* meat). Globally there are 1 479 recorded farm cattle breeds, of which 255 breeds have become extinct over the past 100 years. Of the existing cattle breeds, 630 are classified as not at risk, with the risk status of a further 295 is unknown. This leaves 299 reported at risk of being lost within a particular country (Table 2.5). OECD countries account for around 60% of the world total of farm cattle breeds considered at risk of being lost. However, this is likely to overstate the number of cattle breeds truly at risk by “double-counting” the number of breeds in the total because the same breed can be at risk in a number of countries (Wetterich, 2003).

Table 2.5. Risk status for farm cattle in OECD countries[1]

	Critical Breeds[2]					Endangered Breeds[3]				
		Local or indigenous[4]		Not local or indigenous			Local or indigenous[4]		Not local or indigenous	
Country	Total	In conservation[5]	Not in conservation	In conservation[5]	Not in conservation	Total	In conservation[5]	Not in conservation	In conservation[5]	Not in conservation
Australia	..	..	..	..	..	3	..	2	..	1
Canada	1	..	..	..	1	4	1	..	..	3
Czech Republic	7	1	2	..	4	4	..	..	..	4
EU-15	52	19	14	1	18	94	42	23	3	26
Austria	3	3	..	..	..	4	4	..	..	..
Belgium	..	..	..	..	..	1	..	1	..	..
Denmark	1	1	..	..	..	4	2	..	..	2
Finland	2	2	..	..	..	..	..	..	..	..
France	8	3	4	..	1	15	7	5	3	..
Germany	16	..	3	..	13	18	..	6	..	12
Greece	2	..	..	..	2	..	..	..	..	..
Ireland	..	..	..	..	..	5	1	..	..	4
Italy	5	3	1	..	1	9	8	1	..	..
Luxembourg	..	..	..	..	..	1	..	..	..	1
Netherlands	2	1	1	..	..	3	2	1	..	..
Portugal	..	..	..	..	..	..	..	..	..	..
Spain	7	3	4	..	..	14	8	6	..	..
Sweden	1	1	..	..	..	7	4	1	..	2
United Kingdom	5	2	1	1	1	13	6	2	..	5
Hungary	..	..	..	..	..	3	..	..	..	3
Iceland	1	..	..	..	1	..	..	..	..	..
Japan	2	..	2	..	..	..	..	..	..	..
Mexico	..	..	..	..	..	..	..	..	..	..
New Zealand	1	..	..	..	1	..		..	..	..
Norway	2	2	..	..	..	4	2	2	..	..
Poland	1	..	..	1	..	2	..	1	1	..
Slovak Republic	..	..	..	..	..	..	..	..	..	..
Switzerland	1	1	..	..	..	2	1	..	1	..
Turkey	..	..	..	..	..	..	..	..	..	..
United States	1	..	1	..	..	6	..	2	..	4
OECD[6]	69	23	19	2	25	122	46	30	5	41
World[6,7]	106	27	45	3	31	193	59	78	7	49

Notes:

1. The risk status categorisation of breeds refers only to the status of the breed population in that country and should not be interpreted as reflecting the global picture.

2. A breed is categorized as critical if the total number of breeding females is less than or equal to 100 or the total number of breeding males is less than or equal to 5; or if the overall population size is less than or equal to 120 and decreasing and the percentage of females being bred to males of the same breed is below 80%.

3. A breed is categorized as endangered if the total number of breeding females is greater than 100 and less than or equal to 1000 or the total number of breeding males is less than or equal to 20 and greater than 5; or if the overall population size is greater than 80 and less than 100 and decreasing and the percentage of females being bred to males of the same breed is above 80%; or if the overall population size is greater than 1000 and less than or equal to 1200 and decreasing and the percentage of females being bred to males of the same breed is below 80%.

4. This category identifies breeds that are considered as being of local or indigenous origin by that country.

5. This category identifies populations for which active conservation programmes are in place or those that are maintained by commercial companies or research institutes.

6. Excludes Korea.

7. In 1999, the total recorded number of farm cattle breeds was 1 479, of which 255 are extinct, the risk status of 295 is unknown and 630 are not at risk, leaving 299 breeds either classified as critical or endangered.

Source: OECD Secretariat, data drawn from Scherf (2000).

54. It is also important to distinguish between local or indigeneous breeds, and exotic (non-native) breeds for whom the host country may consider that they have no responsibility to preserve even though they are classified as critical or endangered under this definition. Frequently, rare animal species are kept by non-farmers for leisure purposes. Within OECD countries, of the 191 cattle breeds identified as being at risk (either critical or endangered) just over 60% (118) are indigenous breeds or breeds that have a long

history in the country. This compares with 84% (91 out of 108) in non-OECD countries. Further, nearly 60% (69) of indigenous breeds in OECD countries are part of active conservation programmes to maintain these breeds. In non-OECD countries, less than 20% (17) of indigenous breeds are in such programmes.

55. Dairy production also has an impact on ***ecosystem diversity***. Within agricultural systems, changes occur when the spatial patterns created by traditional production systems are replaced by the simpler patterns of intensive grazing, with introduced grass species, and silage cutting. More intensive systems, relying on fertilisers and pesticides, further impacts on biodiversity by encouraging the dominance of competitive plants. In general, species richness declines markedly when grassland is intensified through either increased stocking rates of fertiliser application, although the optimum level of operation differs according to the environment, the type of animal and the history of production. Compared to some of the previous environmental issues there is much less information available on the impact of dairy farming on ecosystem diversity at a national level that would allow cross-country comparison.

56. A recent study in **Germany** found that vegetation complexity was significantly higher on ungrazed grasslands compared to pastures, and vegetation did not differ between intensively and extensively grazed pasture. Insect species richness was also higher on ungrazed pasture, but was higher on extensively than on intensively grazed pasture (Kruess and Tscharntke, 2002). Analysis in **Austria** shows that plant species richness decreases with increased nitrogen supply and intensive silage production (Zechmeister *et al.*, 2003). It also found a significantly higher number of endangered species of bryophytes (non-flowering plants such as mosses) growing in upland areas dominated by moderately intensive cattle farming than in lowland areas using more intensive farming styles (Zechmeister *et al.*, 2002). In **New Zealand**, a biodiversity issue concerns the grazing of understories by dairy cows which threatens the persistence and indigenous diversity of forest stands (Burns *et al.*, 2000).

57. Dairy farming can also have an impact on bird populations. A reduction in pasture area has contributed to a decline in the starling population in **Sweden** (Smith and Bruun, 2002). In the **United Kingdom**, more intensively managed grassland has lead to a decline in species dependent on soil invertebrates (particularly earthworms) and an increase in generalist insectivores such as corvids (Barnett *et al.*, 2004). Some intensively managed grassland in the **Netherlands** is of strategic importance to migrating wildfowl (Verschuur *et al.*, 2003).

2.7 Landscape

58. Dairy production can impact on the surrounding landscape and biodiversity. For example, when shrub and bush are cut to expand productive capacity, or when dairy production ceases and are replaced by scrub and tree encroachment. The reduction in dairy farming in north eastern **United States** has increased forest cover, blocking the views from one of the most scenic highways, the Taconic Parkway (Mendelsohn, 2003). Whether these changes are viewed as positive or negative environmental consequences very much depends on the specific situation, and the value placed by society on the alternative land-use possibilities.

59. In the **European Union** many traditional dairy landscapes involving polyculture, bocage, hedgerows and hay meadows are considered to have cultural and aesthetic value (CEAS, 2000). At the same time, large tracks of open countryside which have been shaped by intensive dairy farming systems are also considered of importance in regions such as Brittany (**France**), southern **Sweden** and **Finland**, and much of **Denmark** and the **Netherlands**.

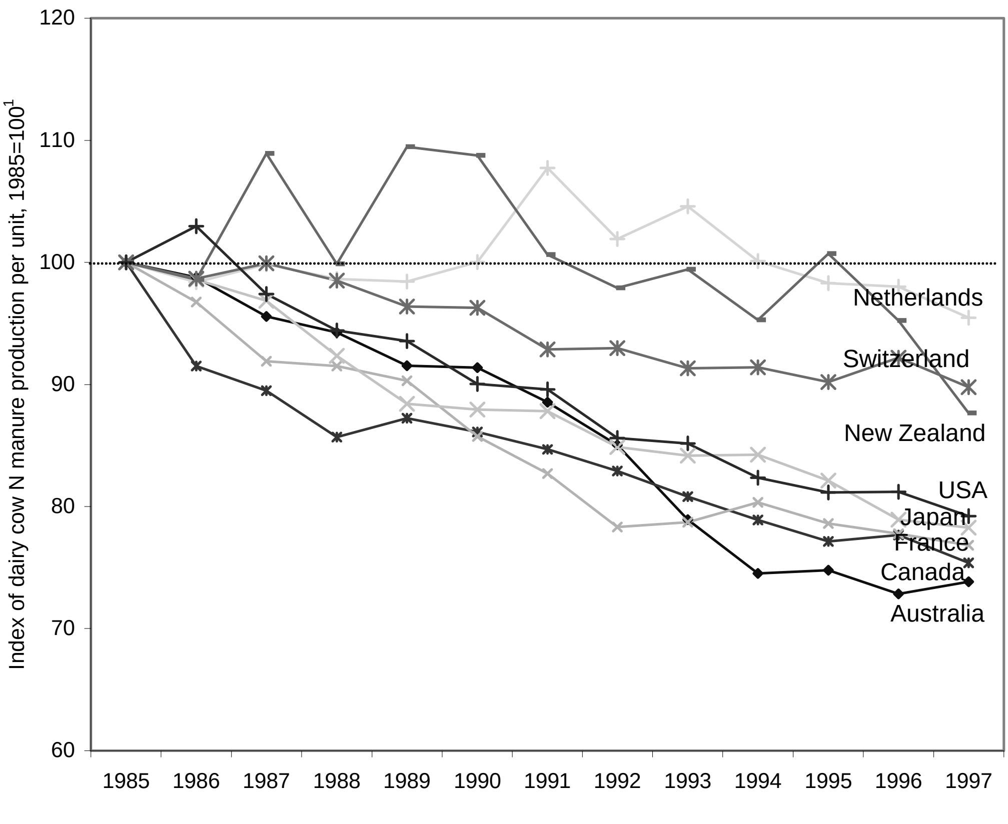
60. Mountain dairy farming in countries such as **Austria**, **Italy**, **France** and **Switzerland** play an important role in preserving the alpine plant ecosystems. For example, a major long-term study in **Switzerland** found a wider range of flora and fauna species on extensive dairy cattle grazing areas compared to extensively managed conservation areas where the grass is cut (Schmid, 2001). Such systems are also important for tourism, by keeping an open landscape, and for the protection of human settlements

from natural hazards such as avalanches and mudflows. In these fragile landscapes, there is a fine balance between milk production and the environment. Increased stocking rates, heavier animals, and greater fertiliser use have in some instances increased trampling damage and the frequency of landslides (OECD, 2002). But countries with mountain dairy farming consider the risks of abandonment to be of more importance.

2.8 Decoupling environmental impacts from production

61. For a large number of countries, it appears that increases in dairy production have become more "decoupled" from the output of nitrogen manure and maybe also ammonia and GHG emissions. The term "decoupling" in this context refers to weakening the link between environmental pollution and economic growth. In the context of agriculture it can be measured in terms of the relative growth rates of an environmental pressure (*e.g.* dairy cow nitrogen manure production, ammonia and methane emissions) and an economically relevant variable (*e.g.* milk production) to which it is causally linked.

Figure 2.6. Dairy cow nitrogen (N) manure production per unit of milk in selected countries, 1985-97



Note:

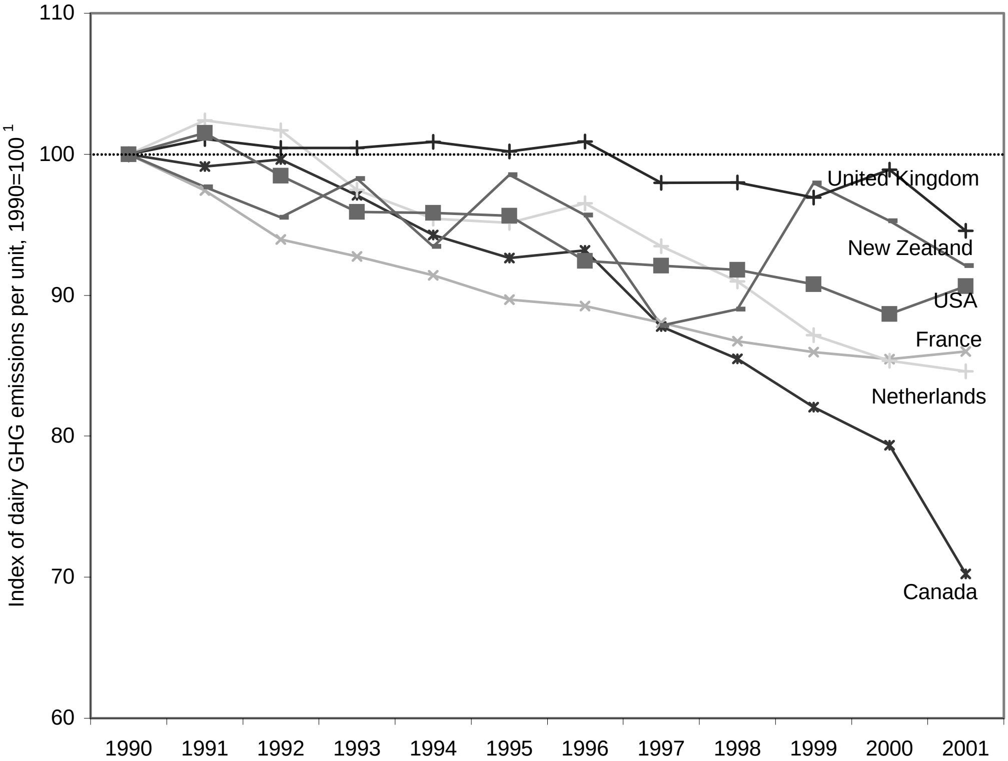
1. Each point represents the level of dairy cow N manure produced per tonne of milk, with 1985=100.

Source: OECD Secretariat.

62. As discussed in Section 2.2, the volume of nitrogen manure production has decreased in some countries while at the same time the volume of milk production has increased, or has decreased at a faster rate than production. Reductions in the quantity of nitrogen manure produced per unit of milk production are observed in a number of countries (Figure 2.6). For example, in **Australia**, **Canada** and **France**, the

output of manure nitrogen per unit of milk produced has fallen by 20% or more over the twelve years 1987-97. A similar trend can be observed in relation to the output of GHG emissions, with the volume of GHG emissions per unit of milk decreasing by more than 10% over the 1990-2001 period in Canada, France and the **Netherlands** (Figure 2.7).

Figure 2.7. Dairy cow GHG emissions per unit of milk in selected countries, 1990-2001



Note:

1. Each point represents the level of dairy cow GHG emissions per tonne of milk, with 1990 = 100.

Source: OECD Secretariat.

63. An important factor that may be influencing “decoupling” is the improvements in productivity of dairy production *i.e.* as the coefficient factors to calculate nitrogen manure production from dairy cows are based on live animals, with productivity improvements this implies less nitrogen emissions per unit volume of milk produced. The research literature also provides some evidence that dairy producers are improving their environmental performance through applying technologies and husbandry practices and systems that reduce emissions or the pollution risk. Some caution is required in interpreting these trends, especially because of data deficiencies and the relatively short time period over which these observations have been made.

3. Developments in the structure and practice of dairy farming

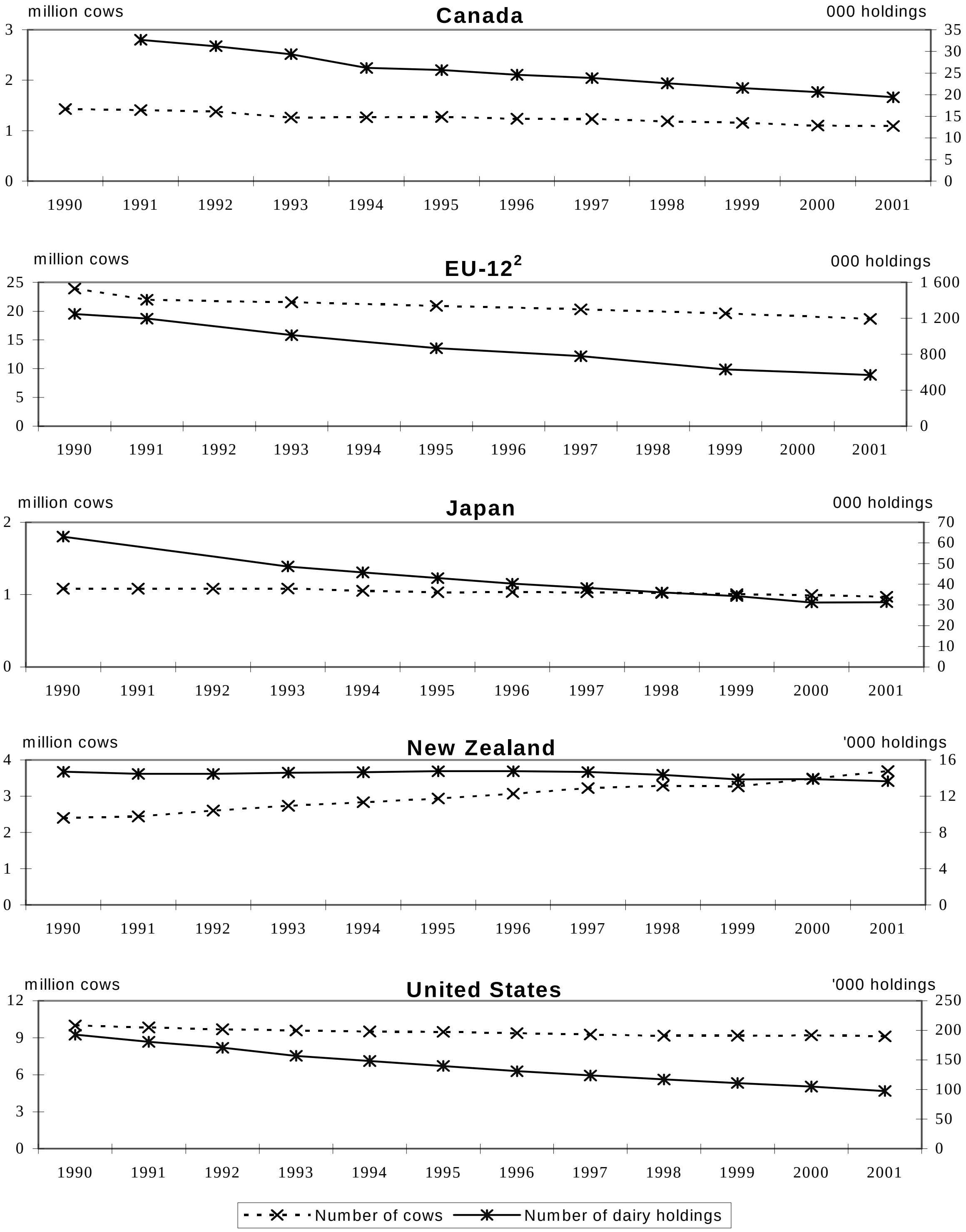
- In all countries, the scale of dairy farming is increasing with fewer farms milking a larger number of cows, even in countries where the number of cows is decreasing.
- The regional distribution of dairy farming has remained fairly static in countries which maintain production quotas like the European Union and Canada, but significant changes have occurred in other countries such as New Zealand and the United States.
- Milk production is also becoming more intensive, with increased yield per cows and generally a greater number of cows per area of fodder production. The intensity is greatest in some northern European countries and Japan, and has grown significantly in southern European countries.
- Increases in the scale and intensity of milk production are likely to have increased environmental pressure. The environmental impact of changes (or no change) in the regional distribution are more difficult to estimate.
- Technologies and management practices have been developed to reduce the environmental impacts of production, *e.g.* improved feeding patterns, methods of manure spreading etc. Some of these are also economically beneficial to producers, and some require significant financial investment or increase variable costs. Pollution averting technologies in particular are not considered to be scale neutral.

64. The first three sections of this chapter provide an overview of some of the structural changes relating to the size, location and intensity of production that have taken place in dairy farming since 1990. The structure of production and environmental concerns are closely related. For example, one way to reduce potential water quality problems from manure is to apply it to fields to help meet crop nutrient needs. However, the opportunity to jointly manage animal manure and crop nutrients as part of a single operation has decreased as a result of the trend towards fewer, larger, and more specialized animal production units. Larger dairy operations create larger local concentrations of manure, increasing the potential for adverse effects on local water quality. But the actual environment impact depends to a large degree on the technical and managerial practices adopted by farmers. The next two sections describes some of these practices according to environmental objective, and identifies where possible the uptake of these practices by dairy farmers in OECD countries. The final section draws some conclusions about the potential environmental impact of different dairy farming systems.

3.1 Scale of production

65. The scale of production can be measured by the number of animals per farm and the size distribution of farm holdings. Similar trends in the number of cows in milk, dairy operations and cows per farm can be found throughout the OECD (Figures 3.1 and 3.2), although exceptions to the trend in cow numbers do occur. In the **European Union**, the number of dairy cows in the EU-12 decreased from 24 million in 1990 to fewer than 19 million in 2001, an annual decrease of 2%. Over the same period, the number of holdings with dairy cows declined from 1.25 million to 570 000, an annual rate of 5%. This resulted in a 70% increase in the average number of cows per holding to 33 cows per farm. It should be noted that an increase in the scale of production does not correspond to an increase in intensity as the area per farm has also expanded in many cases (Section 3.3 deals explicitly with changes in intensity).

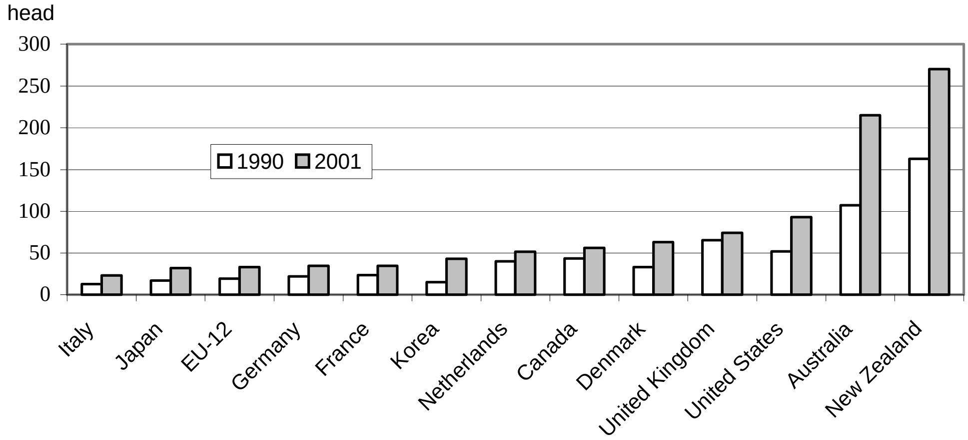
Figure 3.1. Number of cows in milk and dairy holdings in selected countries, 1990-2001[1]



Notes:
1. Cow numbers are based on cows in milk.
2. EU-12 is the EU-15 less Austria, Finland and Sweden.

Source: DFC (2002), EUROSTAT, MAFF Japan (various years), LIC (2003), Blayney (2002).

Figure 3.2. Average number of cows in milk per holding in selected countries, 1990 and 2001[1]



Note:

1. National averages can hide significant regional variations in the average number of dairy cows per holding, see Table 3.3.

Source: LIC (2003), DFC (2002), EUROSTAT, MAFF Japan (various years), Blayney (2002), NACF (2002).

66. A similar pattern of decreasing cow numbers and number of farms, and increasing farm size are observed in the **United States**, **Japan** and **Canada**. During the period 1990-2001, the United States dairy cow herd decreased from 10 million to just over 9.1 million animals, a 1% annual decrease, while the number of dairy farms decreased by 5% per year from 192 000 to 98 000. Consequently, the average number of cows per farm grew by 80% to 93 head per operation. Similar rates of change are observed in Japan, with a 5% annual decrease in the number of farms, a 1% annual decline in the dairy herd, and an increase in average farm size to 32 cows, an 80% increase. In Canada, the decline has been less dramatic though still significant. Dairy cow numbers and the number of holdings decreased at annual rate of 2% and 4% respectively between 1990 and 2001, with the average herd size increasing by 30% to 56 cows.

67. In **New Zealand** and **Australia**, the trend in cow numbers is different from other countries, with cow numbers increasing during the period 1990-2001. For example, in New Zealand, the number of dairy cows increased from 2.4 to 3.7 million, an annual increase of 5%. The downward trend in the number of dairy farms observed in other OECD countries has also occurred in Australasia, resulting in large increases in the size of dairy farms. In New Zealand, the average herd size has increased from 164 cows to 270 cows in milk, a 65% increase.

68. The increase in scale of production is also shown by the rise in the number of larger, more capital-intensive and specialised operations (Tables 3.1 and 3.2). In the **United States**, 55% of all dairy cows in 1993 were held on farms with more than 100 cows, with these farms representing 14% of all dairy farms. By 2000, 71% of all dairy cows were held on farms with more than 100 head. In **Korea**, the growth in large holdings has been particularly rapid in the last half of the 1990s.

69. In the **European Union** as a whole, only 14% of dairy cows were held on farms with more than 100 dairy cows in 1990, with these large farms accounting for only 1% of all holdings with dairy cows. By 2000, 18% of cows were held on these farms. In general, the development within the different herd size classes in all European Union countries shows a similar trend of increase in the number of holdings and animals in the larger herd classes, and a significant decrease in the number of small farms. However, differences occur between countries – with **Denmark**, **Germany**, **Italy** and the **United Kingdom** all having the largest share of animals on large farms, with the increase most rapid in Denmark. Consequently, the average size of dairy herds varies considerably among European Union countries (Figure 3.2). In

Austria, only 1% of dairy holdings have more than 30 dairy cows, with an overall average of only 9 cows per farm. **Finland**, **Greece**, **Portugal** and **Spain** have similar average herd sizes (approximately 15 cows), although Finland has far fewer large dairy farms. The largest average herds (with more than 100 cows) are found in east Germany, northern England and Scotland, Denmark and Spain (Cataluña and Aragon) (EC, 2002*a*).

Table 3.1. Share of dairy cow population on holdings with more than 100 cows in selected countries

%

Country	1990	1993	1995	1997	2000
EU12	14	15	17	18	20
Austria			0	0	<1
Belgium	3	4	5	5	6
Denmark	7	11	13	19	27
Finland			0	0	<1
France	1	2	3	3	3
Germany	22	18	19	21	21
Greece	4	3	5	8	14
Ireland	8	9	11	10	11
Italy	17	21	26	27	31
Netherlands	10	11	13	13	16
Luxembourg	0	1	2	3	4
Portugal	6	8	8	10	14
Spain	7	10	12	13	15
Sweden			7	9	11
United Kingdom	42	43	45	45	53
Korea	4	4	5	7	10
United States		55	60	65	71

Source: EUROSTAT, NACF (2002), Blayney (2002).

Table 3.2. Share of holdings with more than 100 cows in selected countries

%

Country	1990	1993	1995	1997	2000
EU12	1	2	2	3	4
Austria			0	0	<1
Belgium	<1	<1	1	1	2
Denmark	2	3	4	7	12
Finland			0	0	<1
France	<1	<1	<1	<1	<1
Germany	1	1	2	2	3
Greece	<1	<1	<1	<1	1
Ireland	2	2	2	3	3
Italy	1	2	3	3	4
Luxembourg	0	<1	<1	<1	2
Netherlands	3	4	4	4	6
Portugal	<1	<1	<1	<1	<1
Spain	<1	<1	<1	1	2
Sweden			1	2	2
United Kingdom	18	19	20	21	25
United States	11	14	15	18	20

Source: EUROSTAT, Blayney (2002).

70. In **New Zealand**, 96% of herds have more than 100 cows. The number of herds with more than 300 cows has been increasing. In 1990, 6.5% of the herds had more than 300 cows; by 2000, 26% of the herds were this large although the most common herd is still 150-199 cows (LIC, 2003).

3.2 Regional concentration

71. In addition to the scale of farming, the regional concentration of production may also play an important role in determining the environmental impact of dairy farming. For example, the geographic concentration of animal production can overwhelm the ability of a watershed to assimilate the nutrients contained in the manure and maintain water quality. If excess nutrients from animal production cannot meet the needs of a large share of a county's cropland and pastureland, extra measures might need to be taken to assure that animal manure is properly handled for disposal.

72. In most countries, while dairy farms can be found in almost all regions, the majority of milk production occurs in specific regions (Table 3.3). A noticeable feature of the regional structural pattern is that the distribution of dairy production has remained relatively static in countries which operate quota systems like the **European Union** and **Canada**, with much more significant changes occurring in countries which do not restrict production, such as **New Zealand** and the **United States**, and to a lesser extent **Australia** and **Korea**. The increase in large operations, particularly those located in certain geographic regions, for example in California (United States), and Canterbury and Southland (New Zealand), has raised public concerns about the environmental effects of dairy production.

73. In the **European Union**, four countries account for 65% of the total dairy cow herd – **Germany** (23%), **France** (20%), **Italy** (10%) and the **United Kingdom** (11%), with **Ireland**, the **Netherlands** and **Spain** each having approximately 7% of EU dairy cows. Large populations of dairy cows can be found in certain regions of France (Bretagne, Pays de la Loire and Basse Normandie), Germany (Bayern, Niedersachsen, Baden-Württenberg, Nordrhein-Westfalia and Schleswig-Holstein), Italy (Lombardia and Emilia-Romagna), Spain (Galicia) and the United Kingdom (south-west). There is a high density of cows in all regions of the Netherlands except the south-east (EC, 2002*a*).

74. The three provinces of Alberta, Ontario and Quebec are home to over 80% of dairy cows and farms in **Canada**. Like the **European Union** countries, there has been little change in the regional structure of dairy production during the period 1990 to 2000.

75. In the **United States**, the dairy industry has grown most rapidly in areas that had not traditionally been a major dairy producer, particularly in the Mountain (including Idaho and New Mexico) and Pacific (including California) regions. As feed is a major cost factor, dairy production has traditionally been located in areas which grew grass relatively abundantly or were major feed grain producing regions. The growth in dairy production in the non-traditional areas indicates that close proximity to feed sources might no longer be a necessity as efficiency gains can be realised through improved managerial and production techniques. The low cost of acquiring and shipping feed from the growing regions of the US Midwest in the late 1990s has also contributed to the expansion of milk production in the Western states (Dobson and Christ, 2000). Evidence in the United States also shows that growth in the emergent regions occurs mainly in the very large farms category, providing them with cost advantage over most producers in the traditional region who still operate on a relatively small scale. The average farm size has grown much more rapidly in the Mountain and Pacific regions of the United States than in other regions.

Table 3.3. Regional dairy farm structural characteristics in selected countries

	1990			1995			2000		
	Share of cows	Share of holdings	Cows per holding	Share of cows	Share of holdings	Cows per holding	Share of cows	Share of holdings	Cows per holding
Country/region	%	%	head	%	%	head	%	%	head
Australia[1]	**100**	**100**	**107**	**100**	**100**	**133**	**100**	**100**	**215**
New South Wales	14	14	107	12	13	120	12	12	215
Queensland	12	13	102	10	12	108	8	10	161
Victoria	59	57	110	59	59	133	64	64	215
Canada[2]	**100**	**100**	**44**	**100**	**100**	**50**	**100**	**100**	**54**
Alberta	9	6	66	8	5	77	8	5	91
Ontario	33	33	44	33	33	49	34	34	55
Quebec	38	43	40	40	46	43	39	47	44
France	**100**	**100**	**23**	**100**	**100**	**29**	**100**	**100**	**33**
Basse-Normandie	12	11	27	12	11	33	12	10	38
Bretagne	18	18	24	19	18	30	19	18	34
Pays-de-la-Loire	13	12	25	12	12	30	13	12	35
Rhône-Alpes	7	10	16	8	10	21	7	10	25
Germany	**100**	**100**	**22**	**100**	**100**	**26**	**100**	**100**	**31**
Baden-Württemberg	9	15	13	10	15	16	9	15	20
Bayern	30	42	15	30	43	18	31	44	21
Niedersachsen	16	15	23	16	15	29	17	15	35
Nordrhein-Westfalen	9	10	19	9	10	24	9	9	30
Schleswig-Holstein	8	5	37	8	5	44	8	5	50
Italy	**100**	**100**	**13**	**100**	**100**	**19**	**100**	**100**	**23**
Campania	5	11	6	7	15	9	8	12	17
Emilia Romagna	14	9	21	13	8	31	15	9	36
Lombardia	27	12	28	30	14	42	30	15	46
Veneto	11	14	10	10	12	16	10	13	19
Korea	**100**	**100**	**9**	**100**	**100**	**11**	**100**	**100**	**23**
Metropolitan Area	47	46		43	49		41	39	
New Zealand[3]	**100**			**100**			**100**	**100**	**271**
Canterbury	3			6			11	5	504
Taranaki	16			15			13	17	221
Southland	1			3			7	4	432
Waikato	37			37			32	32	244
United Kingdom	**100**	**100**	**64**	**100**	**100**	**67**	**100**	**100**	**73**
Northern Ireland	10	15	41	11	16	45	12	17	54
South West England	25	22	73	25	21	78	24	21	82
Scotland	9	7	79	9	8	79	9	7	88
Wales	11	14	52	11	14	55	12	14	62
United States	**100**	**100**	**52**	**100**	**100**	**69**	**100**	**100**	**88**
Appalachian	6	9	37	6	8	51	5	7	56
Corn Belt	12	17	36	11	17	45	10	18	49
Lake States	28	29	50	25	32	54	24	31	66
Mountain	6	5	58	8	4	121	11	4	212
Northeast	19	19	51	18	20	63	18	22	72
Pacific	15	5	153	18	5	257	20	4	413

Notes:

1. Data for 2000 is based on year 2002.
2. Data for 1990 is based on year 1992.
3. Data for 2000 is based on year 2001.

Source: EUROSTAT, ADC (2001), Canadian Dairy Information Centre, MAF (New Zealand), LIC, Blayney (2002).

76. In **New Zealand**, the vast majority of dairy farms (83%) and cows (76%) are located in the North Island, particularly in the Waikato and Taranaki regions. During the 1990s there has been a significant increase in dairy production in the South Island, specifically in Canterbury and Southland. Farms in the South Island are on average larger than those in the North Island, in terms of both physical size and cow numbers. The average size of new conversions is 650 cows, with a maximum of 1 800 cows (Crawford, 2001). A recent assessment of water quality variables in Southland between 1995 and 2001 indicate that increased dairy farming has been associated with increasing concentrations of dissolved reactive phosphorus (Hamill and McBride, 2003).

77. As part of the rationalisation of the dairy industry in **Australia**, there has been a longer term move in production away from the high-priced land in urban areas and, to a lesser extent, away from the environmentally sensitive coastal river valleys. The net effect has been a reduction in environmental pressures (LWRRDC, 1998). However, the expansion of urban areas is bringing dairy farming into closer contact with communities who may be more concerned about water quality and environment amenity values than about farm productivity. In the shorter term, the deregulation of the state milk marketing arrangements in 2000 has lead to significant adjustment in the industry. Since June 2000, the number of dairy farms has fallen by 15% to just over 11 000 farms. The largest percentage falls have occurred in New South Wales, Queensland and Western Australia where the number of farms has fallen by about one-quarter. In South Australia and Tasmania farm numbers have fallen by about 20%, while the number of farms in Victoria (the largest dairy producing state) fell by only 9%.

78. In **Korea**, dairy farming began in the 1960s to provide drinking milk to consumers and was centred nearby to the main metropolitan areas of Seoul and Incheon, and in the Gyeonggi province. With the rapid development of the Korea economy and increasing urbanisation, the price of land around the major cities has increased dramatically. At the same time, concerns regarding the disposal of dairy effluent lead to the introduction of stricter environmental regulations. Consequently, dairy farms in these regions, particularly those with smaller herds, have ceased milk production, leading to a reduction in the share of production located near the major metropolitan areas (Yoo, 2002).

3.3 Intensity of production

79. In addition to the scale and regional distribution of production, the intensity of production is also important to consider in relation to potential environmental impacts. As discussed in Chapter 2, nitrogen excretion per cow is closely related to yield so that as yields increase so does the quantity of manure. Further, as the number of animals per hectare increases, so does the volume of manure per hectare, increasing the potential for greater environmental problems. There have been significant changes in the intensity of milk production in most OECD countries as defined by variables such as milk produced per cow, the number of cows per hectare and the quantity of milk produced per hectare (Table 3.4).

80. In all countries there has been an increase in *milk yield per cow* over the period 1990-2000, generally averaging between 2-3% per annum. Annual increases above 3% occurred in **Australia**, **Canada**, **Greece**, **Italy**, **Portugal** and **Spain**, with growth of less than 1% only occurring in **Ireland**. In 2000, the average quantity of milk produced per cow varies between 3 641 kg per year in **New Zealand**, to more than double this in **Japan** and the **United States** where over 8 000 kg of milk was produced per cow.

81. There is a positive relationship between country average milk yields and the nitrogen manure output per cow contained in the OECD soil surface nitrogen balance discussed in Chapter 2 (Figure 3.3). Although nitrogen output appears to increase at a diminishing rate as milk yields increase, the results indicate that a one percent increase in milk yield per cow is associated with a 0.42% increase in manure output per cow. However, this relationship explains less than half of the variation in the nitrogen output across countries and (apart from the possibility of errors in these data) explanation of the remaining

variation could be sought in differences in feed and animal characteristics and other features of national milk production systems.

Table 3.4. Intensity of milk production in selected countries

Country	Milk per cow				Cows per hectare[1]				Milk per hectare			
	kg			annual % change	number			annual % change	kg			annual % change
	1990	1995	2000	1990-2000	1990	1995	2000	1990-2000	1990	1995	2000	1990-2000
Australia	3 891	4 481	5 146	3.2								
Canada	5 581	6 217	7 396	3.3								
EU-12	4 569	5 385	5 866	2.8	2.26	2.26	2.28	0.1	10 323	12 164	13 368	3.0
Austria[2]	3 801	4 178	4 428	1.2		1.57	1.47			6 554	6 490	-0.2
Belgium	4 288	4 903	5 561	3.0	4.06	4.05	3.89	-0.4	17 417	19 844	21 623	2.4
Denmark	6 224	6 652	7 371	1.8	3.47	3.08	3.12	-1.0	21 579	20 506	23 012	0.7
Finland[2]	5 850	6 231	6 798	1.8		1.28	1.31			7 952	8 892	2.4
France	4 949	5 495	5 945	2.0	1.71	1.76	1.77	0.4	8 444	9 677	10 516	2.5
Germany[3]	4 787	5 483	5 946	2.4	2.32	2.21	2.20	-0.5	11 087	12 103	13 087	1.8
Greece	3 498	4 158	5 132	4.7	7.25	6.93	8.68	2.0	25 347	28 802	44 535	7.6
Ireland	4 054	4 075	4 426	0.9	1.90	1.99	2.15	1.3	7 685	8 121	9 516	2.4
Italy	4 036	4 830	5 682	4.1	2.61	3.13	3.10	1.9	10 524	15 104	17 609	6.7
Luxembourg	4 795	5 527	5 859	2.2	2.01	1.88	1.83	-0.9	9 622	10 411	10 744	1.2
Netherlands	6 009	6 613	6 647	1.1	3.98	3.79	3.44	-1.3	23 906	25 033	22 878	-0.4
Portugal	4 177	4 610	5 791	3.9	2.51	2.47	2.52	0.1	10 472	11 365	14 599	3.9
Spain	3 600	4 532	4 747	3.2	2.37	2.38	2.79	1.8	8 536	10 789	13 232	5.5
Sweden[2]	6 084	6 863	7 465	1.8		1.38	1.40			9 490	10 471	2.1
United Kingdom	5 366	5 746	6 208	1.6	2.11	2.10	2.16	0.2	11 316	12 059	13 390	1.8
Japan[4]	7 576	8 106	8 566	1.3		4.89				39 640		
Korea	6 007	6 283	7 224	2.0								
New Zealand	3 035	3 272	3 641	2.0	2.40	2.50	2.66	1.1	7 283	8 179	9 685	3.3
United States	6 705	7 441	8 257	2.3								

Notes:

1. Cows per hectare is measured on the basis of the area in fodder production (including pasture and fodder crops) rather than the total agricultural area of farms with dairy cows (which would include arable crops, horticulture etc), taking into account total livestock units kept on farms with dairy cows.

2. For these countries, the annual percentage change in yield is calculated on change between 1995 and 2000 to make the calculation consistent with the other two calculations of annual change.

3. Estimated by the OECD for 1990 and 1995 based on changes in dairy cow numbers.

4. The number of cows per hectare of forage crop production in 1993 (Nagamura, 1998). Another study of six dairy farmers in Japan indicates an average of over 11.2 milking cows per hectare (Masaoka *et al.,* 2000).

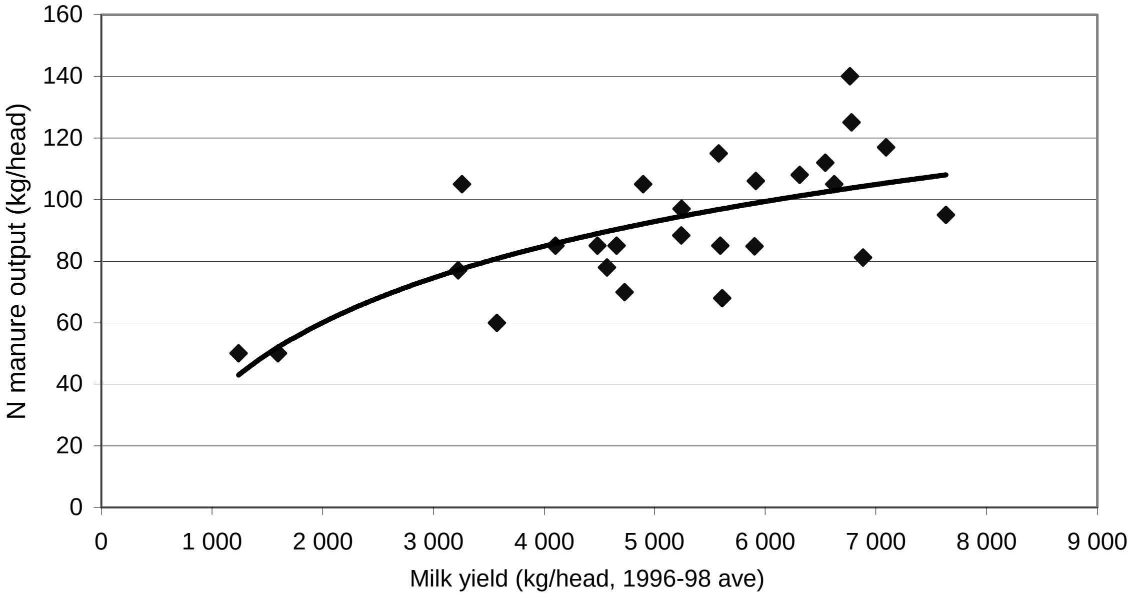
Source: EUROSTAT, LIC (2003), Blayney (2002).

