

Comparison of environmental and health-related standards influencing the relative competitiveness of EU agriculture vis-à-vis main competitors in the world market

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Comparison of environmental and health-related standards influencing the relative competitiveness of EU agriculture vis-à-vis main competitors in the world market
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Synthesis of the principal environmental and human-health related standards applying to agriculture in the EU, Australia, Canada, New Zealand and the USA. The report provides one of the first comprehensive surveys of the main environmental and human health problems related to agriculture in these countries. A broad range of problems is surveyed, including the quality of water, soil and air, bio-diversity and landscape, genetically modified organisms, animal welfare and human health. The policy measures in place to treat the measures are compared. Using this analysis, a preliminary assessment is made of the implications of differences in standards for the relative competitiveness of EU agriculture vis-à-vis the other four countries.

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Preface

This study sought to compare environmental and human health-related standards applying to agriculture in the EU vis-à-vis its main competitors on the world market. It was commissioned by the European Commission (DG Agriculture). The objectives of the study were:

- to compare the main environmental and human health issues causing concern in the EU, Australia, Canada, New Zealand and the USA;
- to compare the policy measures and standards that have been put in place to address these concerns in each country, and identify their implications as constraints at farm level; and from this
- to make some initial assessment of areas where differences in on-farm standards might imply effects upon competitiveness across these countries, in terms of agricultural trade in major commodities.

The financial support of the European Commission is gratefully acknowledged. The content of the report is the sole responsibility of LEI. It does not necessarily reflect the views of the Commission or its services, and in no way anticipates the Commission's future policy in this area. The study was co-ordinated by LEI (Floor Brouwer), working with a team of experts from different countries without whom this report would never have been possible. It was a joint effort of LEI with:

- the Institute for European Environmental Policy (IEEP), London, UK (David Baldock and Janet Dwyer);
- the Henry A. Wallace Institute for Alternative Agriculture (HAWIAA), USA (Chantal Carpentier and Dave Ervin);
- the Department of Agricultural Economics and Business, University of Guelph, Canada (Glenn Fox and Jennifer Kidon);
- the Centre for International Economic Studies, University of Adelaide, Australia (Randy Stringer and Kym Anderson);
- the Department of Applied and International Economics, Massey University, New Zealand (Anton Meister, Shamim Shakur and Sue Cassells).

The study was compiled mainly by means of a literature review and interviews with key experts and officials at both national and regional level. We very much appreciate the wide support, useful suggestions and critical remarks we received in preparing the report. Of similar importance has been the cross-national team of experts contributing to the report. This group has been vital in helping to assemble a broad inventory of environmental and health-related standards across different parts of the world. Therefore, we would like to thank them for all their efforts in preparing and discussing this report.

The managing director,

Prof. Dr. L.C. Zachariasse

List of abbreviations

ANZFA	Australia New Zealand Food Authority (Australia and New Zealand)
BOD	Biochemical Oxygen Demand
BSE	Bovine Spongiform Encephalopathy
BST	Bovine Somatotrophin
CAFO	Confined Animal Feeding Operation (USA)
CRP	Conservation Reserve Program (USA)
CWA	Clean Water Act (USA)
EC	European Community
EIA	Environmental Impact Assessment (EU)
EPA	Environmental Protection Agency (USA)
EQIP	Environmental Quality Incentives Program (USA)
ESA	Endangered Species Act (USA)
EU	European Union
FAIR	Federal Agricultural Improvement and Reform (USA)
FDA	Food and Drug Administration (USA)
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act (USA)
FQPA	Food Quality Protection Act (USA)
GMAC	Genetic Manipulation Advisory Committee (Australia)
GMF	Genetically modified food
GMO	Genetically modified organism
HACCP	Hazard Analysis Critical Control Points
IPPC	Integrated Pollution Prevention and Control (EU)
LU	Livestock Unit (EU)
MAC	Maximum Acceptable Concentration
MAF	Ministry of Agriculture and Fisheries (New Zealand)
MAFF	Ministry of Agriculture, Fisheries and Food (United Kingdom)
MCL	Maximum Contaminant Level (USA)
MRL	Maximum Residue Level
NHT	Natural Heritage Trust (Australia)
NRA	National Registration Authority (Australia)
NRCS	Natural Resources Conservation Services (USA)
NRS	National Residue Survey (Australia)
OECD	Organisation for Economic Co-operation and Development
PMO	Pasteurised Milk Ordinance (USA)
PMZ	Pesticide Management Zone (USA)
RMA	Resource Management Act (New Zealand)
RTF	Right to Farm (USA)
USDA	United States Department of Agriculture (USA)
VAT	Value Added Tax

WHIP Wildlife Habitat Incentives Program (USA)
WHO World Health Organisation
WPA Wildlife Protection Act (Australia)

Executive summary

This report is a synthesis, drawing on five national studies of the principal environmental and human health related standards applying to agriculture in the EU, Australia, Canada, New Zealand and the USA respectively. It provides a first comparison of the main environmental and health issues causing concern in the five countries, the policy measures and standards that have been put in place and some of the implications at the farm level. On this basis a preliminary assessment is made of the implications of differences in standards for the relative competitiveness of EU agriculture vis-à-vis the other four countries, which are competitors on the world market.

The method adopted

The study was co-ordinated by the Agricultural Economics Research Institute (LEI) in the Netherlands, working with specialist institutions or individuals in each of the five countries. National reports were produced for each country, including the EU, on the basis of a common framework. This framework followed a sequence beginning with broad issues of concern and ultimately considering specific constraints on farmers and competitiveness effects. The reports sought to identify the key issues in the country concerned, comment on the weight given to a common set of issues and describe the policy measures in place. The pattern, legal status and range of application of these policy measures was assessed and put in the context of the conditions applying in each country. To varying degrees these measures introduce standards applying to agriculture many of which give rise to constraints on farming activities. Specific examples of farm level constraints arising from legal and other standards were given.

The initial intention was to assess the impact of the specific constraints or standards on production costs and the overall competitiveness of farms in production sectors identified at the beginning of the study because of their trade significance for the five countries. This was to be attempted on the basis of existing literature rather than fresh research or analysis. However, the national research teams found that the coverage of the literature does not include all the relevant commodities and some countries have done much more than others. In addition, international comparisons of cost estimate are problematic because of things like exchange rates and differences in production practices unrelated to environmental regulation. It was possible only to report on studies illustrating the scale of potential impacts and the opinions of experts in the field. Those studies, which were identified, adopted a range of different methodological approaches, hampering direct comparison between them.

The final stage of the project was to undertake a comparison between the five countries, utilising both the national reports and other material collected subsequently. This synthesis report focuses primarily on the key issues affecting agriculture, and the policy measures and standards established in the five countries, making a comparison between

them in the light of varying national circumstances. The implications for the competitiveness of farmers in the EU relative to the other countries are explored by means of a series of examples. A much larger exercise would be required to allow a more rigorous assessment of the impact of specific standards for particular traded commodities, given the lack of material currently available.

The principal issues

A standard set of key issues in environment and human health policy was selected at the beginning of the project following a brief survey of each country. While there were significant differences in the main issues related to agriculture in each country and the weighting given to specific concerns varied considerably, most of the leading issues were similar. The national reports were structured to address each of these key issues irrespective of their significance in the country concerned in order to ease the process of comparison. The key issues were grouped under seven main themes as follows:

- water quantity and quality (nutrient enrichment by nitrates and phosphates, water born sediments, pesticides, and issues connected with irrigation);
- soil related issues (including soil erosion, contamination and salinisation);
- air quality (including odour, ammonia emissions, pesticide drift, crop burning and noise);
- nature conservation, biodiversity and landscape protection and management (including endangered species, habitat conservation and protected landscapes);
- genetically modified organisms;
- farm animal welfare (including housing for livestock, transport conditions and slaughter);
- human health issues (the use of hormones in livestock rearing, the ingredients used in animal feed, pesticide residues in food, safety of those applying agrochemical, hygiene rules for dairy farming and veterinary requirements).

Under these seven main headings a standard set of 18 more specific issues was developed and used to structure the national reports.

The main differences regarding environmental and health-related issues

A summary of the varying significance of most of the key issues in the five countries is given in figure 1. This is based on the national reports, with significance being judged on the evidence of physical impacts, perceptions of the issue by policymakers and the wider public and the policy priority being given to the issue. Some evidence of agricultural impact on the environment is clearly documented, for example, there is widespread data indicating contamination of groundwater by pesticides in certain regions. However, there is also an important element of judgement. The scale of public concern, reflected in the media, parliamentary debates et cetera is more difficult to compare between countries.

A simple ordinal scoring system is applied in the figure. Where an issue appears both to be an issue of significant concern and there has been substantive response in the form of

public policies or initiatives in the private domain, this is indicated by three stars rather than two. Thus, the figure distinguishes between the following categories:

- No issue;
- * Issue identified as a problem, but not of major concern;
- ** Issue identified as a problem, and of significant concern;
- *** Major issue with high priority in policy.

The figure is not meant to provide an overall judgement regarding the state of the environment in any of the countries involved. In those countries where certain issues are not perceived to be of major public concern, it does not imply that there is no problem. For example, farm animal welfare is less of a public policy issue in the USA than in the EU and certain other countries. Standards of animal welfare may not necessarily be higher in the USA than elsewhere, but broad sustained public interest remains limited.

Issue	European Union	USA	Canada	Australia	New Zealand
Nutrient enrichment by nitrates and phosphates	***	***	*	*	*
Sediments in water	*	***	*	*	**
Pesticides (including drift and applicator safety)	***	***	*	**	*
Irrigation	**	**	*	***	**
Salinisation	*	*	*	***	-
Soil contamination	*	*	*	*	*
Soil erosion	**	***	*	***	***
Ammonia	**	-	*	-	-
Odour and nuisance	***	**	***	-	-
Crop burning	*	*	-	-	-
Biodiversity, landscape	***	**	*	***	***
GMOs	***	*	*	*	***
Animal welfare	***	*	*	*	*
Hormones (and animal feed ingredients)	**	-	*	*	*
Pesticide residues in food	**	***	**	**	**
Hygiene in dairy farming	**	**	**	*	*
Veterinary	**	*	*	*	*

Figure 1 Issues of concern in the five countries

The figure inevitably simplifies the differences between countries - for example in the EU the biodiversity and landscape issue has a major impact on farmland whereas it is primarily focussed on non-agricultural land in the other countries. There are many similarities between the countries but also important differences. For example public concerns about the potential animal welfare issues surrounding modern production systems are widespread in the EU. By contrast, animal welfare is a less prominent issue in the other

countries examined. The analysis suggests that there is a larger number of significant issues associated with agriculture in the EU than elsewhere. The impression is confirmed by the pattern of legislation and associated standards, which covers a broader range in the EU than elsewhere.

Some differences are accounted for by biophysical and agricultural conditions with the EU distinguished by relatively large areas of intensive farming, stable soils in a majority of regions, frequent proximity between agricultural and urban/residential areas, relatively small scale production, a lack of wilderness and a large endowment of cultural landscapes. Other differences, concerning animal welfare, food residue and quality questions and the use of GMOs, hormones and other technologies in farming appear to reflect different perceptions and social choices. These have implications for competitiveness.

Basic features of legislation in the countries studied

In all five countries there is a general framework of legislation at the federal, EU or country-level, with varying degrees of delegation of powers for specific policies to the state or more local (regional or even community) level. Private sector actions and initiatives also play an important part in setting effective standards for farms, especially in Australia and New Zealand. This diversity of policy instruments and varying role of formal legislation in setting standards makes concrete comparisons of precise impacts at farm level very difficult.