82. There is a much more mixed picture when it comes to the *number of dairy cows per hectare*, as measured in terms of area in fodder production. Increases of around 2% per annum during the 1990s occurred in **Greece**, **Italy** and **Spain**. On the other hand, the number of cows per hectare decreased on average in a number of other countries, notably **Austria**, **Belgium**, **Denmark**, **Germany**, **Luxembourg** and the **Netherlands**. This results from the fact that dairy farms are becoming larger in terms of both the number of animals per farm and the area size of the holding. The average number of cows per hectare involved in dairy production also varies considerably between countries, from just under 1.5 cows per hectare of fodder area in Austria, **Finland** and **Sweden** to over 8 cows per hectare in Greece.

83. Consequently, there have been significant variations in the intensity of milk production as shown by the *quantity of milk produced per hectare* of fodder land on dairy farms. There has been a significant increase in the intensity of production in the southern European countries of **Greece**, **Italy**, **Portugal** and **Spain** of 4% or more per annum. Increases of over 3% occurred in **New Zealand**. Only in **Austria** and the **Netherlands** has the quantity of milk produced per hectare decreased. While **Finland** and **Sweden** have relatively high milk yields of between 7 000-7 500 kg per cow, the low stocking density in these countries

means that they have a much lower level of intensity when measured by the quantity of milk produced per hectare. The lowest level is found in Austria. **Ireland** and New Zealand displaying a similar level of production intensity. **Belgium**, **Denmark** and the Netherlands all produce over 20 tonnes of milk per hectare of land in fodder production, with dairy farms in Greece and **Japan** producing over 40 tonnes.

Figure 3.3. Relationship between nitrogen manure output and milk yields per cow



Source: OECD Secretariat.

84. A difficulty compounding the problem of increased concentration of manure production on farms in countries like **Japan** and **Korea** is that a large proportion of the animal feed is imported. This reduces the options of using livestock manure as a nutrient input on land used for producing animal feed. However, problems relating to the expansion and intensification of dairy operations are not limited to capital-intensive housing systems of dairy production or those relying solely on “brought in feed”. For example, although the pasture based systems in **Australia** are largely extensive when compared to North American and European systems, 30% of the cow’s diet on the average dairy farm now comes from brought in feed. In **New Zealand**, the dry matter intake of the “average dairy cow” is made up of 88.5% grazed pasture, 5.5% pasture silage, 3.0% maize silage, 2% purchased grazing and 1% other supplement (Verkerk, 2003).

3.4 Factors driving changes in structure and practice

85. These developments have been made possible through continuous changes to dairy farm management practices and the adoption of a range of new technologies, some of which are capital-intensive (*e.g.* advanced milking parlours, genetically superior milking cows) and other which are management-intensive (*e.g.* require record keeping, improved nutrition and feeding practices such as rotational grazing). Although many of these practices and technologies are similar across OECD countries and have been contributing to productivity increases in dairy farming over a long period of time, the importance of the different factors and there take-up-rate amongst farmers differs between countries according to the type of dairy farming system employed.

86. For example, the proportion of dairy cows artificially inseminated varies from nearly 100% in **Nordic** and **West European** countries, and 85% in **New Zealand**, to low proportions in some **Southern European** countries (van Arendock and Liiamo, 2003; Verkerk, 2003). Dairy farming systems based on year round calving due to the indoor housing of animals have no need for routine oestrus synchronisation and/or calving induction, a more frequent practise on farms which operate with strong seasonal calving patterns, with the former growing in use, and the second being discouraged (Verkerk, 2003).

87. In **Australia**, productivity and intensity of production have been driven by the increased use of supplementary feeding (silage, concentrates and grain), fodder conservation, soil testing, artificial insemination, synchronised oestrus, defined mastitis control programmes, computers and new dairy shed technologies (ABARE, 2001). In **North America** and **Europe** (particularly the major dairy producing countries of **France**, **Germany**, **Italy**, the **Netherlands**, and the **United Kingdom**), reproductive technology is moving on from artificial insemination of semen to embryo transfer, although use is only carried out in the relatively larger herds (van Arendock and Liiamo, 2003). At the end of 2000 about 500 machine milking robots were in use in Europe, about half of which were in the Netherlands. This technology is finding its way to the early adapters amongst dairy farmers (van Horne and Prins, 2002).

88. The first modern biotechnology to be approved for animal agriculture in the **United States** was bovine somatotropin (bST) for use in the dairy sector, which has been on commercial sale since 1994. Application of recombinant bST to dairy cows typically increases milk yields in the United States by 10-15% although larger increases can be achieved through excellent management. Bovine somatotropin is currently in commercial use in 19 countries, and in the United States it is being administered to more than 3 million cows, about one-third of the dairy herd (Etherton, 2003).

89. Technological developments have contributed to the increase in the scale of production. Evidence from the **United States** suggests that the adoption of capital and management-intensive technologies will considerably improve the production performance of dairy farms (El-Osta and Morehart, 2000). Similarly, the optimal scale of milk production in **Norway** has been increasing significantly over time due to technological change, although the actual scale of milk production has not (Loyland and Ringstad, 2001). The move to larger-scale production has also been driven by attempts to reduce on-farm production costs. Further, not all technologies are capital-intensive, providing a cost advantage to the larger-operations, but they all do require a relatively large investment in human-capital. Increasing herd sizes introduce a number of challenges for maintaining reproductive performance including accurate record-keeping, heat detection, and the drafting and selection of animals for individual events such as artificial insemination.

3.5 Technologies to improve the environmental performance

90. There are many technological options which can contribute to the mitigation of pollution from dairy production. Indirectly, this might be achieved through improvements in the productivity of dairy production, leading to more efficient use of inputs by lowering feed usage, energy and water needs, and reducing water and air pollutants per unit of product (Section 2.7). Other technologies have the potential to directly reduce environmental pollution from dairy farming, and principally concern housing systems, manure storage facilities and technologies for manure treatment.

Table 3.5. Distribution of dairy cow nitrogen (N) manure production by management system in selected countries, 2001

	Total dairy cow N manure production (tonnes)	Manure Management System[1] (% of total dairy cow N manure production)					
		Anaerobic lagoon[2]	Liquid system[3]	Daily spread[4]	Solid storage and dry lot[5]	Pasture range and paddock[6]	Other
Australia	441 989	5	0	2	0	93	0
Canada	167 184	0	53	0	27	20	0
Czech Republic[7]	61 100	0	46	24	21	8	1
European Union							
Austria	37 523	0	19	0	70	11	0
Denmark	78 113	0	73	0	12	15	0
Finland	34 061	0	25	0	47	28	0
France[7]	427 170	0	46	24	21	8	1
Germany[7]	454 401	0	46	24	21	8	1
Ireland	112 663	2	28	0	12	58	0
Netherlands	313 347	0	75	0	0	25	0
Portugal	38 363	0	35	0	35	30	0
Spain	80 433	0	15	25	59	0	1
Sweden	54 490	0	34	0	25	41	0
United Kingdom	264 330	0	31	14	10	46	0
New Zealand	546 789	11	0	0	0	89	0
Norway[7]	30 372	0	46	24	21	8	1
Switzerland	79 686	0	65	0	28	7	0
United States	1095 359	19	14	19	35	11	2

Notes:

1. Manure management systems as defined in Table 4-8 of the *Revised 1996 IPPC Guidelines for National Greenhouse Gas Inventories, Reference Manuel Vol.3*, http://www.ipcc-nggip.iges.or.jp/public/gl/invs6.htm.

2. Anaerobic lagoons: are characterised by flush systems that use water to transport manure to lagoons. The manure resides in lagoons for periods from 30 days to over 200 days. The water from the lagoon may be recycled as flush water or used to irrigate and fertilise fields.

3. Liquid systems (slurry): are characterised by large concrete lined tanks built into the ground. Manure is stored in the tank for six or more months until it can be applied to fields. To facilitate handling as a liquid, water may be added to the manure.

4. Dairy spread: is manure collected in solid form by some means such as scraping. The collected manure is applied to fields regularly (usually daily).

5. Solid storage manure: is collected as in the daily spread system but is stored in bulk for a long period of time (months) before any disposal. Dry lot manure is collected from animals in dry countries which are kept on unpaved feedlots where the manure is allowed to dry until it is periodically removed. Upon removal it is spread on fields.

6. Pasture, range, paddock: the manure from pasture and grazing animals are allowed to lie as is, and is not managed.

7. These countries have adopted the Western Europe default values for the percentage of manure N produced in different management systems, as found in Table 4-21 of the document referred to in Note 1.

Source: OECD Secretariat, based on information contained in 2003 country submissions to the UNFCCC Greenhouse Gas inventory, http://unfccc.int/program/mis/ghg/submis2003.html.

91. Pollutant emissions from *dairy housing*, mainly gas emissions (ammonia, methane, nitrous oxide and hydrogen sulphide associated with odours) can be reduced through changes in the building's ventilation and hygiene, and manure management. There are numerous different systems to lower gas

emissions from dairy housing, but these essentially involve changes to the: design of the floor areas (*e.g.* fully slatted, reduce pit areas); floor covering methods (*e.g.* straw, deep litter); temperature control and ventilation systems (*e.g.* exhaust air cleaning with bio-scrubbers) (Phillips *et al*., 1999; Jungbluth *et al*., 2001). As they can require extensive changes to housing systems, they can be expensive to install in existing buildings and may be better suited for newly constructed buildings.

92. Manure from dairy cows is captured in a range of different *manure storage systems* across OECD countries (Table 3.5). In countries with pasture-based production systems like **Australia** and **New Zealand**, around 90% of nitrogen in manure is deposited on the pasture during grazing. In such systems cows travel to and from the dairy shed, and spend a significant time in the dairy shed pre and post milking. While the share deposited in these areas is small, it can represent a considerable amount of manure that needs to be carefully managed. Over the 1990s there were significant changes in the type of effluent disposal systems used on Australian dairy farms, with a reduction in the number of farms directly disposing of effluent onto the paddock falling by more than half to less than 25% (Riley, 2001). This has been accompanied by a doubling in the number of farms using effluent pond systems. In general, the management of captured systems in Australia is poor (Gourley, 2001). The storage capacity is often too small, manure is mostly applied to readily accessible areas, and rarely is the fertilizer value of the effluent accounted for.

93. At the other extreme, in **Switzerland**, only 7% of manure is directly excreted onto pasture, the remaining 93% is captured in some form. In **Europe**, slurry is generally stored in tanks, but there are different requirements regarding the need for covering. Lagoon storage systems are commonly used in **Australia**, **New Zealand** and the **United States**. While lagoons are cheaper as storage systems than tanks they require larger areas and are less efficient in reducing air pollution (Gronauer and Schattner, 2001). Covering dairy manure storage facilities, whether lagoons, tanks or solid storage piles, can led to a large reduction in air pollutants (Phillips *et al*., 1999; Sommer, 2001).

94. Developments have also been made to improve the *treatment of manure*, including the use of aeration, anaerobic biodigestors, and solid separation and composting, with new methods such as thermal treatments, use of chemical additives and membrane processes (USEPA, 2001; Young and Pian, 2003) These technologies have different end uses, ranging from the extraction of nutrients for compost to the extraction of methane gas for energy production. Other recent developments include the harnessing of solar energy to grow algal biomass on stored manure (Wilkie and Mulber, 2002). However, while there are many promising technologies for the treatment of manure only limited viable markets have been identified and established for the end products due to the economic feasibility of the technology (Williams, 2001).

3.6 Management practices to improve the environmental performance

95. Practices relating to feeding, including the time and area grazed, and manure management within the context of overall farm fertilisation appear to have the most important implications for the environment. Use and uptake of these farm management practices in dairy farming are closely linked to the adoption of the various technologies outlined in the previous section.

96. Changes in *dairy feed composition* or increased *feed conversion efficiency* can lead to a reduction in nutrient excretions per unit of production. A number of studies show that reductions in nutrient loadings from dairy production, particularly for phosphorus, can be achieved through changes in feed composition with either little additional cost to the producer, or in some cases a reported cost saving (Dou *et al*., 2002; Rotz *et al*., 2002, Stokes and Tozer, 2002; Tozer and Stokes, 2001). A review of research in **Denmark** concluded that it seems possible to reduce the nitrogen surplus through better management and feeding without reducing production efficiency (Borsting *et al.,* 2003). Management strategies to improve the accuracy of nitrogen feeding appear to have less of an impact compared to strategies that increase

production per cow which increase nitrogen utilisation efficiency (Jonker *et al.,* 2002). It is also argued that bST improves production efficiency (milk/feed), and decreases animal waste, fossil fuel use and enteric methane (Johnson *et al.,* 1992).

97. The choice of management practice to *spread slurry/manure* on fields can considerably alter ammonia emission levels, nutrient soil surface run-off and leaching. Depending on the timing, methods, climate, soil conditions, crop uptake and other factors, ammonia emissions as a percentage of the nitrogen applied in manure can vary on arable land from 0-40% for the more efficient soil injection method, to 20-100% for broadcast spreading, although timing is critical in minimising ammonia emissions (Sommer and Hutchings, 2001). The incorporate of dairy manure after spreading can also result in a 33-45% reduction in phosphorus run-off, at relatively small to moderate cost to dairy producers (Osei *et al*., 2003). Practices, such as the non-fertilisation of urine-affected areas, can also have a substantial effect on reducing nitrate leaching (Hack-ten Broeke and van der Putten, 1997).

98. Moreover, environmental performance can be enhanced by applying manure and fertiliser at rates that take into account differences in natural productivity among soil types due to water supply, rate of mineralization and the amount of nutrients already in the soil. A more precise application of nutrients, from both manure and fertiliser, will result in a lower amount of fertiliser being used and less lost to the environment (Kuipers and Manderslott, 1999).

99. In most countries, soil analysis and interpretation is now widely recognised as an essential tool for sustainable management. For example, in **Australia** considerable effort has been directed towards defining soil test calibrations, not only for providing fertiliser advice but also to assess environmental risks and impacts (Gourley, 2001).

100. Further practices to reduce the level of water pollution from dairy farming include the fencing of water-ways to prevent access by grazing cattle, the planting of riparian strips along water courses, and the use of alternative crops with higher nitrogen up-take and alternative crop rotation patterns (van Keulen *et al*., 2000). In some countries, keeping cows indoors at night during the grazing season is a viable way to reduce urine excretion on land and decrease nitrate losses by leaching.

101. Another practice that has been extensively explored in recent years is the establishment of wetlands to reduce nutrients, biochemical oxygen demand and faecal coli forms (Blackwell *et al*., 2002). Results indicate reductions in potential pollutants of between 40-100% (Knight *et al*., 2000; Schaafsma *et al*., 2000; Mantovi *et al*., 2003). The feasibility of constructed wetlands varies with climate and while the cost is low, the site must be properly maintained (Cronk, 1996).

102. As with many other technologies and practices to reduce environmental pollution, the more efficient (soil injection) method of manure application in fields is the most costly practice. Another important issue is that a management practice introduced to deal with one environmental aspect can have a detrimental impact on another. For example, in **New Zealand**, while soil injection was found to result in a lower level of ammonia emissions than surface application, the amount of nitrate leached was substantially higher following soil injection (Cameron *et al.,* 1996). Restricted grazing, while decreasing nitrate losses from leaching, increases ammonia volatilization; and while rinsing of slatted floors can reduce ammonia volatilization from housing, it results in a higher volume of slurry (Kuipers and Mandersloot, 1999).

103. Changes in management practices can also be introduced to reduce the emission of greenhouse gases from dairy production. The changes that can be undertaken vary from system to system, and region to region. In **Australia**, the most effective way to reduce GHG emissions is by reducing methane emissions through feeding good quality diets, involving high quality pasture and high energy supplements, and to improve nitrogen fertiliser management (DRDC, 2002). In the **Netherlands**, it is estimated that

dairy farmers can reduce emissions by 20-25% at no great cost (van der Weijden and Kool, 2001). While change in tractor use etc can reduce the level of carbon dioxide emissions, the best chance for reduction relates to nitrous oxide through a more efficient handling of nitrogen in the system, precision application of fertiliser and by reduced grazing in September when nutrients are less well utilised by grass.

104. Farm practices to enhance biodiversity vary according to whether the desired biodiversity is part of farming system or impaired by farming. When the desire is to protect natural reserves and native bush etc, simple practices such as the fencing off of such areas from grazing livestock can be an important step. When the desired biodiversity is part of the dairy farming system, then practices relating to the appropriate application of fertiliser and the timing of mowing etc become more important.

3.7 Environmental comparison of dairy farming systems

105. Comparing the efficiency of different *dairy farming systems* in controlling environmental pollution is complex**.** This is because of the large array of dairy production systems across OECD countries, ranging from indoor to outdoor systems, extensive to intensive units (both indoor and outdoor), through to organic rearing of dairy cows. While one particular system might be highly efficient in producing milk in terms of economic cost it might be poorer in attaining high standards in terms of human health, animal welfare and environmental objectives or vice versa.

106. At present there is little empirical work to validate the competing claims between the relative efficiency, in economic and environmental terms, of different dairy systems and scales of production. The next Chapter reviews the studies that had been undertaken that specifically compare organic and non-organic systems. Although the majority of research studies have been carried out in Europe, it appears that organic systems perform better in terms of soil and water quality, but may perform worse in relation to greenhouse gas emissions. Results from other comparative work indicate that larger, more intensive operations appear to have a higher risk of environmental damage but these may be managed.

- A major study classified all dairy farms in the **European Union** into one of ten broad dairy systems based on management practices, location and resources. It concluded that four high input/output production systems, accounting for 84% of EU milk production, had an overwhelming negative impact on the environment. Two ecologically valuable dairy production systems were identified, accounting for only 6% of production (CEAS, 2000).

- In Florida, **United States**, the accumulation of phosphorus in soils on highly intensive dairy production was 20 times higher than on pasture dairy production (Graetz *et al.*, 1999).

- Similarly, studies in **Australia** indicated that the risk of phosphorus loss increases on farms with high stocking rates and a greater reliance on supplementary feeds (Gouley, 2001).

- A comparison in **New Zealand** showed that while nil and restricted grazing systems would reduce nitrate leaching compared to convention grazing systems, the nil grazing system had higher overall nitrogen losses because of increased gaseous emissions (de Klein and Ledgard, 2001). The nil grazing system was also less economically viable, providing a negative return on capital, while the profitability of a restricted grazing system depended on whether an effluent application system was already in place (de Klein, 2001).

- A study of farm size, intensity and regional concentration of livestock production in **Canada** found that two of the major high-density livestock areas were among small-scale, less intensive dairy farms in Quebec and Ontario (Beaulieu, 2001). The cumulative impact of several non-intensive small farms may be comparable to the impact of a few large intensive farms.

- In the **Netherlands**, nitrogen surplus per hectare was found to be highly depended upon milk quota per hectare and the amount of concentrates per cow per year (Rougoor *et al*., 1997). A study of dairy farmers in the **Netherlands** concluded environmental efficiency is positively related to milk yield, but negatively related to the herd size and the quantity of feed that is purchased per cow. Other factors influencing environmental efficiency included agricultural education (positive), age (negative) and the type of soil on which the farm operated (Reinhard *et al*., 2002).

- A recent review of **Dutch** dairy farming concluded that farm management is a more important factor in the improvement of nutrient efficiency and reduction of nutrient surplus than farm structure (Ondersteijn, 2002). Another study of Dutch dairy farmers concluded that the main farmer characteristic explaining improved environmental management was education – better educated farmers could increase production and cope with the environmental consequences (Ondersteijn *et al*., 2003)

107. A number of policy issues arise from this discussion. How can the polluter-pays-principle (PPP) be applied so that all dairy producers, regardless of their scale or system of production, are encouraged to account for the full external costs resulting from environmental pollution? What is preventing the uptake of various technologies and management practices to improve the environmental performance of dairy farms, and what can be done about? What is the appropriate policy mix to encourage the provision of environmental services? In all cases it is important to establish the cost and benefit implications for the various alternative policies that could be implemented.

4. Environmental impacts of organic dairy systems

- On the basis of the studies reviewed, predominately European based, organic dairy systems appear to have a less stressful impact on the environment than conventional systems.
- In particular, organic dairy systems generally have less impact on water quality and have a beneficial impact on soil quality mainly due to the better management of farm inputs. Differences between systems in relation to biodiversity, landscape and air quality are less well defined, with organic dairy production likely to have higher methane emissions than conventional systems.
- The studies also highlighted that while organic systems perform environmentally better on a per hectare basis, the difference when measured on a per kilogram of milk reduces substantially.
- These results lead to a number of policy implications including the need to evaluate the environmental performance of organic dairy farms when support payments are provided, the conflict with current support policies which encourage increased production per hectare, and the need to include extension and advisory services to ensure that appropriate management practices are adopted.

108. Organic production is considered to be environmentally sustainable by its proponents, and this is often cited as the major reason for government intervention. For their part, consumers perceive important environmental benefits and appreciate the health aspects of synthetic pesticide-free products, for which they are prepared to pay a price premium. But is this the case for organic dairy production? This chapter attempts to evaluate the environmental impacts of organic versus non-organic dairy systems. The first section provides an overview of the environmental comparison, with a more detailed comparison of farming systems by agri-environmental indicator in section two. The final section draws some conclusions and policy implications.

4.1 Overview of environmental impact

109. There is no single definition of organic dairy farming, and variations exist between standards set down in national legislation and/or private bodies. Nevertheless, some of the key characteristics would include: protecting the long-term fertility and quality of the soil; providing nutrients in natural and organic fertilizers; weed, disease and pest control through crop rotations, natural predators, diversity, organic manuring, and limited biological and chemical intervention; and extensive management of livestock (Stockdale *et al*., 2001).

110. Differences between organic and conventional farming systems will vary from country to country. For example, organic farms in **New Zealand** do not have large numbers of housed animals to provide bulk manure for nutrient supply. Further, the conventional clover-based pasture dairy systems in New Zealand are perhaps more similar to the organic farming concept than they are to the conventional dairy farming systems involving animal housing and feedlots in **Europe** or the **United States**. Another difficulty is that mixed farms are more common within organic farming systems, although specialized arable, horticultural and livestock operations exist. IFOAM principles highlight the importance of creating a harmonious balance between crop production and animal husbandry (IFOAM, 2002).

111. Organic dairy farming is assessed in this study by evaluating its resource use and environmental impact relative to conventional farming systems. This follows the methodology adopted by Stolze *et al.* (2000) and Dabbert (2003). An alternative methodology for evaluating organic systems would be to compare the outcome of organic farming with some specific environmental targets. However, since these targets very rarely exist, such an approach cannot be undertaken.

112. The comparison is made across the following selected range of OECD agri-environmental indicators: farm input and resource use, soil quantity, water quality, air quality, biodiversity and landscape (OECD, 2001*a*). Two additional indicator categories are included in this study, animal health and welfare, and product quality, because these are often cited as important reasons for supporting and/or consuming organic products (Table 4.1).

Table 4.1. Assessment of organic dairy farming's impact on the environment compared to conventional dairy farming[1]

INDICATORS	++	+	0	-	--
Farm input and resource use					
Nutrient use		X			
Water use			?		
Pesticides	X				
Energy use		X			
Soil quality					
Soil organic matter		X			
Biological activity	X				
Structure		X			
Erosion			?		
Water quality					
Nitrate leaching		X			
Phosphate leaching (Eutrophication)		X			
Pesticides	X				
Soil			?		
Air quality					
Carbon dioxide (CO_2)			X		
Nitrous oxide (N_2O)		X			
Methane (CH_4)				X	
Ammonia (NH_3)			X		
Biodiversity					
Genetic diversity			X		
Species diversity		X			
Habitat diversity			?		
Landscape			?		
Animal health and welfare					
Health			X		
Welfare		X			
Food quality			X		

Note:

1. Organic dairy farming performs: ++ much better, + better, 0 the same, - worse, -- much worse than conventional dairy farming; where no data were available, the rating is shown by a "?". Borders indicate subjective confidence interval of the final assessment which is marked as "X".

Source: OECD Secretariat.

113. The assessment is made by reviewing scientific studies that specifically compare the impact of organic and conventional dairy systems across one or more of the relevant indicators. Currently, there are a limited number of scientific studies comparing organic systems with non-organic systems in general – and even less specifically comparing dairy systems. The large majority of the comparative dairy studies are from European countries. Care therefore must be made in interpreting the results for the OECD as a whole because differences between organic and conventional systems vary across countries. However, the limited studies that have been included from non-European sources draw similar conclusions to the European based studies.

114. The hypothesis behind the comparison is that there is no difference between organic and conventional farming. The decision as to whether organic dairy farming performs ++ much better, + better, 0 the same, – worse, or – – much worse than conventional dairy farming, with regard to specific environmental indicators, is subjective, and based on the reviewed studies. Acceptance of the hypothesis comes about when there is no clear evidence that a difference between the two systems exists. When there is no information available to compare between systems in relation to a particular indicator a "?" is shown. A subjective confidence interval highlights where variation between results exists.

4.2 Comparison by agri-environmental indicator

4.2.1 Farm input and resource use

115. The efficient and economical use of farm inputs and natural resources is a prerequisite for sustainable agriculture. Farm input and resource use is measured by use variables for four factors: nutrients, water, pesticides and energy.

- *Nutrient use* – As organic farms rely heavily on internal nutrient cycling, their nutrient balances should be lower than on conventional farms and generally close to zero. A study in **Denmark** found that surpluses of nitrogen (N) on organic dairy farms are significantly lower than on conventional dairy farms, while deficits of the growth-enhancing nutrients, phosphorous (P) and potassium (K) prevail, although results vary depending on the level of feed self-sufficiency (Hansen *et al.*, 2001). A comparison of dairy farms in the **Netherlands** reported significantly lower surpluses of nitrogen and phosphorous on organic farms, measured a per-hectare basis. If measured in terms of surplus per kg of milk, the difference between production systems still exists, though much smaller (OECD, 2000*c*). Other comparative studies of dairy farms in Denmark and the **Netherlands** reported similar findings (Stolze *et al*., 2000).

- *Water use* – Lack of comparative studies specific to dairy farming prevents any conclusion.

- *Pesticide use* – The use of synthetic pesticides is banned in organic farming.

- *Energy use* – A study comparing farming systems in **Denmark** found almost identical use of *direct* energy *i.e.* fuel, electricity and energy for housing and machinery, but a lower use of *indirect* energy on organic farms because they do not use agro-chemicals and have a lower requirement for energy-demanding feed products (Dalgaard *et al.*, 2003). This result is supported by other studies in Denmark, **Germany** and **Sweden** which also indicate a lower energy use on organic dairy farms relative to conventional dairy systems on a per hectare basis (Cederberg *et al.*, 1998; Haas *et al.*, 2001; Hansen *et al.*, 2001). On a per unit of output basis, the studies show that energy use per unit of milk produced for organic dairy farming is at least equal or less than in conventional dairy farming. Work by the Federal government in Germany found that one tonne of organic milk needs 1 474 MJ energy whereas one tonne of conventional milk requires 2 721 MJ energy (Bockisch *et al.*, 2000). Certain management practices, such as the feeding of grass pellets, can raise the energy requirements per unit of milk to a level close to that of conventional dairy farming.

4.2.2 Soil quality

116. Enhancing soil quality is essential for maintaining agricultural productivity and can be degraded by physical, chemical or biological processes. These processes are closely linked to management practices, climate and technology. Four indicators of soil quality on dairy farms are reviewed: soil organic matter, biological activity, soil structure and erosion.

- *Soil organic matter* – In principle, organic dairy farms should have a higher degree of organic matter in soils due to the practice of maintaining soil fertility using manure and organic material rather than chemical fertilisers. While there are many comparative studies confirming this for crops and horticultural production, only one comparative dairy study was found. In **Norway**, the organic dairy farming was found to significantly increase the carbon content of soils that originally contained less than 1.7% of their weight as carbon (Hansen, *et al.*, 2001).

- *Biological activity* – Encouraging a high level of biological activity in the soil is a major aim of organic farmers. Agro-chemicals are known to affect soil decomposers. The supply of organic manure also influences the number of earthworms in the soil. Studies in **Denmark** and the **United States** have found that the earthworm population density is significantly higher in organic dairy farms compared with conventional dairy farms (Axelsen *et al.*, 1998; Vazquez *et al.*, 2003). Another study in Denmark found that microbial biomass C was higher in organically than in conventionally managed dairy soils (Schjonning *et al*., 2002). A study of dairy farms in transition in **New Zealand** found a marginal increase in the level of soil microbial activity compared to conventional farm sites (Macgregor, 2002).

- *Structure* – A well-structured soil is an important component for sustaining yields and preventing soil erosion. The addition of organic matter and the activities of earthworms enhance soil structure but it can be damaged by soil compaction caused by the passage of vehicles. Soil structure can be measured by a number of parameters including the stability of aggregates, coarse pores, air and water holding capacity. Comparative studies of organic systems in general have been mixed in relation to the impact of organic agriculture on soil structure (Stockdale *et al*., 2001; Stoltze *et al*., 2000). A study in **New Zealand** found that biodynamic dairy farms had a better soil structure in terms of a soil which broke down more readily to a good seedbed, a lower soil bulk density and lower penetration resistance, although results were mixed in relation to soil respiration (Reganold *et al*., 1993).

- *Erosion* – Lack of comparative studies specific to dairy farming prevents substantiated comment.

4.2.3 Water quality

117. Agriculture can be an important contributor to water pollution. The principal sources of water pollution from agriculture include nutrients (in particular nitrate and phosphate), pesticides and soil sediments. Differences between organic and conventional dairy farms in relation to water pollution from these four sources are considered.

- *Nitrate leaching* – Lower stocking densities and lower inputs of nitrogen suggest that nitrate (NO_3) leaching from organic dairy farms will be less in comparison to conventional farms although water pollution may occur through poor management of the organic farm. For example, ploughing in grass and legumes at the wrong time with no subsequent crops to capture the mineralised N; low feed self-sufficiency; and composting farmyard manure on unpaved surfaces can all increase the possibility of nitrogen leaching in organic systems. Field investigations comparing nitrate leaching between organic and conventional dairy farms in **Denmark** and **Scotland** show lower levels of nitrate leaching from organic dairy farms on a per hectare basis (Hansen *et al.*, 2001). Computer simulations in **New Zealand** and the **United States** predict that organic systems are likely to result in lower nitrogen leaching loses than the comparable dairy conventional system (Digiacomo *et al*., 2001; Condron *et al*., 2000).

- *Eutrophication* – Phosphate (P_2O_5) pollution and eutrophication of surface water occurs less in organic farms (Regouin, 2003), although organic farming can carry a high risk of P_2O_5 leaching where fields are receiving or producing sources of organic matter (animal manure, green manure, clover grass) (Hansen *et al.*, 2001).

- *Pesticides* – The use of *synthetic* pesticides is banned in organic farming and so therefore water quality should improve. The risks associated with pesticides allowed in organic farming have hardly been investigated. The limited number of disinfection measures allowed reduces the possibility of polluting waste water originating from milking barns.

- *Soil (erosion)* – Lack of comparative studies specific to dairy farming prevents any conclusion, but one study in the **United States** indicates a reduction in sediment loss on organic dairy farms (Digiacomo *et al*., 2001).

4.2.4 Air quality

118. The most important greenhouse gas emissions are carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4). Agriculture, and especially the dairy sector (Chapter 2), can contribute to the emission of such gases. In addition, agriculture also contributes to air contamination through ammonia (NH_3) volatilization.

- *Carbon dioxide (CO_2)* – Differences in emissions of CO_2 are mainly caused by differences in the use of fossil energy. A comparative study in **Sweden** estimated higher emission rate per kg of milk on organic farms mainly due to increased tractor use, while studies in **Germany** and the **United Kingdom** estimated organic farms had lower per kg milk emission rates (Stolze *et al*., 2000; Bockisch *et al.*, 2000; Haas *et al.*, 2001).

- *Nitrous oxide (N_2O)* – Nitrous oxide is emitted from a number of farming activities including inorganic fertilizers, manure and the application technique. A study in **Germany** found lower emissions of nitrous oxide in organic dairy farming (Haas *et al.*, 2001), although a **Swedish** study found higher NOx emissions per kg milk on organic dairy farms than on conventional dairy farms (Stolze *et al*., 2000; Haas *et al.*, 2001).

- *Methane (CH_4)* – The main source of methane is enteric fermentation from ruminant livestock. Studies in **Germany**, the **Netherlands** and **Sweden** conclude that there are higher emissions of CH_4 on organic dairy farms because the lower stocking density is more than offset by the increase share of fodder in the cows' diet, which increases methane emissions per unit of milk produced (Stolze *et al*., 2000; Haas *et al.*, 2001; de Boer, 2003).

- *Ammonia (NH_3)* – Studies draw different conclusions because the level of ammonia emission depends heavily on the animal housing and manure management systems in place. Studies in **Germany** and **Sweden** found that organic dairy farms emit lower amounts of ammonia because of their lower stocking rate and lower milk production (resulting in lower N-excretion) compared to conventional farms (Haas *et al.*, 2001). Analysis of the **Netherlands** claims that ammonia emissions remain high for organic animal production on the basis of per unit of output (de Boer, 2003).

4.2.5 Biodiversity

119. In the context of OECD agri-environmental indicator work, the biodiversity impact of agriculture is considered at three levels: genetic diversity (the diversity of genes within domesticated plants and livestock species and wild relatives); species diversity (the number and population of wild species affected by agriculture); and habitat diversity (the ecosystems formed by populations of species relevant to or dependent upon agriculture. Dairy organic and conventional production systems are assessed in relation to all three areas.

- *Genetic diversity* – In general, the same cultivars and breeds are used in organic dairy farming as in conventional dairy farming (Regouin, 2003; Haas *et al.*, 2001).

- *Species diversity* – In general, the diversity of grassland species on all farms is low compared with the situation 30-40 years ago. Due to the prohibition of the use of agro-chemicals and the more extensive grazing regimes for dairy cows, many studies have concluded that insect and bird life are more diverse on organic farms. For permanent grassland higher biodiversity is observed in favour of organic farming compared to conventional farming (Younie *et al.*, 1997).

- *Habitat diversity* – The creation and maintenance of hedgerows and trees to shelter grazing livestock also has the effect of stimulating the presence of wildlife and creating diversity in the habitat. This practice is not, of course, unique to organic farms, but conventional farmers generally lack the ideological motivation to do this (Regouin, 2003). Further, because more of the farmland that has been converted to organic production lies in less favoured areas like mountain or low-yield regions than in more productive regions, the existence of higher habitat biodiversity on these farms may be due to their location rather than whether they are organic or not (Stolze *et al*., 2000). The absence of comparative studies specific to dairy farming prevents any conclusion.

4.2.6 Landscape

120. Some of the benefits claimed for organic farming include the presence of attractive landscape features such as ponds, hedgerows and trees to provide shade for livestock. These elements can make organic farms markedly different from conventional farms in some situations. The creation and maintenance of a diverse landscape is frequently the result of certain management needs, such as animal welfare. It is sometimes argued that intensive production systems require a smaller area to produce the same quantity of output and therefore, in theory, any remaining land could be dedicated to nature preservation. However, the landscape and related biodiversity resulting from this outcome will be different from that associated with land in organic production. The lack of comparative studies specific to dairy farming prevents any conclusion.

4.2.7 Animal health and welfare

121. As an indication of the growing interest in the animal health and welfare aspects of organic farming, a number of research reviews have been recently undertaken (Sundrum, 2001; Hovi *et al.*, 2003; and Lund and Algers, 2003). The results of these surveys are summarized here.

- *Health* – Organic dairy cows tend to have a longer average productive life than conventional dairy cows. There are indications of a better standard of health in animals on organic farms because of lower production levels, hence lower physical stress. Some comparative studies found decreases in the incidence of mastitis and metabolic diseases in organic dairy cows; others found no difference. Similarly, data reflecting reproductive performance and fertility are contradictory. Studies of organic dairy farms tend to find issues such as the appropriate treatment of mastitis and the control of external and internal parasites to be among the most important management issues for farmers.

- *Welfare* – Outdoor grazing is normally offered to organic dairy cows. Usually, the minimum area per head of cattle in a barn is larger on organic dairy farms than on conventional farms. For example, EU Regulation 1804/1999 for organic livestock production, stipulates the minimum area per head of cattle (which is larger than under conventional production) and requires regular inspections to ensure that minimal standards are met. However, besides housing conditions, there are factors which may not be regulated but which affect animal welfare including patterns of feeding, climatic factors and hygiene.

4.2.8 Food quality

122. Food quality is one area that has received much attention in the debate between organic and conventionally produced foods. Food quality in this context is limited to studies that have examined the nutritional value, sensory quality and food safety issues of milk produced by organic and conventional dairy systems. Recent reviews of such studies indicate that there is very little difference between systems in terms of these aspects of food quality (Bourn and Prescott, 2002; Kouba, 2003; Tauscher *et al.*, 2003).

123. In terms of nutritional value, no major differences have been established between organic and conventional milk, although organic milk may contain slightly more calcium. There have been very few sensory quality studies on milk, and none of these suggest there are differences between organic and conventional milk. Studies have also found no differences between the microbiological count of organic and conventional milk. There is some evidence that compared to conventional milk, organic milk has lower levels of mycotoxins (toxic compounds linked to cancer, immunosuppressive action etc).

4.3 Implications of the comparative analysis

124. Based on the research surveyed, most indicators of soil and water quality *i.e.* soil organic matter, biological activity, soil structure, and nitrate, phosphate and pesticide leaching, generally show positive impacts of organic dairy farming in comparison to non-organic dairy farming systems. These reflect a better use of farm inputs such as nutrients, pesticides and energy. For some indicators like genetic diversity, carbon dioxide, ammonia, and animal health there is no conclusive evidence that there is any difference in the effect on the indicator under either system. Evidence from the different studies is often contradictory. For other indicators, *i.e.* water use, habitat diversity, landscape, erosion and soil in water quality, the lack of comparative studies specific to dairy farming prevents any judgment between the systems.

125. On the other hand, organic dairy systems are likely to lead to higher methane emission levels than on conventional dairy farms, with the possibility of higher levels of nitrate and phosphorus leaching, carbon dioxide emissions and animal health concerns depending on farm management practices. In the final assessment, the comparative environmental performance of organic dairy farming, and organic farming in general, should be considered in terms of its broad impact on a range of variables rather than its impact on any specific indicator.

126. An important issue arising from a number of studies concerns the relevant unit for assessing and comparing the potential environmental impacts of organic and non-organic dairy farming. In general, the

more favourable environmental performance of organic systems is greater when measured on a per hectare basis, but reduces when compared on a per unit of output basis.

127. There are a number of policy implications that can be drawn from this analysis.

- The mixed results indicate that governments need to quantify the environmental benefits and costs arising from conversion to organic dairy farming if they wish to achieve effective environmental benefits from supporting organic agriculture through monetary payments. Moreover, the financial incentive structure of support means that those farms that have less changes to make to their operations will convert first, implying that that the environmental change resulting from conversion will be less. Other issues relating to the impact of organic farming on society may also be important to consider.

- When included in their analysis, some studies suggest that variations between organic and conventional dairy systems diminish when measured on a per product basis. In this regard, it should be noted that almost all support for organic farming is provided in the form of per hectare payments rather than on the basis of outputs or inputs used (Chapter 8).

- The benefits that are to be derived from conversion to organic farming may be undermined by agricultural support policies which encourage increased production per hectare. Where organic farmers are also subject to the same price support policies as conventional farmers, they have the same an incentive to increase production per hectare. However, organic farming requirements, such as those setting maximum stocking density and the principle of achieving a balance between inputs and outputs, will limit the response of organic producers.

- Payments for organic production provide an incentive to produce “organically” rather than to produce using other farming practices and systems that can be just as environmentally friendly. While organic farming can provide a range of environmental benefits, an alternative way to reduce pollution from agricultural activities may be to implement an appropriate tax regime or regulations. Support for organic farmers should not detract governments from efforts to ensure that all farmers take into account the pollution they cause.

- Governments need to play a role in ensuring that labelling and promotional claims for organic products can be substantiated by scientific analysis as organic farms have the potential to outperform conventional farms on a number of environmental variables.

- If governments wish to support organic dairy farming for environmental it is important that farmers are provided with adequate research and extension, including for areas where they can perform below conventional farming otherwise the environmental benefits may not arise.

5. Agricultural policies supporting dairy production

- Support levels for milk are, with just a few exceptions, high in most countries, and are higher than for most other commodities within countries.
- Market price support (tariffs and export subsidies) is the main form of support provided to milk producers, which explains the large annual variations in the level of support.
- Many countries impose quantitative restrictions on production in the form of farm level milk quotas.
- Those countries with the highest levels of support for milk are also the countries with the highest risk to water pollution from dairy production.
- The link between changes in support levels and environment risk is much more difficult to discern. Reductions in support are likely to lead to an increase in the scale of production and a change in the regional distribution of production.

128. Over recent years there have been considerable developments in both agricultural support and environmental policies. Agricultural support policies have been affected by the WTO Uruguay Round Agreement on Agriculture (URAA) commitments to reduce the level of support provided through trade measures such as quotas, tariffs and export subsidies, and other production distorting support. Regional and bilateral trade agreements and unilateral decisions to reform support policies have also had an effect on the level and form of support. At the same time, the number and strength of policies to address environmental issues in agriculture has been increasing in response to growing public concern about the environmental impact of agriculture. This chapter considers the agricultural policy measures that support dairy farmers in OECD countries, drawing on the OECD's PSE/CSE database, supplemented with information on tariffs and export subsidies. Policy measures introduced to address environmental issues associated with dairy production are described in Chapter 7.

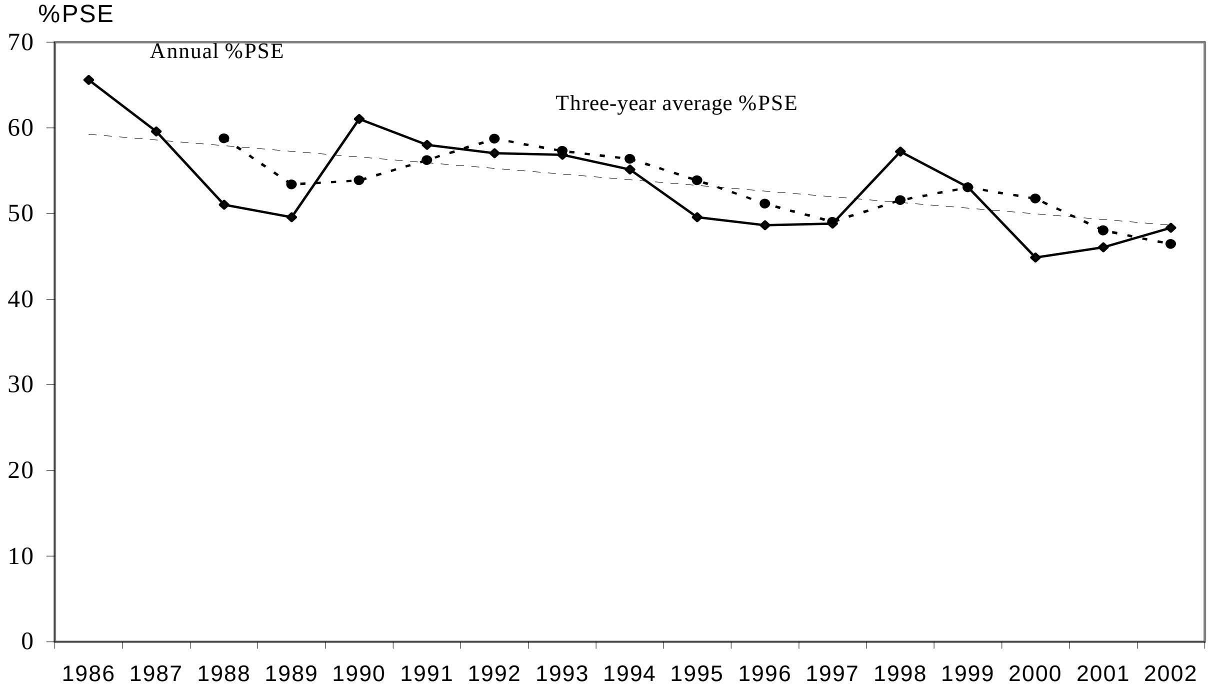
5.1 The level of support at the OECD level

129. Every year the OECD calculates the level of support provided to producers through agricultural policy measures: the Producer Support Estimate (PSE).[1] The percentage PSE (%PSE) expresses the monetary value of support as a share of gross farm receipts.[2] A notable feature of the %PSE for milk, calculated at the total OECD level, is the downward trend in support since the early 1990s, falling from a high of 59% in 1986-88 to 46% in 2000-02 (Figure 5.1). Around this downward trend there have been some annual variations caused by market price changes (see Section 5.5).