It is apparent that there are differences in the overarching philosophies and property rights governing policies in each country. Australia and New Zealand make less use of binding environmental legislation, but have advanced further along the private sector route with voluntary guidelines; this is linked to the very strong export-orientation of their markets and the need to meet EU standards for several products. This approach is also consistent with a greater vesting of property rights in the environmental resource with the private sector. The European Union, USA and Canada have a mix of legislative procedures at different levels with a wider range of federal legislation in the USA than in the EU or Canada. There is considerable diversity between Member States in the EU and notable variations between states in the USA and in the other countries. However, the non-European countries share the same legal system, and their institutional structures and procedures are less diverse than in the EU. At the sub-national level, legislative controls, guidelines and planning controls/zoning laws are evident in all countries, especially in the EU.

The EU and USA, in particular, have made more widespread use of public funds to support environmental programmes which offer financial rewards to producers in return for generating public benefits. By contrast, in New Zealand and Australia there is less emphasis on public goods provision and many issues are dealt with through voluntary advisory services, such as the 'Landcare' approach. Such programmes aim to promote partnerships and co-ordinated action among governments, industries and communities in order to provide incentives to change land management practices.

In all five countries regulation plays an important role in policies for pollution control (pesticides, water pollution, food hygiene, and food quality). A far more diverse picture is observed in relation to policies for soil, nature conservation, landscape and issues

related to certain new technologies (for example GMOs, antibiotics in animal feed, and hormones). With some exceptions, such as soil erosion control, the pattern of intervention appears heavier in the EU than elsewhere.

Legislation and command-and-control measures are relatively widely used in the EU to protect physical resources, as well as to advance human-health and animal welfare objectives. EU legislation affecting agriculture is concentrated particularly on water quality but the new IPPC Directive introduces a multi-media approach for larger livestock farms. Regulation is currently used selectively in the USA to control water pollution and, to a lesser extent, air pollution both by the federal government and most states. Regulation is mostly targeted on large point source emitters, with medium and small farmers largely exempted from water pollution regulations, although this is changing. Codes of Practice for protecting resources are rather common in Canada, Australia and New Zealand. However, often a producer can be sued if he or she is not in compliance with the relevant Codes. This makes the Codes 'binding' in a way not dissimilar to regulations.

Setting standards

It is clear from the study that the processes and systems used for producing agricultural commodities do vary considerably, although the products themselves may be largely or completely identical. The study is concerned with standards relating to farm practice and process since they commonly translate into on-farm constraints and they are the main concern with regard to competitiveness.

Product standards are covered to a limited extent only. Thus we exclude most hygiene requirements applying to the production of agricultural commodities (e.g. milk) since they mainly specify product standards. However, to a lesser extent some hygiene standards may also affect processes and procedures at farm level and, to that extent, therefore, they must be considered as part of the assessment of competition effects. In effect they translate into on-farm operational constraints requiring action by farmers.

The research work revealed that a significant proportion of the standards imposed on farmers in the countries studied derives from local and regional measures, rather than national legislation. Within the EU, there is a range of different levels at which standards are developed, stretching from the Community itself down to the commune, resulting in significant differences within regions and countries, as well as between Member States. In the United States, there is a body of federal legislation applying to the agricultural sector but a considerable proportion of the standards considered are developed by individual states or authorities at a more local level. The pattern is similar in Canada and local legislation is also important in both Australia and New Zealand, where command and control legislation at national level is relatively infrequent.

Considerable difficulty was confronted in translating comparable policy objectives, such as preventing water pollution by manure, into comparable standards at the farm level, although this was necessary in order to explore the economic implications of the policies. Different countries have approached issues of concern through a wide variety of measures. For example, in the EU there are many policy objectives for water quality, which can affect farm-building standards with regard to siting, design, scale, waste management et cetera as well as manure application, livestock density et cetera. In Canada, new farm

buildings for livestock are controlled principally by spatial planning mechanisms designed mainly to control nuisance, especially odour. These determine minimum separation distances between installations. These rules will certainly have impacts upon water quality, but they are not regarded as part of water quality policy *per se*. Thus when comparing apparent constraints at farm level, the approach needs to be applied with a sensitivity to the fact that environmental measures can have multiple effects beyond the problems that prompted action. So, in the Canadian context, farmers meeting the separation distance standards generate joint effects - reduced air quality conflicts, lower stocking rates and less risk of groundwater contamination.

For this reason, the most meaningful scale at which to determine and describe standards in such a way that they can be compared between countries, is to attempt to identify the level of on-farm operational constraints - i.e. the direct effects of standards on producers. The study needed to be adapted to consider how far it is possible to translate standards into the constraints imposed on farmers and thus to obtain a common framework for comparison between countries.

Constraints at farm level

The study revealed that a direct comparison of farm level constraints taking into account the range of constraints applied at the national, regional and local levels, the substantial variations within some countries and the highly indirect nature of certain constraints (such as pesticide residue limits for food and water) would be a major exercise. It would require some detailed investigation and carefully selected case studies of specific issues and/or regions. This would be a potentially valuable approach for future research.

In this overview study, the analysis is necessarily qualitative in nature - although we used quantitative evidence when it was available. In addition to the factors mentioned above, it should be emphasised that:

- it is difficult to derive precise farm level constraints, which reflect the cumulative impact of different layers of policy intervention from information provided about the policy objectives pursued in any one country. Even measures sharing similar objectives and mechanisms, such as upper limits on the permitted concentration of pesticides in fresh water, may result in quite different practical constraints on farming operations in different regions and localities;
- when attempting to consider the comparative impact of constraints arising under the major policy headings such as soil contamination, drinking water pollution, nature conservation et cetera, it is often necessary to consider a wide range of specific measures. Within a single entity such as the EU, a variety of different measures may be used by individual Member States, whilst some will give greater emphasis to a particular measure than others, even when the policy tools are broadly similar. The result is that there is no clear 'aggregate' constraint for the EU as a whole and there are also barriers to comparisons with other countries; it is not easy to arrive at a common denominator of constraints.

Differences in farm level constraints

There are several areas where differences between the five countries in the constraints imposed at farm level do not appear very significant, taking account of the different measures applied. These include pesticide residue standards for foodstuffs, standards applying to slaughter of farm animals, hygiene rules affecting dairy farms, conditions relating to veterinary requirements and the control of the main livestock diseases.

There is a further set of issues where there are clear differences in standards but these appear unlikely to affect costs very significantly in the main agricultural sectors. The relevant issues are standards applying to soil contamination, erosion and sedimentation, sediments in water courses, irrigation, the burning of crop residues and certain animal welfare standards, including the housing of farm animals and transport away from the farm.

More significant cost differences arise in relation to:

- nutrient enrichment of water, including manure management;
- pesticide authorisations and levels of pesticide permitted in water and other environmental elements;
- emissions and nuisance arising from livestock farms, including ammonia and odour;
- Biodiversity and landscape constraints on the farm;
- the regulation of GMOs;
- the permitted use of certain substances in livestock production, including growth hormones in beef, BST and certain animal feed constituents including a number of antibiotics.

Figure 2 highlights the policy areas across the five countries, and attempts to identify the main constraints they place upon farming, based upon the comparative assessment in chapter 3 of the synthesis report. It identifies leading policy areas, which put major constraints upon farming, on the basis of the available evidence as presented in this report. A simple ordinal scaling system has been applied in the table, to indicate relative levels of constraint. We have focused on those policies that internalise an external cost attributable to agricultural production. The figure distinguishes the following categories:

- No apparent constraint upon farming and no obvious policy in place in relation to agricultural practices;
- * Policy in place, but not considered to imply a real constraint for farming;
- ** Policy identified as a constraint upon farming but unlikely to be a major cost to the sector as a whole (e.g. limited geographical coverage or low-cost implications);
- *** Policy indicated as a major constraint upon farming which implies significant on-farm costs.

Some of these variations in constraints arise specifically from differences in environmental and agricultural conditions. Intensive production systems in close proximity in Europe create pressure on water quality and give rise to the need for constraints on agriculture. Other constraints, relating to GMOs, hormone use, certain pesticide authorisations cannot be explained in this way. Further study of this topic is necessary, particularly with regard to landscape and biodiversity constraints, which are important in Europe.

Issue	European Union	USA	Canada	Australia	New Zealand
Nutrient enrichment by nitrates and phosphates	***	**	*	*	*
Pesticides	***	***	***	**	*
Sediments	-	**	-	**	**
Irrigation	*	*	*	**	**
Salinisation	-	-	-	**	-
Soil contamination	**	**	**	*	-
Soil erosion	*	-	-	**	**
Odour, nuisance, ammonia	***	**	**	*	*
Crop burning	*	*	-	-	-
Biodiversity, landscape	***	*	*	*	*
GMOs	***	*	*	**	***
Housing (laying hens)	**	*	**	**	**
Transport	**	*	*	*	*
Slaughter	*	*	*	*	*
Hormones and animal feed ingredients	***	*	*	**	*
Pesticide residues in food	*	*	*	*	*
Hygiene rules in dairy farming	**	**	**	**	**
Veterinary requirements, control of animal diseases	*	*	*	*	*

Figure 2 Constraints upon farming which internalise external costs to environment and health

Impacts on costs

The maintenance and introduction of standards may, in principle, impose both recurring and non-recurring costs on farmers. Investment costs may arise directly from the introduction of new standards but may also be necessitated by the need to meet existing standards. There may also be opportunity costs for farms required meeting certain standards – such as the loss of the option to expand the capacity of a livestock unit because of environmental controls. These costs need to take into account a wide range of different options for the farm concerned and are more difficult to establish than direct costs. The literature on opportunity costs and shadow prices is particularly sparse, although the impact on competitiveness may be considerable.

The study showed that very few detailed studies have been made of the costs for particular sectors of agriculture in the five countries, of meeting different environmental and health-related standards. There is a very broad range of issues involved in determining how these standards actually affect producers' costs. As a result the analysis is necessarily qualitative in nature although we used quantitative evidence when it was available.

While most new standards are perceived to increase costs, this is not necessarily the case. Standards can result in improved efficiency, for example better use of nutrients on the

farm, potentially cutting costs and increasing gross margins. There is evidence from the USA of precisely this effect on some livestock farms.

The study disclosed the extent to which the impact of standards varied between farms, even within a particular region or target group for example dairy farms. Many studies indicated that variations were accounted for by factors such as:

- the biophysical conditions of the farm and the surrounding area;
- the technical options available to the farmer;
- the production systems in use and the capacity to adapt the enterprise to changing conditions;
- farm size (as well as the scale effects, it is notable that some standards apply only to larger units);
- the investment cycle on the farm, including the age of buildings and equipment affected the timescale for renewal, discount rates et cetera;
- when new standards are introduced, the extent to which farms may decide to abandon a particular management practice or form of production.

Detailed empirical studies based on farm interviews rather than solely modelling exercises are required in order to establish the range of incidence of cost effects accurately. The high cost of such studies is clearly one of the principal reasons for their scarcity. Published work provides useful cost estimates, most often expressed in terms of aggregate costs for a particular group, sector or region or as an estimated range. However, these studies are too variable in their basic assumptions, target groups studied etc to provide more than a rather general comparison.

Cost comparisons

Most of the literature on the impact of environmental, animal welfare and health related constraints on agriculture suggest that the overall impact on production costs in the sector concerned is relatively modest. This is true of the relatively few studies available in the EU as well as elsewhere. Nonetheless, it is clear that certain groups of producers can be severely affected and may even be forced to abandon production. It should be noted that standards have been tightened recently in several countries, including the EU and these changes have not usually been reflected in the literature.