1. The PSE is an indicator of the annual monetary value of gross transfers from consumers and taxpayers to agricultural producers (in this case specifically milk producers), measured at the farm-gate level, arising from policy measures that support agriculture, regardless of their nature, objectives or impacts on farm production or income.

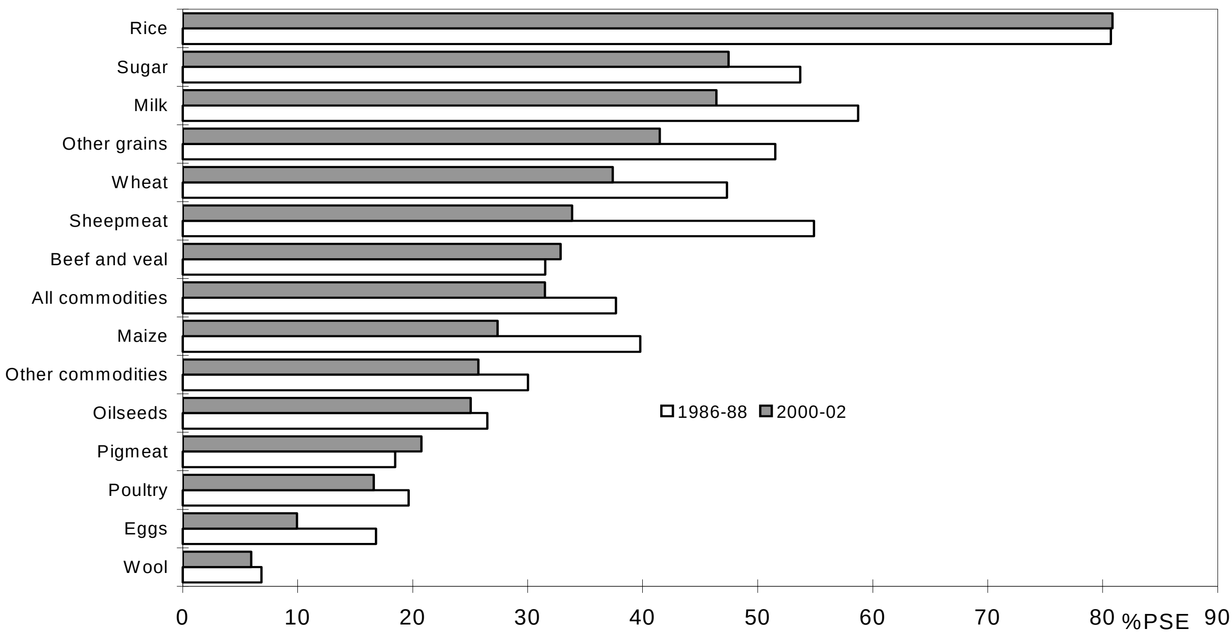
2. Gross farm receipts is the sum of the gross value of transfers arising from support policies *i.e.* the PSE, plus the returns obtained from the market. A %PSE of 25% for example, means that the value of support is equivalent to 25% of the value of gross farm receipts; in other words, a quarter of gross farm receipts come from support policies.

Figure 5.1. OECD average Producer Support Estimate for milk, 1986-2002
Per cent of value of gross farm receipts



Source: OECD PSE/CSE database, 2003; see Annex Table 5.1 for further details.

Figure 5.2. Producer Support Estimate by commodity, 1986-88 and 2000-02
OECD average as a per cent of value of gross farm receipts



Source: OECD PSE/CSE database, 2003.

130. Expressing support as a share of gross farm receipts allows comparison to be made between the level of support provided to milk relative to other commodities (Figure 5.2). Along with rice and sugar, milk is one of the highest supported commodities. Support for milk is significantly higher than that provided to other livestock products such as beef and sheepmeat. The decrease in the %PSE for milk between 1986-88 and 2000-02 is similar to the trend in support levels observed for almost all other agricultural commodities. Since 1986-88, a greater reduction has occurred in support for milk than for rice and sugar, but less than the decrease in support for sheepmeat which was almost as high in the base period.

131. While this analysis focuses on the PSE for milk, dairy farmers in many OECD countries not only produce milk but other commodities, particularly beef. For example, in the **European Union** about two-thirds of meat originates, directly or indirectly from dairy herds, contributing an additional 10% to the value of agricultural output from dairy farms. The practice of cross-breeding to beef breeds or the existence of traditional, dual-purpose breeds is of particular importance in **France**, **Greece**, **Portugal** and **Spain**, and to a lesser degree in **Belgium**, **Ireland** and the **United Kingdom** (EC, 2002*a*). Consequently, the transfers that dairy farmers receive are not limited to those received for milk. Furthermore, changes in the level of support for different commodities can influence the production mix on an individual farm.

5.2 Comparison of support levels between OECD countries

132. Within the total OECD PSE there are significant variations between countries in the level of support provided to milk (Figure 5.3). Support levels in 2000-02 were highest in **Japan, Korea** and the non-EU European countries of **Iceland**, **Norway** and **Switzerland** where over 70% of gross farm receipts for milk are generated by support policies. In the **European Union**, **Hungary** and the NAFTA countries of **Canada**, **Mexico** and the **United States**, support ranges between 45-55%. In the **Czech Republic**, **Slovak Republic** and **Turkey**, support average just over 30%. Support has been very low throughout the whole period in **New Zealand** and **Poland**.

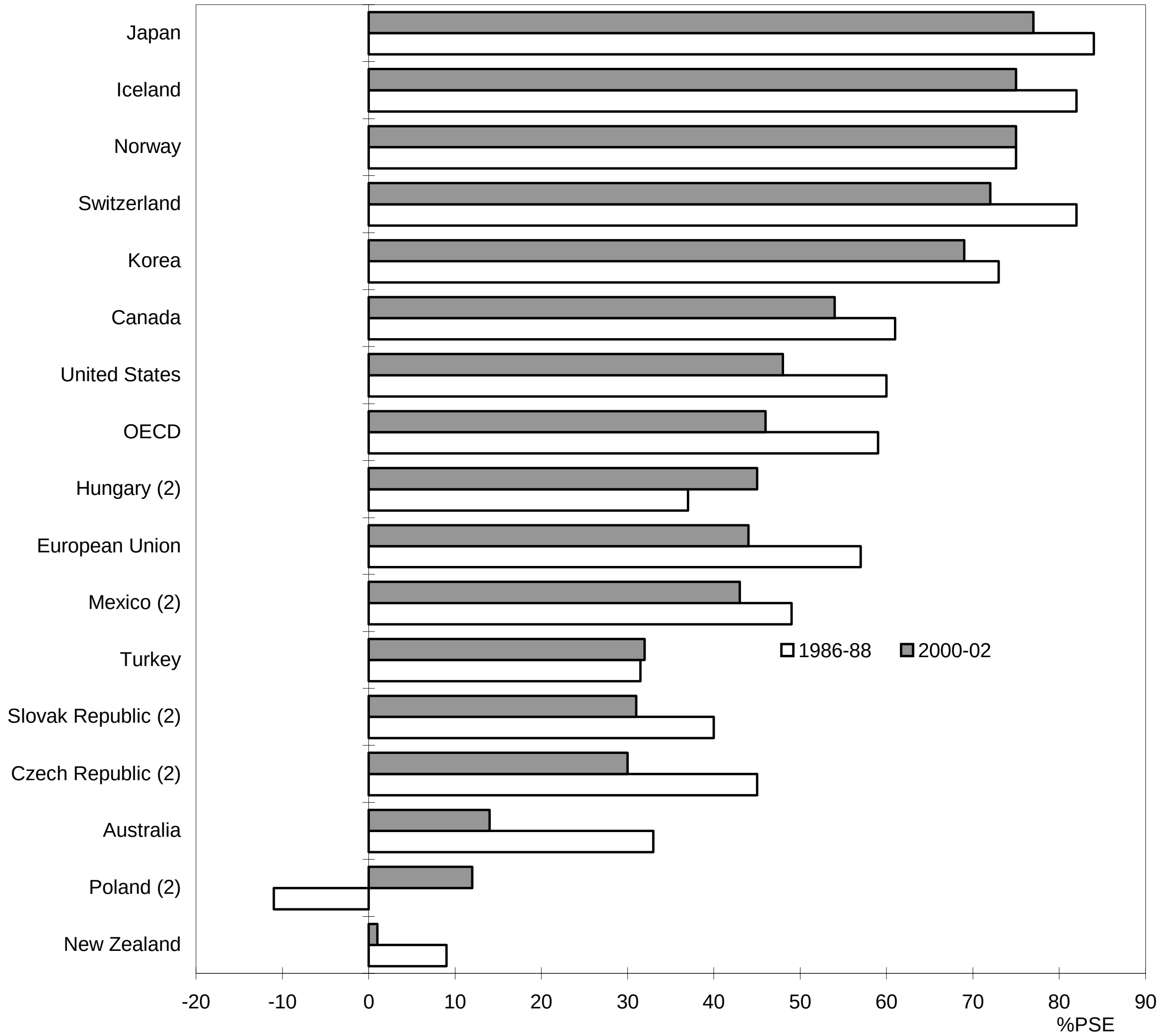
133. Between 1986-88 and 2000-02 there has been a reduction in the level of support provided to milk in all countries except **Norway** where it has stayed the same, and in **Hungary** and **Poland** where it has increased. The reduction in support has been most significant in absolute terms in **Australia**, the **Czech Republic**, the **European Union**, **Switzerland** and the **United States**, with a reduction in the %PSE of more than ten percentage points, while the greatest proportional decrease occurred in **New Zealand**. The %PSE for milk is generally higher than for most other commodities in all countries. Throughout the whole period, support to milk in the European Union, Japan and the United States contributes around three-quarters of the OECD total (Annex Table 5.1).

134. The level of support can also be expressed on a product weight basis (Annex Table 5.2).[3] On average, transfers from consumers and taxpayers to milk in **Iceland**, **Japan**, **Norway** and **Switzerland** amounted to over USD 0.50 kg in the period 2000-02, while producers in **Australia** and **Poland** received just USD 0.02 kg and producers in **New Zealand** receive virtually nothing. Dairy producers in the **European Union** and the **United States** received on average USD 0.15 and USD 0.13per kg of milk respectively during the same period.

3. Derived by dividing the PSE (in monetary terms) by the quantity of milk produced.

Figure 5.3. Producer Support Estimate for milk by country, 1986-88 and 2000-02[1]

Per cent of value of gross farm receipts



Notes:

1. Countries are ranked according to 2000-02 levels.

2. For the Czech Republic, Hungary, Mexico, Poland and the Slovak Republic, 1991-93 replaces 1986-88.

Source: OECD PSE/CSE database, 2003; see Annex Table 5.2 for further details.

5.3 Composition of support policies

135. In addition to the level of support, the way in which support is provided is also important, particularly when understanding the effects of support policies on factors such as production, trade, farm

income and the environment.[4] A study in the crop sector found that *market price support* (*e.g.* tariffs, administered prices, export subsidies etc.), *payments based on output* (*e.g.* deficiency payments etc.) and *payments based on input use* (*e.g.* fertiliser subsidies etc.) are more production and trade distorting, and less efficient at increasing farm household income than payments based on area (OECD, 2001*b*).

136. The impacts of agricultural support measures on the environment are more complicated to evaluate and largely depend on the distortions they introduce into farm-level decision-making. In general, the more a measure is linked to an output or an input (*i.e.* those classified as *market price support, payments based on output* and *payments based on input use* in the PSE), the higher is the pressure on the environment through effects on the scale and location of production, input usage and structure. For example, output-linked support creates a greater incentive to increase production of specific agricultural commodities. Adverse environmental impacts occur in so far as farmers make more intensive use of environmentally harmful inputs or the use of environmentally sensitive land, driven in part by increased land prices. Agricultural policies that increase livestock production also imply an increase in the volume of manure. Constraints on providing support (*e.g.* through production quotas or environmental cross-compliance) and restrictions imposed by regulations may help to reduce the environmental impacts of support measures. By lowering those forms of support most closely linked to outputs or inputs, and shifting to direct payments and other less production linked ways of providing support, policy reforms have in many cases generated a double benefit. They have resulted in a more efficient allocation of resources, have reduced environmental damage and enhanced the provision of certain positive environmental services.[5]

137. While there is some variation between countries in terms of the composition of support provided to dairy producers, the most distortive categories of support dominate (Table 5.1 and Annex Table 5.3). *Market price support* has traditionally been the most dominant support category in all OECD countries except **New Zealand** and has remained so with only a few exceptions. However, market price support in **Canada**, the **European Union**, **Norway** and **Switzerland** has been accompanied by restrictions on the level of production, *i.e*. milk quotas. *Payments based on input use* is the next most important category of support, with every OECD country calculated to be providing support measures to dairy farmers that are classified in this category. *Payments based on output* are relatively important in **Iceland**, **Norway** and the **Slovak Republic**; *payments based on animal numbers* in the **Czech Republic**, **Norway** and Switzerland; and *payments based on historical entitlements* in **Australia** and **Switzerland**.

138. Since 1986-88, there have been changes in the composition of support in most countries. On the positive side, there has been a reduction in some of the most distorting categories of support. *Market price support* measures have been removed in **New Zealand** and virtually in **Australia**, and have lowered in importance in the **Czech Republic**, the **European Union**, **Iceland**, **Japan**, **Korea**, **Mexico**, the **Slovak Republic**, **Switzerland** and the **United States**, in some cases by a significant extent. There has been a decrease in the importance in gross farm receipts of *payments based on output* in **Canada**, Japan, **Norway** and **Turkey**. There has also been a decrease in the importance of measures classified under *payments based on input use* in Canada, the European Union, Japan, Mexico, New Zealand, **Poland**, Switzerland and the United States, although the extent of the reduction has varied considerably.

139. At the same time, there have been some attempts to introduce or increase support provided through less production distorting measures and those more directly targeted at environmental or farm income objectives. For example, it is calculated that support measures classified under *payments based on historical entitlements* have been introduced to the benefit of dairy producers in **Australia**, **Canada**, the

4. For a detailed description of the various PSE categories and the methodology for classifying support measures consult *Methodology for the measurement of support and use in policy evaluation* at www.oecd.org/dataoecd/36/47/1937457.pdf.

5. See OECD (1995) and OECD (1998) for some examples of these relationships and benefits.

Czech Republic, the **European Union** and **Switzerland**. Measures classified under p*ayments based on input constraints* or *payments based on overall farm income* have been either introduced or increased in many countries, but their overall significance remains very low in all cases.

140. On the negative side, there have been increases in the most distorting forms of support in some OECD countries between 1986-88 and 2000-2002. The importance of *market price support* measures in gross farm receipts has increased for dairy producers in **Canada**, **Hungary**, **Norway**, **Poland** and **Turkey**, although producers in Canada and Norway have been constrained by production quotas. *Payments based on output* have been introduced in the **Czech Republic**, Hungary and the **United States** but these are all relatively small. They have also been expanded in **Iceland**, the **Slovak Republic** and **Switzerland** although in all three countries quantitative limits are placed on production. While both the level and percentage change has been small in some instances, the importance of *payments based on inputs* in gross farm receipts has increased in **Australia**, the **European Union**, Hungary, **Japan**, **Korea**, Norway and the Slovak Republic**.**

Table 5.1. Composition of milk PSE by country, 1986-88 and 2000-02

Producer support categories as a share of gross farm receipts (%)

Share of gross farm receipts[2]		Australia	Canada	Czech Republic[1]	EU15	Hungary[1]	Iceland	Japan	Korea	Mexico[1]	New Zealand	Norway	Poland[1]	Slovak Republic[1]	Switzerland	Turkey	United States	OECD
Producer Support Estimate	1986-88	**32.3**	**60.9**	**44.5**	**57.3**	**36.9**	**81.6**	**84.1**	**72.4**	**49.4**	**8.1**	**74.8**	**-10.7**	**40.5**	**81.5**	**31.5**	**60.1**	**58.7**
	2000-02	**13.6**	**53.5**	**29.9**	**43.8**	**45.5**	**75.1**	**77.4**	**69.3**	**43.1**	**0.6**	**74.8**	**11.5**	**31.5**	**76.9**	**32.1**	**48.0**	**46.4**
Market Price Support (unlimited output)	1986-88	28.8	-	42.1	-	33.3	73.6	75.6	71.9	44.6	1.3	-	-11.3	24.4	-	21.0	52.4	**21.2**
	2000-02	0.8	-	20.9	-	34.1	25.1	69.8	66.9	40.6	-	-	9.5	12.6	-	30.4	41.8	**19.8**
Market Price Support (limited output)	1986-88	-	47.7	-	54.0	-	-	-	-	-	-	14.6	-	-	65.8	-	-	**30.0**
	2000-02	-	50.9	-	39.4	-	-	-	-	-	-	24.7	-	-	41.6	-	-	**20.0**
Payments based on output (unlimited output)	1986-88	-	-	-	-	-	-	0.3	-	-	-	-	-	-	-	1.2	-	**0.4**
	2000-02	-	-	0.1	0.4	2.3	-	0.2	-	-	-	-	-	-	-	0.8	1.1	**0.5**
Payments based on output (limited output)	1986-88	-	7.6	-	0.4	-	0.7	4.5	-	-	-	33.1	-	1.9	1.1	-	-	**1.4**
	2000-02	-	0.7	-	-	-	46.1	3.2	-	-	-	16.1	-	8.2	8.9	-	-	**0.8**
Payments based on input use	1986-88	2.7	4.6	1.7	2.2	3.2	7.0	3.8	0.5	4.8	6.5	15.3	2.8	3.9	6.6	9.3	4.0	**3.4**
	2000-02	8.2	1.4	1.7	2.7	6.1	3.9	4.2	0.9	2.2	0.6	19.1	1.9	5.9	2.7	0.8	3.8	**3.3**
Payments based on animal numbers	1986-88	-	0.1	0.6	0.3	0.4	0.3	-	-	-	-	9.9	-	7.2	6.0	-	1.4	**0.8**
	2000-02	-	-	6.2	0.4	1.1	-	-	-	0.1	-	10.2	-	4.6	11.3	-	-	**0.7**
Payments based on historical entitlements[3]	1986-88	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**0.1**
	2000-02	4.2	0.3	0.8	0.7	-	-	-	-	-	-	-	-	-	10.7	-	-	**0.7**
Payments based on input constraints	1986-88	-	-	0.1	0.4	-	-	-		-	-	1.8	0.0	-	-	-	1.8	**0.6**
	2000-02	-	-	-	0.5	0.0	-	-	0.2	-	-	3.6	0.0	-	-	-	0.1	**0.3**
Payments based on overall farm income	1986-88	0.8	-	-	-	-	-	-	-	-	0.3	-	-	3.0	-	-	0.6	**0.4**
	2000-02	0.5	-	0.1	-	-	-	-	1.2	0.3	-	1.1	-	0.2	-	-	1.2	**0.4**
Miscellaneous payments	1986-88	-	0.8	-	0.0	-	-	-	-	-	-	-	0.1	0.2	1.9	-	-	**0.1**
	2000-02	-	0.3	-	-0.2	-	-	-	-	-	-	-	0.1	-	1.7	-	-	**0.0**

Notes:

1. For the Czech Republic, Hungary, Mexico, Poland and the Slovak Republic, 1986-88 is replaced by 1991-93 for individual country analysis.

2. A percentage figure indicates that support policies classified under that PSE category were in place. A percentage figure in 1986-88 but not in 1999-01 indicates that there are no longer support policies classified in that PSE category. A percentage figure in 2000-02 but not in 1986-88 indicates that there is now support policies classified in that PSE category whereas none existed in 1986-88.

3. Payments based on historical entitlements existed in Poland in the period 1986-88, which explains why there is a number at the OECD level but none at the individual country level.

Source: OECD PSE/CSE database, 2003.

5.4 *Trade policies affecting milk production*

141. The importance of *market price support* reflects the historical use of trade measures *e.g.* tariffs, import quotas and export subsidies in many OECD countries to protect dairy producers from traded products and to enable domestic pricing arrangements. An indication of the level of tariff protection provided by OECD countries to dairy producers is provided by the bound tariff rates on dairy products scheduled by WTO members as part their URAA commitments (Table 5.2 and Annex Table 5.4). In almost all instances, tariffs on dairy products are above the country average for all agri-food products and are among the highest on agricultural products. Average tariffs vary considerably between OECD countries: they are comparatively low in **Australia** and **New Zealand**, and comparatively high in **Canada**, the **European Union**, **Japan**, **Norway**, **Poland** and **Switzerland**.

142. Twelve OECD countries maintain tariff quotas for dairy products. Across the implementation period, average fill rates for dairy product tariff quotas was around 70% *(i.e.* the quantity of product imported through the dairy product tariff quotas amounted to 70% of the permitted quantity). These low rates of fill may be due to problems with tariff quota administration, or reflect market conditions in quota countries.

Table 5.2. Average tariffs for dairy and agri-food products, 1997[1]

	Ad valorem equivalents[2]			
	Dairy products		All Agri-food products	
	Applied[3]	Bound	Applied[3]	Bound
Australia	12.9	14.4	1.9	5.3
Canada	136.0	136.0	24.7	24.7
Czech Republic	22.7	27.2	10.1	13.8
EU-15	122.5	122.5	44.2	44.2
Hungary	60.6	76.2	28.4	36.6
Iceland	27.6	478.0	10.5	141.3
Japan[4]	77.6	280.0	23.6	63.7
Korea	77.9	85.3	60.2	73.3
Mexico	42.4	67.1	17.2	51.0
New Zealand	3.9	11.3	3.0	7.1
Norway	167.6	365.9	55.9	150.6
Poland	159.8	159.8	37.4	46.6
Turkey	34.6	87.3	22.3	43.0
Switzerland	229.3	229.3	109.8	109.8
United States	48.0	48.0	14.6	14.6
ROW	19.5	91.9	20.0	74.0

Notes:

1. The average is the simple average of the in-quota, non-quota and out-of-quota tariff rates.

2. Specific rates are converted to *ad valorem* equivalents using world import unit values. They are consequently dependent upon the price and exchange rate assumptions used in the analysis.

3. These tariffs may overstate the extent of protection as they do not take into account preferential agreements countries may have, such as North American Free Trade Agreement (NAFTA), the European agreements, or the Generalised System of Preferences some developed countries have for developing countries.

4. Some designated dairy products imported into Japan are required to pay an additional “mark-up” on top of the applied tariff, as stated in Japan’s Schedule of URAA commitments.

Source: Walkenhorst and Dihel (2003).

143. In addition to border protection, a number of OECD countries also support the export of dairy products. Under the WTO URAA, countries that used export subsidies on agricultural products were required to set commitment levels on the volume and value of export subsidies that could be provided on a commodity basis (Table 5.3). The most significant user of export subsidies on dairy is the **European Union**, accounting for 81% of the total value of exports subsidies granted during the period 1995-2000, with **Switzerland** accounting for a further 10% of total export subsidies. A number of countries with export subsidy commitments on dairy products have not provided export subsidies over the Uruguay Round implementation period, and those that have provided subsidies have usually done so at a level well below their commitment level with the exception of **Norway**.

Table 5.3. Dairy product budgetary export subsidies, 1995-2001[1]

Country	Budgetary Export Subsidy	Unit	1995	1996	1997	1998	1999	2000	2001
Australia	Commitment	AUD million	135.64	126.20	116.54	106.97	97.43	87.87	87.87
	Actual		-	-	-	2.00	3.74	-	-
Canada	Commitment	CAD million	146.53	133.41	120.28	107.16	94.03	80.91	80.91
	Actual		51.44	5.81	nn	nn	nn	nn	nn
Czech Republic	Commitment	CZK million	3 710.00	3 473.00	3 237.00	3 000.00	2 763.00	2 526.00	2 526.00
	Actual		1 064.00	1 135.30	1 112.00	1 295.20	1 154.00	787.44	967.00
European Union	Commitment	EUR million	3 417.10	3 177.30	2 955.40	2 724.70	2 493.80	2 263.00	2 263.00
	Actual		1 562.30	1 725.20	1 359.30	1 325.40	1 812.40	1 012.20	952.40
Hungary	Commitment	HUF million	45.00	42.00	39.00	37.00	34.00	31.00	31.00
	Actual		3.90	1.68	0.32	13.00	57.00	45.00	-
Iceland	Commitment	ISK million	3.80	3.60	3.40	3.10	2.90	2.60	2.60
	Actual		-	-	-	-	-	-	-
Norway	Commitment	NOK million	620.20	556.00	491.80	427.50	363.20	299.03	299.03
	Actual		453.80	431.80	505.00	443.80	455.70	289.10	214.70
Poland	Commitment	USD million	20.40	19.10	17.80	16.30	15.20	13.90	13.90
	Actual		-	-	-	-	15.00	3.83	4.70
Slovak Republic	Commitment	SKK million	751.00	703.10	652.20	607.30	559.30	511.30	511.30
	Actual		188.40	203.00	308.80	293.20	316.60	345.10	206.10
Switzerland	Commitment	CHF million	417.10	390.50	364.00	337.40	310.40	284.00	284.00
	Actual		338.00	305.00	294.20	265.80	266.30	184.50	nn
Turkey	Commitment	USD million	0.53	0.51	0.50	0.49	0.48	0.46	0.46
	Actual		-	-	0.01	0.01	-	-	nn
United States	Commitment	USD million	185.63	171.82	158.02	144.22	130.42	116.62	116.62
	Actual		20.43	121.46	110.16	145.31	78.52	8.49	54.62

Note:

1. The year (calendar, marketing or budget) varies from country to country. For example, the period for the USA budget commitments is the year beginning 1 October.

n.n. Not yet notified to the WTO.

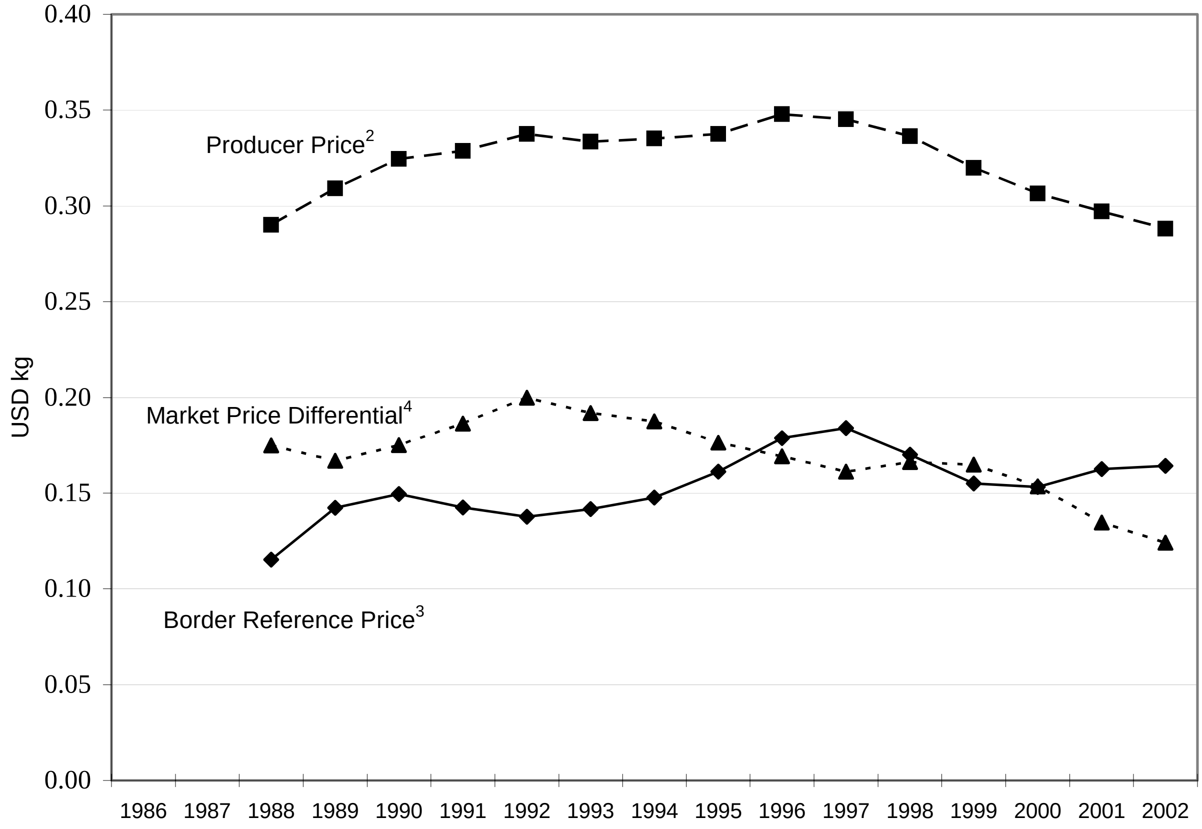
Source: Country notifications to the WTO.

5.5 Developments in market price support

144. Examining in closer detail the movement in *market price support* highlights some interesting trends and provides the main explanation for changes in the PSE for milk, at both the OECD and individual country levels. It is calculated by multiplying the level of production by the difference between the farm-gate price the producer receives and a border reference price (the market price differential). For livestock producers, including dairy farmers, any extra costs that they pay because of market price support provided to feed-grain producers (termed the "excess feed cost") is subtracted although it is very small at the overall OECD level for milk.

145. In nominal terms, the average OECD farm-gate producer price for milk has followed a slightly different pattern to that observed for most other commodities, *i.e.* increasing during the period 1986-1996 and decreasing since then, with some annual fluctuations this trend (Figure 5.4). The average border reference price shows a similar trend, although the increase between 1986 and 1996 was greater and the decrease since 1996 has been more moderate. Consequently, over the period 1986-2002, the market price differential has decreased from a high of USD 0.20 per kg of milk in 1990-92 to USD 0.12 per kg in 2000-02. This is the major explanation for the decline in overall %PSE for milk since 1990 (Figure 5.1).

Figure 5.4. Market Price Support for milk, 1986-2002[1]



Notes:

1. Calculated on the basis of moving three-year averages, *i.e.* 1988 is the average for the period 1986-88 etc.

2. Producer Market Price is the average price received by milk producers, measured at the farm gate.

3. Border Reference Price is the average reference price for milk, calculated at the farm-gate level.

4. Market Price Differential is the Producer Market Price minus the Border Reference Price.

Source: OECD PSE/CSE database, 2003.

146. Although the market price differential has decreased, trade barriers continue to offer significant protection to dairy producers in most OECD countries. Market price support policies are designed to protect producers from lower prices, insulating them from market changes and they have been effective in doing this. For example, in 1997, the average price received by OECD dairy farmers was 90% above the

border reference price but in 1998 the difference increased to 130% when the reduction in border prices was not matched by a similar reduction in producer prices.[6]

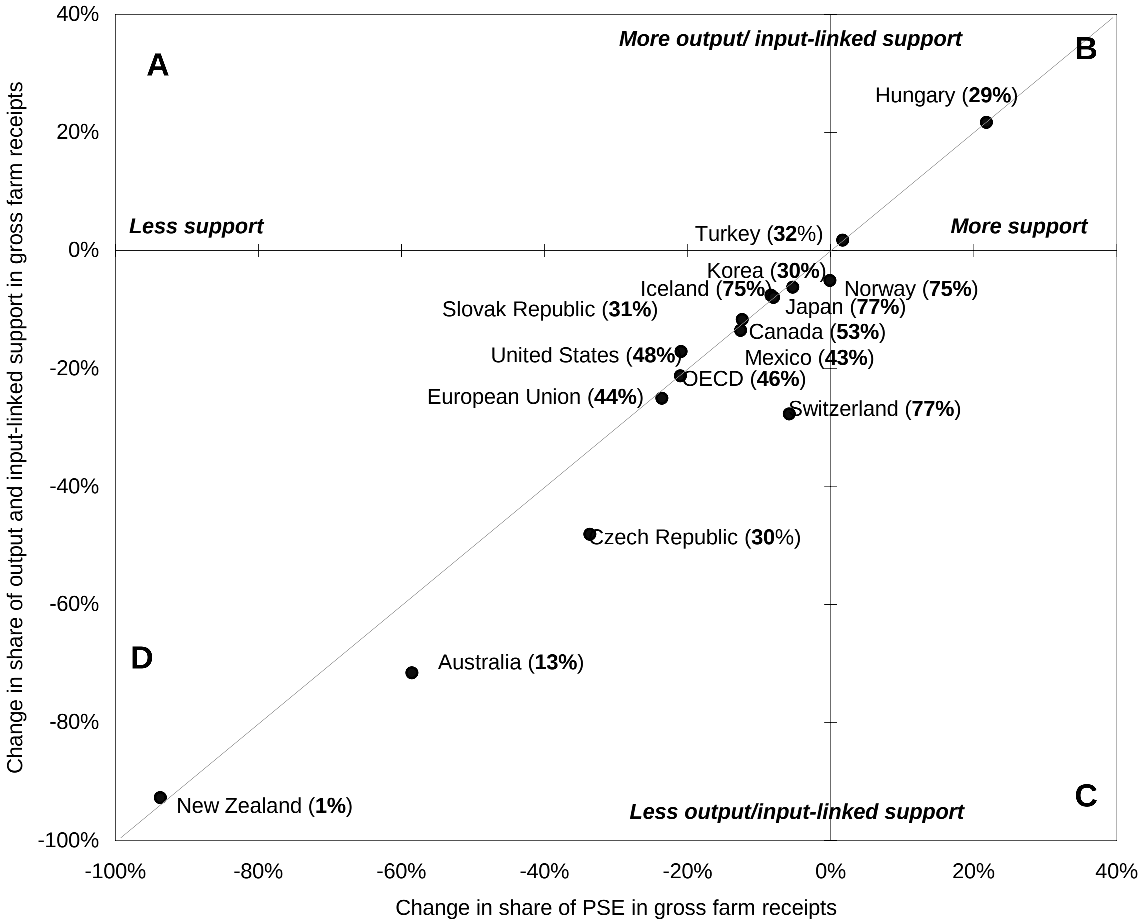
5.6 Summary of agricultural policy reform in the dairy sector

147. On the basis of the above analysis, a number of conclusions about agricultural support policy reform in the dairy sector can be drawn (Figure 5.5). The reform progress has varied between countries. Both the level of support and the importance of the most distorting forms of support (those linked to outputs or inputs) in gross farm receipts have increased for dairy producers in **Hungary**, **Poland** and **Turkey**, although in Poland it was from a very low base, and the increase was very small in Turkey. The most dramatic decreases in support have occurred for producers in **Australia** and **New Zealand**, although there were from a much lower level than in almost all other OECD countries. A significant reduction in support has also affected dairy producers in the **Czech Republic**.

6. As measured by the Producer Nominal Protection Coefficient (NPC*p*), an indicator of the nominal rate of assistance to producers measuring the ratio between the average price received by producers (at the farm gate), including payments per tonne of output, and the border price (measured at the farm-gate level) (Annex Table 5.1).

Figure 5.5. Policy reform in the milk sector by country, 1986-88 to 2000-02[1,2]

Changes in %PSE and in the share of output and input-linked support in gross farm receipts



Notes:

1. For the Czech Republic, Hungary, Mexico, Poland and the Slovak Republic, 1986-88 is replaced by 1991-93.

2. Poland could not be included on the scale used for the graph but would appear in Quadrant B.

Source: OECD PSE/CSE database, 2003.

148. In most cases the change in support is on the diagonal axis, indicating that the change in overall level of support is being driven by the change in the most distorting forms of support, and in particular market price support. Points away from the diagonal line indicate a shift in the composition of support. In **Australia**, the **Czech Republic**, **Switzerland** and to a lesser degree **Norway**, with points below the line, the importance of output and input-linked support in gross farm receipts has decreased more than the reduction in the overall level of support, indicating that other forms of support have increased to offset the reduction in farm receipts associated with the fall in the most distorting forms of support.

5.7 Impact of agricultural policy on the environment

149. The trend and pattern of support, in terms of both the level and composition, has influenced milk production patterns, including the location of production, and consequently changed the pressure on the environment. The countries which were identified in Chapter 2 as having the highest risk of nitrogen water pollution from dairy production are also those with the highest level of support to dairy producers *e.g.* **Belgium**, **Czech Republic**, **Denmark**, **Germany**, **Ireland**, **Japan**, the **Netherlands**, **Norway** and **Switzerland**. Support policies in Japan and **Korea**, which provide high levels of support for milk through high tariffs on dairy products and no or minimal tariffs on feed grain imports, have contributed to the development of very intensive dairy production.

150. However, high support levels are not a necessary condition for environmental pressure. Negative environmental impacts of dairy production at the local or regional level are also evident in **Australia** and **New Zealand**, two countries with the lowest levels of support. It is very difficult to separate out the policy impacts, with similar patterns of intensification and specialisation occurring in countries under a variety of policy systems. Some changes in practices have come about by technological developments, for example the replacement of hedges with electric fencing, or the substitution of silage for hay. Nevertheless, the high levels of support under dairy policy regimes in most OECD countries have reinforced and in some cases encouraged these kinds of changes.

151. A notable feature of agricultural policy has been the introduction of milk quotas in some countries to limit the expansion of dairy production under high price support schemes. Quotas have resulted in a lower level of milk production and therefore have reduced the environmental impacts that would have occurred with higher production. For example, it is estimated in the **Netherlands** that the lower level of production set by the milk quota compared to the higher production level that would have occurred in their absence at current support prices has resulted in the following benefits: 14 500 tonnes less phosphate (P_2O_5) equivalent contributing to eutrophication; 1 563 tonnes less carbon dioxide (CO_2) equivalent to GHGs; and 17 200 tonnes less sulphur dioxide (SO_2) to acidification (van Beers *et al.*, 2002). In addition to an effect of the level of production,, quotas appear to be having a variety of impacts on the scale, distribution and intensity of production, depending to some degree on the rules governing tradability in the individual EU countries, and supply and demand for milk within countries.

152. In countries where quotas are tradable, they appear to have had little effect on the long-term trend of a rising average dairy herd size even though they increase the cost of expansion[7]. In fact, by creating an asset, the size of which is proportional to the scale of production, quotas may have speeded up concentration in the sector. Consequently there has been the noticeable decline at the total EU level in the proportion of holdings with less than 19 cows, while the share of holdings with more than 50 cows increased from 7.7% to 18% (EC, 2002*a*). However, in countries where there have been stricter rules governing tradability, quotas have slowed structural change, particularly where quota volume is lower than demand such as in **Spain** (Baldock *et al.*, 2002).

153. A similar effect is observed in **Switzerland**. The increase in farm size has been much more rapid after quotas were made tradeable in 1999. Over the ten years, 1990 to 1999, the average farm size increased by 1.8 hectares; the same increase occurred in the following three years. The average milk quota rose by 1 900 kg per year from 1990 to 1999, but since then has been increasing at an annual level of 3 800 kg.

7. For 1997-98, it is estimated that active UK milk producers have incurred costs equivalent to as much as 12.5% of total milk revenue in order to acquire additional quota (Colman, 2000).

154. In terms of the regional distribution of production, it was noted in Chapter 3 that this has changed far less in countries with quotas than in countries without quotas. For example, a feature of the **European Union** quota policy is that member states are permitted to lay down rules preventing the exit of production form Less Favoured Areas (LFA), which account for around one-third of EU milk production. These rules have contributed to the maintenance of dairy production in such regions, with the number of dairy farmers and dairy cows in LFAs as a share of total EU increasing between 1983 and 1993, and have remained stable since (EC, 2002*a*). In **France**, the strong link between milk quotas and land, and the priority redistribution of milk quotas to farmers within regions has helped to keep a significant number of dairy farms in the mountains (Chatellier and Delattre, 2003).

155. To the extent that extensive milk production systems in many LFAs constitute a valuable form of land use for the protection of habitats and valuable, fragile landscapes of high value for tourism, the quota system has contributed to the maintenance of these environmental benefits (Baldock *et al*., 2002). However, a major reason for the decision taken in **Switzerland** to abolish milk quotas by May 2006 was that from the point of view of multifunctionality, all agrarian objectives would be better achieved without a milk quota system. Quotas were considered as a hinderance to the future adaptation required by further reductions in support levels, adding unnecessary costs to expansion (Hofer, 2003).

156. While limiting the level of production and changes in terms of the scale and location of production, quotas appear to have little effect on the long term increase in the intensity of production. By restricting the ability of producers to increase revenue by expanding production, they focus attention on lowering production costs by reducing cow numbers and increasing yields per cow. This is particularly the case where quotas have been leased or bought to expand production, raising the fixed costs of the enterprise. In the **European Union**, cow numbers, which had been virtually stable between 1975 and 1985, dropped sharply with the introduction of quotas, falling on average by 2.7% a year from 1986 to 1993. Since 1993, the annual reduction in cow number has slowed due to the expansion of quotas in some countries and smaller increases in yields (EC, 2002*a*).

157. It is more difficult to connect changes in support levels with changes in environmental pressure. Since the early 1990s there has been a general decrease in producer support for milk, although the extent of the reduction has varied across countries. Over the same time there has been a reduction in the risk to water pollution from dairy farming in some countries as a result of a fall in milk production, *e.g.* **Austria**, **Belgium**, the **Czech Republic**, **Denmark**, **Finland**, **France**, **Hungary**, **Italy**, the **Netherlands**, **Poland**, **Sweden** and the **United Kingdom** (Chapter 2). At the same time, the risk of nitrogen water pollution has increased in the low support countries, particularly **New Zealand** where production has increased dramatically. Such changes would be expected to result from the policy reforms that have taken place but other factors have also influenced changes in the environmental risk, including the development of agri-environmental policies, particularly in northern Europe. Changes in environmental pressure therefore need to be analysed on a case-by-case basis, not just at the national level but also at the regional and local level within countries.

158. In **Australia** the dairy industry was deregulated in July 2000 by the elimination of the artificial distinctions in milk supply and facilitation of interstate milk trade (Edwards, 2003). Under the previous milk marketing arrangements, the farm-gate price of milk used for drinking milk was far higher than the farm-gate price of milk used in manufacturing. For example, in 1999-2000 the average price received for milk used for drinking was AUD 0.47 litre, while the average price for milk used for manufacturing was AUD 0.21 litre. This caused significant variations in the average farm-gate price received by dairy farmers from state to state. Deregulation has caused a rebalancing of farm-gate prices, which have now become much more equal across states. Farm-gate prices fell by around 20% in New South Wales (NSW), Queensland and Western Australia, and increased by around 13% in Victoria, the main dairy producing state.

159. Consequently, in the year following deregulation, the number of dairy farmers exiting the industry rose dramatically, particularly in NSW and Queensland. Between 1985 and 1989 the number of dairy farms declined at an annual rate of 2.3%; in 2000-01, 8% of farmers exited the industry as a result of price falls and the availability of funds to exit the industry. At the same time the average herd size increased by 5% in 2000-01, with the exit of some small farms and the expansion of larger farms (PC, 2002). Deregulation has led to: a shift in the regional pattern of production; an increase in the size of operations, in terms of both area and the number of cows; and greater use of purchased feed (ABARE, 2003).

160. There is some evidence that trade liberalisation under the North American Free Trade Agreement (NAFTA) is having an influence on the distribution and scale of milk production in **Mexico** (Dobson and Proctor, 2002). While NAFTA has had little direct impact on **United States-Canada** trade because there was little change in dairy access under the agreement, access for United States product to Mexico through expanding tariff quotas, and from 1 January 2003 duty free access for all dairy products except milk powder (duty free in 2008), has seen United States exports expand. This appears to be driving a change in the location of milk production in Mexico, with production expanding in the northern states closer to the United States border. In general, dairy operations in these states are larger than the farms of the Mexican tropics or semi-confinement dairy operations. These farms are also importing cows and genetics, and adapting new cost reducing technologies such as bovine somatotropin (bST) to remain competitive. Increased production in these regions may raise environmental issues associated with the appropriate disposal of manure and the extraction of water for dairy cow consumption.

161. It is also important to consider the impact of changes in the level of support provided to other agricultural sectors. In **New Zealand**, support policies in the early 1980s favoured sheep production, with a %PSE for sheepmeat in 1986 of 61% compared to 14% for milk and 9% for beef. Consequently, one of the impacts of reform has been a dramatic reduction in sheep production; with the land being used for alternative uses such as dairy and beef production as well as forestry. It is estimated that the conversion of a “standard” sheep farm to dairying in the Southland region results in an average five-fold increase in potential nitrate leaching (Thorrald *et al.*, 1998). For most other countries, with support for milk higher than that for other agricultural productions, reforms could be expected to encourage a shift in resources out of dairy production into other enterprises.

162. In addition to the possible influence of quotas, changes to other agricultural policies may also have been a driving force for increasing the intensity of production. For example, the choice of feedstuffs used for milk production is influenced by cereal price support policies. The **European Union** CAP reforms of 1992 and 2000 lowered intervention prices for cereals, shifting the milk/concentrate price ratio in favour of greater use of concentrates (Ramsden *et al.*, 1999). Overall, the effect has been to accentuate the trend towards the use of concentrated feed, reducing the area needed for grazing animals and freeing land which could be farmed for cash crops (Souchère *et al.*, 2003).

6. The impact of further agricultural trade liberalisation on nitrogen manure output and greenhouse gas emissions from the dairy sector

- Further agricultural trade liberalisation is likely to alter the distribution of milk production among OECD countries, with production increasing in Australia and New Zealand, and decreasing in the EFTA countries, Japan, and marginally in the United States. Quotas remain binding in the European Union and Canada under the modelled scenarios and assumptions.

- Nitrogen manure output from dairy cows, assuming constant milk yields and nitrogen output per cow, will follow a similar pattern, with significant increases in Australia and New Zealand.

- Global greenhouse gas (GHG) emissions from milk production are expected to increase only slightly as a result of further trade liberalisation. The increase in GHG emissions from milk production in New Zealand is likely to be an issue for that country's ability to meet its Kyoto commitment.

- Further liberalisation will increase international trade in milk products, leading to an additional half a million tonnes of carbon dioxide (CO_2) equivalent GHGs. However, this represents only 0.1% of GHG emissions associated with on-farm milk production.

163. Dairy production is one of the most heavily policy-supported farm activities in OECD countries (Chapter 5). A significant proportion of support is derived from market price support measures, including support price programmes and trade measures such as tariffs, tariff quotas and export subsidies. Dairy production also has a significant effect on the environment, in particular effecting water and air quality (Chapter 2). An important policy issue concerns the environmental impact of further trade liberalisation and agricultural policy reform. This chapter focuses on the effect of further trade liberalisation on two important and measurable environmental indicators associated with dairy production: the nitrogen output that arises from dairy herd manure; and GHG emissions from dairy farming.

164. The study's methodology involves the following steps:

- Based in part on a review of proposals and progress in the current WTO agricultural trade negotiations (Section 6.1), construct hypothetical agricultural liberalisation scenarios (Section 6.2);

- Using a suitable international trade model (Section 6.3), simulate some of the national and international outcomes of those scenarios, with particular reference to the level and location of milk production (Section 6.4);

- Estimate how such changes in global milk production patterns may impact on nitrogen and GHG emissions from dairy, assuming no change in environmental policies (Section 6.5) and on GHG emission from increased dairy trade flows (Section 6.6);

- Discuss the implications of the modelling results, drawing on the findings of other studies (Section 6.7).

6.1. Recent progress in dairy policy reform

165. The WTO Uruguay Round Agreement on Agriculture (URAA) made some progress in liberalising trade in agricultural, including dairy products, through reductions in tariffs and expansion of

market access, and reductions in export subsidies and some types of domestic support payments. For example, it required that all non-tariff barriers be converted into tariff equivalents, and to reduce such tariffs by 36% on average, and by at least 15% for any individual tariff line. It specified minimum levels of access for products that had previously been restricted or prohibited through non-tariff means. This was achieved through specification of tariff-rate-quotas (TRQs) that generally impose a relatively low tariff (in-quota) on imports up to the quota volume, with a higher tariff charged on additional (over-quota) imports. TRQs are particularly prevalent in dairy trade. Of the 1 371 TRQs established, 181 (13%) relate to dairy products, a number exceeded only by those within the meats, and fruits and vegetable groups (WTO, 2000). The URAA also placed upper limits on both the amounts spent by WTO members on subsidizing agricultural exports as well as on the volumes of such subsidised exports. While progress has been made, major policy-induced distortions remain in many domestic and international dairy markets.

166. A new WTO Round of agricultural trade negotiations began in March 2000. These talks were incorporated into the broader negotiating agenda set at the 2001 Ministerial Conference in Doha, Qatar. This current Round of multilateral trade negotiations (the Doha Development Agenda) is considering further liberalisation, including commitments to substantially improve market access; reduce, with a view to phasing out, all forms of export subsidies; and substantially reduce trade-distorting domestic support. Special and differential treatment for developing countries shall be an integral part of all elements of the negotiations, and non-trade concerns (such as environmental protection and food security) will be taken into account.

167. In March 2002, agriculture negotiations entered the third stage on “modalities”. The modalities are targets and rules to achieve the objectives of the Doha Ministerial Declaration, and set the parameters for WTO member commitments. The original deadline for the completion of the modalities was 31 March 2003, with the first draft offers of commitments to be considered at the Fifth WTO Ministerial Conference in September 2003 in Cancun. The deadline for the completion of the Round is January 2005.

168. During the third stage, many WTO members put forward proposals for reform. An overview of these was provided by the Chair of the Committee on Agriculture in December 2002. The Chair released in February 2003 a first draft of the modalities negotiations, and a revision was circulated on 18 March. The latter stated that “overall, while a number of useful suggestions emerged, positions in key areas remained far apart”. An agreement on modalities was not reached at the September 2003 Cancun Ministerial.

169. Some recent changes in domestic support policies have been implemented or proposed, in part driven by the URAA and/or the current round of WTO negotiations. The **Australian** dairy industry was deregulated in mid-2000. Previously, state and federal regulations had impacted on prices, supply and marketing arrangements. The 2002 FAIR Act in the **United States** introduced a new counter-cyclical payment for milk producers – the National Dairy Market Loss Payment Program – for the period 2002-05 to provide a monthly payment to dairy farm operators equal to 45% of the difference between a target price fixed at USD 373.5 per tonne of milk and the monthly Class 1 price in Boston. This annual payment is limited to a maximum of 1 089 tonnes of milk per operation, *i.e.* the production of about 135 cows. The 2002 FAIR Act also announced that dairy market price support, which was originally scheduled to end on 31 December 1999 and has been extended each year on an ad hoc basis, will continue over the period 2002-07. As part of the 2003 CAP reform in the **European Union**, intervention prices for butter and SMP will be reduced over the period 2004 to 2006 by 25% and 15% respectively. Compensation payments to producers will be provided as follows: EUR 11.81/tonne in 2004, EUR 23.65 in 2005 and EUR 35.5 from 2006 onwards. The single farm payment will only apply in the dairy sector once the reform is fully implemented (*i.e.* 2007), unless a EU country decides to introduce it earlier (from 2005).

6.2 The liberalisation scenarios

170. Two scenarios reflect some of the elements of various proposals submitted to the WTO (Table 6.1). They incorporate changes within each of the major negotiation pillars – market access, export competition and domestic support. The first scenario has some resemblance to proposals that have been put to the WTO by the **European Union** and **Japan**, while the second is developed with the Cairns Group and **United States** proposals in mind.

Table 6.1. Agricultural trade liberalisation scenarios

Item	Scenario #1	Scenario #2
Change in tariffs[1]		
Developed regions	-36%	Swiss formula[2] (a = 25)
Developing regions	-24%	*If* $t_o \geq 250\%$, $t_1 = 125\%$ *If* $50\% \leq t_o < 250\%$, $t_1 = t_o * 0.5$ *If* $t_o < 50\%$ *Swiss formula* ($a = 50$)
Change in export subsidy expenditure		
Developed regions	-45%	-100%
Developing regions	-45%	-100%
Change in trade-distorting support spending[3]		
Developed regions	-55%	-100%
Developing regions	No change	-50%

Notes:

1. None of the scenarios incorporates changes in non-agricultural tariffs.

2. The Swiss formula is $t_1 = (a*t_o) / (a+t_o)$, where t_o and t_1 are the initial and final tariffs, respectively.

3. Defined for modelling purposes as expenditure on output and input subsidies, and excluding all other payments such as those based on crop areas or livestock numbers.

171. In scenario #1 all agricultural and food tariffs will be reduced by 36% in developed countries and by 24% in developing countries. All countries will reduce their total expenditures on agricultural export subsidies by 45%, and developed regions only will reduce their total spending on trade-distorting domestic support by 55%.

172. Scenario #2 is more complex as the Swiss formula is used for tariff reductions.[8] This approach (which was used to reduce tariffs on industrial goods in the GATT Tokyo Round) makes deeper tariff cuts the higher the initial tariff, with the severity of the cuts determined by the parameter "a". For example, an initial tariff of 100% would be reduced to a tariff of 20% if a=25, and to 33.3% if a=50. These correspond to reductions in the initial tariff of 80% and 66.7%, respectively. In contrast, an initial tariff of 40% would be reduced by approximately 62% and 45% for "a" values of 25 and 50 respectively.

8. The Swiss formula is $t_1 = (a*t_o) / (a+t_o)$, where t_o and t_1 are the initial and final tariffs, respectively.

173. In scenario #2 a Swiss formula with a=25 to used to reduce agricultural tariffs in developed countries. For developing countries, a mix of modalities is used for tariff reductions but the principle of applying progressively deeper cuts the higher the tariff is maintained. For tariffs under 50%, a Swiss formula is used with a=50; tariffs between 50% and 250% are halved; and those over 250% are reduced to a tariff of 125%. Scenario #2 also requires all countries to abolish agricultural export subsidy programmes, while trade distorting domestic support programmes in developed regions are eliminated and such payments in developing regions are reduced by 50%.

174. In each scenario, liberalisation is limited to the agricultural sector – for example, all food and agricultural (*i.e.* not just dairy) tariffs will be reduced, but those on industrial products will remain fixed. None of the scenarios allow for increased farm assistance via "blue" or "green" box programmes, such as payments to compensate farmers for price reductions.

175. It is not possible to model all the details of many of the proposals, such as those related to special safeguards, food aid, state trading enterprises, export credits, and the non-trade concerns. In addition, other simplifications and omissions are made, given the trade model and data used. For example, some proposals suggest reductions (such as in tariff rates) be made from bound levels; others from levels that actually applied in some given base period. This analysis uses applied levels of tariffs and support, rather than the bound rates (Section 6.3.2).[9] The large number of TRQs that exist for dairy products provides a major aggregation problem and the possibility of aggregation bias, since the database aggregates all dairy products into a single commodity (Section 6.3.3). The approach adopted is to make cuts to the applied tariffs, and then interpret the expansion in imports as an "equivalent" expansion in the TRQs, where they exist.[10] Any agreed liberalisation will be phased in over a number of years. As the trade model used here is static in nature and not dynamic, the adjustment path to the targeted reductions in support cannot be revealed.

6.3 The trade model and data

6.3.1 The trade model

176. A modified version of the GTAP [Global Trade Analysis Program] applied general equilibrium model is used (Hertel, 1997). This is a relatively standard, multi-region model built on a complete set of economic accounts and detailed inter-industry linkages for each of the economies represented. Although GTAP is among the most sophisticated applied general equilibrium models currently available, it necessarily involves some simplifications and abstractions from the real world.

177. While resources are heterogeneous, the GTAP production system distinguishes sectors by their intensities in just four primary production factors: land (agricultural sectors only), natural resources (extractive sectors only), capital, and labour, with the latter two assumed to be perfectly mobile between production sectors within each region. Some differentiation is introduced by dividing the labour resource into two classes – skilled and unskilled. While GTAP allows substitution amongst the employment of these resources in any sector in response to price changes, intermediate inputs are used in fixed proportions in producing the various outputs. This assumption has been modified in this application to the extent that substitution among feedstuffs in livestock production is permitted. While all units of output from any sector in a given country are assumed identical, traded products are differentiated by country of origin,

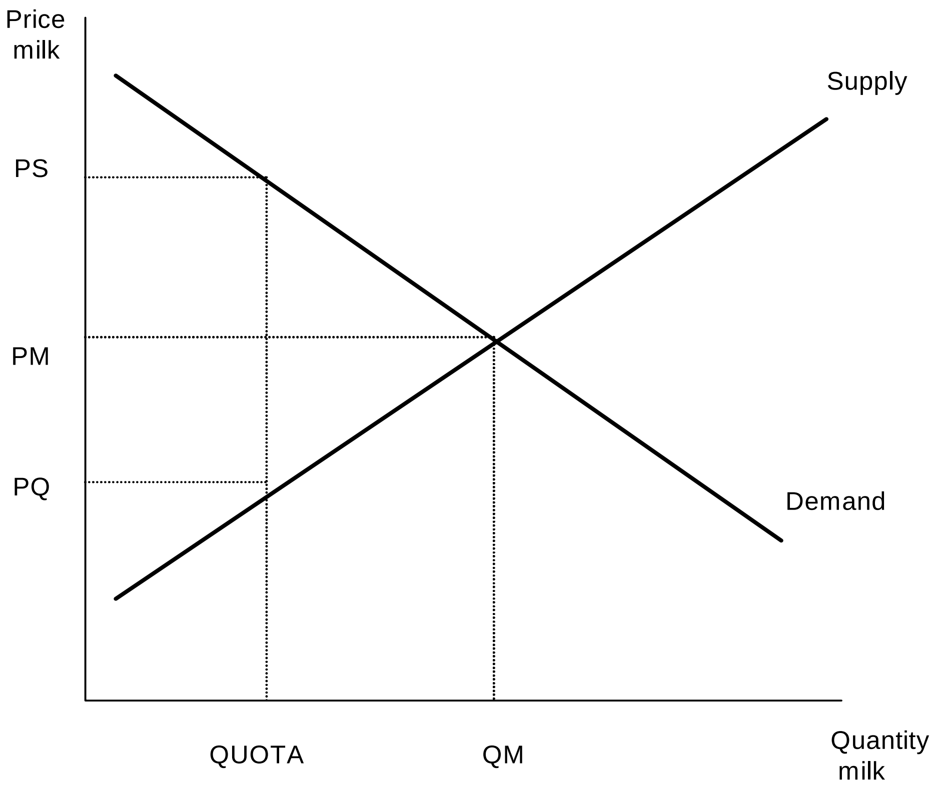
9. In OECD countries, the applied tariff rates are often similar to the bound rates. However, in many developing countries applied rates are considerably below the bound rates, so the modelled liberalisations would overstate the extent of tariff reductions if the final Agreement is based on tariff reductions from bound rates.

10. Of course this introduces other biases, such as in the allocation of revenues from quota rents and tariffs.

allowing bilateral trade to be modelled. This formulation of the model also assumes perfectly competitive markets and constant returns to scale in production. The model is solved using GEMPACK (Harrison and Pearson, 1996).

178. An important modelling issue is the treatment of milk production quotas. Where such quotas exist and are binding (*i.e.* they effectively constrain production at the quota level), then reductions in domestic prices that might occur from trade liberalisation need not result in a reduction in milk production (Figure 6.1). In the absence of a quota, the quantity of milk QM will be produced at price PM where demand equals supply. Should a quota be used to restrict milk production below this equilibrium to the level QUOTA, PS is the new equilibrium price and reductions in this price may not discourage output. In the figure, the producer price would have to fall to PQ before any further price reductions would result in a fall in milk production. The difference between PS and PQ is the rent per unit of quota. Consequently, knowledge of the ratio PQ to PS is essential to a detailed modelling of production quotas.

Figure 6.1. Milk production quotas



179. A recent study for the European Commission contained estimates of PS and PQ for all **European Union** countries for the year 1998 (EC, 2002*a*). The ratio PQ/PS was less than one in each country, indicating binding quotas in all cases, and ranged from 0.51 for **Ireland** to 0.85 in the case of **Sweden** (Annex Table 6.1). Where EU countries were aggregated into larger groups (Section 6.3.3), a weighted average ratio was computed based on milk production. A PQ/PS ratio for **Switzerland** of 0.74 has been estimated (Lips and Rieder, 2002), and is assumed to apply to the entire EFTA region. Milk quotas are also binding in **Canada**, and a PQ/PS value of 0.6 is used (Meilke *et al*., 1998). Modifications to the GTAP model to include these milk production quotas were based on Lips and Rieder (2002).

6.3.2 Economic data

180. All economic data, including that on agricultural trade and protection, are taken from the GTAP Version 5 database (Dimaranan and McDougall, 2002), benchmarked to the year 1997. This contains a number of improvements compared with earlier versions, some of which are central to the present study. For example, agricultural tariffs have been sourced from the Agricultural Market Access Database (AMAD), converted where necessary to *ad valorem* equivalents.[11] Agricultural export subsidies are now based on country expenditure submissions to the WTO, and agricultural domestic subsidies are now classified as in the OECD's PSE measure and data is taken from that source. This means that output and input subsidies, and payments based on land or capital (livestock) are represented separately. International trade data are sourced from the UN COMTRADE database, agricultural commodity balances and producer prices came from the FAO, and input-output tables from national sources.

6.3.3 Regional and commodity aggregation

181. The GTAP Version 5 database covers 66 regions and 57 commodity sectors (including 20 in agriculture and food). Such a detailed disaggregation is unnecessary in this study. The 15 European Union countries were aggregated into eight subgroups, based on their dairy nitrogen manure coefficients, average milk yields and size of dairy farm operations (Annex Tables 6.1 and 6.2). **Austria**, **Greece**, **Italy**, **Ireland**, **Portugal** and **Spain** generally have the lowest values for nitrogen manure output per cow and/or milk yields, while **Denmark**, **Finland**, **Netherlands**, **Sweden** and the **United Kingdom** exhibit the highest values. Denmark, Finland and Sweden were aggregated into an "EU_scand" region; Austria, Belgium, Greece, Luxembourg, Portugal and Spain were aggregated as a "Rest_EU" group; and all other EU countries were modelled individually.

182. At the sectoral level, nine of the twelve modelled sectors represented farm and food production, including separate sectors for milk production and dairy product manufacture (Annex Table 6.3). Land, labour, capital, feedstuffs and other intermediates are inputs to milk production, which in turn is an input to the dairy manufacturing sector. It is the products of the latter sector, not liquid milk, that are internationally tradable in the model. Changes to tariffs or export subsidies on processed dairy products may impact on domestic dairy manufacturers and will influence their demand for raw milk, the domestic milk price, as well as the size of quota rents if applicable.

6.3.4 Environmental data

183. For the first indicator, attention will focus on the gross output of nitrogen (N) from dairy cows rather than on a dairy sector nitrogen balance. Computation of the latter would require additional information, such as the nitrogen input and uptake implications of changes in production of feed crops and pasture that would accompany changes in dairy cow numbers. Nor does this study attempt to measure changes resulting from agricultural trade liberalisation on the national agricultural soil surface nitrogen balance, as this would require analysis of nitrogen flows involving many farm production activities, for example the input and uptake of nitrogen for crop production. While these are significant limitations to the analysis, the appropriate disposal of dairy cow manure has become a major environmental issue in many OECD countries resulting from the trend towards larger and more intensive production units.

184. The coefficients to estimate ***nitrogen manure output*** from dairy cows were taken from the OECD soil surface nitrogen balance database (OECD, 2001*a*). This covers 26 OECD member countries that, in 1997, produced five million tonnes of nitrogen from dairy cattle manure production. For the majority of countries, the coefficients related to cows in milk. For **Australia**, **Japan**, the **Netherlands**,

11. Further details can be found at www.amad.org

New Zealand, and the **United States** the database contains more detailed coefficients for various livestock classes within the dairy herd. In order to be consistent, all N coefficients used were those quoted for milking cows.

185. Where some of the 26 OECD countries were aggregated into regional groupings for this study, weighted averages of the relevant N coefficients were computed, with national milking cow numbers as the weights. This applied to the **European Union** countries that comprise the EU_scand and Rest_EU regions. The N coefficients for the **Czech Republic** and **Poland** were averaged in the same way and applied to the Central Europe (C_Eur) region, and those of **Switzerland** and **Norway** were averaged and assumed to apply to the entire EFTA region. For all other (non-OECD) countries to be modelled, an N-coefficient of 50 kg per cow was assumed, this being equal to the lowest coefficient for the OECD countries (**Mexico** and **Turkey**).

186. For the second indicator, the calculation of GHG emissions from dairy production includes five sources: methane (CH_4) emissions from enteric fermentation and manure management, and nitrous oxide (N_2O) emissions from manure management, the application of manure to the soil and from manure deposited during livestock grazing. Emissions that result from other activities such as fertiliser applied on dairy farms, ammonia volatilisation, nitrate leaching and energy use in machinery and tractors are not included. The five sources included in the calculation are the most significant, with only minor variations in the analysis expected if data on the other emissions were included.

187. Coefficients for ***greenhouse gas emissions*** from dairy cows were calculated by the OECD based on information contained in country submissions to the UNFCCC Greenhouse Gas inventory.[12] The emission factors are expressed in carbon dioxide (CO_2) equivalent but comprise both methane and nitrous oxide emissions from enteric fermentation and manure management. Again, for the OECD regional country groupings GHG emission factors were aggregated, weighted by cow numbers. For all other countries, an emission factor of 2 000 kg CO_2 per head was assumed, based on the lowest estimated coefficient for the OECD countries (**New Zealand**). Annex Table 6.4 gives for each modelled country/region, cow numbers, dairy cow N and GHG coefficients, and total dairy nitrogen manure output and GHG emissions, along with milk yield and production data. All data relates to the 1997 base year of the model.

6.4 Impacts on milk production and trade

188. While the two trade liberalisation scenarios apply policy changes across all farm and food sectors, the focus of this analysis will be on the results as they impact on the milk and dairy sectors. Given the variation in support provided to milk producers in OECD countries, some decline in milk production might be expected in the more highly supported countries, which assist their dairy farmers through high tariffs and/or export subsidies on dairy products, with production increasing in less supported countries. Further, the magnitude of the milk price and production changes should be greater in scenario #2, since the Swiss formula should result in substantial tariff reductions compared with the 36% cuts modelled in the first scenario, and the elimination of export subsidies is modelled in scenario #2, compared with a 45% reduction in scenario #1. Whether such declines occur in countries with binding milk quotas in the base period depends on the extent of milk price reductions and the size of existing quota rents.

189. Very little increase (less than 1%) occurs in the level of world milk production under either of the liberalisation scenarios (Figure 6.2). What is observed is a shift in the distribution of milk production, away from some of the most highly protected OECD countries (particularly **Japan** and the **EFTA** region,

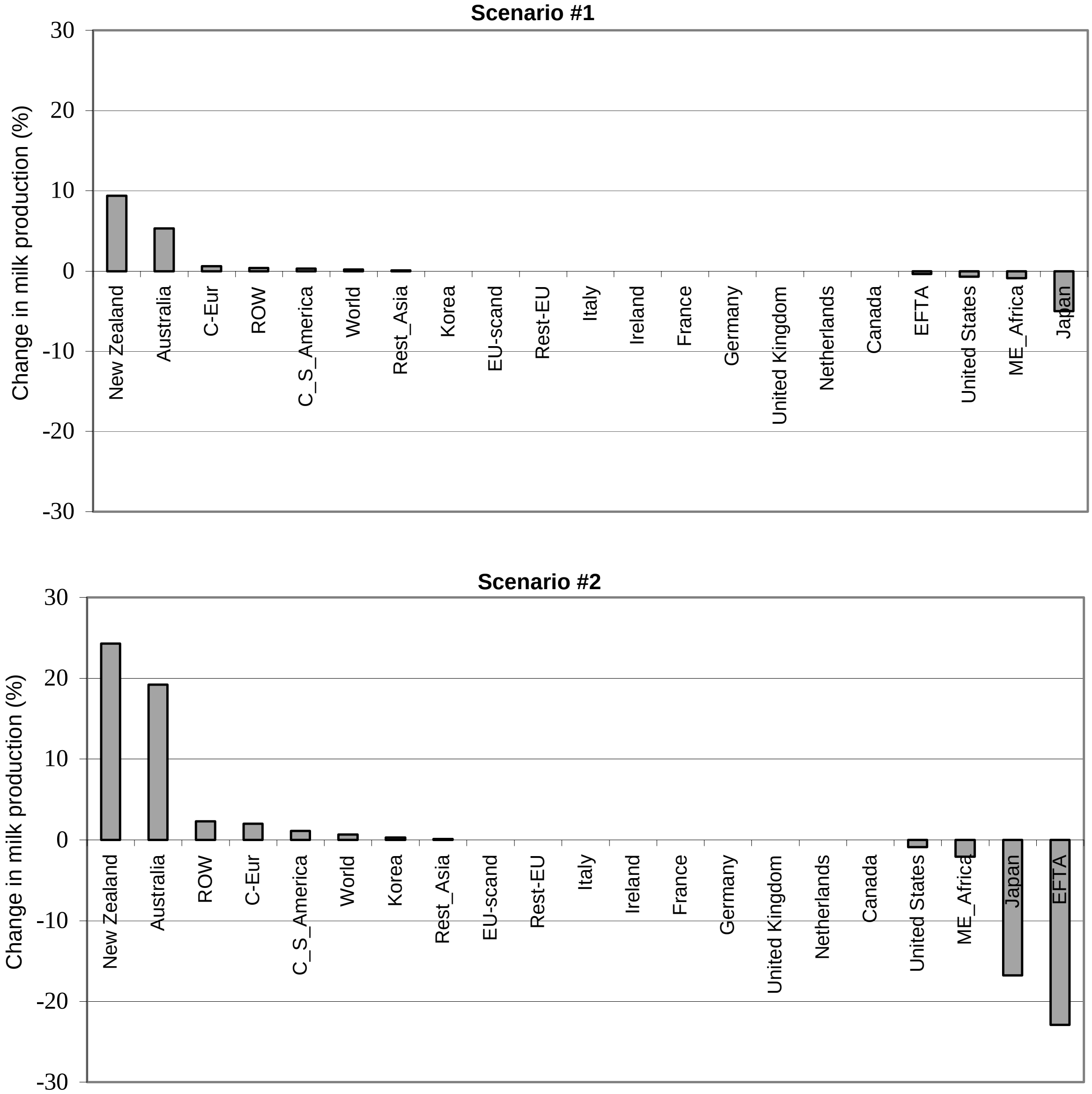
12. Information and data on country submissions can be found at http://unfccc.int/program/mis/ghg/submis2003.html

comprising Iceland, Norway and Switzerland) and towards other countries and regions, most notably **Australia** and **New Zealand**.

190. Under liberalisation scenario #1, milk quotas will remain binding in **Canada** and the **European Union**, with no change in milk production in these regions. This is because modelled reductions in domestic producer prices for milk in these countries are relatively small (less than 10%), leading to reductions of between 20-40% in quota rents. The model predicts that under scenario #1, producer prices will fall enough in the **EFTA** region to remove the quota rent, leading to a fall in milk production below the quota level of less than 1%. Milk production declines in **Japan** and the **United States** by 5% and 1% respectively. Production in **Australia** and **New Zealand** is modelled to increase by around 5% and 9% respectively, with smaller expansions in milk production in Central and South America, **Central Europe** and the rest of the world.

191. Under scenario #2, despite larger decreases in domestic producer milk prices of between 14-40%, quotas remain binding in **Canada** and the **European Union**, with quota rents falling by 40-85%. Again, only in the **EFTA** regions are decreases in producer prices sufficient to result in a decline in milk production, of over 20%. The 17% decline in milk production in **Japan** is greater than in the first scenario, but there is little change in the volume of milk produced in the **United States**. Milk production in **Australia** and **New Zealand** expands even further than under scenario #1, by around 20% and 25% respectively. In Central and South America, **Central Europe** and the rest of the world, milk production expands a little more than in the previous scenario, by between 1% and 2%.

Figure 6.2. Changes in milk production resulting from further agricultural trade liberalisation



Source: OECD Secretariat.

192. In the base period of the model (1997) the major net exporters of dairy products (value of exports less value of imports) were the **European Union**, **New Zealand** and **Australia**. The leading net importers were the Middle East-North Africa, the rest of Asia region, Central and South America, **Japan** and the rest-of-the-world aggregate. In both scenarios, net exports from Australia and New Zealand increase, and by more the greater the liberalisation. The same applies (from a much smaller base) in **Central Europe**. The dairy net imports of the rest-of-the-world region decline with trade liberalisation, and by more the greater the liberalisation, but this region remains a net importer in both scenarios. Net exports of dairy products from the EU are largely unchanged in both scenarios, whereas Japan, **Korea**, Middle East-North Africa, Central and South America and the **United States** all increase their net imports of dairy products as domestic demand expands and/or domestic milk production declines. **Canada** increases, from a very low

base, its net dairy exports in both scenarios, while in the second scenario the **EFTA** region switches from a net exporter to a net importer of dairy products. Overall, the volume of dairy product trade is modelled to increase by 3.6% (2.3 million tonnes in liquid milk equivalent (LME) terms) in scenario #1 and 14% (9.3 million tonnes LME) in scenario #2, which represents about 2% of world production in the base period.

6.5 Impacts on nitrogen manure output and GHG emissions

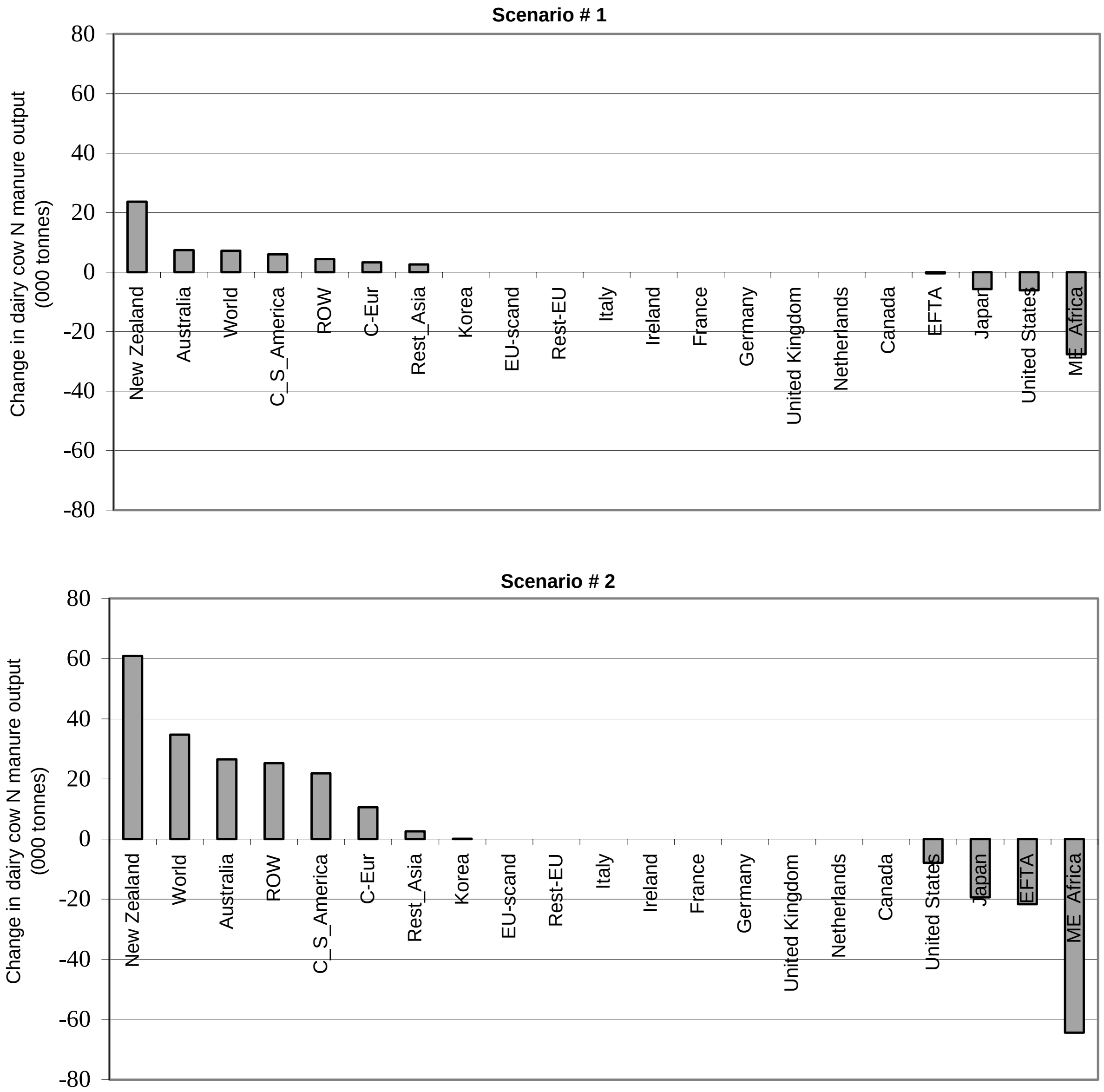
193. Results in this section assume that changes in nitrogen manure output and GHG emissions from dairy cows are proportional to changes in milk cow numbers, and that the latter are proportional to changes in the volume of milk production. In other words, it is assumed that milk yields per cow remain constant and that the nitrogen manure and GHG coefficients are unaffected by changes in livestock numbers. For example, changes in country/regional output of nitrogen manure from dairy cows are computed as the product of the modelled percentage change in milk production and the base levels of nitrogen manure output.

6.5.1 Impact on dairy cow nitrogen manure ouput

194. Summed over all regions, agricultural trade liberalisation results in an increase in global nitrogen manure output from dairy cows of 7 000 tonnes under scenario #1, and 35 000 tonnes under scenario #2 (Figure 6.3). These increases are less than 0.3% of the estimated global production of nitrogen manure output in the base period. While at the global level even the more substantive policy reforms of scenario #2 would appear to have an insignificant impact on nitrogen manure output from dairy production, there are important regional changes that raise some potential environmental issues.

195. At the country level, the most significant increases in nitrogen manure output from dairy cows occurs in **Australia** and **New Zealand**, where nitrogen manure output increases by 26 000 and 60 000 tonnes respectively under scenario #2. The greatest decrease in volume terms occurs in the ME_Africa region, with nitrogen manure output also falling in the **EFTA** region, **Japan** and to a very limited extent in the **United States**. While the percentage changes in the volume of nitrogen manure output from dairy cows mimic the modelled changes in milk production, the actual change in tonnage terms also reflects the initial level of nitrogen manure output. This is why the order of the countries in Figures 6.3 and 6.4 varies from that in Figure 6.2, *e.g.* while milk production decreased in scenario #1 by only 1% in the ME_Africa region compared to 5% in Japan, the ME_Africa region has the largest decrease in nitrogen manure output in volume terms because it’s base level of nitrogen manure output was 26 times greater than in Japan.

Figure 6.3. Changes in dairy cow N manure output resulting from further agricultural trade liberalisation

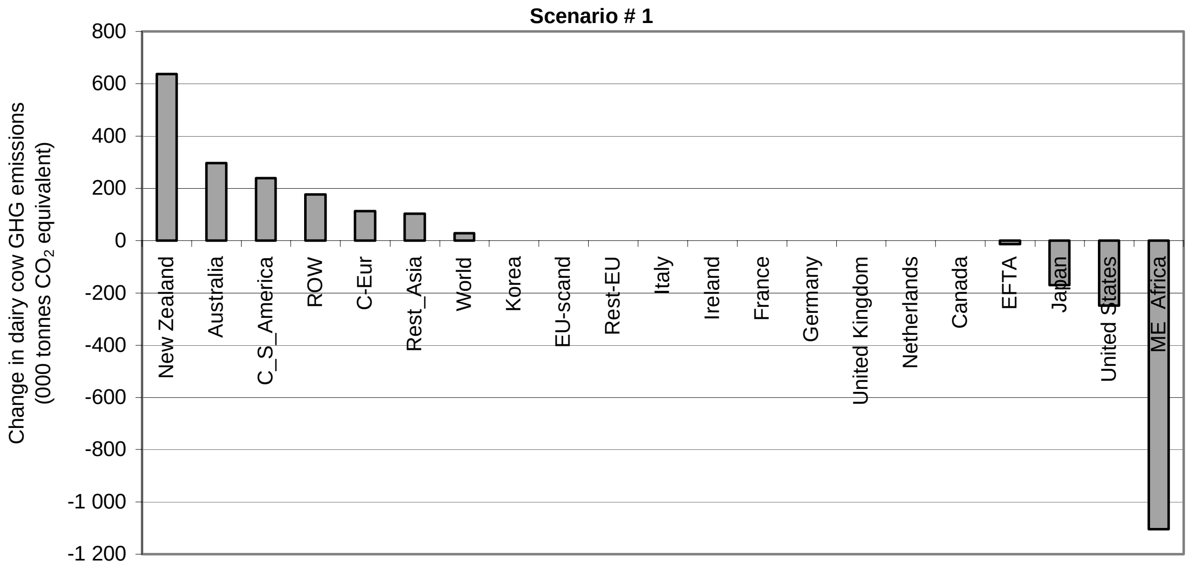


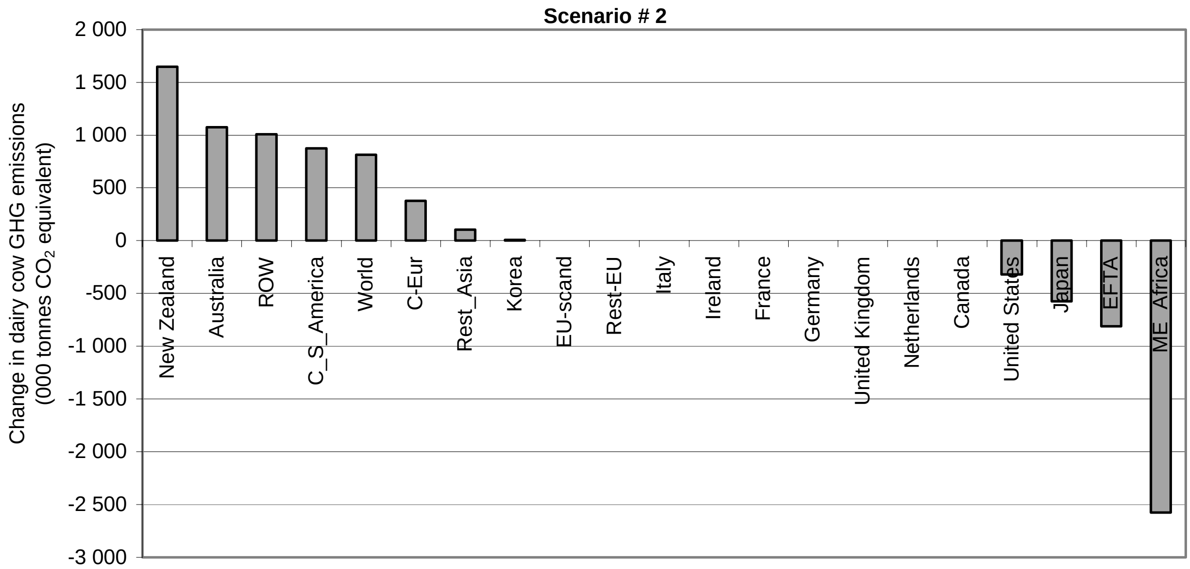
Source: OECD Secretariat.

6.5.2 Impact on dairy cow GHG emissions

196. Similarly, changes in GHG emissions from dairy cows mimic the modelled changes in milk production and cow numbers, but also take account of differences in emission coefficients per cow across countries and milk production systems (Figure 6.4). Summed over all regions, agricultural trade liberalisation results in increases in global output of GHG emissions from dairy cows of 28 000 tonnes CO_2 equivalent under the first scenario, and 813 000 tonnes for scenario #2. Such increased GHG emissions are about 0.2% of estimated global production of dairy GHG emissions in the base period. Thus at the global level, even the more substantive policy reforms of scenario #2 would appear to have an insignificant impact on GHG emissions from dairy production.

Figure 6.4. Changes in dairy cow GHG emissions resulting from further agricultural trade liberalisation





Source: OECD Secretariat.

197. At the OECD country level, there are significant increases in GHG emissions in **New Zealand** and **Australia**, with decreases in the **EFTA** countries, **Japan** and the **United States**. The increase in emissions is potentially important for New Zealand where milk production contributes over 20% of total GHG emissions (Chapter 2). While GHG emissions from other production systems will change as a result of further agricultural trade liberalisation, the estimated increase in emissions from dairy production represents 3% of total New Zealand GHG emissions in 1997.

6.6 Impact on dairy trade GHG emissions

198. Further agricultural trade liberalisation will also result in an increase in dairy product trade, with scenario #2 modelling a 14% increase in the volume of milk traded. Concerns are raised about the environmental impact of increased transportation of agricultural products which can contribute to raising the level of pollutants, particularly GHGs.

199. Emissions from transport depend on the type of transport as well as the distance travelled. For example, planes produce 19 times the GHG emissions of trains and 190 times those of a large ship. Consequently, transporting dairy products by land from the south of **France** to the **United Kingdom** results in the same level of emissions as shipping them from **New Zealand**.

200. An earlier study has estimated that transporting SMP from **Germany** to Nepal (transported by truck from the factory at Mannheim to the port at Trieste, moved by ship to Calcutta, by rail and truck to Kathmandu, and finally distributed to the hinterlands) results in the emission of 61 kg CO_2 equivalent GHGs per tonne of milk (Johnson *et al*., 1997). If all the additional dairy produce traded as a result of further trade liberalisation travelled this distance and by this method, an extra 565 000 tonnes of GHG will be emitted (Table 6.2).

Table 6.2. Increase in GHG emissions associated with increased trade in dairy products

Volume of dairy product trade in 1997 (including intra-EU trade)	000 tonnes milk equivalent	65 261
Increase in dairy product trade under scenario #2 (14.2%)	000 tonnes milk equivalent	9 267
GHG emission factor (Mannheim-Kathmandu)	Kg CO_2 equivalent per tonne milk	61
Estimated increase in GHG emissions	000 tonnes CO_2 equivalent	565
Increase as a share of GHG emissions from milk production in 1997	%	0.1

Source: OECD Secretariat.