In general the literature suggests that compliance costs for meeting environmental requirements would normally be less than three to four% of gross revenue, provided that producers have sufficient flexibility in selecting the means by which they meet their obligations. However costs are significantly higher in the livestock sector than for crop production. Compliance costs may result in a significant loss of competitiveness in the most heavily regulated regions as a result of the cumulative impact of different regulatory regimes. This may in turn affect the location of livestock production, particularly for intensively managed stock. Crop farms seem less likely to face compliance costs on a scale, which will affect future location.

Competitiveness

Costs in agriculture may be somewhat higher than the available studies for other sectors (e.g. manufacturing, services, and chemical), but they do not appear to be large enough to drive location of production decisions generally. In crop production, we did not find evidence to suggest that compliance with environmental regulations has been or will be a driving force determining the location of production.

With respect to livestock production, it may be a different story. The costs of compliance with nutrient regulation and measures to control odour and nuisance from intensive livestock production units are increasing in several parts of the world (e.g. EU, USA and Canada). It is primarily a question of finding a location for a facility that reaps the available size economies and at the same time is far enough away from adjacent land uses. And here, there are significant differences within and among countries. The compliance costs of producing pigs and poultry have increased during the past ten years in the EU, USA and Canada, and this may have a significant effect on the location of production in the future.

Future research

The synthesis report is designed to make a strategic comparison of the main environmental and health-related standards applying to EU agriculture vis-à-vis those of some key competitors in the world market. Future studies should, in our view, be focused on a narrow range of key sectors and might also be most usefully confined to the production structures, which are most export-oriented, within each country. Issues of environmental context, financial compensation and voluntary initiatives, and other non-environmental constraints upon production costs will continue to be essential considerations for these studies.

1. Introduction and overview

1.1 Outline of the report

This synthesis report is designed to make a strategic comparison of the main environmental and health-related standards applying to EU agriculture, vis-à-vis those of some key competitors in the world market, namely the USA, Canada, New Zealand and Australia. It is based upon the findings of five 'national reports' which were prepared by project partners in each of these countries between September 1998 and May 1999:

- Environmental and health-related standards influencing agriculture in the European Union. Report prepared by Floor Brouwer, Janet Dwyer and David Baldock (LEI and IEEP).
- Environmental and health standards: Compliance costs for US agriculture. Report prepared by David E. Ervin and C. Line Carpentier (Henry A. Wallace Institute for Alternative Agriculture, Greenbelt, Maryland, USA).
- A review of the costs of environmental compliance in Canadian agriculture. Report prepared by Glenn Fox and Jennifer Kidon (Department of Agricultural Economics and Business, University of Guelph, Guelph, Ontario, Canada).
- Environmental and health-related standards influencing agriculture in Australia. Report prepared by Randy Stringer and Kym Anderson (School of Economics and Centre for International Economic Studies, University of Adelaide, Adelaide, Australia).
- Environmental and health standards affecting food and agriculture in New Zealand. Report prepared by Anton Meister, Shamim Shakur and Sue Cassells (Department of Applied and International Economics, Massey University, Palmerston North, New Zealand).

Drawing upon the more detailed findings of the national reports, this synthesis summarises the broad pattern of environmental and health policy in place in the five countries. Where possible the implications for standards at farm level are drawn out. The report then seeks to identify where there are clear differences in standards between the countries, at the farm level (i.e. direct, operational constraints upon farming practices). These differences need to be evaluated in the context of the different environmental and health needs of the countries, to determine where differences mainly reflect specific natural resource, environmental and socio-cultural settings or where they appear likely to distort competitiveness¹. The essential question is whether input intensity and other aspects of agricultural production practices combined with competing non-agricultural demands for resources has created different levels of intensity of environmental problems attributable to agriculture.

¹The most common understanding of 'distortion' appears to be that prices do not reflect properly scarcity or - in the case of public goods - social costs. The latter depend on both preferences and site-specific conditions (vulnerability of sites, differences in pressures).

Without this crucial contextual analysis, which is difficult to provide for individual measures in practice, it is incorrect to draw conclusions about trade distortion from information about standards. Within this perspective the report proceeds to a preliminary assessment of the implications of these differences in standards for the relative competitiveness of EU agriculture, vis-à-vis its main competitors on the world market. This is done by relating operational constraints to potential costs, with special reference to selected importing and exporting sectors of agricultural production.

The report includes a mix of reasoned qualitative analyses and, where the data allows, a few illustrative and comparative summary tables of the environmental and health-related standards and/or on-farm constraints affecting each of the five countries. The project team understands that a comparison of on-farm constraints for environmental purposes across countries is not a substitute for an economic comparison of relative costs, including exchange rate effects. However, insufficient credible cost figures for the on-farm constraints are available to permit a rigorous competitiveness analysis. We view the assembly and comparison of the on-farm constraints as a necessary first step to eventually conducting such a trade competitiveness analysis. This report is a contribution to such a comparison but a very much larger exercise is required if the full range of national, regional and more local constraints is to be taken into account. The report is divided into chapters that reflect the steps outlined above:

1. *Introduction and overview of the study and its methods*
2. *Broad comparison of environmental and health issues and legislation*

Comparing the main environmental and health-related issues and basic features of legislation in the EU and four other countries. It includes a reasoned selection of the most important elements. This chapter also summarises differences in background conditions, which affect the issues claiming attention in the different countries and the policies adopted. We also discuss the different legislative models – how laws work and the main actors involved in implementing them, as well as how constraints are implemented and enforced, and where costs are non-compensated or partly or wholly compensated, typically through investment aid, 'cost sharing' or incentive schemes;
3. *Comparison of environmental and health-related standards*

This chapter focuses upon an identification of the major differences in the policy and legislation as it applies at farm level, focussing on specific constraints where possible, noting the considerable variation within the EU and some of the other countries in the study. This chapter also considers differences of context, and plausible reasons for possible differences in standards. These might include different biophysical conditions, different agricultural structures, property rights, functions of land use, consumer expectations, and socio-cultural values regarding food, the environment and landscapes. Countries may introduce tighter standards because they have mainly intensive production systems, such that there is a concentration of production in certain regions, with relatively severe environmental impacts. This may be the primary reason for differences in on-farm constraints, rather than differences in policy objectives. This might be the case with certain EU water quality protection policies, for instance. In addition, certain other points may be relevant, as when standards are

primarily set for export purposes (e.g. New Zealand) differ from what might be set as national standards;

4. *Impact of environmental and health-related standards on the relative competitiveness of EU agriculture vis-à-vis the main competitors on the world market*

This chapter builds on the comparison between countries of on-farm constraints, and explores the economic implications in the various countries of the policies identified in terms of size and composition of agricultural production, for example:

- what are the main apparent differences in standards between the EU and non-EU countries?
- which agricultural products are affected most in the EU, by the prevailing or upcoming standards for the commodities selected?
- how far can we draw conclusions about the influence of the standards identified on the relative competitiveness of EU agriculture vis-à-vis the main competitors in the world market?

5. *Conclusions and outlook*

The study concludes by highlighting the key areas (in terms of issues and commodity sectors) where differences seem most apparent, discusses the lessons learned from this particular study, and sets out possible avenues for future, more detailed research.

1.2 Methodology used and difficulties faced

A common framework is essential for getting comparable results from the national investigations. The approach of the studies and interim results were discussed at two team meetings in October 1998 and March 1999. At these meetings it was discovered that a broad comparison of environmental and human health standards, as expressed in national and regional regulations or policies, was not sufficient for exploring the economic implications of the policies, since different countries have approached issues of concern through a wide variety of measures. For example, in the EU there are many policy objectives for water quality, which can affect farm-building standards with regard to siting, design, scale, waste management et cetera. In Canada, farm buildings for livestock are critically affected by spatial planning mechanisms designed mainly to control nuisance, especially odour; these determine minimum separation distances between installations. These rules will certainly have impacts upon water quality, but they are not regarded as part of water quality policy *per se*. Thus when comparing apparent constraints at farm level, the approach needs to be applied with a sensitivity to the fact that environmental measures can have multiple effects beyond the problems that prompted action. So in the Canadian context, farmers meeting the separation distance standards generate joint effects - reduced air quality conflicts, lower stocking rates and less risk of groundwater contamination.

It was therefore decided that in principle, the most meaningful scale at which to determine and describe standards in such a way that these could be compared between countries, was to attempt to identify the level of on-farm operational constraints - i.e. the direct effects of standards on producers. By trying to translate standards into the constraints imposed on farmers it was hoped to obtain a common framework for comparison between

countries. The various stages from policy goal towards on-farm constraints are summarised in figure 1.1.

The national reports, from which this report is developed, cover the main areas of environmental and human health policies affecting agriculture in each country, and identify on-farm operational constraints which are derived from the various standards established by environmental and health policy. These operational constraints are considered in the light of existing environmental problems, animal welfare and human health issues in each country. This is to set the constraints in context, so that comparisons are tempered by an understanding of differences in environmental or health contexts. Contextual issues include public preferences for improving aspects of the environment or lowering human health risks, measured environmental or human health conditions, and the way in which responsibility for bearing the costs or receiving the benefits of environmental services attributable to agriculture is distributed.

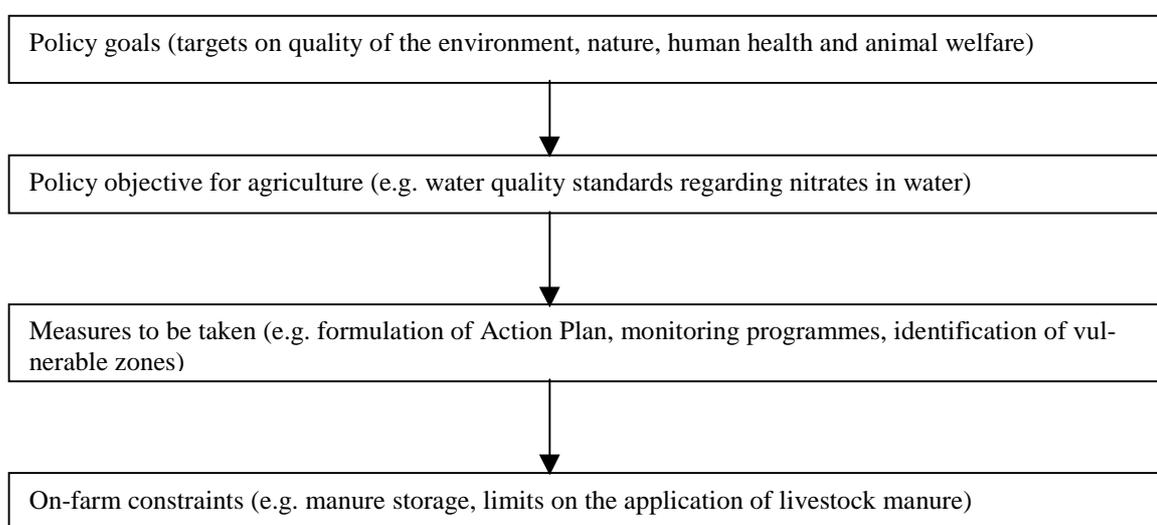


Figure 1.1 The various stages from policy goal towards on-farm constraints

The countries included in this study have experienced different levels and types of externalities attributable to their national agriculture and they have attempted to internalise those externalities in different ways. Regulations and standards are one means of internalisation. To the extent that those regulations and standards accurately reflect differences in preferences, environmental conditions and past effects of production practices, they can simply reflect true comparative advantage. As noted already differences may exist in relation to pressures on the environment, the vulnerability of sites to certain practices, and consumer attitudes towards risk. Apparently higher standards might distort competition, but they can also be a correct expression of different national conditions.