201. While GHGs emissions associated with the transport of dairy products are likely to increase as a result of further trade liberalisation, this must be considered in the context of emissions from milk production and consumption. In terms of production, the increase in GHG associated with expanding trade represents only 0.1% of GHG emissions from milk production as estimated in 1997. This is an overestimate of the importance of transport in total GHG emissions from dairy product production as emissions from energy use on farm and from the production of dairy products are not taken into account. In terms of consumption, life cycle assessments of dairy products indicate that the most important environmental impact from transportation comes from the transportation between retailers and households *i.e.* people using cars to travel to and from supermarkets (Sonesson and Berlin, 2003).

6.7 Implications of the modelling results

202. Milk production is one of the most highly protected farm activities in OECD countries. Liberalisation of agricultural trade barriers, and a reduction in production-distorting domestic support, has

the potential to substantially shift the geographic location of milk production away from those countries with high levels of support to dairy farming to other regions within and without the OECD. Measuring the extent to which this occurs is made problematic given the existence of binding milk production quotas, and hence the presence of quota rents to milk producers in some of the most highly-protected countries.

203. Give its assumptions this study found that further agricultural trade liberalisation, as modelled to be indicative of some proposals that have been submitted to the WTO during the current Doha Development round of negotiations, could lead to an increase in total nitrogen manure output from dairy cows of less than 0.3% and would thus appear to have only a minimal impact on nitrogen pollution from dairy production globally.

204. For a given level of environmental pollution from livestock manure, its costs to society in any region are likely to be a function of that region's human population density. To the extent that farm support is highest in the high-income, densely populated countries of Northeast Asia and Western Europe, lowering farm protection in these countries could see less manure output from livestock, with consequent gains to society. Furthermore, some of the livestock production is likely to shift to other regions of the world, where human population densities are much lower and farm production systems are more extensive. Thus the additional environmental costs to society in the latter countries could potentially be less than the benefit gained through a reduction in environmental damage in the densely populated regions, generating an overall environmental benefit. Nevertheless, the increase in nitrogen manure output in countries in such as **New Zealand** and **Australia** may increase livestock environmental problems, and add further to those countries efforts to design appropriate environmental policies.

205. Results from the model indicate that while global milk production will expand, total GHG emissions associated with dairy farming are unlikely to alter very much. The largest increases in country GHG emissions occur in **Australia** and **New Zealand**. For New Zealand, having ratified the Kyoto Protocol with a commitment to keeping GHG emissions in the period 2008-12 to their 1990 level, this may be an important policy issue. While New Zealand is likely to comfortably meet its emission target because of the option of taking into account part of the carbon capture occurring in forests, the increase in GHG emissions from dairy has an opportunity cost in terms of the permits that could have been sold on the world market.

206. There are a number of important tradeoffs and limitations with this type of analysis. Manure nitrogen output from dairy cows is only one potential source of nitrogen pollution associated with dairy production. Nitrogen fertiliser used for forage production, both pasture and fodder crops, can also be significant. Further, local factors such as climate and soil type will determine the actual pollution that takes place.

207. A study by Saunders *et al.* (2004) estimated impacts of trade liberalisation on nitrogen groundwater pollution from milk production in a selected range of countries (**Australia**, the **European Union**, **New Zealand**, and the **United States**) based on modelled changes in nitrogenous fertiliser and concentrate feed use. Under a scenario of complete agricultural policy liberation in OECD countries, milk production declined in the EU (3%) and the United States (2%), but increased in Australia (3%) and New Zealand (4%). Changes in input use in milk production included increased use of nitrogen fertilisers in New Zealand, and increased feeding of concentrates in Australia and the United States. Use of both inputs declined in the EU. Changes in groundwater nitrogen concentrations were not dramatic – increases of up to 2% in Australia and New Zealand, declines of 3% to 4% in the EU and almost no change in the United States.

208. Changes in other agricultural sectors will also impact on the *net* national and international environmental impact resulting from further trade liberalisation. For example, changes in the number of

cows milked in any country will also be accompanied by changes in outputs of other farm enterprises and pasture utilization, where all of these changes may impact on nitrogen inputs and outputs, and GHG emissions from agriculture (Annex Tables 6.5 and 6.6 gives, for each scenario, percentage changes in all agricultural and non-agricultural sectors). A more complete study would involve the computation of the change in national nitrogen balances and GHG emissions due to trade liberalisation, recognizing the above changes occurring in the dairy sector and also changes in other farm activities.[13]

209. With a focus on global trade reforms, the analysis required treatment of nitrogen manure output and GHG emissions at the national level. While this is not such a problem for GHG emissions since the environmental concern is a global one, there often exist "hot spots" of nutrient pollution, the environmental impacts of which may be many times more severe than is indicated by national indicators. Other recent studies have tried to model the environmental impact of further trade liberalisation on nitrogen pollution at the sub-national level, including the impact of the dairy sector (Saunders *et al.*, 2004; Cooper *et al.*, 2003). Both studies find only minor regional changes occurring within the countries analysed.

210. Another issue to consider is the possible impact of trade liberalisation on the intensity of production, particularly given this study's assumption of constant yields per cow. It is well known that increases (decreases) in producer prices per unit of yield will encourage increases (decreases) in yields. For example, a study of **United Kingdom** dairy farms found that a reduction in milk price shifts production to a lower input-output system while an increase in the milk price favours a high input-output system (Ramsden *et al*., 1999). This is relevant to the study of nitrogen manure output from milk production since the nitrogen coefficient is positively related to milk yield per cow but at a diminishing rate (Chapter 2).

211. Consequently, lower producer prices for milk could encourage farmers to feed cows less intensively, resulting in lower yields and lower N-manure output per cow. Conversely, higher prices to producers could lead to more intensive feeding, higher yields and higher N-manure output per cow. To the extent that these effects occur within the modelled milk production changes (*i.e.* the change in milk production is not solely driven by changes in animal numbers), and assuming that the change in N-manure output per cow is less than the change in milk yield total nitrogen in dairy cow manure would rise less sharply in regions where milk output expands, and decline less sharply in regions where production declines, relative to the results given above under a constant-yield assumption.

212. Finally, this study only examined some of the environmental implications relating to the dairy sector. Other important environmental impacts such as ammonia emissions and biodiversity will be affected by further trade liberalisation. For example, a study in the **United States** indicated that lowering support prices for milk will reduce incentives for farmers to keep marginal agricultural land in production, increasing land in forest production and thereby reducing soil erosion (Plantinga, 1996).

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13. An initial effort is made in Rae and Strutt, 2003.

7. Policy measures addressing environmental issues in the dairy sector

- Environmental policies focus on reducing water pollution from dairy production, with some policies introduced to deal with ammonia emissions and biodiversity.
- The most frequently adopted policy measures are regulations, research, and technical assistance and extension. Regulations have been introduced to limit point source pollution (*e.g.* prohibit direct discharge into water ways) and reduce non-point source pollution through controlling the quantity of manure produced, the quantity spread and how the manure is spread.
- Payments are provided to offset the capital costs of regulations particularly relating to manure storage requirements.
- They have also been provided to encourage farms to adopt more environmentally friendly farming practices. Such payments are important for producers in a few countries, such as Austria, Finland, Norway, Sweden and Switzerland.
- Other economic instruments, *e.g.* taxes and tradable rights, have only been used to a limited extent. Over time, policy measures are becoming more stringent, with regulations increasing in severity and complexity, and tax rates increasing.

213. This chapter discusses the policies used to address environmental issues in the dairy sector and how these have changed over time.[14] Policy measures are grouped into three general categories: economic instruments; regulatory and legal measures; and advisory and institutional measures. Within each category there is a further breakdown into the type of policy instrument according to the classification system established for the OECD's *Inventory of Policy Measures Addressing Environmental Issues in Agriculture*.[15] Policy measures are also discussed according to their environmental objective. Chapter 8 deals specifically with policies to promote organic dairy farming and these are not included in this analysis.

7.1 Overview of developments

214. Some general observations can be made about developments in policies to address environmental issues in the dairy sector (Table 7.1). Almost all the agri-environmental policies discussed in this chapter are not specific to the dairy sector, applying to all producers or all livestock producers etc. This analysis attempts to describe those general policies that are most likely to affect dairy producers.

- All countries have environmental regulations in place affecting dairy producers. Although changes in regulations are not shown, evidence indicates that these are becoming more stringent.
- Payments relating to farm fixed assets, such as assistance for the construction of manure storage facilities, have often been used as a policy instrument to offset the costs of regulatory requirements.

14. This chapter is based on available information and may not fully represent the situation faced by every producer in every country. This is especially true when having to incorporate sub-national information for provincial, state or municipal policies. This was done on a limited basis to be representative and does not fully explore the situation for all producers at the local level.

15. For further information on this inventory consult www.oecd.org/agr/env/.

- Measures broadly classified as advisory or institutional have also been more widely used in recent years. All countries are now undertaking some form of research relating to the impact of dairy production on the environment. This research has often been translated into technical assistance and advice to farms, with the goal of persuading farmers to voluntarily change their management practices or adopt suitable technologies. Some attempts have been made in the last few years to develop community-based measures.

- Other economic instruments, environmental taxes and charges, and tradable rights/quotas, have only been implemented in a few countries. Where taxes have been used, the threshold levels and tax rates applicable have been altered to increase the cost to dairy producers.

- Cross-compliance measures have been imposed on agricultural support payments received by dairy producers in just a few cases.

Table 7.1. Agri-environmental policies affecting dairy producers in selected countries[1, 2]

Country	Payments based on farm fixed assets	Payments based on resource retirement	Payments based on farming practices	Environmental taxes/charges	Tradeable rights/quotas	Regulations	Cross-compliance mechanisms	Research[3]	Technical assistance and extension[3]	Labelling standards/certification	Community based measures
Australia					X	X		X	X		X
Canada						X		X	X		
Denmark	X		X	X		X		X	X		X
France	X		X	X		X		X	X		
Germany	X		X			X		X	X		
Ireland	X		X			X		X	X		
Italy	X		X			X		X	X		
Japan	X					X		X	X		X
Korea	X					X		X	X		X
Netherlands	X		X	X	X	X		X	X	X	
New Zealand						X		X	X		X
Norway	X		X	X		X	X	X	X		
Sweden	X		X	X		X		X	X		
Switzerland	X		X			X	X	X	X		
United Kingdom	X		X			X		X	X		
United States	X	X	X	X	X	X		X	X		

Notes:

1. Policies adopted for organic dairy production are not included in this table. See Table 8.1 for details of organic policy measures affecting dairy production.

2. An "x" indicates that a policy measure(s) exists. The table mainly captures measures at the national level and so not all sub-national measures may be identified.

3. An "x" identifies specific research, and technical assistance and extension provided for environmental purposes. Dairy producers benefit from other forms of research, and technical assistance and extension.

Source: OECD Secretariat.

215. The major environmental objective of policy instruments affecting the dairy sector has been to reduce the incidence of water pollution arising from milk production, particularly nitrogen (N) but also phosphorus (P). Other environmental concerns addressed by policy measures include ammonia emissions,

greenhouse gas (GHG) emissions, landscape and biodiversity. In some cases, policy measures have been introduced with the specific purpose of meeting more than one objective. In other cases, a particular policy measure introduced to deal with one environmental objective has an effect on other environmental objectives.

7.2 Economic instruments

216. Economic instruments affect costs and benefits of alternative actions open to economic agents, with the purpose of influencing behaviour in a way that is favourable to the environment. These instruments typically involve either a monetary transfer *e.g.* payments from governments to farmers or charges/taxes paid by farmers – or the creation of new markets *e.g.* tradable pollution rights. The actual level of support to or tax paid by dairy producers within the various programmes is not calculated. Taxes/charges and tradable quotas/rights are very rarely used in the dairy sector.

7.2.1 Payments based on farm fixed assets

217. Payments based on farm fixed assets are policy measures granting a monetary transfer (including implicit transfers such as tax and credit concessions) to farmers to offset the investment cost of adjusting farm structure or equipment to adopt more environmentally friendly farming practices.

218. The main payment provided under this category is assistance to livestock producers to install manure storage facilities that allow them to meet the requirements of manure management regulations. This form of support has been used in a number of OECD countries including the **European Union** countries of **Denmark**, **France,** the **Netherlands** and the **United Kingdom**, as well as **Japan**, **Norway** and the **United States**. In general, such assistance is available to farmers for a limited period of time in conjunction with the introduction of new regulations. Assistance generally covers a portion of the expense rather than the whole amount, and has taken the form of grants, interest rate concessions or tax breaks.

219. For example, financial assistance has been made available (in accordance with Council Regulation 2328/91/EEC, as amended by 2843/94/EEC) to livestock producers in areas defined as Nitrate Vulnerable Zones (NVZs) under the **European Union** Nitrates Directive to assist them with the capital costs associated with restrictions on the land application of manure.[16] In **Scotland**, GPB 29.4 million (USD 47 million) is being made available over five years (2003-7) to assist livestock holdings in NVZs install fixed equipment for the storage and handling of manure and slurry, silage effluent collection facilities, and clean/dirty water diversion systems. Support is provided at a rate of 40% of eligible expenditure to a maximum of GPB 85 000 (USD 137 000) per operation (EC, 2003).

220. In **Japan**, following the introduction of “the Law concerning the Appropriate Treatment and Promotion of Utilization of Livestock Manure” in 1999, the government has supported the construction and adaptation of manure storage facilities through direct grants, low-interest loans, and tax deduction. The estimated annual cost of these measures is JPY 6.7 billion (USD 760 million).In order to encourage a greater use of manure in crop production, the government is also subsidising the chemical analysis of manure (FAPRC, 2001). Since 1990, **Korea** has supported the installation of manure treatment facilities on livestock operations through grants and preferential loans.

221. In the **United States**, Environment Quality Incentives Program (EQIP) is the only federal conservation programme that contains an explicit clause targeting funds to address environmental concerns

16. See Council Directive 91/676/EEC in Official Journal No. 375, 31/12/1999, 0001-0008. Austria, Denmark, Finland, Germany, Luxembourg and the Netherlands have all designated their entire country as a NVZ under the Nitrates Directive.

arising from livestock production. It provides a voluntary conservation programme for farmers and ranchers who face serious threats to soil, water, and related natural resources through both cost-sharing and incentive payments to farmers, as well as technical and educational assistance.[17] Cost-sharing payments are categorised under payments based on fixed inputs, and applies to structural and vegetative practices, and may pay up to 75% of the costs of installation. Examples of eligible practices include manure management facilities, as well as grassed waterways, filter strips and capping abandoned wells (see 7.2.3 *Payments based on farming practices* for other forms of EQIP payments to dairy farmers).

222. Total annual budgetary expenditure under EQIP has been fairly consistent at around USD 200 million, with applications for EQIP funding ranging from USD 400-600 million each year. In the 2002 Farm Security and Rural Investment (FSRI) Act, annual funding for EQIP was increased to USD 1.3 billion. Total cost-share and incentive payments were initially limited to USD 10 000 per person per year and USD 50 000 for the length of the contract. The 2002 FSRI Act altered the limit in that the amount received per producer cannot exceed USD 450 000 from all EQIP contracts over the period of the 2002 FSRI Act (period 2002 to 2007).

223. While owners of large concentrated animal feeding operations with over 1 000 animal units (defined as CAFOs) were initially not eligible for cost-share assistance for animal waste storage or treatment facilities, the 2002 FSRI Act removed this limit. One of the reasons for this was in preparation for stricter rules on livestock operations under amendments to the 1972 Clean Water Act introduced in early 2003. Previously, all CAFOs were required to obtain a National Pollutant Discharge Elimination System (NPDES) permit. The standard permit states that all manure from the operation should be collected and stored. However, an important exemption from obtaining a permit was provided to CAFOs that only discharged in the event of a 25 year, 24 hour storm. Under the new regulations, all CAFOs must obtain a permit, regardless of whether they discharge only during large storms (Ribaudo *et al.*, 2003).

224. Nationally, half of the funding for EQIP is targeted to natural resource concerns related to livestock. The remainder is targeted to other significant conservation priorities. In FY1997-2000, EQIP directed 60% of available funds to livestock producers as part of approved conservation plans. Of that, 55% was spent directly on waste management and water quality conservation practices, the rest going to land management (12%), habitat (8%), fencing (11%), crop nutrients (4%) and the remainder on other miscellaneous practices. In addition to federal funding, 25 states provide their own cost sharing programmes to encourage environmental compliance (Hegg, 2001).

7.2.2 Payments based on resource retirement

225. Payments based on resource retirement are policy measures granting monetary transfers (including implicit transfers such as tax and credit concessions) to farmers for retiring or removing resources from commodity production for environmental purposes, including environmentally fragile land. No such policy measures that specifically address dairy producers exist at the national level, although the state of Florida, **United States**, has paid for the removal of dairy cows as part of a wider strategy to reduce phosphorus loadings.

7.2.3 Payments based on farming practices

226. Payments based on farming practices are policy measures granting annual monetary transfers (including implicit transfers such as tax and credit concessions) to farmers to encourage or constrain the

17. Established by the 1996 FAIR Act, EQIP replaced four former programs: the Agricultural Conservation Program (ACP), Water Quality Incentives Program (WQIP), Great Plains Conservation Program (GPCP), and Colorado River Basin Salinity Control Program (CRSCP).

use of certain farm inputs (farming practices) and/or offset the costs of implementing more environmentally friendly farming practices. Such payments are used to support dairy producers to achieve environmental objectives in a number of countries.

227. In the **European Union**, a large number of support programmes that fall under this classification have been established under the 1992 Agri-Environmental Regulation 2078/82, later brought under the 1999 Rural Development Regulation 1257/99.[18] This policy imposes a general obligation on EU member states to develop programmes for the promotion of the environment and the maintenance of the countryside which go beyond mandatory requirements and normal "good farming practices". Farmers are reimbursed their costs on the principle of profit forgone, sometimes with the addition of an incentive element.

228. Under these regulations, payments have been made to dairy farmers in all **European Union** countries. First, dairy farmers have been eligible for payments to assist in the conversion and maintenance of organic dairy production. Chapter 8 provides further details on these payment rates and how they vary between OECD countries.

229. Second, dairy farmers have been eligible for grassland management payments. For example, payment is provided for grassland management in Bolzonna, **Italy**, where dairy is a major agricultural activity. In **Austria**, it is likely that a reasonable number of dairy farmers have received support under the ÖPUL programme for extensive cultivation in traditional areas, which, for example, provided an annual payment of EUR 3 700 per farmer in 1997 (CEAS, 2000). In **France**, per hectare payments are made for the maintenance of grassland areas on extensive livestock farms (*Prime à l'herbe*). Eligible farmers must have more than 3 hectares of grassland and more than 3 livestock units, and farmers are required to maintain the permanent grassland area, harvest the grass and generally upkeep the area. Dairy farmers in **Sweden** are eligible for payments for maintaining land in hay-making and grazing to maintain the landscape and biodiversity.

230. A third type of payment provides support for breeds threatened by extinction to promote biodiversity. Payments for rare cattle breeds, including those specifically used for milk production, are provided in all **European Union** countries with the exception of **Denmark**, **Luxembourg**, the **Netherlands** and the **United Kingdom** (Signorello and Pappalardo, 2003). For example, **Swedish** farmers who have the Fjällko, Rödkulla and Allmogeko breeds of cattle are compensated at a rate of approximately EUR 110 per animal (MAFF Sweden, 2000). Analysis of EU member country rural development plans shows a range of average per head payments for rare cattle breeds, from EUR 100 in **Belgium** to EUR 202 in **Italy**.

231. Other payments have been introduced to offset restrictions on input use. Dairy farmers, for example, in **Finland** (under the General Agricultural Environment Protection Scheme) and **Austria** (under the ÖPUL programmes for non-use of specified yield raising substance) have been eligible for such payments, which require among other things farmers to restrict manure application rates and livestock densities.

232. Finally, payments have also been provided to prevent land abandonment by targeting marginal areas where farming is not always economically viable. For example, in **Austria** the ÖPUL programme for Alpine pasturing is provided to promote the cultivation of Alpine pasture areas for livestock grazing and

18. See Official Journal No. L215, 30/07/1992, 0085-0090. In 1996, the Commission established a regulation (Commission Regulation 746/93/EC) setting out detailed rules for the application of this Council Regulation, see Official Journal No. L102, 25/04/1996, 0019-0027. As part of the Agenda 2000 CAP reform, this regulation was strengthened and enlarged as a single chapter within Regulation 1257/1999 on Rural Development.

the use of labour for herding. In 1997, some 7 000 farmers, 4.2% of the total were involved in the payment programme (CEAS, 2000).

233. Data drawn from the **European Union** Farm Accountancy Data Network (FADN) provides an indication of the extent to which dairy farmers are receiving agri-environmental payments (Table 7.2).[19] While 1999 is the latest year for which detailed information is available, a number of points emerge that show the relative importance of such programmes between EU member countries and these are unlikely to have changed.

- On average across the EU, 27% of agri-environmental payments went to specialist dairy holdings. A share of around 40% or more occurred in **Belgium**, **Denmark**, **Germany**, **Luxembourg**, the **Netherlands** and **Sweden**. Less than 10% of such payments went to specialist dairy operations in the southern European countries of **Greece**, **Italy**, **Portugal** and **Spain**.

- More than 40% of specialist dairy holdings in the EU were participating in agri-environmental programmes in 1999, more than double the average across all holdings.

- In **Austria**, **Finland**, Luxembourg and Sweden, all or nearly all specialist dairy farms received agri-environmental payments. These countries account for around 8% of total EU milk production.

- In the two largest dairy producing countries, Germany and **France**, around 60% and 30% respectively of all specialist dairy farmers received agri-environmental payments. Within France, dairy farmers in mountain areas receive a significantly greater proportion of the agri-environmental payments (Chatellier and Delattre, 2003).

- The average level of agri-environmental payments per specialist dairy farm was also highest in Austria, Finland, Luxembourg and Sweden. While a smaller share of specialist dairy farmers in Denmark, **Ireland** and the **United Kingdom** participated in such programmes, those that did received payments that resulted in a per farm receipt level above the EU average.

19. FADN contains farm level data on the structure, output and income of 60 000 commercial farms in the European Union. For further information consult http://www.europa.eu.int/comm/agriculture/rica/index_en.cfm.

Table 7.2. Agri-environmental payments to specialist dairy farms in the European Union, 1999

	Agri-environmental payments				Share of holdings recieving agri-environmental payments		Share of EU milk production
	All holdings	Specialist dairy[1]			All holdings	Specialist dairy	
Country[2]	EUR million	EUR million	% total holdings	average EUR per farm receiving agri-envrionmental payments	% total holdings	% total specialist dairy	%
Austria	508	160	31	5 700	99	100	3
Sweden	212	108	51	7 900	83	98	3
Finland	294	94	32	4 300	93	97	2
Luxembourg	10	6	60	6 200	94	96	0
Germany	527	227	43	3 600	46	61	23
Italy	576	44	8	3 300	16	33	9
France	236	58	25	2 700	19	31	20
Netherlands	44	17	39	2 200	19	28	9
Ireland	218	42	19	5 500	34	23	4
Denmark	31	13	42	6 000	12	22	4
Portugal	116	8	7	2 500	21	22	2
United Kingdom	210	29	14	6 800	20	15	12
Belgium	1	1	43	400	5	9	3
Greece	1	-	-	-	-	-	1
Spain	4	-	-	-	-	-	5
EU-15	2 988	807	27	4 300	19	42	100

Notes:

1. Specialist dairy farms are those defined as “type 41” according to the FADN classification.

2. Countries are ordered according to share of specialist dairy holdings receiving agri-environmental payments.

Source: Brouwer and Godeschalk, 2004.

234. In the **United States**, dairy producers are eligible to receive incentives payments under EQIP, which are designed to encourage producers to perform land management practices they may not otherwise use, and may be provided for one to ten years depending on the contract. Incentive payments are not directly linked to producers’ actual costs as cost-sharing payments are. Rather, a payment ceiling is determined practice by practice. Eligible practices include nutrient management, manure management, integrated pest management, irrigation water management, and wildlife habitat management. Farmers can choose from among approximately 250 eligible conservation practices, and a producer can hold more than one contract, either simultaneously or sequentially.

235. In **Norway**, payments have been made to dairy farmers to support summer dairy farming since 1990. The programme’s original objective was to contribute to the use of grassland resources in mountain areas through grazing and thereby contributing to the maintenance of the cultural landscape. Since 1997, all summer dairy farms have been eligible for this support, with the objective broadened to maintain and encourage traditional summer mountain dairy farming, and to ensure the maintenance of the traditional cultural landscape through animal grazing and prevent forestation. Support is provided through a fixed-sum annual payment, and in 2001 was NOK 13 000 (USD 1 445) per unit. To be eligible for this payment,

commercial production of milk on the mountain farm must take place for at least four weeks during the summer. There had been a very rapid decline in the number of mountain dairy farms from around 44 000 in 1907 to 2 609 in 1995. The number appears now to have been stabilised, with 2 620 mountain dairy farms receiving support through the scheme in 2000. A new headage payment was introduced in 1998 to support the outlying field grazing of livestock. The objective is to stimulate the use and management of outlaying fields which have been traditionally grazed and which maintain a particular biological diversity. To receive the payment animals must be grazed outside for a minimum of eight weeks a year. The annual payment rate varies on the type of animal and until 2002 farm size.

7.2.4 Environmental taxes/charges

236. Environmental taxes and charges are policy measures imposing a tax or charge relating to pollution or environmental degradation, including taxes and charges on farm inputs or outputs that are a potential source of environmental damage.[20] Dairy producers in OECD countries face a limited number of environmental/taxes or charges, and these can be divided into two main groups. First, in a few OECD countries, all agricultural producers have been subject to the general taxes imposed on pesticides (**Belgium** [1996-], **Denmark** [1986-], **France** [2000-] **Norway** [1988-] and **Sweden** [1984-]), and commercial fertilisers (**Austria** [1986-1994], **Finland** [1976-1994], Norway [1998-2000], Sweden [1984-] and recently introduced in a few states in the **United States**) (ECOTEC, 2001).

237. Second, there are more direct taxes focused on pollution caused from livestock production in **Belgium**, **Denmark** and the **Netherlands**, where taxes are levied on nutrients (Table 7.3). In Denmark the levy is based on nitrogen (N), while in Belgium and now in the Netherlands the levy is based on both nitrogen and phosphorus (based on P_2O_5). In Belgium and initially in the Netherlands, the basis for the levy is manure production alone, while in Denmark and now in the Netherlands, the basis for the levy takes into account inputs of nutrients from all sources (including commercial fertilizers) and uptakes of nutrient *e.g.* in crop production. In all three countries the tax/levy rate applied has been increased since initially introduced, *e.g.* doubling in Belgium and increasing by almost 20 times in Denmark.

238. Large livestock producer in **France** are also subject to a tax on the amount of pollutants produced based on the average estimates of emissions for different types of animals. By undertaking certain management practices farmers are able to reduce the bill (OECD, 2003*d*).

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20. Fines imposed on producers for failure to meet regulations are not classified as taxes/charges. They provide an economic incentive to adhere to a mandatory regulation, like cross-compliance payments.

Table 7.3. Taxes on manure in OECD countries

Country	Years applied	Basis for levy	Tax rate
Belgium	1991-1999, manure decree.	On surplus manure nutrient (N and P_2O_5) production above a maximum applicable rate per hectare.	EUR 0.5 for every kgN and every kgP_2O_5 above this level.
	2000-, under the second Manure Action Plan.	A "nutrient stop" level on every farm, limiting the annual level of manure nutrient production out to the year 2005 equivalent to the maximum annual level in the period 1995-97, in both N and P_2O_5 equivalents.	EUR 1 for every kgN and every kgP_2O_5 above the farms "nutrient stop" level.
Denmark	1994-1997, established under the 1991 Action Plan for Agricultural Development	An annual N quota per farm is calculated based on inputs (fertiliser and manure) and outputs of N (crops, livestock etc) using set coefficients.	If N application rate exceeds this level by less than 10 kg/N/ha then producers receive a warning. If application exceeds this level by more than 10 kgN/ha a maximum levy of EUR 0.13 kg/N/ha.
	1998-, under the Action Plan for the Aquatic Environment II		If application exceeds this by up to 30 kgN/ha, producers are fined EUR 1.35 kgN/ha. By more than 30 kgN/ha, the fine increases to EUR 2.70 kgN/ha.
The **Netherlands**	1986-97, under the Fertiliser Act	Manure nutrient production above 125 kgP_2O_5/ha, determined by multiplying animal number by animal specific coefficients.	EUR 0.11 kgP_2O_5 between 125 and 200 kgP_2O_5/ha, and EUR 0.23 kgP_2O_5 above 200 kgP_2O_5/ha.
	1998-, introduction of the mineral accounting system, MINAS[1]	Taxes are levied on farm surplus of N and P_2O_5, above a certain level, taking into account all inputs and outputs. This level has been gradually lowered to 180 kgN/ha on grassland (140 kg/N/ha on dry sandy soil), 100 kgN/ha on arable land (60 kg/N/ha on dry sandy soil), and 20 kgP_2O_5/ha in 2003.	The tax rates were annually increased to reach EUR 2.3 kgN and EUR 9 kgP_2O_5 in 2003.

Note:

1. See Chapter 9 for further details on the MINAS programme. In October 2003, the European Court of Justice ruled that the MINAS programme failed to meet the requirements of the Nitrates Directive (91/676/EEC). As a consequence, MINAS will be replaced in 2006 by a simpler system with strict limits on the maximum application of manure nitrogen per hectare. It is estimated that the new measure will cut administrative costs, currently EUR 195 million per year, by 40%.

Source: OECD Secretariat.

239. In general, OECD governments have been reluctant to impose environmental taxes/charges on farmers. In part this is due to the difficulty in many cases of identifying the level of pollution being caused by an individual farm operation. But governments have also been concerned about imposing additional costs on producers. For example, as part of **New Zealand's** policy response to achieve it's obligations under the Kyoto Protocol, the government will introduce an emissions charge on fossil fuels and industrial process emissions. While farmers, along with other consumers of energy will face extra charges, the agricultural sector has been exempt from a tax on agricultural non-carbon dioxide emissions (*i.e.* methane and nitrous oxide) provided the sector invests in research (see Section 7.4.1) (MAF New Zealand,

2003*a*).[21] Despite the fact that agriculture is a significant contributor to GHG emissions in New Zealand (Chapter 2), and that GHG emissions are relatively easy to identify, the sector has been exempt because at the moment reducing animal numbers is the only effective management option for farmers to reduce emission levels.

7.2.5 Tradable rights/quotas

240. Tradable rights/quotas are measures that establish environmental quotas, permits, restrictions and bans, maximum rights or minimum obligations to economic agents which are transferable or tradable. There have been relatively few such measures introduced in OECD countries to deal with agri-environmental issues. Tradable water rights have been introduced in some states of **Australia** and the **United States** to allow a shift in the allocation of water use. Dairy producers located in these regions have been required to participate in the various schemes.

241. The other tradable rights instrument that has been introduced in OECD countries that directly affects dairy producers is in the **Netherlands**. In 1994, a portion of the manure production rights of livestock producers, established in 1986, were made tradable between livestock producers. In order to reduce production levels, the government takes 25% of the quota involved in each transaction. This system has continued with the establishment of MINAS in 1998.

7.3 Command and control measures

242. Measures classified under this category involve a compulsory restriction on the choice of economic agents, *i.e.* they are left with no choice but to comply with specific rules or face penalties (including the withdrawal of financial support).

7.3.1 Regulations[22]

243. Regulations are compulsory measures imposing requirements on producers to achieve specific levels of environmental quality, including environmental restrictions, bans, permit requirements, maximum rights or minimum obligations. They are the most common policy measure used in OECD countries to limit the environmental impact of dairy production. These regulations range from the very broad prohibitions or requirements, to intricate details about farm management practices. It should be emphasised that relatively few of these regulations relate exclusively to the dairy sector. In most OECD countries, *fines* and *penalties* are imposed on producers who are found to breach regulations or other legal requirements.

244. Regulations affecting dairy producers in OECD countries can be divided into thee main types according to environmental objective. First, there are regulations that deal with reducing *water pollution*, and these probably have the greatest effect on dairy producers. However, the incidence of the regulations and the requirements that they place on dairy producers have varied between OECD countries, and within OECD countries. All countries have banned the direct discharge of manure into waterways. While some countries ban any discharge of manure, others permit discharge after appropriate treatment. Regulations also impose restrictions on the quantity of manure that can be produced; on the form of and size of manure storage facility; on the quantity of manure that can be spread; and on the method and timing of application. There has been a growing requirement for farmers to prepare nutrient plans.

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21. It is estimated that the cost imposed by the carbon charge on energy and transport will increase the total energy cost of dairy farmers by 4.7% if carbon is priced at NZD 10 per tonne, or 11.8% if carbon is priced at NZD 25 per tonne (MAF New Zealand, 2003*a*).

22. See OECD (2003*a*) for a more detailed description of the environmental regulations affecting livestock produces.

245. Second, there are regulations focussing on *air emissions* from livestock production. These have mainly focussed on odour and noise issues, and have been dealt with at the local level though distance requirements for housing facilities, the spreading of manure etc (Brouwer *et al*., 2000). Over the 1990s, environmental issues relating to ammonia and GHG emissions have arisen. Regulations have already been imposed on dairy producers in northern European countries such as **Denmark**, the **Netherlands** and **Norway** to reduce ammonia emissions, in particular placing requirements on the storage and spreading of manure. In October 2001, the **European Union** adopted the Directive on National Emission Ceilings for Certain Atmospheric Pollutants (NEC Directive) which will require by 2010 a 20% reduction in the total European Union wide level of ammonia emissions from the 1990 level. The reduction requirements will vary from country to country depending on the contribution to total emissions and the environmental effects emissions are having. To date, there have been no regulations introduced that specifically target greenhouse gases.

246. Third, there are regulations that focus on the impact of agriculture on *nature, biodiversity and landscape*. A study on regulations in **Australia**, **Canada**, the **European Union**, **New Zealand** and the **Untied States** found that governments in all these countries have legislated to protect remaining valuable non-farm habitats such as wetlands from drainage, or bush or forest from clearance (Brouwer *et al*., 2000). In the European Union, additional regulations are in place to protect valuable farmland habitat through the Habitats Directive and the Wild Birds Directive. However, the impact of such measures on dairy farming is likely to be considerably less than for arable enterprises (CEAS, 2000).

247. Chapter 9 details the manure management regulations that affect dairy farmers in six OECD countries: Ontario (**Canada**), **Denmark**, **Japan**, the **Netherlands**, Waikato (**New Zealand**) and **Switzerland** (Table 9.2). A number of points emerge from comparing these regulations, and these appear to have general applicably across OECD countries.

- Regulations focus more on nitrogen rather than phosphorus. In the **European Union** this largely reflects the requirements of the Nitrates Directive which sets a maximum manure application level of 170 kg N/ha in areas identified as NVZs unless other actions are taken which compensate for a less restricted rate being allowed. Only a few countries base their nutrient management legislation on phosphorous, or a combination of N and P.

- Regulations were first introduced in northern European countries and appear to more stringent in these countries.

- Over time, the stringency of regulations has been increasing in all countries, with a number of regulations recently introduced that are being phased into effect on dairy producers.

- Variations in regulations do reflect differences in geographic and climate features between countries *e.g.* dairy farmers in New Zealand are not as restricted in the period they can apply manure because of the more temperate climate.

7.3.2 Cross-compliance mechanisms

248. Cross-compliance mechanisms are measures imposing environmentally friendly farming practices or levels of environmental performance on farmers participating in specific agricultural support programmes. They have been a common development in some OECD countries over recent years (Annex Table 7.1). However, they have mainly been used on support payments for arable crops, and headage payments for beef and sheep. Only in **Norway** and **Switzerland** are cross-compliance requirements likely to be significant for dairy producers.

249. In **Norway**, the Acreage and Cultural Landscape Programme accounts for one quarter of total budgetary support to farmers, and consists of area based payments for a variety of agricultural production, including the area in roughage production (grass), cereal, oilseeds, etc. Payment rates are differentiated with respect to geographical location, farm size and production, and range from NOK 1 500 to NOK 19 000 per hectare. A total of 977 000 hectares received this payment in 2001, approximately 94% of agricultural land use in Norway. From 1991, requirements relating to the maintenance of the cultural landscape were placed on the receiving of this payment, and these requirements have been altered only to a limited extent since they were originally introduced. Specifically, to be eligible for the area payment farmers are not allowed to: close or canalise open streams and ditches; cultivate areas like border zones or forest edges; remove stone walls; level fields; close walking paths; or use pesticides on border zones; or farm within two metres of a watercourse. Additional requirements can be placed on land at risk of soil erosion. Cross-compliance requirements are also placed on the receipt of headage payments, which make up a further 10% of budgetary support. Specifically, livestock farmers who indicate in their annual fertiliser plan that they will fertilise at a level above established application limits are penalised with a reduction in the headage payment rate.

250. In **Switzerland** direct payments to dairy producers are conditional on certain livestock nutrient management practices. Since 1999, Swiss farmers can only receive direct payments if they provide Required Environmental Services (RES). One of these RES is a balanced fertiliser budget, whereby a farm’s nitrogen and phosphate inputs and outputs are calculated, with a maximum allowable surplus of 10% (Hofer, 2000).

7.4 Advisory and institutional measures

251. Advisory and institutional measures include collective projects to address environmental issues and measure to improve information flows to promote environmental objectives. This information can be provided to both producers, in the form of technical assistance and extension, and to consumers, via labelling.

7.4.1 Research

252. Research measures grant support to institutional services to improve the environmental performance of agriculture through research on environmentally friendly production technologies, pollution prevention, quality control management systems, and green marketing. Across all OECD countries, governments are funding ***research*** investigating the relationship between dairy production and the environment. This research is undertaken in order to establish best management practices to be communicated to farmers through on-farm technical assistance, or to establish the most appropriate regulations or other policy measures. It often covers a broad range of scientific enquiry including ecology, engineering, farm management practices, farmer behaviour, and economics.

253. Research has traditionally focussed on water and odour concerns, with a particular emphasis on nitrogen as the nutrient of concern. There appears to have been less research with regard to the impact of phosphorus, other chemical elements and pathogens (Williams, 2001). A growing amount of research is focusing on ammonia and greenhouse gas emissions.

254. The types of research undertaken can be divided into three broad areas. First, research is being undertaken to improve the understanding of the link between dairy production and the environment. In **Australia**, the dairy industry formed a partnership with the National Land and Water Resources Audit, called “Sustaining Our Natural Resources – Dairying for Tomorrow” to assess the sustainability of production in the eight major dairying regions, survey current practices and farmer attitudes and develop programmes to promote more sustainable practices (NLWRA, 2002). A number of research projects in

Australia are also working to better define the relationship between milk production, and phosphorus and nitrogen fertility. The largest of these have indicated that soil P targets recommended by both fertiliser companies and government agencies should be reduced (Gourley, 2001).[23]

255. A second area of research is focussed on finding ways to reduce the level of pollutants arising from dairy production, including those excreted in manure and those admitted through ruminant digestion (contributing to greenhouse gases). For example, the **New Zealand** government has proposed the establishment of an Agricultural Emissions Research (AER) body to oversee the research and development of technologies and practices to reduce GHG emissions from agriculture (MAF New Zealand, 2003*a*). It is also proposed that the AER be funded by a levy imposed on livestock producers to raise the annual NZD 8.4 million (USD 5 million) estimated for research. Dairy farmers are likely to be charged per kilogram of milk solids, the basis on which farmers are paid in New Zealand, at a rate equivalent to NZD 0.72 per cow per year.

256. Another broad area of research is looking at how best to manage the nutrients that are produced to minimise their environmental impact. This mainly involves research into areas such as livestock housing, manure storage facilities and the spreading of manure. For example, in terms of manure spreading, research has been examining the extent to which different methods, such as shallow and deep injectors, trailing shoe spreaders and band spreaders, reduce ammonia emissions. Other techniques being investigated include covers for slurry storage tanks (such as rape seed or chopped straw) and lactic acid as a slurry additive to reduce the pH value.

257. In the **Netherlands**, the De Marke Centre for Dairy Farming and Environment has for over a decade been working to develop and demonstrate a system of sustainable dairy farming on dry sandy soils that meets strict environmental standards, even stricter than those imposed by Dutch regulation. The main focus of the research is directed at ways of reducing nutrient losses to the environment, by adapting feeding regimes, the proper use of manure and cropping patterns.[24] The Zegveld Centre for Dairy Farming on Peat Soils is the only research and information station on peat soil in the world. A major research issue is the integration of sustainable dairy farming and nature management.

7.4.2 Technical assistance and extension

258. Technical assistance and extension are policy measures providing farmers with on-farm information and technical assistance to plan and implement environmentally friendly farming practices. All OECD countries provide ***advisory services*** specifically targeted at improving the environmental performance of dairy producers. This assistance can take a variety of forms including: technical advice regarding the construction of manure storage facilities; practical advice on the spreading of manure; the development of nutrient management plans; and the monitoring of environmental impacts.

259. For example, in the **United States**, dairy producers are provided with assistance in dealing with environmental issues through the Conservation Technical Assistance (CTA) Program, operated by the National Resources Conservation Service (NRCS). The CTA Program provides voluntary conservation technical assistance to land-users, communities, units of state and local government, and other Federal agencies in planning and implementing conservation systems. This assistance is for planning and implementing conservation practices that address natural resource issues.

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23. See OECD (2003*a*) for further examples of generic research being undertaken to reduce the environmental impact of livestock production.

24. For examples of the research results see Hilhorst *et al.* (2001) and Hack-ten Broeke (2001).

260. In the **European Union**, technical assistance has been provided to assist the implementation of the voluntary codes of good practice required by the Nitrates Directive which are mandatory in areas designated as NVZs. These inform farmers about practices to reduce the risk of nutrient pollution. The codes regulate the time and circumstances during which manure may be spread, the storage and spreading technology, and application norms for different crops. In some countries the codes are very detailed and intended as an advisory instrument for farmers (*e.g.* **United Kingdom**) while others only contain the bare minimum of requirements (*e.g.* **Greece**) (De Clercq *et al*., 2001).

261. In **Canada**, the Livestock Environment Initiative, funded under the Canadian Adaptation and Rural Development (CARD) programmes builds on the success of the Hog Environment Strategy. Through this initiative CAD 1 million is provided for research and the development, assessment and transfer of technology to the livestock industry for addressing environmental issues in livestock production. The funds are managed by the industry-led Livestock Initiative National Committee (LINC), which consists of representatives at the national level from each of the beef, poultry, dairy and pork sectors, and one representing all other livestock organizations.

262. A number of regional councils in **New Zealand** provide farmers with assistance in the establishment of environmental farm plans (MFE, 2003*a*). While plans have traditionally focussed on soil conversation, targeting erosion problems on hill and high country sheep and beef farms, some councils, particularly in the Taranaki, Waikato and Bay of Plenty regions, are increasingly focused on dairy. For example, the Taranaki Regional Council prepares Riparian Pans, which outline fencing, land retirement and planting options for farms on the Taranaki ringplain with the objective of improving water quality. Seventy such plans were prepared on dairy farms in 2002. The Bay of Plenty Regional Council assists with the preparation and implementation of an Environmental Programme for each farm, focussing on such issues as the protection and enhancement of indigenous biodiversity, and soil and water conservation. The Council also undertakes to monitor the effectives of each programme. The Sustainable Management Fund has supported the establishment of specialist discussion groups, which focus on best environmental practice for dairy farmers, and the development of an environmental management system for dairy farmers.

263. In addition to government established codes discussed above, producer groups have established own codes of practice in a number of countries. For example, in 1997 dairy farmers in Tasmania, **Australia**, developed a code of practice for managing dairy farm effluent, covering aspects such as site management and system design hazard analysis (Hubble and Phillips, 1999). Similar dairy farm specific codes of practice now exist in some other Australian states such as Queensland. In **New Zealand** Fonterra has recently signed a “Dairying and Clean Steams Accord” with the Ministry for the Environment, Ministry of Agriculture and Forestry, and regional councils to achieve clean, healthy water, including streams, rivers, lakes groundwater and wetlands, in dairying areas (MFE, 2003*b*). Priorities include fencing off streams and rivers, providing stock crossings at critical points, fencing significant wetlands, appropriate disposal of dairy shed effluent and management of nutrients applied to farms. Each party has an assigned role, with the Accord to be reviewed annually.

264. Dairy farmers are also receiving advice and guidance on sustainable farm management practices from the private sector, in particular dairy processing companies who are increasingly aware of the growing consumer demand for environmental integrity. For example, Nestlé France has developed a “preference” approach by entering into quality assurance partnerships with dairy farmers.[25] With the help of a Nestlé advisor, farmers are required to review all aspects of milk production, including feeding, hygiene, animal health and welfare, water and energy, and soil and water quality, with the aim of making dairy farming more sustainable.

25. For further information consult www.agri.nestle.fr/public/cadre_public.htm.

265. The involvement of processing companies in on-farm environmental management is likely to increase. Within the context of the Sustainable Agriculture Initiative Platform, a Working Group on Dairy was established in October 2003.[26] Active members of the Working Group include Campina, Friedland Coberco Dairy Foods, Groupe Danone, Kraft, Nestlé and Unilever. Work is underway to define suitable indicators and production practices for sustainability, and to initiative farmer programmes.

7.4.3 Labelling standards/certification

266. Labelling standards/certification are voluntary participation measures defining specific eco-labelling standards that have to be met by farm products for certification. To date, no measures that specifically establish eco-labelling and certification for dairy producers have been introduced, apart from those dealing with organic dairy production (Chapter 8). In the **Netherlands**, a Green-Label housing system was introduced in 1993 to promote the adoption of housing techniques that reduce ***ammonia emissions***. A farmer who invests in such a system is supported by a special income tax rate and a guarantee that the government will not require them to rebuild their barns for 15 years. The Green-Label system is being phased out, to be replaced with a requirement that all livestock farmers must use best available technology (BAT) in their production process.

267. Again, there are a number of private sector initiatives that are occurring in this area, without the direct involvement of government. These are important to recognise in terms of identifying areas where the market is being used to reward environmental stewardship and for ensuring that government policy measures do not negatively impact or crowd out such initiatives. For example, in the **United Kingdom,** the leading conservation charity exclusively dedicated to wildlife, The Wildlife Trusts, has recently launched a brand of milk labelled “White & Wild”.[27] Farmers supplying White & Wild milk must follow farm conservation plans, which designate a minimum of 10% of the farm to habitat management and which are monitored by The Wildlife Trusts, in return for a premium of 3 pence per litre.

7.4.4 Community-based measures

268. Community-based measures are those granting support to public agencies or community-based associations to implement collective projects to improve environmental quality in agriculture. A number of such measures have been introduced in recent years, and while they often deal with sustainable agriculture in general, dairy producers are being affected by them.

269. In **Australia**, a major government initiative to reduce the environmental impact of dairy production, along with other agricultural output, and promote the sustainable use of resources has been through the National Landcare Programme. Expenditure is provided through the National Heritage Trust to support actions by communities to manage land, water, vegetation and biological diversity. In 2001, a major programme was launched under the National Heritage Trust for the rehabilitation of the Murray-Darling river basin, a region containing significant dairy production. The programme aims to develop integrated plans, commence major on-ground works to address land and water degradation, restore riparian land systems, wetlands and floodplains, and encourage ecological land use by reducing salinity and waterlogging in irrigated areas.

270. In **New Zealand**, the Sustainable Farming Fund, launched in 2000, provides short-term (1-3 years) funds to enable local communities to obtain the necessary information, technology and tools in

26. SAI is a food industry platform to support the development of and communicate about sustainable agriculture, involving all stakeholders of the food chain. For further information consult www.saiplatform.org

27. For further information consult www.whiteandwild.co.uk.

order to overcome barriers to economic, social or environmental well-being. Out of the 186 projects approved to date, 23 projects specifically relate to sustainable dairy production, at an average of cost of nearly NZD 150 000 (USD 70 000) per project (MAF, 2003*b*).

271. In order to encourage a closer connection between livestock production and crop farming, the government in **Japan** began in 1999 supporting local organisations to undertake actions within their specific rural area to co-ordinate supply and demand of manure (FAPRC, 2001).

272. Dairy farmers have benefited from government funded projects to develop alternatives uses for manure in a number of countries such as **Austria**, **Denmark**, the **Netherlands**, **Korea** and the **United States**. While such projects have met with varying success, perhaps the most significant and long-term government investment has occurred in Denmark, where 20 large community-based biogas plants have been established, using both pig and dairy manure (Hjort-Gregersen, 1999). Under the 2002 FSRI Act, new funding was established for biomass research and development. One of the projects chosen to receive a grant from this programme, at a cost of USD 747 000, is one to convert manure from several small dairy farms in Vermont into methane gas.

7.5 Impact of agri-environment policy measures on trade

273. This section provides a qualitative assessment of the potential trade impact of the policy measures to address environmental issues in the dairy sector that have been reviewed in the previous sections. In most OECD countries, an initial policy response by governments to address environmental issues was to develop research programmes and provide on-farm technical assistance and extension services to farmers. Such policy measures remain an integral part of the overall environmental strategy in most countries. The possible impact on trade patterns of such measures, along with the other measures classified under the *advisory and institutional* category, would appear to be minimal. The more important issues to consider are the potential impact on trade of taxes, regulations and measures providing financial support to dairy producers for environmental purposes.

274. An important issue with the introduction of environmental taxes is the extent to which they reduce the competitiveness of the industries facing the charges. The initial taxes levied on livestock producers in **Belgium**, **Denmark** and the **Netherlands** in the early 1990s appear to have been very marginal. These taxes have increased in recent years, particularly in Denmark and the Netherlands. Evidence suggests that a large number of producers in these countries were applying too much fertiliser and in fact could increase their profits by decreasing fertiliser use. Similarly, it is estimated that Dutch dairy farmers could be able to reduce their feed input without any financial loss. Consequently, it is concluded that the introduction of taxes as part of the MINAS system will have only a limited effect on the cost of dairy production because of changes that farmers are able to make to their farming practices, with higher costs being borne by pig and poultry producers (ECOTEC, 2001). Since the introduction of MINAS, differences in yields between dairy farmers affected by MINAS and those outside the requirements have been observed, with those subject to MINAS showing a much larger increase in yields as farmers attempt to maintain production but lower cow numbers to meet the environmental requirements.

275. Dairy producers in OECD countries face an array of regulations impacting on their production levels and practices. Over time there has been a clear trend for the number of regulations to be increasing and to be imposing stronger conditions on dairy farmers. It is likely that this trend will continue over the coming years. For example, it is estimated that the new confined animal feedlot operation (CAFO) regulations introduced under the Clean Water Act in the **United States** will cost large dairy CAFOs a total of USD 128.2 million a year in additional expenses, or approximately USD 88 400 per CAFO, and medium-sized dairy CAFOs USD 22 million, or USD 11 300 per CAFO (USEPA, 2003). It is anticipated that these costs will have a moderate effect on the profitability of 30% of the large dairy CAFOs, with the

remaining 70% finding the costs affordable. Like the situation in the **Netherlands**, the cost is likely to be greater on other livestock sectors, in particular beef feedlot and pig operations.

276. Variations in the severity of environmental regulations from country to country could be having an impact on trade patterns by imposing different production costs on producers. However, to the extent that these extra producer costs are associated with reducing the environmental cost associated with dairy production they are in conformity with the polluter-pays-principle. The environmental cost of dairy production is likely to vary between countries, just as labour, land and capital costs vary between countries. A detailed comparison of the production cost of manure management regulations in different countries is provided in Chapter 9.

277. Financial support has been provided in many countries to offset the increased costs imposed by regulations, particularly to reduce the level of capital expenditure required to bring production facilities into conformity with regulations. The 1974 OECD Council Act on the implementation of the polluter-pays principle specifies the situations where subsidies could be offered to help polluters comply with environmental measures. One of the important specifications is that such support should not create significant distortions in international trade and investment. It is difficult to quantify whether such support in the dairy sector has had a significant impact on trade by maintaining operations in production that would have otherwise ceased dairy farming. Again, drawing on recent work in the **United States**, the provision of 50% cost-sharing to assist in meeting the new CAFO rules is estimated to reduce the number of enterprises leaving the livestock sector only marginally, from 285 to 261 closures and none of those remaining because of the support were in the dairy sector (USEPA, 2003).

278. The production and trade effects of payments provided to dairy producers to improve the environmental performance through farm management (classified under *payments based on farming practice*) are very difficult to gauge. This is because many of the payments are not made specific to a sector, but target a wider objective, for which dairy farmers may or may not be eligible. A number of factors suggest that the impact has been limited to date. First, the majority of these payments appear to exist in countries which are not major dairy producers, although dairy production may be an important agricultural activity. Second, a large majority of payments have gone to farmers who use more extensive types of dairy production systems, and often have conditions such as stocking rate limits which restrict the ability of producers to expand production. Finally, the level of payment has been small to relatively modest, and is dwarfed by the production incentives provided through traditional agricultural support policies. However, it appears that in the area of organic milk production payments have had a significant influence on production and trade flows, although this remains a relatively small segment of the overall milk market (Chapter 8).

279. While such payments may not have lead to an increase in production, they may have been sufficient to keep some producers in dairy production that may have otherwise left the sector. Further, the level of funding being provided through such measures is increasing. To the extent that these payments offset reductions in income associated with further reform of agricultural policy measures in the high support countries, they may have the effect of reducing the adjustment in the sector that would have otherwise occurred.

8. Organic dairy production – policy measures and market developments

- All OECD countries either have, or are in the process of establishing, regulations defining national standards for organic milk. Governments also play a major role in inspecting and/or certifying organic production.
- Almost all countries in Europe provide specific financial support for organic milk production on an annual basis, with conversion payments also provided in a few states of the United States.
- Greater efforts are being made by governments to develop a co-ordinated mix of policy instruments.
- There has been a significant increase in the production of organic milk in many OECD countries although it remains a very small part of overall production except in Austria, Denmark and Switzerland. Financial support has played an important role in increasing the supply of organic milk in the European Union.
- Premiums in the organic dairy market are generally higher at the consumer level than at the farm gate level, which may reflect the extra costs of processing and marketing smaller volumes of product. The increase in supply has not always been matched by an increase in demand, leading to a fall in price premiums for organic milk, sometimes significant. Not all organic dairy producers obtain a price premium for their product, selling it at conventional milk prices.
- In some countries, the market for organic fluid milk appears to have reached saturation level at about 10% of total milk consumption, though demand for further processed organic dairy products such as cheese could expand.
- International trade in organic dairy products is likely to increase, bringing greater attention on the influence of organic regulations and payments on trade flows.

280. Within OECD countries, one of the most important areas of agri-environmental policy potentially affecting dairy farmers concern policies for organic agriculture. Given the wide range of policy instruments that have been adopted to promote and support organic agriculture, and the political interest in this form of farming, this chapter specifically considers policy instruments that have been adopted by OECD governments for organic agriculture as they potentially affect dairy farmers within the context of the broader discussion on policy measures addressing environmental issues in agriculture (Chapter 7). It also serves as part of the follow-up to the OECD Workshop on Organic Agriculture, held in September 2002, which provided some to the background material for this chapter (OECD, 2003*b*).

281. In the first section, the range of policy instruments used is discussed, with policy measures classified according to the OECD's *Inventory of Policy Measures Addressing Environmental Issues in Agriculture*. The second section examines the development of organic dairy farming in OECD countries since the early 1990s. Finally, drawing on these developments, some conclusions are made about the trade implications of organic policy measures.

8.1 Policy measures affecting organic dairy production

282. A wide range of policy measures, including regulations, labelling, inspection, research, extension and various types of payments are used in OECD countries to support and promote organic milk production at the farm level (Table 8.1). These measures have generally been developed to cover all organic production. An attempt is made to distinguish those applying to organic milk, particularly in

relation to regulations and payments. Organic milk production has received specific attention in some countries, for example **Austria** and **Denmark**, reflecting the relative importance of milk within overall organic production.

Table 8.1. Policies to support organic dairy farming in OECD countries[1]

Country	Regulations[2]	Labelling[3]	Inspection/ control	Research	Technical assistance/ extension	Payments[4]
Australia	X		X			
Canada			X	X		X
Czech Republic	X	X	X		X	X
European Union	X	X	X	X		X
Austria	X	X	X	X	X	X
Belgium	X		X	X	X	X
Denmark	X	X	X	X	X	X
Finland	X	X	X	X	X	X
France	X	X	X	X	X	X
Germany	X	X	X	X	X	X
Greece	X		X			X
Ireland	X		X	X	X	X
Italy	X		X	X		X
Luxembourg	X		X			X
The Netherlands	X	X	X	X		X
Portugal	X		X			X
Spain	X	X	X			X
Sweden	X		X	X	X	X
United Kingdom	X		X	X	X	X
Hungary	X		X	X		X
Iceland	X		X			X
Japan						
Korea	X					
Mexico						X
New Zealand			X			
Norway	X		X	X	X	X
Poland	X		X	X		X
Slovak Republic	X	X	X	X	X	X
Switzerland	X		X	X		X
Turkey	X		X	X		
United States	X	X	X	X	X	X

Notes:

1. An “X” indicates that a measure exists under that policy classification. Note that the actual type of measures varies from country to country.
2. An “X” under Regulations indicates that national regulations for organic milk production are in place. Countries without an “X” may have in place national regulations for other organic products and/or private sector standards for organic milk.
3. An “X” under Labelling indicates that a national organic label has been developed by the government.
4. For more details on the payments available to organic dairy farmers see Table 8.2.

Source: OECD Secretariat.

283. In addition to these measures, a number of countries are also providing support programmes for the processing and marketing of organic products. This was identified as one of the priority areas for funding in the **European Union** Rural Development Regulation (EC Reg. 1257/99) (Lampkin *et al.*, 1999). For example, in **Ireland** a grant of 40% (up to a maximum of EUR 254 948) is provided on projects (*e.g.* developing facilities for the preparation, grading, packing and storage of organic products) costing over EUR 2 540. While providing support across the whole agriculture, forestry and fishing industries, the New Industries Development Programme (NIDP) in **Australia** has provided funds for the establishment of

production facilities (using small-scale, batch-based, modern technologies) and supply chains for producing and distributing organic milk (DAFFA, 2003). Other countries providing such assistance include **Austria**, **Denmark** and **Germany** [the Federal Organic Farming Scheme], the three largest organic milk producers.

284. Another notable feature has been the development of "Action Plans" which co-ordinate a range of different policy measures within a single framework. The objective is to achieve a better balance between supply (push) and demand (pull) initiatives (Lampkin, 2003). This is partly in response to situations where supply has grown at a faster rate than demand, including in the diary sector (Section 8.2), placing downward pressure on organic price premiums. While these have mainly occurred in **European Union** countries (*e.g.* Denmark, England, Finland, France, Germany [the Federal Organic Farming Scheme], the Netherlands, Sweden and Wales), developments in the **United States** and **New Zealand** indicate that greater attention is being paid in other OECD countries to the mix of policy measures affecting organic production.

8.1.1 Regulations

285. Generally, organic regulations set down the requirements for such things as production methods (both prohibited and required inputs and farm practices), conversion requirements, inspection, labelling, processing and trade in organic products. For organic livestock products, including milk, additional requirements are set regarding breeding, nutrition (including the use of appropriate feedstuffs), animal health and welfare, and transportation. While private sector standards for organic milk have been in place in some countries for sometime, the adoption of national livestock standards has been a very recent phenomena.

286. Almost all OECD countries have national regulations for organic milk production – apart from **Mexico**, which has yet to implement its finalised regulation, and **Japan** and **New Zealand**, which are in the process of developing national standards. **Canada** has a voluntary national standard for organic production. However in Quebec there is a mandatory standard and national regulations are being developed. For **European Union** countries, the most important initiative was the introduction of EU-wide legislation covering organic crop production (EC Reg. 2092/91) and, following this, legislation on livestock production (EC Reg. 1804/99). Many other European countries have used these standards as the basis of their legislation.

8.1.2 Labelling

287. Just under half the OECD countries have established a national label for organic products, whereas the others have only private labels. In some countries where there is a national label for organics there also exists private labelling schemes established, for example, by organic producer groups e.g. **Austria** and **Finland**. Private labeling schemes sometimes place additional requirements on producers. In other countries only the national label is allowed. The **European Union** has a union wide logo for organic products, which was introduced in 1999, although it is not commonly used.

8.1.3 Inspection/control

288. In terms of inspection and control of organic production, the role chosen by most governments is to accredit and audit organic certification bodies who are given the responsibility for on-farm inspection and certification. In a few countries government agencies carry out the inspection of organic farms *i.e.* **Denmark**, **Finland** and **Spain.** In **Australia** and **New Zealand**, the government audits the organic industry primarily for the purpose of providing assurance to importing countries that exported organic products meets their import requirements.

8.1.4 Research

289. Another common policy measure is to support organic research, including production methods, economic viability and environmental impacts. Most of the original organic research was undertaken by private research institutes, which still play a major role. In the mid-1990s governments began supporting organic research through the provision of specific funding to already established government and private research institutes (such as INRA in **France** and FAL in **Germany**), and/or the establishment of specific research institutes (such as the Organic Agriculture Centre of **Canada** and the **Danish** Research Centre for Organic Farming DARCOF). In the **United States**, the 2002 FSRI Act established annual funding of USD 3 million from 2003-2007 for organic research, distributed through competitive research grants. Efforts have also been made to achieve a greater level of coordination in research through the establishment of institutions such as the International Society of Organic Agricultural Research (ISOFAR).

8.1.5 Technical assistance/extension

290. In several countries the government provides or co-finances technical assistance or extension services to organic producers including on-farm advice, training courses (for both farmers and/or advisors), analysis of farm data and demonstration projects. The **European Union** places great importance on the provision of information and advice on organic farming, and organic producers and their organisations are regarded as a valuable source of information. In recognition of this, producer organisations in seven European Union countries receive public support (Lampkin, 2003). Similar support is provided at the state level in the **United States**.

8.1.6 Payments

291. Some form of direct financial assistance to organic dairy farmers is provided in most OECD, with the exception of **Australia**, **Canada**, **Korea**, **Japan**, **New Zealand** and **Turkey** (Table 8.2). The types of payments available to organic farms vary considerably. The most common form of support for is the provision of annual per hectare payments for the conversion and/or maintenance of organic production. While used extensively in Europe, they are very rarely available in other countries. A few states (Iowa, Minnesota and New Jersey) in the **United States** have made funds available to support organic producers through the nationally funded Environmental Quality Incentive Program (EQIP).

292. Several countries (**Austria**, **Hungary**, most **German** Landers, **Mexico, Poland** and the **United States**) reimburse part of or all of the costs associated with inspection for certification purposes or membership of organic farmer associations. Hungary, **Ireland**, the **Netherlands** and Norway offer investment support for organic producers. **Iceland** and Norway provide a one-off payment at the time of conversion. A few countries offer headage payments to organic dairy producers: **Norway** (with payment rates differentiated by region), **Sweden** and **Switzerland** (a payment to support animal welfare).

293. Five **European Union** countries (**Austria**, **Denmark**, **Finland**, **Germany** and **Sweden**) provided support to organic producers prior to 1992. More widespread application of policies for supporting conversion to and continuing in organic farming came into effect in 1992, when support for organic farming in the European Union was included in the agri-environment programme under Regulation 2078/92. This payment system was strengthened as part of the Rural Development Regulation (EC Reg. 1257/99) of Agenda 2000. An important new requirement was that farmers who receive payments must maintain organic production for at least five years *i.e.* farmers enter into five year contract during which annual payments are made. Organic farming received approximately 15% of total agri-environmental expenditure under Rural Development programmes in 2001 (Häring *et al.*, 2004). The Regulation also provides EU member countries with the opportunity to support organic producers with

investment aid, marketing assistance and demonstration farms etc. In 2001, a special exemption was given to allow organic producers to use set-aside land for the feeding of livestock.

Table 8.2. Typical payments supporting organic dairy farmers in selected OECD countries[1]

Country	Type of payment	Land use	Maintenance payment EUR/ha or head	Conversion payment EUR/ha or head[2, 3, 4]
Austria[1]	Annual area payments	Arable crops	327	
		Multi-cut permanent meadows and cultivated pastures	250	
		One-cut permanent meadows	160	
		Meadows producing hay, grazing land etc	55	
	Certification assistance – EUR 36/ha for max 10 ha.			
Belgium[3]	Annual area payments	Annual crops eligible for arable area payments	112	180
		Other annual crops	223	300
		Pasture	174	298
Canada	Certification assistance – organic certifying bodies may receive a grant of up to 50% (max CAN 25 000) of their annual accreditation fee to the Standards Council of Canada.			
Czech Republic[2]	Annual area payments	Arable crops	55	
		Permanent grassland	23	
Denmark[3]	Annual area payments[5]	All land uses	80	141
Finland[4]	Annual area payments	All land uses	103	147
France[4]	Annual area payments[6]	Arable crops		409-136
		Grassland		180-60
Germany[3,4]	Annual area payments[7]	Arable crops	102-255	409-153
		Permanent grassland	102-255	409-130
	Certification assistance – most Lander states grant a subsidy for inspection costs			
Hungary	Certification assistance – 100% of costs On-farm investment – reimburse up to 40% of cost for special machinery, untreated seeds etc.			
	Financial support for organic farmers covering *i.e.* membership fees, costs of analyses and for consultancy.			
Iceland				

Table 8.2 (continued). Typical payments supporting organic dairy farmers in selected OECD countries

Country	Type of payment	Land use[1]	Maintenance payment EUR/ha or head	Conversion payment EUR/ha or head[2,3,4]
The Netherlands[2]	Annual area payments[9]	Cattle fodder (including pasture and fodder crops)	136	
	Tax concessions – organic farmers are eligible for a tax free allowance, and interest and dividends earned on private investments in organic farming, processing and marketing are tax-free.			
Norway[2]	One-off payment	Pasture		1 061
	Annual area payments	Pasture	79	
	Annual headage payments	Dairy cows payment per head (Eastern and Southern Norway)	89	
		Dairy cows payment per head (Western and Northern and mountain areas)	125	
	On-farm investment			
Poland	Annual area payments[10]	Meadows and pastures	12	30
	Certification assistance			
Slovak Republic[3]	Annual area payments	Arable crops in pilot localities Arable crops in other areas	69 18	138 24
		Grassland in pilot localities with more than 0.35 LU/ha	46	92
		Grassland in pilot localities with less than 0.35 LU/ha	18	37
		Grassland in other areas	5	12
	Certification assistance-rates vary according to soil utilisation			
Sweden[2]	Annual area payments[11]	Cereals	149	
		Grass/clover leys	57	
	Annual headage payments	Per livestock unit	195	
Switzerland[2]	Annual area payments	Minimum ecological requirements[12]	750	
		Arable crops	375	
		Grassland	63	
	Annual headage payments	Animal welfare: free range (per livestock unit)[12]	84	
United Kingdom[3]	Annual area payments	Eligible for arable area payments or under permanent crops	48	358-215
		Improved land not eligible for arable area payments	37	279-167
		Unimproved grassland or rough grazing land	8	43-16
United States	Certification assistance – a maximum of 75% of the cost, up to USD 500, is provided through the Agricultural Management Assistance (AMA) program.			
	Conversion assistance – EQIP funds may be used by States to support conversion to organic production.			

Notes to Table 8.2 next page:

Notes to Table 8.2:

1. Details on payments for both pasture/grassland and arable crops are provided in this table as the later would include land used for growing fodder crops. Payment rates provided to other organic production such as fruits and vegetables are not included.
2. For these countries the annual maintenance rates begin during the conversion process, *i.e.* farmers receive the same payment rates during and after conversion.
3. For these countries the conversion payments are paid for two years, after which the annual maintenance rates are received.
4. For these countries the conversion payments are paid for five years, after which the annual maintenance rates are received.
5. Denmark – With the EU per hectare funding and the organic funding the maximum funding per farm is EUR 672.25 per farm per year.
6. France – Payment rates decrease over the 5 year conversion period, with a total limit of EUR 75 770 per farm during the conversion period.
7. Germany – Payment rates vary widely between Lander states, with a maximum amount of support (per farm) applying in some areas.
8. Ireland - Payments in respect of livestock production are calculated on the basis of a minimum stocking level of 0.5 livestock units per hectare of the forage area qualifying for the payment. Payments for organic farming are on top of basis REPS payment of EUR 151/ha, payable on a maximum of 40 hectares.
9. The Netherlands - If the total payment for a farmer would be under EUR 4 537.80, no payment is given at all (minimum). The total payment for a farmer can not be higher then EUR 181 512 for conversion and not higher then EUR 22 689 for maintenance. Farmers were given there last opportunity to join the payment scheme in 2002.
10. Poland – Aid for organic farms and for farms converting to organic farming is dependent on the size of the farm *i.e.* farms with less than 50 ha receive 100% of the sum rate ha; farms between 50 ha and 100 ha receive 50% of the rate per ha; and farms over 100 ha receive no subsidy.
11. Sweden – Payment for organic and integrated farms.
12. Switzerland – Payments for all farms fulfilling the requirements.

Source: OECD Secretariat.

294. In all **European** OECD countries annual per hectare payments are available to support organic milk production with the exception of **Hungary** which is in the process of establishing such support. In a few countries no distinction is made between land use type for all forms of organic production *i.e.* **Denmark**, **Finland** and **Ireland.** In the **Netherlands** and the several Lander states of **Germany** the same rate applies for all land used for fodder production. In all others, a distinction is made between land used for arable crop production and that for grassland.

295. For some countries (*i.e.* **Austria**, **Czech Republic**, the **Netherlands**, **Norway**, **Sweden** and **Switzerland**) the annual maintenance rate paid for land used for milk production begins during the conversion process. Other countries offer a higher payment rate during the conversion period to compensate producers for being unable to receive any organic price premium during this time.

296. The period required for transition from non-organic to organic is stipulated in national regulations and varies depending on land use and type of animal. For example, under the European Union regulations, the legally required transition period for pasture is one year, and two years for arable land with animal fodder. The legally required transition period for dairy cows is six months.

297. In **Belgium**, **Denmark**, **Ireland**, the **Slovak Republic** and the **United Kingdom** these higher conversion rates are paid for two years before the maintenance rates are then received. For **Finland**, the higher conversion payment is provided for five years, while in Germany the higher conversion payments are paid for two years in some Landers and for five years, in others. **France** is an exception within Europe. It provides conversion payments for five years but does not pay annual maintenance payments for land continuing in organic production. **Sweden** is the only country which does not require farmers to be certified as organic to receive the organic support payments, although the organic certification of animals is not required in **Finland**.

298. Although it is difficult to compare payment rates across countries because the land/animal number requirements and definitions vary, some general observations can be drawn. The lowest rates are provided to organic milk producers in the central European countries (**Czech Republic**, **Poland** and the **Slovak Republic**) and the **United Kingdom** while the highest rates are provided in **Austria** and

Switzerland. Where a separation based on land use is made, payments for arable crop production is generally higher than for grassland/pasture, with the exception of **Italy**. A number of countries place restrictions on the amount of financial support organic producers are eligible to receive, either in terms of total organic payments or total agri-environmental payments, but this varies significantly between countries imposing such restrictions.

8.2 Organic dairy market development and issues

8.2.1 OECD wide developments

299. Reliable, comparable and up-to-date statistics on organic agriculture in general is very limited, let alone data relating to a specific sector such as milk. The information available indicates that there has been a large increase in organic milk production in OECD countries since the mid-1990s (Table 8.3). For example, between 1995 and 2000, organic milk production increased by more than 300% in **Belgium**, **Finland**, **France**, **the Netherlands,** the **United Kingdom** and the **United States**. Growth rates were lower in **Austria**, **Germany** and **Switzerland**, countries with a higher volume of production.

300. Despite the rapid increase, the relative importance of organic milk as a share of production remains quite small, representing just 1.5% of **European Union** milk production in 2000, and 0.5% or less in **Canada**, **New Zealand**, **Slovak Republic** and the **United States**. However, in **Austria**, **Denmark** and **Switzerland** organic milk is significant, accounting for 5% or more of total milk production.

Table 8.3. Organic milk production, consumption and trade

Country	Organic milk production				Organic milk consumption		Organic milk exports	Organic milk imports
	million litres			% total milk produced	million litres	% total milk consumed	million litres	million litres
	1995	1997	2000	2000	2000	2000	2000	2000
Canada[1]			13	0.05				
EU-15			1788	1.5	987	1.0	111	84
Austria[2]	373	363	470	14.1	171	6.4	30	1
Belgium	4	7	23	0.9	20	1.0	3	6
Denmark	49	139	444	9.4	132	10.6	30	0
Finland[2]	5	7	22	0.9	10	0.4	0	0.03
France	41	70	144	0.6	145	0.6	1	25
Germany	250	283	370	1.3	282	1.0	25	15
Ireland			3	0.06				
Italy			33	0.3	41	0.4	7	12
Netherlands[2]	27	50	90	0.9	75	1.0	15	3
Spain			4	0.1	1	0.04		
Sweden			99	3.0	47	1.4	0.01	0.02
United Kingdom[2]	15	20	86	0.6	104	0.8	0	22
New Zealand			17	0.1				
Slovak Republic			6	0.5				
Switzerland[2]	123	144	199	5.1				
United States[3]	39	86	350	0.5				

Notes:

1. Data represents the province of Quebec only and is for year 2002.
2. 1996 data is used for 1995.
3. OECD estimate.

Sources: Foster and Lampkin (2000); Hamm *et al.* (2002).

301. Producer price premiums for organic milk vary considerably between countries, and are almost always lower than consumer price premiums (Table 8.4). In the **European Union**, organically produced milk receives an average price premium ranging from 8 to 36% higher than conventional prices (Offermann and Nieberg, 2002). In 2000, the highest producer price premiums are found in **Belgium**, **France**, Italy, the **United Kingdom** and the **United States**. The lowest producer price premiums are in **Canada**, **Finland**, **Germany** and **New Zealand**.

302. In most cases the premiums are simply supplements paid on top of the ordinary milk price rather than determined by the organic market or by organic production costs. Because of supply and demand imbalances, not all organic dairy farmers receive the price premiums for their milk. It appears that in 2000 producers in more than half of the EU countries had problems selling milk into the organic market. However, this was an improvement over the situation in 1997, with the exception of **Denmark** and **Sweden**, two countries experiencing over supply problems.

303. The highest consumer price premiums for organic dairy products are in **France**, **Spain** and the **United States**. There are large variations in the consumer price premiums across the different types of dairy products being sold. In particular, the price premium for other organic dairy products is generally higher than that for milk, perhaps reflecting the additional processing costs. From the manufacturer's point of view, the requirement of a separate processing chain for organic foods means that there are advantages in producing foods that require relatively little processing. European sales of organic milk and yoghurt account for around 85% of the value of sales for organic dairy products, while organic cheese sales are only in the region of 10%.

Table 8.4. Price premiums for producers and consumers of dairy products

	Producer price premiums				Consumer price premiums, 2000	
	% above conventional		Share of organic milk sold as organic		% above conventional	
Country	1997-98	2000	1997-98	2000	milk	other dairy products
Canada[1]		11				
EU-15		22			39	48-73
Austria	20-30	18	30-40	50	27	11-46
Belgium	20	32	75	85	69	38-76
Denmark	20-25	19	80	41	18	19-33
Finland	10	11	60	60	48	23-128
France	20-30	23		90	35	61-91
Germany	15	10	50	76	56	72-176
Ireland		22		100	18	9-89
Italy	15	25	70	100	31	15-77
Netherlands	10	18	100	100	33	38-127
Spain	20-30		31	100		
Sweden	15-20	18	85	52	22	20-43
United Kingdom	40	74	95	100	59	8-43
New Zealand		10				
United States[2]		27			50-72	

Note:

1. Data represents the province of Quebec only.
2. Consumer price premiums between 1996 and 1999. Producer price premium in the state of California.

Source: Santucci (2002), Hamm *et al.* (2002), Dimitri and Greene (2002), Butter (2002).

8.2.2 Specific developments in some European Union countries

304. Organic milk production is the largest organic agricultural production system in **Denmark.** However, the market growth for some dairy products has slowed at the same time as production has expanded. A number of dairy producers started the transition process from conventional to organic dairy production during 1997 and 1998 because the then-approaching EU Regulations on organic production methods for livestock required a two-year transition period. The transition period in Denmark was only one year before the EC Regulation came into force. In 2000, overproduction resulted in over half the organic milk produced having to be sold as conventional milk. Consequently the biggest dairy company selling organic milk, Arla Foods, reduced the price premium paid to organic milk producers from 20 to 15% in 2001. At the same time the company has introduced a 100% organic feeding requirement, increasing the total feeding costs.

305. **Sweden** has also experienced problems of oversupply in organic milk. In 1999, Sweden's largest processor of organic dairy products, Arla, produced nearly 40% more organic milk than it could sell. As a result Arla paid its producers a price premium lower than it collected in the market, since the surplus milk had to be sold at a lower price as conventional milk.

306. Similar problems have emerged in the **United Kingdom**, where the market for organic dairy products expanded by 205% between 1997 and 2001 In 1999, 40% of organic dairy sales in the UK were met by imports (Barrett *et al.*, 2002). By 2001, the British organic dairy sector experienced oversupply with up to half of the organic milk produced sold as conventional milk, whereas all had been sold as organic the year before. The oversupply problem arose due to an increase in organic milk volumes coming onto a market where the growth rates had slowed. Domestic organic milk production doubled in 2001 due to a large number of dairy farmers ending their organic conversion period. The oversupply situation was exacerbated by the new EU regulations which shortened the conversion period to organic production for dairy farmers from 27 months to 24 months. This caused a large influx of organic milk in spring 2001, a few months before schedule.

307. Imported organic dairy products continued to enter the British market because supermarkets had contracts with European suppliers, many of which were able to offer lower prices than British producers. The UK cannot export organic dairy due to previous outbreaks of foot and mouth disease, which creates the problem of how to deal with oversupply in the future. Hoping to ease the oversupply, the Organic Milk Suppliers' Cooperative (OMSCo) launched a "drink organic" national marketing campaign to encourage British organic milk consumption.

308. Organic milk was one of the first organic food products to be established in **France**. Hypermarkets first started selling organic milk in 1996 and it can now be found in nearly all of the major retailers. The organic dairy products market is projected to show accelerated growth in coming years as French dairies raise production levels. In previous years France has experienced shortages of organic milk, resulting in volumes being imported from neighbouring countries. Currently the organic cheese market is the least developed in the French organic dairy sector and it is predicted to show significant growth in the future (Organic Monitor, 2002*b*).

309. Demand for organic dairy products continues to boom in **Germany** with many retailers reporting record sales growth in 2001. The organic fresh milk market continues to dominate sales but increased growth in demand for organic fresh cream and butter, as well as for UHT organic milk which was introduced in 2000, have also been observed. Methods used to boost market returns to organic producers have been state support and increasing the availability of organic foods in supermarkets (Organic Monitor, 2001*c*). The price premiums for organic dairy products account for 10-48% of profits for organic dairy farms (Offermann and Nieberg, 2002).

310. **Italy** has one of the largest markets for organic dairy products in Europe. The market has been reporting high growth since 2000 due to Italian dairies raising production levels to meet growing interest from the major retailers. Italy is highly import-dependent with significant quantities of all products, including raw organic milk, being imported (Organic Monitor, 2002*c*).

311. In **Ireland**, the failure of larger dairy processors to become involved in producing organic dairy products is a result of the small and fragmented organic dairy supply base. In 2001 there were only 20 organic milk producers in Ireland. The only processing company, Glenisk, is oversupplied with organic milk during the summer months but experiences shortages of milk in winter. To increase conversions to organic would take a commitment from a processor of a 3- or 5-year contract with a guaranteed price for the milk. In the short term this is unlikely to happen as the market is not perceived by major processors to be large enough to sustain price differentials. Organic milk production in Ireland is therefore likely to remain a niche market with any developments occurring on a small scale (Teagasc, 2001). Organic farming is less profitable than conventional dairying, with organic milk producers' income levels being 10% lower. Although there is a price premium of over 20%, milk yields are 40% lower than in conventional production. In order for organic milk producers to have comparable incomes to those in conventional dairying, they would need a price premium of 36%.

312. Prior to the implementation of the EU regulations on organic livestock production in November 2001, organic dairy in **Greece** was entirely import-reliant. The small-scale organic dairy production in Greece was sold as conventional products because of the absence of formal regulations on organic production. Greek inspection and certification bodies are now officially accredited to certify organic dairy products, and financial incentives to organic dairy are being provided for the first time (Organic Monitor, 2001*b*). Demand for organic dairy products in **Spain** is met by imports and there seems to be little interest from dairy farmers to convert to organic production methods (Organic Monitor, 2002*c*).

8.2.3 Specific developments in other OECD countries

313. In Quebec, **Canada**, organic milk production tripled from 4.5 million litres in 2000 to 13 million litres in 2002. There are only 39 organic farmers supplying milk to several cheese, yoghurt and fluid milk processing plants in central Quebec. Some raw milk is also exported to the province of Ontario. Quebec can export organic dairy products to the **United States**. In Ontario, the OntarBio co-operative obtained permission to segregate organic milk for processing from the carefully regulated supply management system in 1995. The approval process took many years, but finally it became clear that if Ontario farmers did not produce organic milk themselves then the demand would be met from outside the province. The Loblaws supermarket chain decided to market organic milk in 2002. Consumer demand for the product was high, leading the president of Dairy Farmers of Ontario, to appeal to the membership for more milk producers to convert to organic. A smaller but fast-growing organic milk industry is developing in British Columbia (Jannasch, 2002).

314. In January 1995 the first organic dairy products were launched on the **Norwegian** market. However, organic milk has not enjoyed the success expected by organic milk producers. Consumer studies have concluded that, while significant interest in organic food exists, very few people actually consume organic products on a regular basis. The dairy co-operative did not promote organic milk, and national policy measures, which have emphasised production subsidies, have not assisted market development (Gunnar, 2000). The government has responded by increasing its attention on market development, advisory services and information (Orlund, 2003).

315. While a very small amount of organic milk was being produced in **New Zealand**, with some sold as organic milk and fermented products to consumers, a significant development occurred in September 2002 when the Fonterra Cooperative Group entered the organic market by producing for the first time

organically certified cheese and milk powders for export. These products are processed and certified in line with the EU Regulations governing production and inspection of organic agricultural products. CertNZ is providing the audit process under the NZ Food Safety Authority's Technical Rules of Organic Production. This followed the decision by the EU in June 2002 to accept the New Zealand Food Safety Authority's ability to recognise organic certifiers on its behalf. From 2 December 2002, **United States** bound NZ organic products that meet US organic standards have been allowed to carry the USDA organic seal (USDA, 2002).

316. As of 2001, 48 677 dairy cows were certified as organic in the **United States**. The top five states in terms of the number of organic dairy producing farms were Wisconsin, California, New York, Pennsylvania and Vermont (Greene and Kremen, 2003). Organic dairy was the most rapidly growing organic market segment during the 1990s, with sales up over 500% between 1994 and 1999. Sales of most organic dairy products – including milk, cheese, butter, yoghurt and ice cream – have been rising in both conventional and natural foods supermarkets (Dimitri and Greene, 2002). Two-thirds of the organic milk and cream, and half of the organic cheese and yoghurt are sold through conventional supermarkets. Organic dairy sales are expected to capture 15% of the total US domestic organic food sales during 2003.

8.3 Trade implications of organic policy measures

317. Common policy measures provided by governments to promote organic milk production include: the development of standards; the accreditation of organisations to provide inspection and certification services; and the development of national labels to enhance consumer confidence. Research on organic production and marketing initiatives are also often used. Several countries cover the inspection costs associated with organic certification. European countries have provided significant economic incentives for the conversion to, and in most cases, maintenance of organic systems within broader agri-environmental payment programmes. Since the mid-1990s there has been a large increase in the number of dairy farms converting to organic production.

318. To date, trade in organic milk and dairy products has been rather limited and has mainly involved intra-**European Union** trade, although there is some export of organic cheese to third markets. Within the EU, the biggest exporters of organic milk and dairy products are **Austria**, **Denmark**, **Germany** and the **Netherlands**. All these countries are relatively self-sufficient in organic milk production, exporting the majority of their surplus production to other EU countries. The first three have been providing financial assistance to organic production since the early 1990s. **Belgium**, **France**, **Italy** and the **United Kingdom** import the most significant amounts, although some markets such as **Spain** and **Greece**, while small, are very dependent on import supply.

319. Competition between countries looks likely to increase. At current prices, demand for some organic dairy products in some markets appears to have reached its peak, such as for organic drinking milk in **Denmark** and yoghurt in the **United Kingdom**. Competition is likely to intensify as more European markets reach maturity and market demand slows, although the increased focus on "demand pull" policies in Action Plans may expand demand. Increasing integration of the organic product market is being observed in Europe although significant price variation still exists (Michelsen *et al*., 1999).

320. Second, supplies of organic dairy product are increasing. Within the **European Union**, established exporters, such as **Austria,** are facing increasing competition in their traditional export markets, such as **Italy**, from growing domestic supply that is increasing in response to the introduction and/or increase in support payments, and the market opportunity. This is in turn placing downward pressure on organic farmer returns in both markets. Supply is also increasing in other major dairy exporting countries such as **New Zealand** and the **United States**, with the former specifically targeting the export market as the opportunity to expand production.

321. There are a number of conclusions that can be drawn on the trade impact of policy measures supporting organic milk production.

322. Potentially, one of the most significant barriers to trade can be differences in national standards and certification requirements. Standards for organic foods have certainly helped increase consumer confidence and reduced fraudulent claims. But the large number of private, national and international government standards that have emerged has resulted in an increasingly complex system for international trade of organic products in general (OECD, 2003*b*).

323. There is evidence that the lack of a common **European Union** standard for livestock until 1999 and differences in certifying procedures hindered trade in organic milk and milk products (Michelsen *et al*., 1999). For example, **German** producers of organic milk who wished to export to **Denmark** found great difficulty in obtaining the Danish logo and had to give up entering the market. Another illustration of the trade importance of regulations was the timing of the entry of Fonterra into the organic dairy product market. This occurred just after **New Zealand** authorities had established equivalence with the **European Union**, just before they obtained it with the **United States**, and as they begin discussion with **Japan** – all major dairy export markets.

324. As international trade in organic dairy products is likely to increase, the influence of regulations and standards will become more important. A recent review of organic livestock regulations from a developing country perspective concluded that they were biased towards livestock production systems more common in developed countries (Harris *et al.*, 2003). The work being undertaken by bodies such as the IFOAM/UNCTAD/FAO International Task Force on Harmonisation and Equivalence in Organic Agriculture is crucial to maintaining the integrity of organic production systems while minimising their impact on trade.

325. Once the regulatory hurdle has been passed, the pattern of trade may also be influenced by support payments. Differences in organic payment rates may have an impact on the competitiveness of organic producers in different countries and therefore on trade flows. Those that assisted the early development of organic milk production have been some of the major exporters.