The national reports each cover a standard set of key issues in environment and health policy selected to ease comparison, while recognising that the weighting given to different issues varies considerably. The issues are as follows:

- water (nutrient enrichment by nitrates and phosphates, water born sediments, pesticides, and issues connected with irrigation);
- soil (soil quality aspects related to salinisation and soil contamination, and soil erosion);
- air (air quality, including odour, ammonia and noise, pesticide drift and crop burning);
- nature conservation, bio-diversity and landscape (bio-diversity, endangered species, habitat conservation and protected landscapes);
- genetically modified organisms;
- animal welfare (housing, transport and slaughter);
- human health (hormones and animal feed ingredients, pesticide residues in food, applicator safety, hygiene rules for dairy farming and veterinary requirements).

Environmental and health standards are commonly set through a mix of national, federal, regional and local measures, in each country. The research work revealed that a significant proportion of the standards imposed on farmers in the countries studied derives from local and regional measures, rather than national legislation. Within the EU, there is a range of different levels at which standards are developed, stretching from the Community itself to the commune, resulting in significant differences within regions and countries, as well as between Member States. In the United States, there is a body of federal legislation applying to the agricultural sector but a considerable proportion of the standards considered are developed by individual states or authorities at a more local level. The pattern is similar in Canada and local legislation is also important in both Australia and New Zealand.

Furthermore, standards do not always apply to all producers within a particular administrative region. For example, some regulation applies only to larger producers, for instance those with more than a given number of pigs or poultry. Other standards apply solely to sensitive areas, which may be a relatively small proportion of the administrative region. In certain cases, a county level authority applies standards in a discretionary way. It may be the body responsible for issuing consents for new developments.

For both these reasons, it is not possible to establish an authoritative inventory of standards or farm level constraints applying to all producers of a particular commodity in an individual country without taking account of a very substantial number of different measures. It has not been feasible to undertake this exercise in the countries concerned because it goes beyond the scope of a report intended to examine the main issues and trends primarily at the national level. Unavoidably, it proved necessary to focus on major federal, national and selected regional measures and to refer to more specific and local policy initiatives in a more selective way.

Since it was not possible to examine all constraints, for all issues in all countries, the national reports attempted a strategic assessment of the general level of on-farm constraints imposed in relation to each main issue. This was illustrated by reference to specific examples for a sample of sub-national cases, wherever possible.

In considering the effects of on-farm constraints on the relative competitiveness of EU agriculture, a number of commodities of special interest were identified for the purposes of this study. These are all commodities for which international trade issues are

relevant, and they were selected in order to cover a broad range of systems of production in the five countries. The commodities are dairy products; beef, sheep and pig meat; chicken meat; eggs; wheat; maize; apples; oranges; tomatoes and wine. Each of these commodities was considered in the national reports unless production levels in the country concerned are consistently very low.

The national reports were compiled through literature review and interviews with key experts and officials at both national and regional level. As explained above, it has not proved possible, given the limited time and resources available, to make a thorough and exhaustive catalogue of all standards and their related on-farm constraints. However, by first describing the principal policy objectives and then relating these to constraints, for each of the issues listed above, the reports have allowed us to identify areas where there appear to be significant differences in constraints between the countries, and to illustrate the nature of some of these differences at the farm level by reference to specific examples in using the rather limited material available.

The use of on-farm constraints in the context of the study

This synthesis report follows a strategic approach to the cross-country comparison, attempting to clarify the likely scale of impact of various standards for different product sectors and considering the economic implications of compliance. It goes some way to identifying those particular issues and sectors where differences appear to be greatest between the countries and competition effects are therefore most likely to arise. It thus provides a first overview of some of the most important issues in relation to EU competitiveness *vis-à-vis* the main competitors on the world market. The analysis is necessarily qualitative in nature - although we used quantitative evidence when it was available - primarily for the following reasons:

- very few detailed studies have been made of the relative costs for particular sectors of agriculture in the five countries, arising from different environmental and health-related standards. The present state of knowledge therefore does not allow direct comparison of empirical cost estimates between countries, because of data deficiency problems;
- it is difficult to derive precise farm level constraints from information provided about the policy objectives pursued in any one country. Even measures sharing similar objectives and mechanisms, such as upper limits on the permitted concentration of pesticides in fresh water, may result in quite different practical constraints on farming operations in different regions. Without detailed analysis based on empirical data, a precise measure of the impact of the constraint, is rarely available. Furthermore, there is a question about the rigour with which legislation, voluntary agreements and other measures are enforced. There may be substantial differences between regions and countries which are rarely documented in a reliable fashion;
- when attempting to consider the comparative impact of constraints arising under the major policy headings such as soil contamination, drinking water pollution, nature conservation et cetera, it is often necessary to consider a surprisingly wide range of specific measures. For example, controls on nutrients and fertilisers may be focussed on either the nitrogen or phosphate load. They may be concerned with the composi-

tion of fertilisers (such as the Cadmium content), they may require minimum levels of slurry storage capacity, specific handling or spreading techniques, obligatory green cover on bare land et cetera. Within a single entity such as the EU, a variety of different measures may be used by individual Member States, whilst some will give greater emphasis to a particular measure than others, even when the policy tools are broadly similar. The result is that there is no clear 'aggregate' constraint for the EU as a whole and there are also barriers to comparisons with other countries; it is not easy to arrive at a common denominator;

- any exercise to compare the costs of complying with standards between countries is complicated by the diversity of farm structures and environmental conditions, and the very broad range of issues involved in determining how environmental and health-related standards actually affect producers' costs. This has emerged very clearly from the national reports in this study, and would tend to suggest that simple, quantitative cross-national comparisons, using aggregate cost data, are likely to be of extremely limited value in this particular area of inquiry;
- many of the costs of complying with environmental regulations and standards are opportunity costs, which need to take into account a wide range of alternative options. In general these shadow prices are not directly observable since the environmental values which are impacted by the external effects of agricultural production, for institutional and historical reasons, are often not traded in markets. Therefore, there is a high degree of difficulty associated with trying to compare the magnitudes of the external costs attributable to agricultural production. Notwithstanding the difficulty of determining opportunity costs, it is possible to use enterprise budgets to compare costs of environmental compliance measures as a proportion of overall costs per unit of output. Compliance costs are driven to a large extent by the efficiency of production, and on-farm constraints could be used as a proxy for the efforts required by farmers in bridging the gap between current practice and the operational standard.

Although greatly constricted by these limitations, the report identifies some major areas of potential difference in operational standards and thereby suggests possible fields for future research. It illustrates the difficulties that arise when attempting to identify the economic implications of farm level constraints for particular trading sectors. In considering the cumulative impact of these constraints for the competitiveness of EU farmers, or for a producer of a particular commodity, in the concluding chapter, the approach is necessarily qualitative.

1.3 Key issues

The form of standards and legislation affecting agriculture

The research has revealed the wide variation in the nature and status of the policy instruments, which impose constraints of different kinds on individual farmers, in the countries studied. In addition to the various forms of legislation and regulations, there are codes of

practice and guidelines, which are frequently not binding but may be widely adopted, as well as entirely voluntary schemes. In the domestic context, the main categories include:

- legislation and regulations imposing standards *directly* on farms, for example minimum standards for hygiene, animal welfare, the disposal of pesticides et cetera;
- legislation and regulations affecting the *availability* of certain products to the producer, such as pesticides, which will have cost implications;
- legislation and regulations, which impose obligations on farmers by affecting their practices *indirectly* (e.g. minimum standards for water quality which can be respected only by adhering to a limited range of farming activities);
- legislation establishing *procedures* such as controls on land use and the construction of buildings, consent procedures for removing landscape features, et cetera. The operation of these procedures imposes direct constraints upon producers but to a certain extent, each case is treated individually, making overall assessment of impacts very difficult;
- *codes of practice*, which may be entirely voluntary (e.g. organic production), quasi-legalistic or, in a few cases, binding. Such codes may not be mandatory in themselves but failure to comply with them may expose a producer to prosecution if pollution occurs, for example;
- *cross-compliance* measures which apply only to those producers receiving benefits under a public programme. Penalties for environmental infringements may be introduced through a reduction of direct payments;
- *voluntary standards initiated by public agencies* and promoted widely to producers;
- *voluntary standards developed by processors, retailers or other downstream markets*, which may affect a large proportion of producers and in some cases be 'quasi-obligatory', given market structures.

The existence of legislation and regulations promulgating standards needs to be interpreted in light of enforcement of those standards. Standards can be enforced in various ways, including peer pressure, civil litigation and criminal prosecution.

In addition to the main categories of standards and legislation in the domestic context, in an international context there are also examples of binding standards imposed by governments in importing countries which must be complied with in order to enter their markets, therefore overriding any domestic standards for certain producers. This is a particular consideration for major exporting countries targeting high-value markets, such as Australia and New Zealand. Importing country constraints are commonly binding for specific agricultural commodities. For example, domestic slaughtering and processing standards for sheepmeat in New Zealand might be lower than domestic production standards in the EU. In that case, New Zealand's lamb and mutton for export is already produced to EU standards, which makes it difficult to identify any clear competition effect.

The study focuses on standards relating to farm practice and process since they commonly translate into on-farm constraints; product standards will be covered to a limited extent only. While the agricultural products may be objectively identical, the process through which they were produced may vary greatly. In the main, hygiene requirements applying to the production of agricultural commodities (e.g. milk) specify product standards, such as the quality aspects of the produce. These are beyond the scope of this study.

However, to a lesser extent they may also include processing standards, for example hygiene requirements regarding the conditions in which commodities are produced and, to that extent, therefore, they must be considered as part of the assessment of competition effects. In effect they translate into on-farm operational constraints requiring action by farmers.

The categorisation of binding and non-binding instruments is developed further in later chapters of this synthesis report. In order to make a reasonable evaluation of environmental and health-related standards and their competition effects, it would be necessary for each country study to identify the full range of instruments influencing producers, however difficult it is to derive specific impacts at farm level. Also relevant are related issues, such as the extent to which binding obligations are, or are not, compensated by public subsidy.

The effects of standards on competitiveness

The report provides a qualitative assessment regarding the effects of environmental and health-related standards on the competitiveness of EU agriculture vis-à-vis the main competitors on the world market.

Regulation that internalises external costs, which may imply creating differences in the cost of primary production between areas that have external cost problems and those that do not, influence trade (relative to a situation where external costs are not internalised) but do not distort it. In theory, environmental and health legislation can influence international competition in agricultural products in several different ways (Bredahl et al., 1998):

- creating differences in the cost of primary production in different countries (e.g. due to requirements for housing, hygiene, input bans on restrictions and price effects such as taxes, et cetera). Such differences also include a forced shift in technology and constraints in production levels through upper limits in stocking density;
- affecting the cost and timeliness of delivery for different categories of producer (e.g. border inspections for phytosanitary purposes, which affect importers);
- altering the ability of products to meet consumer demand attributes (e.g. enabling producers to provide improved food safety characteristics because of tighter standards on carcinogenic pesticide residues). Meeting the consumer demand attributes also includes altering the ability of products to meet importing country requirements (e.g. banning the use of methyl bromide for fumigation of fruits, which may have been used in order to meet importing country restrictions on alien pests).

The analysis in this report has concentrated on the first category, i.e. the economic implications of compliance with on-farm constraints arising from environmental or human health-related standards. However, all three categories may be relevant to trade discussions.

The economic impact of compliance with constraints, and the implications for the relative competitiveness of EU agriculture, are examined by exploring the following questions:

- where do the main differences exist between EU and non-EU countries regarding on-farm constraints, derived from the environmental and health-related standards of EU agriculture?
- which product sectors are affected most in the EU, by the prevailing or upcoming standards? This examination covers the commodities selected for analysis.
- which sectors are the most important for the EU, in terms of international trade, either through export to non-EU countries or through import from non-EU countries? This question is important because the relative competitiveness of EU agriculture may be hardly affected if the main impact of different constraints falls upon sectors whose existing or potential importance for international trade is only marginal.

The analysis is primarily from a European Union perspective, trying to identify which differences are likely to affect EU producers most in which sectors. It mainly considers sectors that are trade relevant, with special focus on countries where both the EU and non-EU countries have their export markets. This may include trade in both raw commodities and those which are processed before being exported. Cross-continental trade in eggs, for example, is not significant in economic terms. Any possible differences in housing standards for laying hens, between the countries studied, measures may therefore have limited impact on the relative competitiveness of EU farmers. The export of processed commodities however may be significant on the international market, and costs of processed commodities are also affected by production costs of raw commodities.

2. Comparison of environmental and health-related issues and legislation

Background

In all of the countries considered in this study, public policies affecting agriculture largely focused on the economic development of the agricultural sector until the early 1970s, while the environmental consequences of agricultural development and production received relatively limited attention. Some policies were implemented in particular countries to conserve water and soil resources (e.g. the 1941 Soil Conservation and Rivers Control Act in New Zealand), but these were mainly designed to preserve the productive potential of farmland as a largely economic consideration. Most environmental policies that apply to agriculture have been developed in the past 20-30 years.

Human health has long been a consideration in legislation to secure the quality of food but, until relatively recently, the economic development of agriculture was usually seen as highly beneficial for human health. It is arguably only within recent decades that health concerns have led to the imposition of strict standards upon modern production systems. Animal welfare issues only entered the policy agenda since the late 1980s in most of the countries.

Today, regional and local governments have in place a wide range of standards, codes of practice and other policy measures designed to control pollution, protect environmental resources and avoid significant risks to human health from modern agricultural systems. The agricultural sector, local communities and environmental organisations also have become increasingly involved in environmental management initiatives during the past few decades.

The development of environmental and human health-related policies for agriculture in the EU and non-EU countries has generally progressed through stages. To begin with, measures tended to concentrate upon waste-treatment processes and end-of-pipe measures, treating individual environmental and health problems where they arose, rather than seeking to prevent them. However, there has been a gradual evolution towards policies setting minimum environmental, health and welfare performance standards (e.g. maximum concentrations of pollutants, often expressed as parts per million) and taking more preventive measures to reduce pollution or enhance positive outcomes at source. Finally, there has been growing interest over the past decade or so, in market-linked mechanisms for promoting positive environmental action, either through public intervention to create markets for environmental services, or through labelling and other commercially-driven schemes linking environmental, health and welfare attributes in sales and marketing promotions.

Methodology

The main objective of this chapter is to identify the main differences regarding environmental and health-related issues and basic features of legislation in the EU and non-EU countries. A comparison of issues across countries is an essential part of understanding the context of any constraints imposed upon farmers. Unless this is done, it is possible that the findings of the analysis might be misinterpreted.

For example, if a country has no policies to restrict nitrogen use this might be completely appropriate, if:

- current nitrogen application rates are low;
- there is no evidence of water contamination or other pollution by nitrates from agricultural sources;
- the public in that country is willing to accept a certain level of pollution that another will not.

As noted in chapter 1, such contextual information is relevant in trying to answer the key questions of the study, i.e. whether environmental and health related standards imposed on agriculture in the EU are higher or lower than in those of the other countries under consideration? Standards may appear to distort competitiveness in case relative case prices do not reflect properly scarcity or - in the case of public goods - social costs. However, higher standards in one country that are imposed to combat more serious externality problems that exist in that country relative to a trading partner do not generate distortion of competition effects.

2.1 Comparison of environmental and health-related issues

After an initial survey of current issues in the five countries, seven themes were selected for inclusion in the analysis, covering a broad range of individual issues:

- Water quality (notably nutrient enrichment by nitrates and phosphate, sediments, pesticides) and quantity (irrigation);
- Soil quality (notably salinisation and soil contamination) and soil erosion;
- Air quality (notably odour and noise, ammonia, pesticide drift and crop burning);
- Biodiversity and landscape;
- Genetically modified organisms;
- Animal welfare (notably housing, transport and slaughter);
- Human health (notably hormones and animal feed ingredients, pesticide residues in food, applicator safety, hygiene rules for dairy farming and veterinary requirements).

An overview of the main environmental and health-related issues of concern is provided in the following.

2.1.1 Water quality and quantity

Nutrient enrichment by nitrates and phosphates

European Union

This is a high priority issue for the EU, since contamination of both ground and surface waters and soils is a serious problem in parts of the European Union. Linkages between farming management practices and leaching of nitrates are highly complex and subject to large variations, depending inter alia on soil types, climatic conditions and farming practices. Model calculations indicate that the maximum admissible concentration of nitrates for drinking water - 50 mg per litre, following the standards of the World Health Organisation (WHO) - are exceeded on about 20% of the agricultural land (Stanners and Bourdeau, 1995). Contamination occurs particularly in regions where there are concentrations of intensive livestock production (mainly pigs and poultry) or large areas of specialised crop farms (including intensive horticulture). Affected regions include parts of Belgium, Denmark, France, Germany, northern Italy, the Netherlands, coastal Spain, and the UK. In these areas, heavy nitrate and phosphate loading of soils is common and this can lead to significant water pollution problems. The main causes include high production levels and use of manure and chemical fertilisers. Nitrate pollution of surface waters is highest in the northern part of Western Europe, where much intensive agriculture is concentrated. Excess phosphate from manure is also leading to eutrophication problems in some Member States, including pollution along the Baltic coast and part of the Adriatic Sea. The Nitrate Directive provides an EU framework for controlling pollution, with potentially significant constraints on farmers in 'Nitrate Vulnerable Zones' which cover sizeable land areas.

USA

The quality of surface water for recreational purposes is an issue of concern. Around 70% of cropland is in watersheds where at least one agricultural pollutant is harmful to the quality of these waters for recreational purposes or to ecosystems. In addition, contamination of groundwater sources of drinking water is an issue of concern, with nitrates from fertilisers and livestock manure causing serious problems.

Nutrient enrichment can be found in most states. The problems are both regional and local in character. In two high profile cases, it is clearly a regional concern. The federal government and states surrounding the Chesapeake Bay have undertaken a massive program (albeit mostly voluntary to date) to reduce nutrient pollution in the Bay, about one third of which has attributed to agricultural sources, cropland runoff and animal manure. Although there is no formal initiative yet, a similar approach could easily be adopted to attack the 'Dead Zone' problems in the Gulf of Mexico, for which nutrient losses from agriculture have been heavily implicated. In other cases, nutrient pollution is largely a local concern with excessive concentrations in certain lakes, rivers and wells, such as in Nebraska. Even there, the problems were so widespread, that they passed a state law that enables local implementation. The Nebraska actions were triggered by concentrations of nitrates greater than the WHO standard in groundwater used for drinking water sources.

Canada

Nitrate contamination of groundwater resources, used for drinking water purposes, is identified as a regionally important environmental issue. It also is important from a human health perspective, since in most rural areas, households rely on groundwater almost exclusively for drinking water. Bacterial and nitrate contamination has been detected mainly in areas with intensive potato growing and near livestock and horticultural farms in some regions. Bacterial contamination seems to be the most important ground and surface water quality issue for agriculture in this country, and this has often been attributed to inadequate well construction or maintenance.

Australia

The health risks to humans and livestock related to the quality of drinking water are either not present or extremely rare. However, farming-related eutrophication of inland and coastal waters is an important issue. Agricultural use of superphosphate fertiliser was identified as the primary source of toxic blue-green algae bloom during the summer of 1991 in some major basin areas, requiring the closure of water supplies and largely affecting local communities.

New Zealand

Nitrates are causing concern in the lowland river systems regions of the country. There is evidence of nitrate levels in shallow bores in regions such as Southland, Canterbury, Manawatu and Waikato. About 20% of the shallow bores used for drinking water exceed the drinking water standards of 50 mg per litre. However, these groundwater resources are not intended for drinking water purposes, and the problem still remains rather localised. Water streams receiving discharge from dairy and pigs may not be safe for stock watering. The dairy industry is intensifying to 2-3 livestock units per hectare of land, and land conversion to dairy farming is an important factor to the slowly increasing pressure on the environment. The use of fertilisers also increased in recent years. New Zealand's production systems, however, are generally different from those in the EU with livestock being outside on clover based pastures, which experience grass growth all year round. These soils and pastures are in many cases able to absorb and recycle the nutrients applied from livestock manure and the application of fertilisers.

Conclusion

Compared to non-EU countries, eutrophication in the EU is more of a widespread concern in relation to agriculture. It is an issue at the local level in the non-EU countries. Nutrient contamination of water by agriculture is a high priority issue for the EU and the *USA*, and both have substantive policy programmes in place. The problem of nitrogen leaching is very much related to the intensity of agriculture, as well as climate, geography and water demand, and supply characteristics. Nitrate levels in drinking water in the EU are still above the EU limit in a significant number of areas, which is partly due to the intensity of the operations (i.e. high rates of fertiliser application and high livestock stocking densities) and the density of population. Similar policy objectives exist in all the countries in relation to nitrate levels in drinking water, based on WHO standards. The EU tends to be more interventionist than elsewhere, in relation to policies specifically for agriculture, affecting

drinking water quality and has established a rather comprehensive 'nitrates Directive'. In the USA regulation is used selectively by the federal government and most states; mostly for large point source emitters. Although this is now changing, the medium and small farmers have been largely exempted from water pollution regulation up to now.

Sediments in water

European Union

Sediments are an issue at the regional scale particularly in some regions of southern Europe where the most severe cases of water erosion in recent years have led to water pollution by sediments, leading to flooding and damage to houses and infrastructure.

USA

Cropland cultivation, irrigation and grazing can cause excessive soil erosion and deliver sediments to surface waters. Sediment is an issue of concern mainly in regions with cropland erosion. Soil erosion and delivered sediment levels have tended downwards since the 1980s, primarily because of increased use of conservation tillage, and due to temporary land retirements under the Conservation Reserve Program. Sediment from agriculture operations has been estimated to cause significant economic damage, which are mainly felt by off-farm parties (including sediments delivered to rivers, lakes and other surface water bodies).

Canada

Sediments from soil erosion are an issue of mainly regional concern in Canada. Sediment deposition was identified as an important surface water quality issue in the Grand and Thames river watersheds in the 1970's and 1980's. These rivers drain what is arguably the most diverse and intensively cultivated agricultural region in Canada. Considerable progress in improving water quality in these watersheds in south-western Ontario has been made over the last 25 years. Installation of vegetative buffer strips between agricultural operations and waterways as well as limiting access of livestock to stream and river banks along with increased use of reduced tillage practices have been instrumental in this process. These measures have been largely adopted voluntarily by producers in the region. However, some technical assistance has been made available through the provincial agricultural extension service.

Australia

While soil erosion is an ongoing problem in most agricultural zones, sediments in water tend to be localised, e.g. around urban reservoirs.

New Zealand

A substantial part of the land area of New Zealand is prone to erosion; hence sediment is an issue of concern in terms of soil conservation, water quality and flood control. Sedimentation of eroded material has changed habitats of in-stream fauna, affected water quality and has raised riverbeds, leading to increased flooding. However, the removal of deep-rooted vegetation from hillsides and riverbanks is a main reason for sedimentation of

eroded material, rather than agricultural practices *per se*. Concerns on vegetation clearance only are affected by agriculture in an indirect manner, through rules regarding line clearance by bulldozers for fences or planting.