326. A study of representative organic dairy farms in four **European Union** countries found that organic per hectare payments represented EUR 82 per tonne of milk on the **Italian** organic dairy farm, EUR 42 per tonne on the **German** farm, EUR 19 on the **Danish** farm, while the **United Kingdom** farm received no organic support payments (Häring, 2003). As a share of profits, organic payments represented 33% of profits in Germany, 24% in Italy and 22% in Denmark,.

327. Payments not only have an influence on the competitiveness of farmers. By increasing supply they also impact on the relative competitiveness of the processing and marketing sector, and it appears that processors in some countries have gained from the early development and supply of organic milk which may make it more difficult for new players to enter the market. The need for a separate processing chain for organic milk is often cited as a key obstacle in the early stages of market development. Large dairies that achieve economies of scale in production and marketing already dominate the **Scandinavian**, **French** and **Dutch** organic milk markets. This is important because it is often the case that markets with limited processing requirements, *e.g.* drinking milk and yoghurt have reached market saturation, whereas products which require more processing, and therefore which benefit from economies of scale, *e.g.* cheese, are products where market growth is more likely.

328. There is a growing use of promotional measures to stimulate demand and develop markets for organic products. These also can have an impact on trade flows. On the one hand, communicative policies that raise consumer awareness of organic products generally may result in an expansion of the market to

the benefit of all organic producers, whether local or foreign. To the extent that these communicative policies involve an emphasis on consuming local product relative to imported organic products then the trade pattern may be negatively influenced. However, it is also clear that the purchasing policies adopted by the major retailers have a major influence on the potential market, *e.g.* Sainsbury's in the **United Kingdom** has chosen to source only British organic products.

329. Finally, one of the difficulties in analysing the impact of organic policy measures on the dairy market is that they are being provided in the context of general agricultural support policies. As discussed in Chapter 5, these are very significant in the dairy sector, creating distortions in the production and trade of milk and milk products. There could be significant repercussions on the organic milk market resulting from further policy reform.

330. Organic producers benefit from the same tariff protection as conventional producer so lowering border protection would reduce prices in the protected markets for both organic and non-organic production. How relative prices change between the two and therefore the incentives for different production systems is difficult to determine. Empirical evidence of the positive impact of decoupling of agricultural support is provided by the development of organic farming in **Finland** following their accession to the **European Union**. The 40% reduction in conventional producer prices overnight significantly increased the relative competitiveness of organic farming systems, leading to a doubling in the area under organic production (Koikkalanen and Vehksalo, 1997).

331. Whether this occurs in the context of a broader policy reform is hard to say, but it seems likely that organic milk production systems are disadvantaged in many OECD countries by the current level and composition of support for milk which encourage more intensive production systems. A recent review of ten **European Union** countries concluded that on average organic dairy farms received 33-38% fewer payments per hectare than conventional dairy famers (Häring *et al.*, 2004). Initial calculations in **Germany** indicate that the transformation of all milk and headage payments to a uniform grassland premium would increase the income of organic dairy producers by 15% (EUR 60/ha) compared to comparable conventional farms, highlighting the importance of the general policy framework on the relative competitiveness of organic farming (Offermann, 2003).

9. The effect of manure management regulations on competitiveness

- In the six countries/regions evaluated, the cost of manure management regulations when measured as a share of production costs per cow are lowest in Waikato (New Zealand) and Switzerland, and highest in Denmark and the Netherlands.

- In terms of overall production costs, manure management costs do not appear to have a significant impact on competitiveness, with other factors such as labour and capital costs being far more important.

- Costs associated with manure storage regulations are the most significant cost variable, accounting for approximately 60% of the costs imposed by manure management regulations.

- Cost differences also occur between farm sizes. Small farms have a lower volume of production over to which to spread the increased costs, although large farms may incur the extra cost of transporting manure to other farms.

- In comparison with the results of a similar analysis conducted for the pig sector, manure management costs in the dairy sector are generally lower and have a smaller variation between countries reflecting both the less intensive nature of production and the more stringent requirements applied to pig producers in some countries.

332. This chapter investigates the impact of environmental regulations on the competitiveness of dairy farmers in six OECD countries: **Canada**, **Denmark**, **Japan**, the **Netherlands**, **New Zealand** and **Switzerland**. These countries were selected because they represent the main milk producing regions of the OECD, as well as countries with varying levels of producer support (Chapter 5). For the purposes of this study, environmental regulations are defined narrowly as the regulations that concern the storage and disposal of manure. The appropriate management of manure is one of the key environmental issues of the livestock industry (Chapter 2). The study combines the methodology of comparative public policy analysis with economic analysis, and extends a similar study that examined competitiveness and environment issues in the pig sector (OECD, 2003*a*).

333. Section one provides a brief introduction to the competitiveness debate in the dairy sector. The second section discusses some of the basic conditions and features of the dairy sector in the six countries/regions that have been selected. Details of the manure management regulations in each country/region are provided in section three. The fourth section outlines the study's methodology and the following section then presents the results of applying these different regulations in the context of Danish factor costs. The findings are summarised in the final section where some comparisons are drawn with the previous work on the pig sector.

9.1 Competitiveness issues in the dairy sector

334. With growing international trade in dairy products and further reductions in trade protection and exports subsidies anticipated under the WTO Doha Development Agenda round of trade negotiations, a growing body of research is looking at the competitiveness of milk production among countries and the factors that explain difference in production costs (*e.g.* IFCN, 2002; Kaspersson *et al*., 2002). The IFCN study found that production costs per kg of milk were lowest on a typical dairy farm in **Australia** and **New Zealand** at around USD 0.15 kg. The highest costs were found on small farms (with around 20 cows) in **Austria**, **Finland** and **Switzerland**, and these were four times as high at USD 0.60 kg milk. Costs in **Western Europe** and the **United States** are generally twice as high as in the low cost producers. Such

differences in costs could have a major impact on production and trade flows in a fully liberalised world dairy market.

335. Another recent study attempted to identify the reasons for possible differences in competitiveness between the dairy industries in **Australia**, the **European Union**, **New Zealand** and the **United States**, examining both milk production and processing (Wijsman, 1999). It considered a number of variables across a range of categories including factor costs, demand conditions, related and supporting industries, firm structures and rivalry, government and chance. While countries outscored each other across different variables, "environmental costs" was identified as one area where the European Union dairy industry was thought to be disadvantaged compared to the other three.

336. In general, national approaches to environmental regulations affecting dairy production vary considerably (Chapter 7). Some have rather general requirements while others have developed very specific regulations. Concerns are raised about the possible impacts of environmental standards on the cost structure or productivity of business, which might be reflected in effects directly on trade (competitiveness) or indirectly on trade patterns through plant-siting decisions ("race to the bottom"/"pollution haven") (Box 9.1).

Box 9.1. Potential impact of environmental standards on trade

Concerns about the impact of environmental standards (*e.g.* regulations, taxes, pollution permits etc) on trade arise from the argument that countries with lower standards will possess a comparative advantage. Three possible consequences are often argued: the first impacts directly on the pattern of trade; the second and third indirectly through there impact on plant-siting decisions.

1. Reduced competitiveness – it is argued that strict environmental standards may increase costs and limit the competitiveness of environmentally sensitive industries. If the costs imposed in different countries vary, then a country which has higher costs will either export less or import more of the good.

2. Race-to-the-bottom – if free trade occurs between countries with different environmental standards, countries with higher environmental standards will be forced by the domestic industry groups to lower environmental standards in order for them to become competitive. In this case, environmental standards reduce to the lowest level.

3. Pollution-haven – finally, it is argued that rather than lowering standards at home, business will relocate production to countries or regions which have lower standards, creating "havens" for the dirty industries.

One of the differences between the "race-to-the-bottom" hypothesis and the "pollution haven" hypothesis is that the former implies an overall world level of environmental standard that is less than optimal, while the latter does not. In the "pollution haven" case, differences in environmental standards can reflect among other things differences in the actual environmental impact and public preferences for environmental quality.

In contrast to these three arguments, a fourth perspective, associated with Michael Porter, argues that innovation can take place in response to higher environmental standards leading to innovation offsets, smarter approaches to dealing with pollution and early mover advantages.

337. Recent empirical work in the **United States** has found that differences in environmental regulatory stringency is not a factor explaining the regional change in milk production that has been observed since 1975 (Hearth *et al.*, 2003). What is observed is an increase in regulatory stringency as the number of livestock increases. On the other hand, a survey of 24 dairy farmers who had emigrated from the **Netherlands** to Ontario, **Canada**, during the 1990s found that severe environmental regulations in the Netherlands to be one of the reasons for emigration (Wolleswinkel and Weersink, 2001). This chapter

examines whether differences in manure management regulations are likely to have an impact on the competitiveness of milk production in OECD countries.

9.2 Basic conditions and features in the six countries

338. The study on the pig sector was relatively straightforward because production generally takes place in closed stables, with similar feeding regimes, independent of natural climatic conditions. For dairy cows, production circumstances can differ significantly from one country to another, and even within a country, as cattle are more adaptable to different feeding and climatic conditions. This makes it a more complex task to account fully for the competitive advantages and disadvantages, and the way in which environmental regulations affect these.

339. There are important differences in some of the basic conditions for, and features of, dairy production in the six countries (specific regions within two countries), which have implications both for general competitiveness issues and for the specific approach to manure management (Table 9.1). These include such diverse factors as the nature of the landscape, the climatic conditions, the relative shares of export, as well as the achieved productivity in the dairy sector.

Table 9.1. Basic conditions for and features of dairy production in the six countries

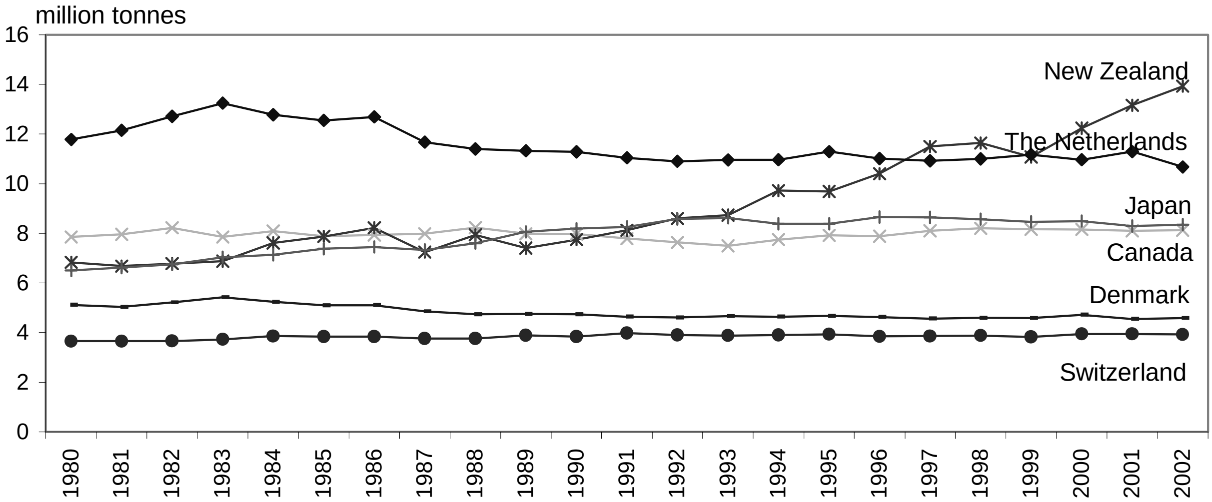
Basic condition and feature of dairy production	The Netherlands[1] 2001	Denmark[2] 2001	Ontario[3] Canada 2002	Switzerland[4] 1998	Japan[5] 2001	Waikato[4] New Zealand 2001/02
Climate	Moderate summer climate, humid-mild winters	Moderate summer climate, humid-mild winters	Moderate summer climate, cold winters	Moderate summer climate, humid-mild to cold winters	Moderate summer climate, cold winters	Moderate summer climate, humid-mild winters
Snow period	Not often	Occasionally	Occasionally	Depending on altitude	Occasionally	No
Landscape	Flat	Flat	Flat	Mountainous	Mountainous/ Hilly	Flat
Grassing period (days)	180-200	150-180 (55 days used)	150-180	Depending on altitude 140-200	150-180	365 (All year)
Dairy cows (in thousands)	1 486	628	376	726	1 725	1 074 (NZ 3 693)
Holdings with dairy cows	26 306	9797	6 244	36 075	32 200	4 399 (NZ 13 649)
Average number of dairy cows per farm	56	63	60	15	54	244 (NZ 271)
Total milk production (thousand tonnes)	10 828	4618	2 399 (Canada 7175)	3 886	8 497	3 804 (NZ 12 998)
Average milk production per cow	7 284	7416	9 242	5 350	7 390	3 554 (NZ 3 678)
Milk quota	Yes	Yes	Yes	Yes	No	No

Sources:

1. www.statline.cbs.nl
2. www.dst.dk
3. www.dairyinfo.agr.ca/
4. www.statistik.admin.ch/stat_ch/ber07/e-vieh/e-milch1.htm
5. www.stat.go.jp/english/data/nenkan/1431-06.htm
6. www.lic.co.nz/pdf/dairy_stats/DS_02_Reg_Dairy_Stats.pdf

340. Further, in all countries except **New Zealand**, milk production has been relatively stable for many years (Figure 9.1). Since 1990, New Zealand has more than doubled its milk production while in **Canada**, **Denmark**, the **Netherlands** and **Switzerland** quotas have limited maximum milk production.

Figure 9.1. Annual milk production in the six countries, 1980-2002



Source: OECD Secretariat.

341. In both **Denmark** and the **Netherlands** dairy production is based on cows housed in buildings. Both countries also have a long tradition of export in dairy products, with well-known brands of cheese and butter on the world market. The Netherlands has about 1.5 million dairy cows on 26 300 holdings, producing on average milk 7 300 litres of milk per cow. The number of animal units (AU) per hectare is approximately 3.2 on dairy farms, which is the highest density found in any country in Europe.[28] Approximately 25% of manure is deposited during grazing, with the remainder excreted in the stables and collected in liquid storage systems (Table 3.5).

342. There are around 630 000 dairy cows in **Denmark**, on approximately 9 800 holdings. There is on average 63 dairy cows per holding, at a stocking rate of 1.7 AU per hectare. Average milk production per cow is about 7 400 litres. Around 65% of the dairy cows are housed in loose holdings systems, with the remainder tied up, although during the summer some of the cows graze on pasture. As an average, it is expected that 15% of the manure is deposited during grazing, approximately 55 days. Three-quarters of the manure is handled as slurry, with the remaining 12% in solid manure/urine or deep litter systems.

343. **Canada** has similar climatic conditions to Denmark and the Netherlands. Most of the milk produced in Canada is used to manufacture butter and cheese for domestic consumption. Within Canada, Quebec and Ontario are the largest milk producing provinces (Chapter 3). Ontario has been selected for this comparative study, and is responsible for approximately one-third (2 400 million litres) of the total milk production. In Ontario, there are 6 200 holdings with 367 000 dairy cows, with an average of 60 dairy

28. Note the AU per hectare figures for Denmark and the Netherlands provided in this section are lower than that given in Table 3.4 which shows the average number of AU per hectare of fodder land on dairy farms to indicate production intensity. A better indicator of the potential environmental pressure related to the dispersion of manure is to take into account all usable agricultural land on the farms, including that in arable crop production.

cows per farm. The average milk yield is just over 9 200 litres per cow. Both tied-up stables and loose-housing systems are found. In Canada as a whole, around 20% of dairy cow manure is deposited during grazing, with another 50% collected in liquid manure storage systems and the remainder in solid manure systems.

344. There are approximately 36 000 holdings with dairy cows in **Switzerland**, milking 726 000 animals. Because of the geographic conditions, production is dominated by smallholders, with an average herd-size of only 15 dairy cows, producing around 5 500 litres per year. Dairy farms hold approximately 1 hectare of agricultural land per dairy cow. In 2001, only 3.4% of the farms had more than 3 dairy cows per hectare. Approximately 85% of dairy cows are tied up, with the remaining 15% in loose housing systems. Around 65% of dairy manure is collected in liquid systems, with a further 28% in solid storage or dry lot. Only 7% of total manure production is deposited during grazing.

345. There are about 1.7 million dairy cows in **Japan**, half on the northern island of Hokkaido where land is more abundant. The average herd-size on Hokkaido is 89 dairy cows compared to 39 in the prefectures on the central islands. The average milk yield in Hokkaido was almost 7 500 litres per dairy cow. Dairy cows are held on a rather small area. On average, the number of cattle per hectare of forage has been calculated at 4.89 in 1993 (Nagamura, 1998), the highest density among the six countries. In many prefectures the average amount of possible nitrogen supply when the livestock manure is uniformly applied to the cultivated land exceeds 200 kgN/ha or up to 600 kgN/ha, although on Hokkaido the average nitrogen level from manure is less than 100 kgN/ha. However, rice fields, which cover one-third of the area, are mainly fertilised with artificial fertilisers, leaving a higher rate of manure application to the remaining area. The high number of cattle per hectare is only possible because of the large import supply of animal feed. Reflecting the limited capacity to spread manure on land, by far the largest amount of manure is handled as solid and composted. Only on Hokkaido, because of greater land availability, are some slurry systems used (Haga, 1998).

346. Milk production in **New Zealand** is favoured by climatic conditions. The Waikato region of the North Island is the most important dairy production area: 1.15 million cows, one-third of the national herd, graze in the region. The average herd-size in Waikato is 244 cows per farm, compared to the national average of 272 cows, with an average of 2.7 cows per hectare. Average milk yield, approximately 3 500 litres per cow, is relatively low compared to the other five countries. Cattle are able to graze outdoors for the whole year and sheds are only required for milking facilities. Almost all dairy farms use a “pasture only” feeding system and organise the lactating period so that the cows are calving in August and dry during the winter (June-July). Consequently, around 90% of the manure is deposited during grazing, with the remainder generally collected in anaerobic lagoons before spreading on to pasture.

9.3 Comparative analysis of manure regulations

347. This section provides an overview of the manure management regulations in the six countries/regions. In most cases there are many detailed regulations, with the most important points summarised in Table 9.2.

9.3.1 The Netherlands

348. The surplus of nutrients from agricultural production has been a major issue in the Netherlands for some time, with policy measures to reduce the environmental impact first introduced in the 1980s. In the first phase efforts were focused on preventing the manure surplus from growing. In the second phase (1990-1998) the governments aim was to significantly lower the manure surplus. The goal of the third phase, which began in 1998, is to achieve a balance in the supply and demand of nitrogen and phosphate (LNV, 2001).

349. Under the mineral accounting system (MINAS), farmers must complete a minerals return every year, declaring their input and uptake of nitrogen (N) and phosphorus (measured in terms of phosphate (P_2O_5)) from all sources including animal manure and chemical fertilizers. If a farm's mineral surplus is higher than the nutrient loss standard the farmer will be charged a levy on the difference. From 2003 the loss standards are generally 100 kgN/ha for arable land and 180 kgN/ha for grassland. The figures are lower for clay and peat soils. For phosphorus the loss standard is 20 kgP_2O_5/ha. The levies on surpluses exceeding the loss standards are EUR 9/kgP_2O_5 and EUR 2.30/kgN (Chapter 7).

350. As a complement to MINAS, manure transfer contracts have become compulsory since an amendment to the Fertilizers Act. Via such contracts the farmers must document that they either have sufficient land, or that transfer of manure can be arranged to other Dutch farms – or abroad. In the latter cases a contract must specify the relevant land user, exporter or processor. With the aid of an accurate system of field registration repeated application of livestock manure can be prevented. The Levies' Office must verify the sufficiency of manure contracts.

351. In addition to MINAS which looks at the whole farm budget, regulations set in place maximum manure N application rates. These have been decreasing over time, and in 2003 the maximum allowable N application to grassland, arable land and land under maize is 250 kgN/ha, 170 kgN/ha and 170 kgN/ha respectively.

352. Application of manure must not take place on some soils (sandy soils) which are susceptible for leaching between 1 September and 1 February and on grassland from 16 September. On arable land outside the designated areas, animal manure may be applied throughout the year. No manure may be applied on frozen soils. On hilly areas (slope >7%) special regulation for manure application has been made to limit leaching. From mid-2002 at least 6 months' storage capacity is required. Manure storage tanks have to be covered with tents or hard coverage.

353. To prevent loss of ammonia, incentives are provided to build low-emission housing. Furthermore slurry application to grassland has to be injected, and on arable land incorporated. From 2008, it will become compulsory that new housing systems are low-ammonia emission systems. Farmers must apply for an environmental license from the municipality.

9.3.2 Denmark

354. The maximum application rate of nitrogen per hectare is scheduled by the Danish Plant Directorate depending on the crop actually grown. The rates are fixed 10% below the economically optimal level to reduce the possibility of nitrate leaching. Nitrogen application rates are up to 170 kgN/ha for cereals and 230 kgN/ha for grass. Rates are corrected annually, depending on precipitation/leaching during the winter period. When animal manure is applied in the field a utilisation rate for nitrogen in the manure is applied. For cattle slurry the utilisation rate is 70% and for solid manure 60%(PDIR, 2003). Levies apply if application rates have been exceeded, the rates are EUR 1.35/kgN if 10<kgN/ha<30; EUR 2.70/kgN if kgN/ha >30.

355. Spreading of manure is not allowed from harvest to 1 February, except for some minor applications (FVM, 2002). To meet the European Union Nitrates Directive's input standard, every farm needs a landbase for manure application of 1.7 AU per hectare, equivalent to 170 kgN in manure. Alternatively, the farmer must present manure transfer contracts with other farmers which meet the requirements. Currently there are no regulations relating to phosphorus.

356. To reduce ammonia emissions, the broad spreading of manure is prohibited and the use of trailing hoses or injection dragliners is compulsory, and manure must be incorporated into the soil within 6 hours,

except in growing crops. Due to the compulsory utilisation rate for manure and the maximum application rate, farmers are provided an incentive to minimise the loss of nitrogen, which supports the more costly injection of slurry to grassland and non-sown areas, compared to broad spreading.

Table 9.2. Manure management regulations in the six countries

	The Netherlands	Denmark	Ontario, Canada	Switzerland	Japan	Waikato, New Zealand
Maximum allowable manure application (kgN/ha)[1]	Arable land 170 kgN Grassland 230 kgN (total allowable nutrient surplus 100-180 kgN)	170 kgN	244 kgN (Surplus ≈ 36 kgN)	150-315 kgN (depending on region) or 3 large cows	Probably no regulation	No regulations but 150 kg from effluent. To this comes manure deposit in the field. (Surplus >140 kgN is assumed high leaching potential.)
Maximum allowable manure application (kgP/ha)[1]	90 kgP_2O_5	No regulation	44 kgP	14-30 kgP	No regulation	No regulation (Surplus > 30 kgP is assumed high)
Manure storage capacity and technology	180 days concrete with tent or hard cover	Min. 180 days (270 days in practice) - Concrete	240 days concrete or liners	120-210 days concrete	- concrete or liners with cover and side wall	Not applicable - sealed ponds
Allowed manure application technology	Injection and trailing hose	Trailing hose or injection	All	All	All	All
Application-free period	15 Sep. – 1 Feb. On snow and frozen soils	From harvest to 1 Feb. On snow and frozen soils.	When snow cover >5cm and on frozen soils	On snow and frozen soils	-	Not applicable
Nutrient planning	Yes	Yes	Yes	Yes	Yes	No
Nutrient bookkeeping	Yes	Yes	Yes	Yes	Yes	No
Nutrient accounting	Yes	Yes	Yes	Yes	Yes[2]	No
Soil analysis	No	No	Yes (every third year)	Yes, every year	No	No
Pollution permits required	Yes	No	No	No	No	No
Environmental Impact Assessment	Yes	For farms larger than 250 AU	Yes, EIS	No	No	No
Land ownership requirements	Yes	Yes	No	No	No	No
Buffer zones	-	Minimum 2 metres along watercourses	Different zones, minimum 3 m. and up to 30 m to watersheds Minimum Distance to several objects	Minimum 3 metres along watercourses and hedges	-	20 metres for effluents
Compliance Incentives	-	No	Yes	Yes	Yes	No
Contingency Plan	-	No	Yes	-	No	Yes for effluent
Levies	2.30 EUR kgN/ha 9.00 EUR kg P_2O_5/ha	10<kgN/ha<30 1.35 EUR kg/ha; >30 kg/ha : 2.70 EUR kg/ha	No	-	No	No

Note:

1. This is only manure. Mineral fertilisers may be applied in addition too.

Source: OECD Secretariat.

357. Bookkeeping of the amount of nitrogen is compulsory at farm level (but not on field level as in the Netherlands and Ontario), and has to be reported to the Danish Plant Directorate each year. At least nine months' storage capacity is compulsory. To reduce ammonia emissions slurry tanks have to be covered, either with crust, pebbles or straw.

9.3.3 Ontario, Canada

358. In Canada there are both federal and provincial regulations on nutrient management. In July 2003, the Ontario government introduced a provincial nutrient management regulation and protocol under their Nutrient Management Act (OMAF, 2003). The regulations will apply from 30 September 2003 to all new and expanding livestock operations and from 1 July 2005 to existing operations with over 299 nutrient units (approximately 200 Holstein cows). The Act introduces a system of mineral accounting in which the applied amount of nutrients per hectare has to be calculated. Farms that apply nutrients to agricultural land must complete a nutrient management plan and a workbook, and the management plan must be renewed every five years. Other provinces, notably Quebec, have similar regulations in place.

359. For nitrogen the amount applied to a certain field should not exceed 224 kgN/ha, unless the actual crop removal is greater. The N-surplus must not exceed 36 kgN/year, which by European standards appears as a strict figure. For phosphorus, the application must not exceed 44 kg P_2O_5/ha. However, for soils with lower hydraulic conductivity and on slopes, the requirements are stricter.

360. Furthermore, a nitrogen and phosphorus index for each field has to be calculated. Each index is based on the sum of two indices; the first is the amount of nutrient applied, but reduced by the amount in the harvested crop – and the second is a calculation of the amount available for loss. The sum of these two figures must not exceed a certain level, which depends on the hydraulic conductivity in the field and the slope of the field.

361. To prepare a nutrient management plan, attendance of a special workshop is required. From 2006, an actual nutrient application licence is required. For every farm the total acres available for nutrient application must be detailed. Because the application rate of manure depends on the actual field, a soil analysis is required for each field. A soil sample has to be taken every third year to measure the phosphorus content.

362. For new and expanding livestock operations the storage capacity should be at least be 240 days. Manure must not be spread on fields that have snow-covered or frozen soil. Manure has to be injected or incorporated within six hours, unless applied to a living crop. For large dairy farms (>165 cows) actual laboratory analysis of the nutrients is required. At the local level there are varying minimum separation distances for manure spreading.

9.3.4 Switzerland

363. The federal law on agriculture and the ordinance on direct payments prescribes, that on every farm with animals a harmonious manure balance should be achieved, and manure should be applied in an environmentally friendly way. The federal law on water protection states, that no more than the manure from three AU (1 AU = one 600-kg cow) may be applied per hectare in the most favoured regions. This is equivalent to 315 kgN/ha and 45 kgP/ha when using Swiss standards for the nutrient content of manure (BLW, 1994). A utilisation rate of 50% of the nitrogen in the manure should be obtained. Guidance has been made for the farmers to achieve the environmental goal. The Cantons may adapt these values to local climatic and terrestrial circumstances, so that according to the production zones the allowable manure application varies from 1.4 AU (mountainous regions) and up to to 3.0 AU (plains). From 2006, the maximum AU will be reduced to the levels of 1.1 AU/ha and 2.5 AU/ha respectively.

364. Under national requirements storage capacity is set at a minimum of three months production. However, individual cantons may set up stricter regulations depending on ecozone or altitude and consequently the minimum storage capacity differs from four to seven months (*e.g.* Luzern, 2000). Storage and slurry tanks have to be built of durable materials. The use of broad spreading of slurry, compared to more costly trailing hoses, is preferred on fields with slope. Farmers are encouraged to incorporate solid manure and slurry within one day. If there are 2.5-3.0 AU per hectare the farmer must document that the crops do not receive more phosphorus than removed with the crops. If there are more than three AU per hectare the farmer has to specify the nutrient budgets for both phosphorus and nitrogen (BLW, 1994). To avoid groundwater contamination Switzerland has introduced *Action N* where farmers are encouraged to reduce the level of fertilisation and shift to crops that reduce leaching.

9.3.5 Japan

365. In 1999, the "Law concerning the appropriate treatment and promotion of utilization of livestock manure" was introduced (MAFF Japan, 1999*a*). This law regards manure as a resource, and promotes its effective use, while also putting an end to unsuitable disposals with unwanted environmental and public health consequences. For these purposes the law defines a management standard for treatment and storage, which requires:

- that manure should be managed in suitable storage and treatment facilities – for solid manure, a floor made from impermeable material with a suitable cover and sidewall, for liquid manure, a tank made from impermeable material;
- immediate verification and reparation of storage facilities;
- bookkeeping of the annual amount of manure produced and its treatment/disposal methods using a mandatory protocol format.

366. Compliance with the new management standard is expected by the end of October 2004, except for small-holders with less than 10 cows. Breaching of standards by storing manure in the landscape is illegal. The government is supporting the enhancement of manure management (*e.g.* compost facilities with ventilation systems) with subsidies, low-interest loans and credits. Manure records can be based either on measured amounts or on use of official coefficients for the relationship to the number and type of animals.

9.3.6 Waikato, New Zealand

367. In 1991, the Resource Management Act (RMA) came into force to protect the environment. Under the RMA, Regional Councils have responsibility for water management. In order to improve water quality the application of dairy effluent (wash water and manure collected from the milking shed) to water is no longer allowed and effluent should be applied to land, although the conditions of land application varies between Councils (Cassells and Meister, 2001).

368. In the Waikato region, applying effluent to land is a permitted activity. This means a farmer does not require a resource consent to apply effluent to the land as long as they follow these conditions:

- the farmer/contractor must have contingency measures in place in case there is prolonged wet weather or a pump breaks down;
- any ponds or effluent holding facilities must be sealed to reduce leakage;
- the farmer/contractor must spread effluent and sludge in a way that reduces odour and spray drift;

- no more than 150 kg of nitrogen per hectare per year can be applied (it recommends that the spreading area for effluent is at least 4 hectares per 100 cows to avoid ground water contamination);
- each application must not be more than 25 millimetres deep;
- effluent must not run off the land into waterways;
- effluent must not pond on the surface for more than five hours.

369. If asked by Environment Waikato, the person applying the effluent must be able to show that the above conditions have been fulfilled. The effluents may be spread by big gun systems (irrigation systems) or by trailers. The effluent may either be spread daily from the milking stable or every 2-3 days from a pond, or with higher daily intervals. It is not recommended to apply effluent within 20 metres of any waterways, or within 50 metres of water used for human or stock consumption.

9.4 Methodology for comparing the cost of manure management regulations

370. In this study the costs imposed by the different manure management regulations in the six countries/regions are calculated on the basis of Danish factor costs and costing principles, *i.e.* the different regulatory requirements are compared on the basis of the costs they would impose on Danish dairy producers should they be required to comply with the different set of regulations. Denmark was chosen as the “base” because of the availability of financial and management data, and because of the relatively strict regulations for manure management that exist there.

371. This method of comparison provides an estimate of the relative importance of environmental regulations rather than the significance of absolute cost differences as derived from environmental requirements. It should also be noted that this cost is a gross cost in that an estimate of the manure management costs without regulations are not calculated. Such an estimate would then allow us to calculate the marginal or extra costs imposed by manure management regulations.

372. One implication of this approach is that differences in factor costs for capital and labour are not reflected. This is because the study is only interested in the cost impact that results from differences in environmental regulations. Further, because the cost assessment is at the budget level of the producer, the social costs of environmental regulations, *e.g.* in terms of lost opportunity costs due to restrictions on how much the production could be extended, or the costs of environmental damage that occurs or is prevented, are not estimated.

373. The cost assessment is based on a bottom-up approach and starts from the physical and regulatory requirements facing the producers. The costs are calculated for three representative Danish dairy farms, where one animal unit is approximately 1 cow.

A. – a small farm of 40 cows;

B. – a middle-sized farm of 80 cows;

C. – a large farm of 160 cows.

374. The costs of manure storage and application have been calculated on the basis of prices surveyed and published in the annual publication of the Danish Agricultural Advisory Service (DAAS). All capital costs have been annualised, assuming a 6% interest rate and depreciation periods according to those applied by DAAS. The use of the most cost-efficient external contractor for the application of manure is assumed.

375. It is also assumed that all animal waste is slurry manure. This is a simplification, since the form of animal waste depends on the exact type and model of the housing structure, but slurry manure is predominant for intensive farms, particularly those found in **Denmark** and the **Netherlands**. Slurries systems are used less in **Japan**, **Ontario** (Canada) and **Switzerland**, where a greater proportion on manure is collected using older straw-based solid manure systems. Although only a small proportion of the total manure excreted by dairy cows occurs in the milking shed on **Waikato** dairy farms, the use of water for cleaning produces a lot of effluent - 50 litres per cow per day (Cassells and Meister, 2002).

376. The following costs associated with manure management regulations are calculated, with the costs varying according to the regulatory requirements of each country, as set out in Table 9.2:

1) *Manure storage facility*: determined by the type of storage facility (tank, lagoons etc) and the minimum storage requirements (usually in months of manure production). The relative costs of storage tanks decrease with scale, which is reflected in prices per storage volume. Storage tank capacity is also adjusted for the precipitation rate. If a cover is required, the cost is calculated on the basis of a 4 metre high storage tank and the type of cover mandated.

2) *Application-on-farm:* determined by the maximum allowable manure application rate, the type of application method that is permitted (*e.g.* liquid dragline, soil injection, spray etc) and timing and distance requirements. There is a substantial amount of transportation involved in manure application. Slurry manure is voluminous and 1 tonne is assumed to be equivalent to 1 m^3. Field application transport itself is less than one-third of the covered transport; the greater part is transport to and from the storage facility.

3) *Application-off-farm*: in many cases, **Danish** dairy farms do not have sufficient land and need to rely on neighbouring land for application (disharmony). It is assumed that only model dairy farm C has this additional transport requirement and costs are calculated on the assumption that 40% of the manure is applied on a farm 5 km away from the storage tank except in the case of **Waikato**, due to the smaller amount of slurry which has to be spread.

4) *Administration*: determined by the annual time required for nutrient planning, nutrient accounting, nutrient trading, screening procedures with regard to Environmental Impact Assessments (EIA), etc. These costs have been assessed according to best estimates from county officials and local agro-advisory centres.

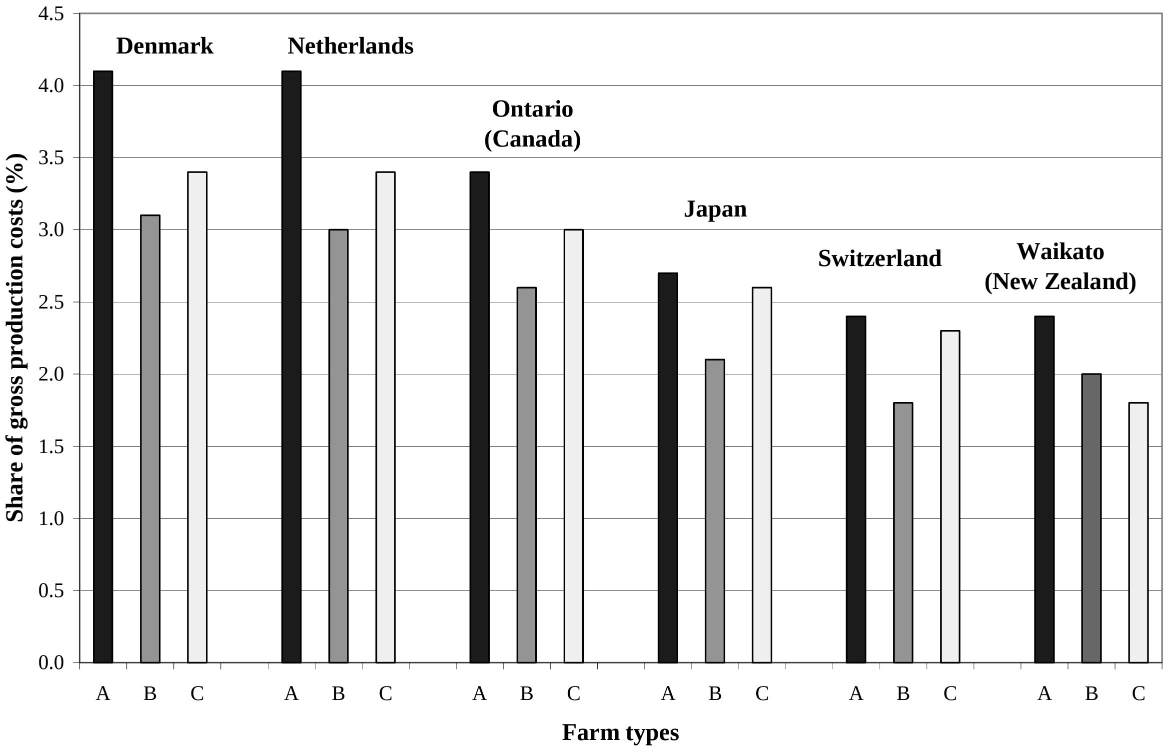
5) *Value of nitrogen in manure*: rather than a cost, the nutrients provided in the manure are a benefit to the farmer. The nutrient content of manure is variable and depends on the feeding regime. The amount of nitrogen to be spread is determined according to the prescribed storage capacity plus 9% of manure deposited during days where the dairy cows are assumed to be grassing as an estimate of the manure deposited in confined areas when the dairy cows are waiting for milking. Loss of nitrogen in stables and storage due to ammonia emission is assumed to be 8% of nitrogen per animal (Poulsen *et al.*, 2001). From the remaining nitrogen, the utilisation level depends on the specified application technique. For broadspreading, 37% is used; for hosetrailing and injection, 50%. In practice these figures vary much more. The value of the manure is assessed on the basis of a shadow price for fertiliser and based on the legally required utilisation rate. In this analysis only the nitrogen content of the manure is priced because of the focus on manure nitrogen under current regulations. This will understate the value of the manure because other nutrients such as phosphorus and potassium are not taken into account.

9.5 Manure management costs under different regulations

377. These five cost variables have been calculated for the three different Danish dairy model farms using the regulations applying in the six countries/regions. There are differences between countries/regions and between farm types. Comparing countries/regions (Figure 9.2), the lowest costs per cow are found for **Waikato** (New Zealand) and **Switzerland** (1.8-2.4%) and the highest for the European Union countries **Denmark** and the **Netherlands** (3.0-4.1%). Manure management costs in **Ontario** (Canada) under the new regulations are about half a percentage point below the EU-level; in **Japan** costs are about half a percentage point above Switzerland. These results are consistent with findings in other recent research which estimate costs imposed by manure management requirements as a share of production costs of between 2.1-3.2% in New Zealand and 0.5-1.5% in the **United States** (Cassells and Meister, 2001; Ribaudo *et al.*, 2003).

Figure 9.2. Comparison of manure management costs in six countries

Share of total production costs per cow



Source: Department of Policy Analysis, National Environmental Research Institute, Denmark.

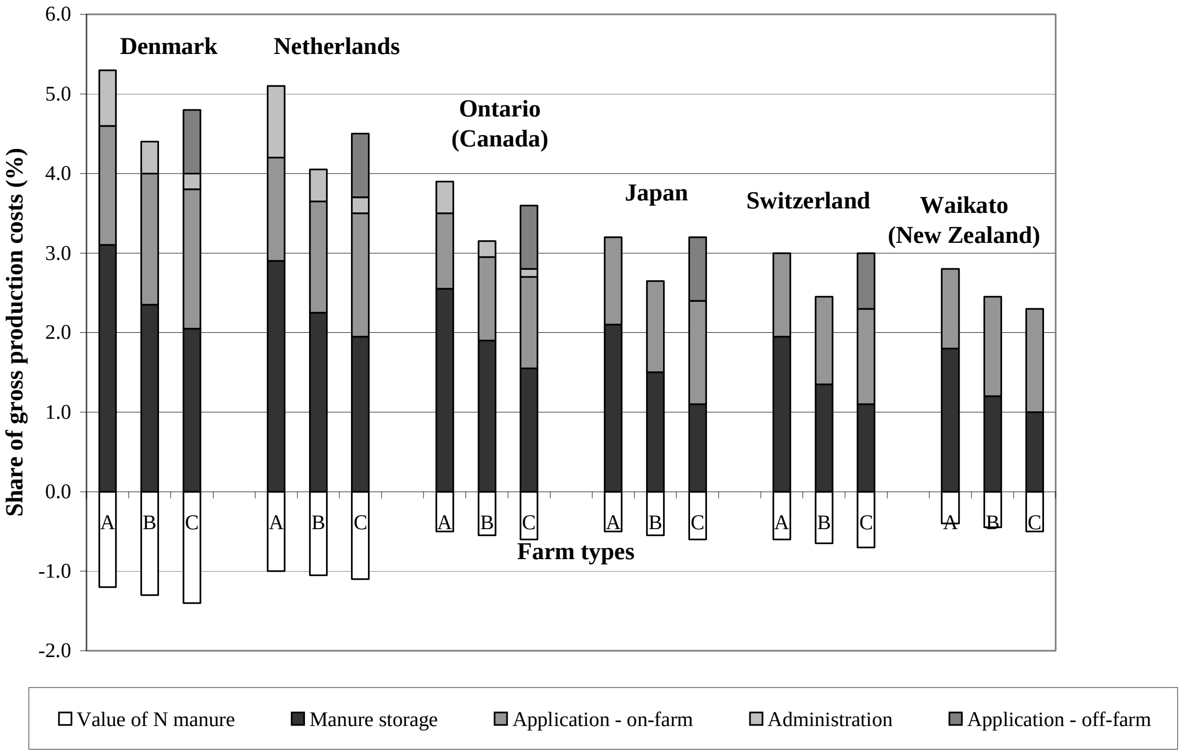
378. There are also notable differences among farm types (Figures 9.2 and 9.3). Two major points are observed. First, smaller farms are lacking the scale advantages in production over which they can spread the extra costs imposed by manure management regulations. In particular, the costs arising from manure storage requirements are the most significant cost component, accounting for approximately 60% of total costs imposed by manure management regulations. Consequently, the decision as to the required storage volume (influenced by the length of period where application is not allowed) seems critical to overall costs. This decision is largely dependent on climatic circumstances, and not entirely at the discretion of regulators. Administrative costs for nutrient planning and accounting are generally at a rather low level, although small farms in Denmark and the Netherlands seem to be disproportionately affected.

379. Second, leaving aside the cost of application-off-farm, manure management costs decrease with the scale of operation. However, manure management costs per cow on large farms increase when, according to environmental regulations, they do not have enough land available for spreading manure and so must apply manure off-farm. The lack of sufficient land entails additional costs for hauling the manure to more distant fields. In **Denmark** and the **Netherlands**, some of the imposed costs are offset by the higher value of manure due to the requirements to use injection or hose trails for manure application.

380. The figures are indicative of the significance of various cost components as the exact figures depend on the assumptions. This is especially the case for the quantity of manure that is required to be transported off farm.