Conclusion

Sediment loading of fresh water is a major issue in several countries, but of more limited regional concern in the EU. The reasons appear to be related at least partly to differences in the environmental context of agriculture, but there are also cultural factors involved as well. Large reservoirs of relatively marginal land in the USA and Australia have historically tended to move in or out of production in response to economic conditions. Many of these soils are relatively prone to erosion, with sediments potentially contaminating watercourses on a large scale. In the EU, the nature of this problem differs greatly between regions and there are undoubtedly serious issues in some areas, particularly in southern Member States and in the East German Länder. However, the issue has received relatively little policy attention in Europe, up to now. By contrast, in the USA, soil erosion, sediment and related problems have been the dominant conservation and environmental issue for agriculture since the 1930s and remain serious problems in many regions.

Pesticides

Water quality concerns related to the use of pesticides are closely connected to other issues involving pesticides, including pesticide drift, affecting air quality and biodiversity, and human health concerns arising from pesticide uses and residues in food. It was decided to treat these issues together, because they are all related to the usage of pesticides in agriculture.

European Union

The health and environmental impact of pesticide use is a continuing concern and a range of measures at EU and national scale reflect the high priority it is given. Pesticides may cause contamination of groundwater resources and surface water across the EU by leaching, run-off and spray drift. Utilisation of pesticides varies greatly within the EU. High levels of pesticides are observed mainly in areas with intensive horticulture, permanent crops and arable farming - including forage maize cropping on livestock farms. Monitoring frequently reveals levels exceeding the very strict standard of 0.1 micrograms per litre (the EU standard) in between 5 and 25% of the samples taken in regions with intensive arable production and horticulture, including part of northern France and southern England. As a result, drinking water samples may exceed EU limits for commonly used pesticides such as atrazine.

Pesticide drift is a particular problem at the regional and local scale. Impacts of pesticide use on biodiversity and the quality of watercourses are widespread and probably are a significant factor in the decline of many species. In addition, health and safety aspects of pesticide application are a concern for farmers and workers applying pesticides in some regions. As in other countries, there are limits on residue levels in food. Interest in organic farming is going rapidly in the EU, partly because of pesticide concern.

USA

Human health concerns related to the usage of pesticides and subsequent residues in food, are high priority issues. There is growing evidence of pesticides in groundwater. Atrazine is the most frequently detected compound, widely applied on maize. The concentration of individual pesticides is substantially below drinking water standards, but the co-occurrence of multiple pesticides is common. Potential harmful effects on the quality of water related to pesticide drift, and safety measures related to usage of pesticides are also an issue of concern.

Canada

Water quality problems related to the use of pesticides (including pesticide drift) are an issue of concern in Canada. However, the detection of pesticides in groundwater resources remains rather local, and there appears to be less evidence of contamination than in the USA. Atrazine is the most common pesticide detected in groundwater. Pesticide contamination of surface waters, potentially harmful to ecosystems is also observed in some regions.

Australia

The quality of drinking water in relation to pesticide use is not an issue of concern in Australia, and human health risks related to the use of pesticides remain limited. However, air quality problems associated with pesticide drift are an important problem in Australia, where large-scale aerial spraying is common. Pesticide spraying has potentially harmful effects on the environment because a large proportion of fruit and vegetable production occurs near rivers or along the coast.

New Zealand

Pesticide levels in groundwater are not a major issue in New Zealand. Triazines are the pesticides, which are most commonly detected in groundwater wells, but at very low levels.

Conclusion

Water quality problems tend to cause some serious concern in each of the countries analysed, although much less in New Zealand than elsewhere. Residues of pesticide in drinking water potentially are a major human health issue in the EU and USA. There are similar but less pronounced concerns in Canada and fewer in New Zealand, while in Australia the primary issues are associated with aerial spraying and surface water contamination. Although they vary in intensity, there are a large number of other pesticides-related concerns in all five countries, including spray drift, and direct impacts on human health and biodiversity. It is therefore unsurprising to find that all five tend to monitor and report on a similar range of issues in relation to the impacts of pesticide use.

Irrigation

Irrigation has emerged as an environmental issue of growing importance in recent years in a significant number of countries. Excessive abstraction of groundwater, depleting re-

sources and adversely affecting ecosystems is a widespread concern but there is a range of other issues, including salinisation, increased use of agrochemicals, enhanced pollution risks, losing biodiversity, et cetera. As with pesticides the issues are clearly linked to the practice of irrigation however diverse the local impacts.

European Union

EU countries, on average, abstract around 21% of their renewable water resources, which is regarded as a sustainable position (EEA, 1999). A growing area of farmland in Europe is irrigated, accounting for about a quarter of the water abstracted, but agriculture is the single most significant user of water in some southern Member States, particularly where horticulture has intensified. Water availability problems occur mainly at local and regional scales. The majority of irrigated farmland is in Southern Europe, with over 3 million ha in Spain and around 1.5 million ha in Greece. Water stress occurs when the demand for water exceeds the available amount during part of the year or when water quality is insufficient to meet demands. More than half of total water abstractions in Greece and Spain are for irrigation purposes (Redaud, 1998). The extraction of water from very limited groundwater supplies is an issue of concern as it can occur at unsustainable levels, may lower the water table and can affect wetlands adversely. This applies particularly to the coastal strips of southern Europe, subject to intensive cropping as well as several other parts of the EU where water for irrigation purposes is primarily drawn from groundwater reserves. Salinisation of water supplies is an important regional issue in several areas, where salts are either drawn in from nearby seawaters, or dissolved from newly exposed soil strata.

USA

The quantity of water used by agriculture is an issue of growing concern in the USA. The effects range from diminished instream flows for threatened or endangered species to high rates of withdrawal from groundwater aquifers. Irrigation water mainly originates from surface water and is supplemented with more expensive groundwater during periods of drought. Problems relating to overuse of water for agriculture are particularly serious in a few regions, e.g. California, the southern Plains' Ogallala aquifer area, and Florida.

Canada

Water is seasonally abundant in eastern Canada and scarce in parts of the prairie provinces. Irrigation primarily is an issue related to the quality of groundwater resources and surface water. The combination of manure application and irrigation is an issue of concern to the available drinking water resources. Also, irrigation may affect water quality because of the leaching of pesticides. Water quantity is important in the more arid regions of the country, especially Saskatchewan and southern Alberta. Reservoir construction for irrigation is an important issue for instream flows. The extraction of groundwater has been less controversial than in the USA, although it is becoming more important in the arid regions of Canada.

Australia

The extraction of too much water for irrigation is a major issue of concern, with high priority in Australia. Agriculture is the largest sectoral water user, consuming 70% of the country's stored water, including groundwater. About 12% of the total area of crops and pastures is irrigated, which is equivalent to 2.5 million ha. It is harmful to aquatic ecosystems, water quality and reduces the availability of groundwater resources. Natural patterns of river flows are inverted due to high water extraction for irrigation in periods of water shortage and low demands in winter.

New Zealand

The extraction of water for irrigation is a significant issue in some regions. The issue is mainly one of conflict between water for recreation, habitat protection and irrigation. The greater value of in-stream waters has reduced water available for agriculture. Water demand by agriculture is highest during summer months when river flows and groundwater levels are at their lowest. The issue will attract increasing priority due to the recent droughts. Agriculture's water demand for irrigation and livestock consumption is nearly 70% of total water extraction, also showing large regional variation.

Conclusion

Irrigation accounts for a major share of water use in most countries and excessive groundwater extraction levels cause concern in several regions in the EU, Australia and the USA. Limitations on the availability of water are a major concern in Australia, and to a lesser extent also in New Zealand, while the issue is not of major concern in Canada. Institutional management systems for irrigation water commonly only consider the costs of access and delivery, but not the opportunity costs of water, which generally include diminished supplies for other users, such as recreation, fishing or urban settlements. This can divert water of agriculture at the expense of other more high valued water uses, encouraging more use of irrigation water than would otherwise be the case.

2.1.2 Soil quality and soil erosion

Salinisation

European Union

Salt intrusion is an issue of concern in a relatively limited number of regions in the EU, mainly the south, especially in Spain. Salinisation is particularly associated with irrigation, e.g. along the Mediterranean coastline, but also occurs in some drained areas in northern Member States, which use seasonal groundwater irrigation for the production of arable and horticultural crops. It is not a major concern at the EU level.

USA

The excessive accumulation of salt is an issue of concern, with at least moderate potential for salinity problems occurring mainly in the western part of the country. However, salinity problems are mostly local in nature.

Canada

Salinity is an issue in the drier regions of Canada, especially Saskatchewan.

Australia

Salinisation of inland and coastal waters, in some areas related to irrigation, is an important issue in Australia. Dryland salinity has emerged as a significant problem in many parts of the country. Estimates suggest that 2.5 million hectares are subject to dryland salinity, mostly due to land clearing practices that replace deep rooted vegetation with shallow rooted crops. The clearing of trees, shrubs and deep-rooted perennial grasses has enabled higher rainfall infiltration rates and a rise in groundwater levels. Salinisation also occurs in areas where irrigation has led to rising groundwater levels. In many of Australia's gravity fed irrigation areas (especially where tree clearing has taken place), irrigation water drains through the soil, adding to the local water table causing it to rise.

New Zealand

Salinisation has not emerged as an issue of concern related to agriculture.

Conclusion

Salinisation is mainly an issue in the drier regions of the countries studied, usually associated with irrigation, as discussed in the previous section. It is a major problem with high priority for policy in Australia. The information available indicates more local salinisation problems in the EU, USA and Canada. It is no issue of concern related to agriculture in New Zealand.

Soil contamination and acidification

European Union

Contamination of agricultural soils by heavy metals and pesticides is an issue in the European Union, as is the diminishing organic content of soils. Soil contamination arises from different sources, including sewage sludge, pesticides and agricultural wastes. The use of sewage sludge has led to some significant incidences of soil contamination in particular regions, particularly in East Germany. There are limit values set for concentrations of a series of heavy metals. These apply to the soil itself, to sludge used in agriculture and to the amounts of sludge which may be applied annually to farmland, based on a ten-year average. Acidification is a concern in certain regions with vulnerable soils including parts of Scandinavia, but most of acid deposition is industrial or urban in origin. Emissions of all gases contributing to acidification are projected to go down. This should lead to improvements of soil quality. The relative contribution of agriculture to these emissions may increase, however, because of the difficulty to reduce the emissions of ammonia, relative to the emissions from industrial and urban sources.

USA

Concern in the US regarding contamination of agricultural soils mainly relates to the application of sewage sludge. An issue of some concern relates to chemicals and metals in the sewage, and the cumulative chemical loading applied on the land surface.

Canada

Soil contamination from sewage sludge is of limited concern.

Australia

Soil acidification is an issue of concern in Australia, causing nutritional disorders in plants as some elements (e.g. aluminium) become available to plant roots in toxic quantities, while other trace elements essential for plant growth become unavailable. Estimates suggest that around 29 million ha are affected by induced acidity. Liming is the main measure applied to redress soil acidity. The accumulation of cadmium in soils is an issue, primarily as a result of high Cadmium residues in superphosphate fertilisers.

New Zealand

Soil acidification is a potential issue of concern in New Zealand with the main focus of concern for human and animal health. However, hard evidence is not available because national trends in soil acidity have not been monitored. Similarly, soil contamination by hazardous chemicals, residues and waste products is something New Zealand has only recently begun to address with industrial sites and landfills.

Conclusion

Soil contamination by heavy metals is at least of some local concern in the five countries. Soil contamination is mainly concerned with heavy metals in the soils. The application of sewage sludge is an important source of heavy metals in the EU and the USA. Cadmium in phosphate fertilisers is an issue in Canada and Australia. Soil acidification is an issue of concern in the EU, Australia and New Zealand, occurring on a large scale in Australia.

Soil erosion

European Union

In contrast to other major agricultural regions of the world, soil erosion is not a significant problem for the EU as a whole, partly because so much of its farmland is under pasture, and partly because of its stable soils, generally temperate climate and long history of agricultural use. However, soil erosion may be increasing across the EU and the problem is greatest in the Mediterranean regions, in several of which it is a severe environmental concern. The most severe cases of water erosion in recent years have been confined to restricted areas, including parts of Italy and Spain, but have led to water pollution, flooding and slides, and damage to houses and infrastructure. Particularly in hilly drier Mediterranean zones, erosion is commonly associated with desertification or the abandonment of land and vegetation management caused by agricultural decline. Soil erosion is linked in part to crop rotations without green cover crops during the winter period, substitution of traditional arable fodder crops by maize for silage and farming of uncultivated land.

USA

Cropland and pasture erosion problems are serious issues in certain areas and have a high priority in policy. The areas most susceptible to erosion damage are in the Great Plains, Corn Belt and Mississippi River Valley regions. Total erosion however showed a declining

trend, and soil erosion rates fell by about one-third from the mid-1980s to the mid-1990s. Still, the problems are serious in many areas, and there is concern that the decline has stopped or reversed. Conservation tillage use has levelled off and 2 million hectares of croplands temporarily retired in the Conservation Reserve Program have returned to production in the 1990s.

Canada

Soil erosion from cropland and the subsequent off-site water quality degradation is an issue of concern regionally in Canada. Some cost-sharing regional programs have been initiated between governments and producers to address diffuse surface water quality problems from off-site erosion. The on-farm productivity effects of erosion attracted considerable attention in Canada in the 1980's in the aftermath of a widely read report from the Federal Senate Committee on Agriculture. That report concluded that soil erosion was having a substantial and adverse effect on farm incomes in Canada. Subsequent analysis, however, largely discredited the conclusions of this report. There is presently no evidence that the on-farm productivity effects of erosion are a significant problem at the national level in Canada.

Australia

Land degradation and water mismanagement are considered the most serious problems affecting the terrestrial environment of Australia. Soil erosion is a major issue of concern and a high priority in the country. Around 20% of the soils are considered to be highly prone to erosion and more than half of the remainder of the territory is moderately prone to erosion.

New Zealand

Soil erosion is probably the most serious and least reversible form of land degradation in New Zealand. There are sizeable concerns in the majority of hill country farmland. Some 80% of hill country farmland need soil erosion control measures. Surveys indicate that the majority of the erodible hill country farmland is not treated in an adequate manner. Soils are also degraded by nutrient depletion, by the loss of organic matter and compaction.

Conclusion

The scale and severity of erosion varies not only with the type of agriculture, but also to local climatic conditions and soil properties. Soil erosion by both wind and water has been a significant policy concern in the USA for many decades, primarily because of off-farm effects, and similar issues are faced in the arable plains of the Canadian wheat belt. Water related erosion problems are of major concern with high priority in policy in Australia and New Zealand. By contrast, these issues are increasingly recognised as a concern in some regions of the EU but as yet controls in most areas are relatively weak.

2.1.3 Air quality

Odour and noise (nuisance)

European Union

Odour and noise are issues of major concern as a source of nuisance at the local level, mainly in regions with intensive livestock production units. The policy response is also local and varies considerably within the EU.

USA

Odour and air quality problems from agriculture are mostly localised, but significant concerns, often associated with the use of anaerobic lagoons. The exposure of people to odour from pig farms, for example, has caused human health problems, and is rising in importance at the local level. It is a serious issue for residents living where the industry is concentrated. The issue that draws most public attention at the national level is the periodic spills and water pollution from concentrated livestock operations.

Canada

Odour problems associated with intensive livestock production units have given rise to significant concern, albeit mostly at the municipal level. It has a high priority in the context of policy.

Australia

Air quality issues associated with odour and noise are not major concerns in Australia.

New Zealand

Air quality issues associated with odour and noise are not major concerns in New Zealand.

Conclusion

Air quality problems related to noise and odour from livestock mainly are an issue of concern for production systems near urban settlements and may attract considerable public attention in certain localities. Local governments are usually responsible for the policy response. Less populated regions of the world enjoy a comparative advantage in certain forms of livestock production. It is identified as a problem at regional and municipal level in the EU, USA and Canada, but not in Australia and New Zealand.

Ammonia

European Union

Ammonia is an issue of significant concern mainly in regions with a high concentration of intensive livestock production units, such as the Netherlands. Well over 90% of total EU emissions of ammonia and the subsequent acid deposition originate from agricultural activities. Soils, water and vegetation can all be affected adversely by acid deposition.

USA

Ammonia is not an issue of concern in the USA, except in isolated local areas where intensive livestock (e.g. chicken) waste is close to populated areas.

Canada

Ammonia is an issue of concern in Canada, but as an odour problem.

Australia

Air quality problems associated with ammonia are not an issue of concern in Australia.

New Zealand

Air quality problems associated with ammonia are not an issue of concern in New Zealand.

Conclusion

Emissions of ammonia are more of a concern in the EU than elsewhere, although only in specific regions where intensive livestock production is concentrated.

Crop burning

European Union

Burning of crop residues such as straw remains an issue in parts of the European Union, but is no longer practised in several Member States such as Germany and the UK, due to national legislation. However, elsewhere it can be a widespread practice because of farm specialisation and it can still cause significant nuisance to nearby settlements. It is not a significant issue on the EU scale.

USA

Local air quality problems that arise from the burning of crops are an issue in the USA, but not of significant concern. Burning can cause acute problems in some areas, if practised nearby settlements and heavily travelled roads. The US has phased out much crop burning where it was a problem, for example for grass straw in Oregon and rice straw in California.

Canada

Air quality problems, associated with crop burning, are not an issue in Canada, because this practice has largely been phased out. The main activity was burning excess straw from small grain production on the prairies. But a combination of change to reduced tillage, as well as local air quality concerns has caused this practice to be largely phased out. The practice has been essentially abandoned in eastern Canada and is being regulated out of existence in the west. Surplus straw is spread out over fields at harvest using a straw spreader attachment on the back of the combine harvester.

Australia

Air quality problems associated with crop burning are not an issue of concern in Australia.

New Zealand

Air quality problems associated with crop burning are not an issue of concern in New Zealand.

Conclusion

Air quality problems related to the burning of crop residues have been a general problem in parts of the EU, USA and Canada. Due to legislation in the USA, Canada and several Member States in the EU it is not of significant widespread concern in any of the countries studied.

2.1.4 Nature conservation, biodiversity and landscape

European Union

The loss of biodiversity and cultural landscapes are issues of major significance in the European Union, and a high priority for policy. A high proportion of flora and fauna depend upon semi-natural habitats and mosaics of farmed and forested land cover. More than a third of bird species are in decline, mainly due to habitat degeneration and land use changes caused by agricultural intensification. In Europe, many of the most valuable areas for wildlife and landscapes are those which have been settled and farmed many centuries, in which species have co-evolved with traditional agricultural management and where landscapes are dependent on regular management for their variety and interest. Marginalisation and abandonment also are a problem in some regions. Losses of biodiversity and landscape quality have also been widespread because of the removal of landscape features, loss of permanent grassland and destruction of other semi-natural habitats, as well as agricultural intensification on production farmland. The policy response is divided between the EU, national and more local levels.

USA

The loss of biodiversity is an issue of significant concern in the USA, especially in grassland areas. At least 55 species of grassland wildlife are listed as threatened with extinction, and 728 more are candidates for listing. Several factors contribute to the loss of biodiversity. The conversion of grasslands and wetlands to cropland, increased field size, reduced crop rotations and increased fertiliser and pesticides use have together contributed to threats to the status of several species. The Endangered Species Act (ESA) is the piece of national legislation that holds the most potential to constrain on-farm production activities. Farmers are not compensated for income losses they face, but ways to provide compensation in the future are being discussed. The protection of farmed landscapes is only a significant issue with respect to the control of urban development.

Canada

Rural landscapes are not the main priority. The loss of biodiversity is an issue, but not of major concern for Canada. The protection of wildlife habitat, including wetlands for the protection of endangered species and to provide habitat for game species are the main policy issues. There is currently no federal endangered species statute in Canada, although a Bill was introduced in 1996 and discussions on new legislative proposals are taking place

at cabinet level. Provincial policies are addressing this issue through expansions of the network of parks and protected wilderness areas. Given the location of these preserves, the impact on agriculture is limited.

Protection of agro-ecosystems, among others, has been identified as priority area in the Agriculture and Agri-food Canada action plan.

Australia

Reduction in biodiversity is a major issue with high priority. However, the reduction of biodiversity that has occurred is largely due to destruction or disturbance of natural habitats and the introduction of non-native species of plants and animals for use in agriculture. Agricultural pressures which have induced the reduction of biodiversity, include grazing, land clearing and irrigation. The protection of agricultural landscapes is less of a concern.

New Zealand

A great loss of biodiversity has been experienced through habitat conversion, fragmentation and destruction and through introduced weeds and pests. Many plant and animal species are now endangered. Biodiversity preservation is a major issue with high priority in policy debates. Much remaining native vegetation is on private land and great efforts (voluntary and some regulatory) are made to preserve this. Controls on widespread clearance of native vegetation, the expansion of national parks and reserves, and a significant amount of control of plant and animal pests have halted the rapid decline experienced in previous decades. Farm landscapes are much less of a concern.

Conclusion

The loss of biodiversity is a sensitive on-farm issue in the EU, which differs from the other countries because of the small proportion of natural habitat and dependence of many species on land managed for agriculture. In North America, by contrast wilderness preservation is the predominant concern. Farming systems in Europe are important for landscape maintenance and voluntary incentives are offered to fund specific land management practices needed for landscape, biodiversity and general environmental objectives. Farmers often live in cultural landscapes, which require management and protection, thus limiting the acceptability of certain production system and priorities. The combination of biodiversity and landscape is a major issue with high priority for policy in most of the EU, and on a lesser scale to Australia and New Zealand. Biodiversity rather than landscape is of significant concern in the USA, with regional impacts, but not an issue of major concern in Canada.

2.1.5 Genetically modified organisms (GMOs)

European Union

There are currently widespread public concerns in many countries in Europe about the potential risks to human health and to the environment that may be posed by the production and consumption of genetically modified food products. Public concerns on GMOs have gained importance recently, following widespread publicity, because of food safety, environmental sustainability and ethical aspects related to the production methods applied

(Blandford and Fulponi, 1999). Consumers, for example, have complained that genetically modified products have been forced upon them and that the labelling is not transparent. In the case of human health, recent papers by scientists have offered conflicting assessments about the potential risk in relation to the environment. It is a fast moving major debate, with key measures adopted at the EU level, but important variations between countries. As a result of all these concerns, adoption of the technology is currently minimal and likely to remain so for several years. Some 2,000 hectares of *Bt* maize is presently under production in France. By the end of October 1998, in total some 30 GM crops were approved or awaiting approval for commercial release in the EC. The development of the commercial use of GM crops in the EU remains less than 0.1% of total land used to grow these crops, and the approval of new GM varieties has currently been stalled by a decision by EU environment Ministers to revise the procedures. Some Member States have now signalled their domestic concern to restrict any further use of GMOs by refusing to authorise products already approved at EU level, and legal action is currently being taken against them by the Commission. In other Member States, testing is underway to determine the environmental impacts of crops for which approval has been sought by the manufacturers.