Figure 9.3. Composition of manure management costs

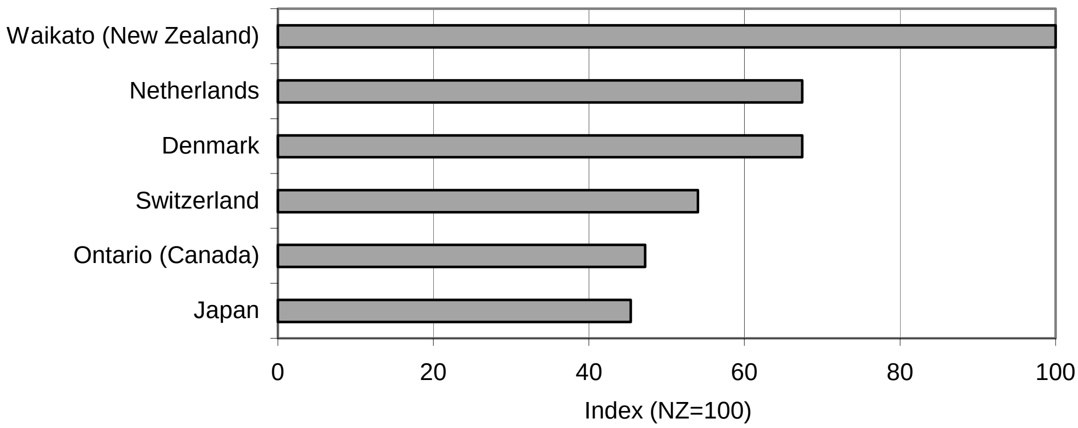
Share of total production costs per cow



Source: Department of Policy Analysis, National Environmental Research Institute, Denmark.

381. When considering the possible trade implications of differences in regulations, a comparison which takes account of differences in milk productivity may provide a more appropriate figure for the producer cost differences caused by manure management regulations. There are quite large differences in milk productivity between OECD countries – it is more than twice as high in Denmark and the Netherlands as in New Zealand for instance (Table 9.2). When costs of manure management regulations are calculated on a product output basis, a different order of countries/regions emerges (Figure 9.4). **Waikato's** (New Zealand) apparent advantages are reversed, and the cost is almost 40% higher than in **Denmark** and the **Netherlands**. For **Switzerland** costs are only moderately below these two EU countries, while **Canada** and **Japan** appear in fact to possess clear advantages, mainly due to their high milk productivity as their manure management costs per cow are only slightly below the two EU countries.

Figure 9.4. Manure management costs per tonne of fat corrected milk



Source: Department of Policy Analysis, National Environmental Research Institute, Denmark.

9.6 Implications of the comparative analysis

382. There are differences in manure management regulations imposed on dairy producers in the six countries/regions analysed. Such differences should be expected to the extent that they reflect among other things, variations in climatic and geographic conditions, as well as the extent to which environmental problems arising from nutrients in manure has been seen as a public policy issue. For example, producers in **New Zealand** are not as limited in their capacity to spread manure by climatic conditions as those in other countries.

383. Regulations have been in place for far longer, are far more developed, and appear to be far more stringent in **Denmark** and the **Netherlands** than in the other countries, reflecting the large environmental problems caused by manure nutrients. In **Japan** and **Ontario** (Canada), new regulations have been recently introduced and will increasingly be applicable to dairy producers. There appears to be a narrowing of the gap between manure management requirements over time between countries.

384. Consequently, the additional costs resulting from manure management regulations vary across the six countries/regions. When measured in terms of production costs per cow, the costs imposed by New **Zealand** and **Swiss** regulations are about 40% lower than in **Denmark** and the **Netherlands**. However, the extra cost is only a small proportion of total per cow production costs, indicating that differences in manure management regulations are not a significant factor in explaining differences in competitiveness. Switzerland is a high cost producer, even though it has relatively lower manure management costs. In the four countries which have milk quotas, these are utilised to their maximum, indicating that the cost of manure regulations are not at a level to affect the volume of milk production.

385. Similar differences in production costs can be found within a country, reflecting differences in size, feed efficiency and animal performance. For example, in the **United States**, the cost of producing milk in varies by almost 60% between the lowest and highest cost producers (Short, 2004). Further, when calculated on a per litre basis, costs imposed by manure management regulations are highest in New Zealand.

386. The study also showed that small producers, in this case represented by a farm with 40 cows, have higher costs per cow than larger farms. This is because of the large fixed costs of manure storage which are not scale neutral and which have to be spread across fewer animals. However, when large farms

are required to dispose of manure off their property, as a result of regulations, their manure management costs increase by around 25%.

387. Two main points arise when these results are compared to those from the similar analysis done for the pig sector. First, manure management costs in the dairy sector (2-4% of production costs per cow) are generally lower in terms of production costs per animal than those found in the pig sector (5-7% of production costs per pig for slaughter). This possibly reflects the less intensive nature of milk production on a per hectare basis as compared to pig production. Again, the recent United States study concludes that the new nutrient standard requirements have a smaller impact on production costs for dairy than for pigs on an animal unit basis (Ribaudo *et al*., 2003).

388. Second, there is a smaller diversity in manure management costs between countries/regions in the dairy sector than in the pig sector. This is a little surprising given the greater variation in production systems in the dairy sector, but it could reflect the more stringent environmental regulations applying to pig production in some countries.

389. There are a number of limitations involved in this analysis. First, it only concentrates on the costs associated with manure management regulations. Other environmental regulations, such as those relating to ammonia, will increase the costs imposed by environmental requirements and may increase the cost difference between countries. Second, the study did not take into account the financial support that dairy farmers in some of the countries are provided with for the purposes of reducing the costs of complying with environmental regulations. For example, dairy farmers in **Denmark**, **Japan** and the **Netherlands** have all been eligible for financial assistance through grants, low interest loans or tax concessions to build or modify manure storage facilities.

ANNEX

Annex Table 1.1. Cow milk production in selected countries

	Average volume 000 tonnes				Annual growth rate %	
Country	1980-84	1985-89	1990-94	1997-01	1980-89	1990-2001[1]
Australia	5 590	6 320	7 152	10 302	2.1	6.3
Brazil				21 729		2.4
Canada	7 997	8 002	7 730	8 146	0.2	0.1
European Union (15)	125 180	122 869	120 477	121 241	-0.3	0.2
Austria	3 564	3 565	3 303	3 144	-0.3	-0.1
Belgium	3 810	3 752	3 468	3 375	-0.4	-0.5
Denmark	5 206	4 911	4 658	4 620	-0.8	-0.2
Finland	3 215	2 908	2 559	2 488	-1.9	-0.9
France	27 221	27 120	25 513	24 845	-0.4	-0.5
Germany	25 633	24 936	27 338	28 378	-0.2	1.7
Greece	776	705	735	776	0.8	1.3
Ireland	5 141	5 531	5 367	5 280	1.6	0.0
Italy	10 727	10 703	10 312	10 902	-0.2	0.1
Luxembourg	281	293	269	266	0.6	-0.6
Netherlands	12 532	11 929	11 029	11 069	-0.4	0.0
Portugal	1 029	1 398	1 659	1 943	6.1	1.5
Spain	6 002	5 967	6 040	6 070	-0.2	0.7
Sweden	3 625	3 514	3 336	3 340	-0.1	-0.4
United Kingdom	16 416	15 638	14 889	14 744	-0.7	-0.3
Hungary	2 715	2 771	2 614	2 040	1.3	-2.1
India				32 568		4.6
Japan	6 810	7 567	8 409	8 494	2.7	0.1
Korea	660	1 393	1 817	2 169	27.1	3.0
Mexico	9 458	7 198	7 124	8 780	-5.2	4.5
New Zealand	6 956	7 738	8 585	11 921	0.9	6.4
Norway	1 985	1 939	1 486	1 755	-0.2	-1.2
Poland	15 995	15 924	13 567	12 048	-0.1	-2.2
Russia				32 895		-0.8
Switzerland	3 713	3 823	3 905	3 885	0.7	0.2
United States	60 956	65 151	68 089	73 396	1.3	1.1
World				483 140		1.2

Note:

1. The annual growth rate for Brazil, India, Russia and the World is based on the period 1997-2001.

Source: OECD Secretariat.

Annex Table 1.2. Major milk and milk product trading countries

	Average				Annual growth rate (%)	
	1980-84	1985-89	1990-94	1997-01	1980-89	1990-2001
Exports ('000 tonnes milk equivalent)						
Australia	1 219	1 689	2 503	5 080	1.2	13.5
Canada	1 070	761	555	781	-4.1	2.9
European Union (15)[1]	33 099	38 207	38 489	42 371	1.8	2.0
Belgium	2 566	2 757	3 713	4 268	1.2	5.5
Denmark	2 266	2 337	2 402	2 287	1.2	-1.0
France	6 471	6 792	7 869	9 216	0.4	2.1
Germany	8 773	10 431	9 452	10 047	0.0	3.3
Ireland	2 201	2 816	2 888	2 915	3.7	2.6
Netherlands	7 294	8 983	7 803	6 795	5.0	-1.8
Spain	23	182	404	798	185.0	16.5
United Kingdom	1 999	2 210	2 127	2 552	-0.1	0.4
Hungary	163	116	228	194	6.1	-2.3
Mexico	1	1	16	92	118.0	1 891.6
New Zealand	4 198	4 805	5 308	8 340	0.9	9.8
Norway	137	158	175	127	7.3	-5.0
Switzerland	307	333	331	424	-1.6	2.6
United States	1 967	2 718	1 816	2 471	6.3	15.3
OECD	42 506	49 321	50 764	61 768	1.7	3.8
World (including intra-EU)	44 058	51 510	54 613	68 552	2.0	4.7
World (excluding intra-EU)	24 199	28 091	28 129	38 646	1.4	7.0
Imports ('000 tonnes milk equivalent)						
Australia	96	115	164	300	7.7	16.3
Canada	140	176	211	539	2.2	30.3
European Union (15)	20 695	25 267	26 890	32 221	3.7	3.4
Belgium	2 324	2 337	3 168	4 086	2.6	6.8
Denmark	298	291	322	451	-1.3	8.5
France	1 069	1 639	2 865	4 200	8.0	13.5
Germany	3 334	3 996	4 222	4 788	5.8	1.3
Italy	5 023	5 669	5 228	5 431	0.1	0.3
Netherlands	5 139	7 362	6 223	6 213	8.7	-0.3
Spain	557	858	1 304	1 746	2.0	9.3
United Kingdom	2 059	1 979	2 157	2 631	-0.4	3.3
Hungary	55	38	47	100	-8.8	57.5
Japan	1 341	1 582	1 572	1 656	1.4	2.0
Korea	88	110	239	413	17.3	29.7
Mexico	1 310	1 792	2 267	2 290	0.7	0.2
Norway	14	13	15	18	-5.4	3.7
Poland	244	229	139	281	5.9	62.3
Switzerland	223	205	213	228	-2.1	0.6
United States	1 073	1 318	1 264	1 824	3.0	4.6
OECD	25 368	30 917	33 157	40 102	3.2	3.5
World (including intra-EU)	44 611	52 348	54 219	65 391	2.0	3.1
World (excluding intra-EU)	24 040	28 224	28 724	35 702	1.3	3.3
Export performance (%)[2]						
Australia	22	27	35	49		
Canada	13	10	7	10		
European Union (15)	26	31	32	35		
Belgium	67	73	107	126		
Denmark	44	48	52	50		
France	24	25	31	37		
Germany	34	42	35	35		
Ireland	43	51	54	55		
Netherlands	58	75	71	61		
Spain	0	3	7	13		
United Kingdom	12	14	14	17		
Hungary	6	4	9	9		
Mexico	0	0	0	1		
New Zealand	60	62	62	70		
Norway	7	8	12	7		
Switzerland	8	9	8	11		
United States	3	4	3	3		

Notes:
1. Data for the European Union includes intra-EU trade.
2. Export performance = ratio of exports to production (volume).
Source: FAO Database, 2003.

Annex Table 5.1. Total OECD Producer Support Estimate for milk

	Unit	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Total OECD PSE for milk	USD mn	50 003	49 121	45 390	44 850	58 924	54 138	56 302	53 366	52 099	50 846	50 218	45 758	54 201	48 771	38 013	41 258	41 139
Three year average	USD mn			*48 171*	*46 454*	*49 721*	*52 637*	*56 454*	*54 602*	*53 922*	*52 104*	*51 054*	*48 941*	*50 059*	*49 577*	*46 995*	*42 681*	*40 137*
Total OECD PSE for milk	EUR mn	50 955	42 616	38 413	40 735	46 415	43 801	43 503	45 561	43 923	38 895	39 561	40 376	48 463	45 773	41 248	46 069	43 651
Three year average	EUR mn			*43 995*	*40 588*	*41 854*	*43 650*	*44 573*	*44 288*	*44 329*	*42 793*	*40 793*	*39 611*	*42 800*	*44 871*	*45 161*	*44 363*	*43 656*
%PSE		66	60	51	50	61	58	57	57	55	50	49	49	57	53	45	46	48
Three year average				*59*	*53*	*54*	*56*	*59*	*57*	*56*	*54*	*51*	*49*	*52*	*53*	*52*	*48*	*46*
Producer Nominal Assistance Coefficient (NACp)		2.91	2.47	2.04	1.98	2.57	2.38	2.33	2.32	2.23	1.98	1.95	1.95	2.34	2.13	1.81	1.85	1.93
Three year average				*2.42*	*2.15*	*2.17*	*2.28*	*2.42*	*2.34*	*2.29*	*2.17*	*2.05*	*1.96*	*2.06*	*2.13*	*2.07*	*1.92*	*1.87*
Producer Nominal Protection Coefficient (NPCp)		3.31	2.72	2.07	2.01	2.67	2.50	2.39	2.32	2.20	1.92	1.87	1.90	2.30	2.10	1.75	1.77	1.83
Three year average				*2.70*	*2.27*	*2.25*	*2.39*	*2.52*	*2.40*	*2.31*	*2.15*	*1.99*	*1.89*	*2.02*	*2.10*	*2.05*	*1.87*	*1.78*
Volume of Production	000 tonne	257 505	252 579	252 348	252 049	254 291	257 639	255 483	255 907	256 646	269 294	269 902	271 146	272 216	277 762	279 449	279 567	281 533
Per unit PSE	USD/tonne	194	194	180	178	232	210	220	209	203	189	186	169	199	176	136	148	146
Three year average	USD/tonne			*190*	*184*	*197*	*207*	*221*	*213*	*211*	*200*	*192*	*181*	*185*	*181*	*170*	*153*	*143*
PSE for milk by country																		
EU15	USD mn	20 657	21 725	20 216	19 556	27 871	26 335	27 813	25 418	24 525	28 852	26 421	22 633	25 389	21 039	15 054	15 304	18 045
United States	USD mn	13 685	11 743	9 495	9 960	12 402	9 983	10 359	10 139	9 904	7 203	10 225	9 713	15 191	13 924	9 715	14 114	9 927
Japan	USD mn	3 977	4 264	4 738	4 335	4 225	4 695	5 112	5 869	6 167	6 539	5 245	4 640	4 394	5 124	5 200	4 379	4 395
Switzerland	USD mn	1 735	2 081	2 104	1 850	2 368	2 465	2 431	2 342	2 463	2 796	2 626	2 190	2 123	1 974	1 707	1 840	2 093
Canada	USD mn	1 752	1 738	1 736	1 811	2 145	2 173	1 828	1 724	1 617	1 386	1 353	1 569	1 644	1 620	1 590	1 444	1 524
Mexico	USD mn	624	355	188	487	783	943	956	1 239	1 052	- 2	455	748	921	1 096	1 144	1 271	1 231
Norway	USD mn	811	995	1 094	1 035	1 414	1 390	1 529	1 237	1 210	1 241	1 228	1 165	1 176	1 066	995	821	994
Korea	USD mn	335	408	483	686	698	703	656	680	687	762	752	626	524	728	880	747	906
Turkey	USD mn	444	298	257	350	865	817	984	934	728	955	989	1 234	1 164	986	797	285	531
Hungary	USD mn	318	247	158	235	324	182	170	195	221	168	128	204	319	293	201	245	414
Czech Republic	USD mn	1 260	1 034	850	1 152	1 453	392	316	268	186	241	253	197	302	216	128	148	311
Poland	USD mn	434	56	124	- 535	- 795	- 353	- 42	- 101	- 267	27	- 74	130	397	235	189	270	292
Australia	USD mn	396	353	324	348	591	619	611	500	542	509	479	533	424	285	258	256	291
Slovak Republic	USD mn	605	511	397	482	676	119	88	128	94	87	60	101	143	98	74	67	113
Iceland	USD mn	57	68	70	63	75	78	81	67	59	64	61	62	76	75	70	52	59
New Zealand	USD mn	95	97	31	22	13	10	10	10	12	17	16	15	12	13	12	14	13
Contribution to OECD total																		
EU15	%	41	44	45	44	47	49	49	48	47	57	53	49	47	43	40	37	44
United States	%	27	24	21	22	21	18	18	19	19	14	20	21	28	29	26	34	24
Japan	%	8	9	10	10	7	9	9	11	12	13	10	10	8	11	14	11	11
Switzerland	%	3	4	5	4	4	5	4	4	5	5	5	5	4	4	4	4	5
Canada	%	4	4	4	4	4	4	3	3	3	3	3	3	3	3	4	3	4
Mexico	%	1	1	0	1	1	2	2	2	2	0	1	2	2	2	3	3	3
Norway	%	2	2	2	2	2	3	3	2	2	2	2	3	2	2	3	2	2
Korea	%	1	1	1	2	1	1	1	1	1	1	1	1	1	1	2	2	2
Turkey	%	1	1	1	1	1	2	2	2	1	2	2	3	2	2	2	1	1
Hungary	%	1	1	0	1	1	0	0	0	0	0	0	0	1	1	1	1	1
Czech Republic	%	3	2	2	3	2	1	1	1	0	0	1	0	1	0	0	0	1
Poland	%	1	0	0	-1	-1	-1	0	0	-1	0	0	0	1	0	0	1	1
Australia	%	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Slovak Republic	%	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Iceland	%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
New Zealand	%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: OECD PSE/CSE database, 2003.

Annex Table 5.2. Milk producer support in OECD countries

Year		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
%PSE																		
OECD	**%PSE**	**66**	**60**	**51**	**50**	**61**	**58**	**57**	**57**	**55**	**50**	**49**	**49**	**57**	**53**	**45**	**46**	**48**
Switzerland	%PSE	84	83	78	75	82	81	80	80	80	79	78	77	78	81	75	76	80
Norway	%PSE	76	75	74	72	80	80	80	78	77	76	76	76	76	75	75	72	77
Japan	%PSE	87	85	80	77	80	81	80	83	83	81	76	76	79	81	79	76	77
Iceland	%PSE	85	83	78	76	82	83	82	80	77	74	73	76	81	80	78	72	76
Korea	%PSE	79	74	67	71	76	76	72	73	71	68	66	66	65	70	71	66	70
Hungary	%PSE	58	44	27	35	46	36	35	39	44	33	27	40	54	50	37	42	55
Canada	%PSE	67	62	54	55	64	64	58	59	55	47	46	53	59	57	55	51	55
EU15	%PSE	63	58	51	49	62	59	59	59	57	54	52	50	57	51	42	41	48
United States	%PSE	70	62	49	48	59	53	51	51	48	35	44	45	60	56	44	53	46
Mexico	%PSE	55	32	16	33	47	50	46	52	48	(0)	24	35	43	44	41	43	45
Czech Republic	%PSE	74	65	53	59	69	55	42	37	28	31	31	30	43	35	23	24	42
Slovak Republic	%PSE	75	66	52	57	70	45	33	43	36	29	20	34	49	38	30	26	38
Turkey	%PSE	50	32	24	29	53	49	52	50	45	47	45	53	53	44	39	22	35
Australia	%PSE	42	33	24	24	40	39	35	29	29	23	21	25	22	15	13	13	15
Poland	%PSE	22	3	5	(26)	(74)	(24)	(2)	(6)	(17)	1	(3)	6	18	11	9	12	14
New Zealand	%PSE	14	10	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
PSE per kilogram																		
OECD	**USD/kg**	**0.19**	**0.19**	**0.18**	**0.18**	**0.23**	**0.21**	**0.22**	**0.21**	**0.20**	**0.19**	**0.19**	**0.17**	**0.20**	**0.18**	**0.14**	**0.15**	**0.15**
Norway	USD/kg	0.43	0.51	0.58	0.54	0.74	0.75	0.83	0.67	0.67	0.70	0.70	0.67	0.68	0.62	0.62	0.52	0.65
Switzerland	USD/kg	0.54	0.67	0.66	0.57	0.75	0.76	0.77	0.73	0.76	0.86	0.82	0.68	0.65	0.62	0.52	0.56	0.64
Japan	USD/kg	0.54	0.57	0.61	0.53	0.52	0.56	0.59	0.69	0.74	0.77	0.61	0.54	0.51	0.60	0.62	0.53	0.53
Iceland	USD/kg	0.49	0.59	0.60	0.56	0.67	0.68	0.71	0.59	0.52	0.56	0.54	0.55	0.65	0.63	0.61	0.45	0.51
Korea	USD/kg	0.29	0.29	0.30	0.39	0.40	0.40	0.36	0.37	0.36	0.38	0.37	0.33	0.26	0.32	0.39	0.32	0.35
Canada	USD/kg	0.22	0.21	0.21	0.22	0.27	0.27	0.24	0.23	0.21	0.18	0.17	0.19	0.20	0.20	0.19	0.17	0.19
Hungary	USD/kg	0.12	0.09	0.06	0.08	0.11	0.07	0.07	0.09	0.11	0.09	0.07	0.11	0.16	0.14	0.09	0.11	0.18
EU15	USD/kg	0.17	0.19	0.18	0.17	0.25	0.23	0.24	0.22	0.22	0.23	0.21	0.18	0.21	0.17	0.12	0.13	0.15
United States	USD/kg	0.21	0.18	0.14	0.15	0.18	0.15	0.15	0.15	0.14	0.10	0.15	0.14	0.21	0.19	0.13	0.19	0.13
Mexico	USD/kg	0.09	0.06	0.03	0.08	0.12	0.14	0.13	0.16	0.14	(0.00)	0.06	0.09	0.11	0.12	0.12	0.13	0.12
Czech Republic	USD/kg	0.26	0.22	0.18	0.24	0.30	0.10	0.08	0.08	0.06	0.08	0.08	0.07	0.11	0.08	0.05	0.05	0.11
Slovak Republic	USD/kg	0.29	0.25	0.19	0.23	0.34	0.08	0.06	0.10	0.08	0.07	0.05	0.09	0.13	0.09	0.07	0.06	0.10
Turkey	USD/kg	0.09	0.06	0.05	0.07	0.16	0.15	0.17	0.16	0.12	0.16	0.16	0.21	0.19	0.13	0.11	0.05	0.08
Australia	USD/kg	0.06	0.06	0.05	0.05	0.09	0.09	0.08	0.06	0.06	0.06	0.05	0.05	0.04	0.03	0.02	0.02	0.03
Poland	USD/kg	0.03	0.00	0.01	(0.03)	(0.05)	(0.02)	(0.00)	(0.01)	(0.02)	0.00	(0.01)	0.01	0.03	0.02	0.02	0.02	0.03
New Zealand	USD/kg	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note:

1. Countries are ranked according to their 2002 level.

Source: OECD PSE/CSE database, 2003.

Annex Table 5.3. Composition of total OECD PSE for milk by support category

		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Composition of PSE (USD million)																		
Total producer support (PSE)	USD million	**50 003**	**49 121**	**45 390**	**44 850**	**58 924**	**54 138**	**56 302**	**53 366**	**52 099**	**50 846**	**50 218**	**45 758**	**54 201**	**48 771**	**38 013**	**41 258**	**41 139**
Market price support	USD million	44 671	43 690	38 340	38 474	51 896	47 612	49 598	46 242	45 406	43 629	43 695	39 710	48 570	42 724	32 639	35 100	35 432
Payments based on output	USD million	1 176	1 326	1 908	2 141	2 368	2 120	1 695	1 359	1 003	997	978	848	802	1 072	1 099	1 497	810
Payments based on input use	USD million	2 574	2 935	2 990	2 919	3 263	2 980	3 120	3 440	3 596	3 750	3 548	3 263	3 232	3 309	2 735	2 960	2 916
Payments based on animal numbers	USD million	339	426	1 316	574	670	805	910	876	916	793	747	766	783	712	558	578	740
Payments based on historical entitlements	USD million	50	52	76	119	113	79	227	350	382	1 020	621	513	459	529	566	598	642
Payments based on input constraints	USD million	714	384	440	309	321	406	515	952	754	719	691	635	224	248	268	187	236
Payments based on farm income	USD million	376	273	239	265	250	109	115	75	75	80	88	127	178	223	238	342	376
Miscellaneous payments	USD million	104	34	83	48	42	28	121	72	- 33	- 142	- 150	- 104	- 45	- 45	- 89	- 5	- 13
Share of PSE																		
Total producer support	**%**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Market price support	%	89	89	84	86	88	88	88	87	87	86	87	87	90	88	86	85	86
Payments based on output	%	2	3	4	5	4	4	3	3	2	2	2	2	1	2	3	4	2
Payments based on input use	%	5	6	7	7	6	6	6	6	7	7	7	7	6	7	7	7	7
Payments based on animal numbers	%	1	1	3	1	1	1	2	2	2	2	1	2	1	1	1	1	2
Payments based on historical entitlements	%	0	0	0	0	0	0	0	1	1	2	1	1	1	1	1	1	2
Payments based on input constraints	%	1	1	1	1	1	1	1	2	1	1	1	1	0	1	1	0	1
Payments based on farm income	%	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1
Miscellaneous payments	%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Share of gross farm receipts																		
Total producer support (%PSE)	**%**	**66**	**60**	**51**	**50**	**61**	**58**	**57**	**57**	**55**	**50**	**49**	**49**	**57**	**53**	**45**	**46**	**48**
Market price support	%	59	53	43	43	54	51	50	49	48	43	42	42	51	47	39	39	42
Payments based on output	%	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	2	1
Payments based on input use	%	3	4	3	3	3	3	3	4	4	4	3	3	3	4	3	3	3
Payments based on animal numbers	%	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Payments based on historical entitlements	%	0	0	0	0	0	0	0	0	0	1	1	1	0	1	1	1	1
Payments based on input constraints	%	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0
Payments based on farm income	%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Miscellaneous payments	%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: OECD PSE/CSE database, 2003.

Annex Table 5.4. Average bound tariffs for dairy products by in, out and non-quota for selected OECD countries

%, including ad-valorem equivalents

Country/commodity	Average tariff[1]	1995	1996	1997	1998	1999	2000
Australia							
Cheese	In-quota	3.2	3.3	3.4	3.2	3.5	3.5
	Out-of-quota	46.2	47.7	46.8	43.7	46.3	43.9
Canada							
Butter	In-quota	11.8	11.4	9.9	8.3	7.8	6.4
	Out-of-quota	351.2	342.2	333.2	324.2	315.2	306.2
Cheese	In-quota	2.2	2.0	1.9	1.7	1.5	1.3
	Out-of-quota	281.8	274.5	267.3	260.1	252.8	245.6
SMP	In-quota	2.4	2.3	2.3	2.2	2.1	1.6
	Out-of-quota	231.3	225.3	219.4	213.5	207.5	201.6
WMP	In-quota	8.0	7.3	6.4	5.6	4.9	4.0
	Out-of-quota	309.2	301.3	293.3	285.4	277.5	269.6
European Union							
Butter	In-quota	54.0	64.3	56.7	54.6	74.2	66.0
	Out-of-quota	173.6	193.3	158.8	141.8	177.6	144.3
Cheese	In-quota	41.6	40.4	38.4	43.0	48.0	42.2
	Out-of-quota	139.5	126.9	112.5	116.8	119.9	96.5
SMP	In-quota	29.0	30.5	31.0	36.9	42.5	35.1
	Out-of-quota	87.6	88.9	87.2	100.1	110.6	87.7
WMP	Non-quota	139.6	139.0	118.0	123.8	130.9	106.9
Hungary							
Butter	In-quota	60.0	60.0	60.0	60.0	60.0	60.0
	Out-of-quota	149.5	139.9	130.4	120.9	111.3	101.8
Cheese	In-quota	50.0	50.0	50.0	50.0	50.0	50.0
	Out-of-quota	97.1	89.3	81.4	73.6	65.7	57.8
SMP	In-quota	30.0	30.0	30.0	30.0	30.0	30.0
	Out-of-quota	75.2	70.4	65.6	60.8	56.0	51.2
WMP	In-quota	30.0	30.0	30.0	30.0	30.0	30.0
	Out-of-quota	75.2	70.4	65.6	60.8	56.0	51.2
Japan							
Butter	In-quota	35.0	35.0	35.0	35.0	35.0	35.0
	Out-of-quota	595.9	612.9	533.3	470.7	663.0	679.2
Cheese	Non-quota	45.0	42.2	39.5	36.7	33.9	31.2
SMP	In-quota	19.3	18.6	17.9	17.2	16.5	15.8
	Out-of-quota	244.8	224.4	223.3	240.2	288.0	275.1
WMP	In-quota	24.0	24.0	24.0	24.0	24.0	24.0
	Out-of-quota	358.1	331.6	298.1	305.7	366.2	376.5
United States							
Butter	In-quota	7.7	8.3	8.3	8.2	9.2	9.1
	Out-of-quota	91.7	108.3	104.2	99.0	123.2	117.4
Cheese	In-quota	12.3	12.3	12.3	12.3	12.3	12.3
	Out-of-quota	74.7	75.5	78.2	86.1	88.6	83.6
	Non-quota	19.1	18.8	18.8	19.4	19.5	18.8
SMP	In-quota	1.5	1.7	1.9	2.3	2.5	2.3
	Out-of-quota	46.3	48.9	54.2	63.6	67.5	59.8
WMP	In-quota	7.2	7.4	7.5	8.0	8.3	8.2
	Out-of-quota	66.7	70.8	70.3	77.8	82.1	78.7

Note:
1. The average tariff is calculated as the unweighted average of each tariff line. Specific tariffs have been converted into *ad-valorem* equivalents for comparative purposes. This explains some of the variations and increases in tariffs during a period of tariff reduction.

Source: OECD Secretariat.

Annex Table 6.1. Selected European Union dairy statistics

Country	N-manure coefficient[1] (kg/cow/year)	Milk Yield[2] (kg/cow)	Cows / holding[2]	Ratio of marginal cost to producer price of milk[3]
Austria	85	4 427	8.4	0.54
Belgium	97	4 943	32.3	0.68
Denmark	125	6 554	50.9	0.58
Finland	108	6 220	13.3	0.76
France	85	5 451	30.7	0.64
Germany	105	5 525	27.9	0.55
Greece	105	4 054	7.7	0.63
Ireland	85	4 177	32.4	0.51
Italy	68	4 901	20.4	0.63
Netherlands	140	6 635	44.1	0.64
Portugal	105	5 011	5.2	0.73
Spain	85	4 689	11.9	0.62
Sweden	117	6 975	29.6	0.85
United Kingdom	106	5 918	68.7	0.57

Sources:

1. OECD Nitrogen Soil Balance Database.

2. EC (2001).

3. INRA-Wageningen (2002).

Annex Table 6.2. Regional aggregation for trade liberalisation scenarios[1]

Acronym	Description
AU	Australia
EU_scand	Denmark, Finland, Sweden
Rest_EU	Austria, Belgium, Greece, Luxembourg, Portugal, Spain
Italy	Italy
Ire	Ireland
France	France
Grm	Germany
UK	United Kingdom
Neth	Netherlands
NZ	New Zealand
CAN	Canada
USA	United States
Rest_ASIA	All Asia except Japan and Republic of Korea
JAP	Japan
KOR	Republic of Korea
C_S_Amer	All Central & South America including Mexico
EFTA	Switzerland, Norway and Iceland
C_Eur	Hungary, Poland, Czech Republic, Slovak Republic & rest of Central Europe
ME_Africa	Middle East incl. Turkey, Northern & Southern Africa
ROW	Former Soviet Republic and rest of world

Note:

1. In relation to the definition of the trade liberalisation scenarios, developing countries are defined as those that comprise the Rest_Asia, C_S_Amer, C_Eur, ME_Africa and ROW regions, and KOR.

Annex Table 6.3. Sectoral aggregation for trade liberalisation scenarios

Acronym	Description
RICE	Paddy rice
WHEAT	Wheat
CGRAINS	Cereal grains *nec*
O_crops	Oil crops, horticulture & all other crops
Milk	Milk
O_lvstk	Livestock, wool & other livestock products *nec*
MEATS	Ruminant & nonruminant meats
DAIRY	Dairy products
O_ProcFood	All other processed foods & beverages
ResProds	Forestry, fishing, coal, oil, gas
MANUF	Manufactures
SVCS	Services

Note: nec: not elsewhere classified.

Annex Table 6.4. Regional base data for trade liberalisation scenarios, 1997

		Milk production		Nitrogen (N) manure output		GHG emissions		
Country/Region	Total dairy cows in milk[1] 000 animals	Milk yield kg/cow	Total milk production 000 tonnes	N-Manure coefficient[2] kgN/cow/yr	Total dairy N manure tonnes	GHG emission coefficient CO_2 equivalent[3] $kgCO_2$/cow/yr	Total dairy GHG emissions tonnes	Ratio of marginal cost to producer price of milk[4]
Australia	1 977	4 706	9 304	70	138 390	2 833	5 600 989	1
New Zealand	3 259	3 393	11 058	77	250 943	2 079	6 776 569	1
Japan	1 032	8 377	8 646	112	115 584	3 315	3 421 080	1
Korea	310	6 405	1 984	81	25 151	3 315	1 026 808	1
Rest_ASIA	51 628	940	48 509	50	2 581 400	2 000	103 256 000	1
EU_scand	1 530	6 778	10 371	118	180 846	3 757	5 747 690	0.71
France	4 411	5 649	24 917	85	374 935	3 905	17 224 690	0.64
Germany	5 026	5 711	28 702	115	577 990	3 255	16 358 474	0.55
Ireland	1 316	3 994	5 256	85	111 860	3 279	4 315 625	0.51
Italy	2 179	5 393	11 752	68	148 172	3 805	8 290 114	0.63
Netherlands	1 643	6 648	10 922	140	230 020	2 515	4 131 603	0.64
Rest_EU	2 331	6 392	14 901	91	211 189	3 291	7 672 078	0.63
United Kingdom	2 476	5 994	14 841	106	262 456	3 587	8 882 006	0.57
EFTA	1 079	5 428	5 856	87	94 197	3 286	3 545 055	0.74
C_Eur	8 436	3 368	28 413	63	529 781	2 228	18 795 408	1
Canada	1 215	6 667	8 100	105	127 575	3 650	4 434 410	0.6
United States	9 309	7 606	70 801	95	884 355	3 805	35 418 976	1
C_S_Amer	39 854	1 362	54 274	50	1 992 700	2 000	79 708 000	1
ME_Africa	61 328	554	33 980	50	3 066 400	2 000	122 656 000	1
ROW	21 961	3 150	69 181	50	1 098 050	2 000	43 922 000	1
World	222 300	2 122	471 767	58	13 001 993	2 255	501 183 574	

Notes:

1. FAOSTAT for Rest_ASIA, C_S_Amer, ME_Africa, C_Eur and ROW. All other regions from OECD Nitrogen Balance Database.

2. OECD Nitrogen Balance Database except for Rest_ASIA, C_S_Amer, ME_Africa and ROW. Coefficients for latter regions assumed to be 50 kg.

3. Coefficients developed by the OECD from country submissions to the UNFCCC. Coefficients for Rest_ASIA, C_S_Amer, ME_Africa and ROW assumed to by 2 000 based on lowest OECD figure available, that for New Zealand.

4. Equals one for non-quota countries.

Annex Table 6.5. Change in agricultural production as a result of trade liberalisation scenario #1

	RICE	WHEAT	CGRAINS	O_crops	Milk	O_lvstk	MEATS	DAIRY	O_ProcFood	ResProds	MANUF	SVCS
AU	7.3	0.7	8.1	-0.2	5.3	-0.3	2.9	5.3	1.9	-0.3	-0.6	0.0
EU_scand		-3.8	-4.6	-0.9	0.0	-1.5	-2.0	0.0	-2.4	0.1	0.2	0.1
Rest_EU	-10.4	-5.6	-7.0	-0.9	0.0	-1.7	-1.8	-0.1	-2.4	0.1	0.4	0.1
Italy	-3.7	-4.5	-2.6	-0.3	0.0	-0.9	-1.1	0.2	-1.0	0.1	0.1	0.1
Ire		-8.2	-8.3	0.1	0.0	-4.0	-5.7	0.5	-3.3	0.1	0.9	0.1
France		-7.2	-9.6	0.0	0.0	-0.5	-1.1	-0.8	-2.0	0.2	0.4	0.1
Germ		-3.9	-4.6	-0.4	0.0	-1.9	-2.6	-0.1	-1.4	0.1	0.2	0.0
UK		-4.3	-5.4	-0.4	0.0	-1.5	-2.4	0.0	-1.0	0.1	0.1	0.1
Neth		-7.4	-22.4	-0.3	0.0	-4.9	-7.0	0.2	-1.7	0.1	0.3	0.1
NZ		5.9	5.9	-1.2	9.4	2.7	17.9	11.0	0.2	-1.5	-3.5	-0.1
CAN		12.7	1.2	1.4	0.0	-2.0	-1.2	-0.3	-0.7	-0.1	-0.2	0.0
USA	2.8	-0.8	-1.4	0.4	-0.7	0.3	0.5	-0.8	0.4	0.0	-0.1	0.0
Rest_ASIA	0.4	0.2	-0.1	-0.1	0.1	0.2	1.2	0.7	0.6	0.0	-0.1	0.0
JAP	-2.3	-35.3	-7.2	-3.6	-5.0	-4.8	-5.5	-5.6	-1.3	0.0	0.3	0.0
KOR	1.8	5.3	-18.9	-1.7	0.0	1.9	1.8	-0.2	1.9	0.0	-0.1	0.1
C_S_Amer	0.8	1.9	1.1	0.7	0.3	0.9	1.2	-0.2	1.3	-0.3	-0.5	0.0
EFTA		-8.9	-9.0	-7.3	-0.4	-2.9	-2.6	-0.2	6.7	-0.1	-0.7	0.2
C_Eur		0.6	1.6	-0.9	0.6	1.5	1.7	1.4	0.0	-0.1	-0.3	0.1
ME_Africa	-0.3	-1.7	-0.1	0.2	-0.9	-0.8	-2.8	-2.8	-0.2	0.1	0.1	0.1
ROW	0.4	1.2	1.1	-0.3	0.4	0.1	-0.3	1.7	0.6	0.0	-0.1	0.0

Annex Table 6.6. Change in agricultural production as a result of trade liberalisation scenario #2

	RICE	WHEAT	CGRAINS	O_crops	Milk	O_lvstk	MEATS	DAIRY	O_ProcFood	ResProds	MANUF	SVCS
AU	48.9	-0.1	20.6	-1.6	19.2	-1.6	5.4	19.3	5.6	-0.8	-1.7	0.0
EU_scand		-1.7	-9.5	-0.4	0.0	-3.1	-4.2	0.1	-3.4	0.1	0.2	0.2
Rest_EU	-21.0	-12.3	-14.1	0.0	0.0	-4.1	-4.6	-0.1	-4.4	0.2	0.7	0.2
Italy	-7.2	-10.3	-5.3	0.9	0.0	-2.0	-2.9	0.5	-1.5	0.1	0.1	0.1
Ire		-14.2	-13.1	1.8	0.0	-2.4	-17.2	0.2	-5.0	0.1	1.1	0.1
France		-16.0	-19.0	1.3	0.0	-1.2	-3.2	-1.6	-3.1	0.4	0.6	0.2
Germ		-8.5	-9.6	0.9	0.0	-4.4	-6.6	-0.2	-2.3	0.1	0.4	0.1
UK		-7.9	-10.5	0.5	0.0	-3.2	-6.7	-0.2	-1.2	0.1	0.2	0.1
Neth		-14.0	-47.7	1.1	0.0	-11.5	-17.4	0.4	-2.5	0.1	0.4	0.1
NZ		17.0	17.0	-8.5	24.3	8.5	55.5	27.7	-2.3	-4.8	-9.6	-0.2
CAN		28.3	3.3	4.5	0.0	-4.5	-2.1	-1.3	-1.9	-0.3	-0.6	0.1
USA	14.7	-0.4	-2.7	1.4	-0.9	0.6	1.2	-1.0	0.9	-0.1	-0.2	0.0
Rest_ASIA	0.8	0.2	-0.2	-0.1	0.1	0.6	3.6	5.2	0.9	-0.1	-0.3	0.0
JAP	-6.8	-81.1	-8.7	-6.8	-16.8	-9.7	-10.3	-19.8	-1.8	0.1	0.7	0.1
KOR	5.0	13.6	-50.3	-4.1	0.3	6.1	5.8	-0.3	5.3	0.0	-0.4	0.1
C_S_Amer	1.2	4.9	2.4	0.4	1.1	2.5	3.6	0.4	1.3	-0.4	-0.8	0.0
EFTA		-46.8	-27.6	-10.7	-22.9	-13.9	-14.4	-32.2	20.3	0.1	-0.2	0.5
C_Eur		0.5	2.9	-1.5	2.0	1.9	1.9	6.8	-1.1	-0.1	-0.4	0.2
ME_Africa	-0.7	-3.9	0.3	-0.7	-2.1	-1.7	-5.3	-6.3	-0.9	0.2	0.5	0.2
ROW	1.0	2.3	2.4	-0.7	2.3	0.1	0.8	8.6	1.4	-0.1	-0.4	0.0

Annex Table 7.1. Cross-compliance requirements in OECD countries

Country	Cross-compliance requirements[1]	Commodity/Programme Coverage	Year introduced
Australia	no		
Austria	yes	set-aside payments	2002
Belgium	no		
Canada	no		
Czech Republic	no		
Denmark[2]	no		
Finland	yes	arable crop, hemp, flax, potato starch and seed area payments all livestock headage premia	2000
France	yes	maize area payments (irrigated crops only)	2000
Germany	no		
Greece	yes	arable crops and cotton area payments in Nitrate Vulnerable Zones sheep and goat headage premia	2001
Hungary	no		
Iceland	no		
Ireland	yes	sheep premia	1998
Italy	yes	arable crops, grain legumes, flax, hemp, tabacco, seeds, rice, olive area payments sheep and cattle premia	2001
Japan	no		
Korea	yes	area payment for paddy field farmers	2001
Luxembourg	no		
Mexico	no		
Netherlands[3]	yes	silage maize area payments	2000
New Zealand	no		
Norway	yes	arable crops, oilseeds, fruits and vegetables and grassland area payments headage payments for all livestock	1991
Poland	no		
Portugal	no		
Slovak Republic	no		
Spain	no		
Sweden	no		
Switzerland	yes	all farmers receiving payments	1999
United Kingdom	yes	arable area payments; headage payments for beef and sheep	1999
United States	yes	arable crops	1985

Notes:

1. Under Agenda 2000, all EU farmers participating in support programmes under EC Council Regulation No. 1257/1999 (Rural Development) must comply with Good Farming Practice (GFP) standards as defined by member countries, which set minimum standards for the environment, animal welfare and hygiene. Cross-compliance measures defined in Chapter 7 and shown in this table focus on environmental conditions attached to agricultural support policies.

2. Denmark introduced cross-compliance requirements on arable area payment and beef premia in 2000 but these were removed in 2003.

3. The Netherlands introduced cross-compliance requirements on potato starch in 2000 but these were removed in 2003.

Source: OECD Secretariat, based on Petersen and Shaw (2000).