USA

There are some scientific and public concerns about the environmental risks involved with using biotechnology. However, these have not yet affected adoption of the technology by farmers. In fact, biotechnology crops have been adopted more rapidly than any previous agricultural technology. The most important transgenic crop in terms of percentage of production (in 1998) is cotton, with 44% of total hectares planted, followed by soybeans at 38%, and corn at 24%. For other crops, the use of transgenic material is still limited to less than 4%. The most important transgenic crop in terms of percentage of production is cotton, with 44% of hectares planted, followed by soybeans at 38%, and corn at 24%. For other crops, the use of transgenic material is still limited to less than 4%.

Canada

Trends in Canada with respect to the adoption of GMOs in crops are similar to those in the USA. Like the USA, the main concern seems to be access to the European market. Trace-back and genetic marking procedures are under development to identify non-GMO products for export purposes. Recent observations suggest that market penetration by GMOs may be weakening as concerns about access to export markets and about domestic consumer reactions intensify.

Australia

There is concern over the release of GMOs to the farmed environment. In particular, the concern relates to the environmental risks associated with herbicide-resistant genes from transgenic herbicide-resistant crops escaping into weedy relatives. In addition, herbicide resistant crops allow for more herbicides to be applied in order to kill weeds without hurting the crop. Thus, the concern is over greater use of herbicides. Adoption of GMO technologies is progressing slowly. An estimated 85,000 ha were planted to *Bt* cotton in 1998, compared with 60,000 ha in 1997 and 30,000 ha in 1996.

New Zealand

Genetically modified organisms are a major issue of societal concern, with consumer resistance with regard to the application and acceptance of gene technology. Adoption is therefore not taking place.

Conclusion

This is a new and fast moving issue of major debate. The technology and its application is most advanced in the USA and Canada, with lower uptake in Australia, little in the EU and almost nil in New Zealand. The reasons for differences appear to be related more to consumer and environmental attitudes and awareness of potential risks than to biophysical differences between the countries.

2.1.6 Animal welfare

The main animal welfare concerns relate to the treatment of farm animals during housing, transport and slaughter. Legislation and other measures typically aim to ensure that the treatment of animals meets certain standards of animal husbandry, including freedom from unnecessary suffering or abuse.

European Union

Public concerns about the potential animal welfare issues surrounding modern production systems are widespread and have increased over time in many Member States. These tend to be strongest in the north of Europe, and particularly in those countries with higher levels of income per head, but they are increasing throughout the EU. Animal welfare concerns presently affect many aspects of production, and, inter alia, focus on:

- animal stress and increased disease incidence related to confinement and high-density stocking and rapid growth rates of intensive livestock production (poultry, pigs and veal); and
- stress that is caused to animals during long-distance transport to slaughterhouses, and the treatment of animals at slaughter.

Public concerns on farm animal welfare are expressed most powerfully in the United Kingdom, exemplified by wide protests against the live export of animals. There is an increasing demand for free-range meat in several EU countries. Farm animal welfare standards are being tightened by legislation at EU and national level.

USA

Animal welfare is less of a public-policy issue in the US than in Europe and many other countries. Mistreatment of animals engenders public reaction, but sustained public interest in altering common husbandry practice remains mostly a local issue in selected areas.

Canada

Abusive treatment of animals is an issue of some public concern in Canada. Farm animal welfare, however, is not an issue of major concern.

Australia

Farm animal welfare issues are of some concern in Australia. They include surgical husbandry procedures without anaesthetics, problems of handling, including round up, and the consequences of drought, bushfire and poor shelter. Abattoirs are usually located on the coast, making livestock transport problems such as prolonged journey time and distances inevitable.

New Zealand

Animal welfare issues are of some concern in New Zealand, and focus on cruelty to animals. Concern, however, is limited to issues such as the provision of farm shelterbelts to protect animals, early lambing and shearing, stressful transport in lorries and on ships and the use of certain housing systems.

Conclusion

Animal welfare issues related to housing, transport and slaughter are a major public concern with high priority for policy in the EU. For example, battery cage size for laying hens is a perpetual issue. There is no broad public concern that animals are generally abused in agriculture in the USA and Canada, but certain specific issues are of concern in Australia and New Zealand.

2.1.7 Human health

Hormones and animal feed ingredients

European Union

In addition to the environmental concerns associated with farming systems, there has been an increasing range of public concerns in the EU, primarily regarding the risks to human health of modern farming methods. Generally speaking, European consumers have a relatively high level of concern about health issues related to residues in foodstuffs. There are significant issues of concern relating to:

- the potential residual effects of hormones which may be used to stimulate animal growth or milk outputs;
- antibiotics for veterinary purposes or for use as growth promoters in livestock feed;
- pesticide residues in food;
- other veterinary residues.

Of increasing concern have been the risks of disease contamination in meat, eggs and dairy products. Salmonella in eggs and poultry, bacterial contamination of meat and tuberculosis in cattle have all been subject of numerous consumer campaigns. Significant concerns exist on the use of bovine somatotrophin (BST) in the EU, as well as on the use of growth-promoting hormones. There is a considerable body of EU legislation in the sphere, including bans on the use of BST and certain growth promoting hormones.

USA

Hormones and animal feed requirements are not a current issue of concern for human health in the USA. Hormones and antibiotics, such as BST in dairy production, are considered to be safe for human consumption. BST is widely used, as are growth promoting hormones for beef production. However, a new Codex ruling supports the EU position on the possible human health effects of BST.

Canada

Human health concerns relating to hormones, animal feed ingredients are an issue, but not of major concern. The use of antibiotics in animal feed is beginning to be an issue in this country, but there is not yet a clear broad public reaction to current practices. Animal health concerns are the basic reason to control the use of growth hormones (i.e. BST) in dairy. The use of antibiotics in feed has human health dimensions.

Australia

Hormones and animal feed requirements are an issue in Australia, but not of major concern.

New Zealand

Hormones and animal feed requirements are an issue in New Zealand, but not of major concern.

Conclusion

The use of hormones, antibiotics and various animal feed ingredients are of significant concern to European consumers because of the potential risks to human health. They are an issue, but not of major concern, to consumers in Canada, Australia and New Zealand and appears not to be an issue of concern in the USA.

Pesticide residues in food

Most countries have concerns regarding the human health aspects related to the level of pesticide residues and other contaminants in food. Standards are introduced to ensure that harvested and livestock products are safe for human consumption.

European Union

Residues of pesticides in food are an issue with significant concern in the European Union.

USA

Pesticide residues in food are a major human health issue in the USA with high priority in policy. It is the most important human health issue relating to agriculture, and receives as much or more priority as environmental issues, as evidenced by the comprehensive 1996 Food Quality Protection Act.

Canada

The occurrence of pesticide residues in food is an issue of significant concern in Canada.

Australia

Residues of pesticides in food are an issue of significant concern, mainly to meet the requirements of consumers in export markets.

New Zealand

Residues of pesticides in food are an issue of significant concern in New Zealand, mainly to meet the requirements of consumers in export markets.

Conclusion

This is an important issue for all the countries. It has a high priority in the USA, although this is difficult to compare with the EU, where the organic sector is now growing rapidly. Legislation is widespread but it is an area where producer protocols and quality assurance schemes are widely applied in order to reduce the risks of food products exceeding permitted residue levels.

Hygiene rules for dairy farming

Hygiene rules apply to a wide range of farm production methods and sectors, particularly cattle, pigs, poultry and other livestock. Hygiene rules applying to pigmeat, however are largely off-farm and therefore mainly apply to the processing stage. In the dairy sector, the relationship with the final product is often closer. It was chosen for comparison in this study, because of the relevance of these rules in the context of on-farm constraints.

European Union

The provision of milk produced in accordance with a high level of hygiene and food safety are of significant concern in the European Union. Authorities need to carry out controls to ensure that good hygiene practices are applied in dairy farms. Raw milk from cows should be free of tuberculosis and should not show symptoms of infectious diseases communicable to human beings. Suppliers of raw milk need to undergo regular veterinary inspections, and hygiene conditions need to be met when milking.

USA

The hygiene of dairy farming is of significant concern in the USA. The hygiene discussion relates to milking requirements, and largely is off-farm, because there is virtually no on-farm processing in the US. The Grade A Pasteurised Milk Ordinance (PMO), issued by the US Public Health Service in 1924 and revised many times since its passage, requires that the cows be milked inside a barn with construction requirements such as concrete floors, clean parlour and equipment, and a parlour equipped with toilet facilities (US Department of Health and Human Services, Public health service, FDA, 1998). The ordinance has been adopted by most states because their producers must comply with its provisions to ship milk across state borders.

Canada

Hygiene of dairy farming is of significant concern in Canada. Hygiene issues on dairy farms are addressed through milkhous equipment and cleaning standards, which seem to

be comparable to the USA and New Zealand. There is virtually no on-farm processing of dairy products in Canada, in contrast to the EU. This is partly because of the supply management policy. So most of the attention to hygiene is at the processing level. Dairy producers and the processing plants are carefully regulated and held responsible for food safety and hygiene control of dairy production.

Australia

The provision of milk produced in accordance with rules applied in the EU is of concern in Australia.

New Zealand

The provision of milk produced in accordance with rules applied in the EU is of concern in New Zealand.

Conclusion

Wide similarities are observed across countries on the issues related to human health and hygiene conditions associated with dairy farming. As well as constraints, public policies can give rise to incentives or other assistance for the farm sector, including training and advice.

Veterinary requirements and conditions to control animal diseases

All countries have policies and procedures for disease control as exemplified below. However, the degree of public concern varies greatly.

European Union

Veterinary requirements and conditions to control the occurrence of animal diseases are of significant concern in the European Union. Concerns involve the risks of disease contamination in meat, eggs and dairy products. Salmonella in eggs and poultry, bacterial contamination of meat and tuberculosis in cattle have all been the subject of numerous consumer campaigns. The growing use of a precautionary approach in human health issues applied to agriculture no doubt relates to the serious and lasting effects upon consumer confidence and agricultural markets of the problem of Bovine Spongiform Encephalopathy (BSE). This is a prime example of an issue where previously lax policies encouraged an undue confidence in livestock production safety up to a point where the disease was able to become a serious epidemic in a few Member States and consumer confidence was badly affected across the whole EU. Control programmes for salmonella exist in several Member States and they are aimed to reduce the infection of animals with salmonella, and their related human health problems.

USA

Veterinarian issues are not of major concern in the USA, rarely making the media, probably because of the absence of a BSE type incident and because many new, larger livestock farming operations are hiring their own veterinarians to assure adequate care and market access. Fewer farmers are currently using private veterinarians. Occasionally, outbreaks of

foodborne illness or disease, such as E-coli and salmonella contamination, alarm the public and lead to better oversight of food safety.

Canada

There is a high degree of confidence in the effectiveness of current procedures to manage animal health in Canada. Veterinary issues therefore are not of major concern. Canada employs an extensive system of animal health monitoring and inspection, including livestock quarantine provisions. This system has been very successful in the control of livestock disease. There has not been an outbreak of BSE.

Australia

Veterinary requirements and conditions to control animal diseases are an issue of concern in Australia, mainly driven by their export-orientation. The Australian Veterinary Emergency Plan is a co-ordinated national response plan for the control and eradication of emergency diseases and emerging or endemic animal diseases. In most cases a 'stamping-out' policy is employed, involving (a) quarantine and movement controls; (b) the slaughter and disposal of infected and exposed animals; (c) decontamination of infected premises; (e) surveillance of susceptible animals; and (f) restriction of the activities of certain enterprises.

Each state and territory has operational responsibility for the control and eradication of animal diseases, whether endemic or exotic, within its borders. Each state and territory therefore administers its own emergency disease control legislation. A cost-sharing agreement is used to fund the eradication of exotic animal diseases (the Commonwealth 50% and the states/territories 50%). A cost-sharing agreement is in place for the following exotic diseases: African swine fever; bluetongue (in its classical virulent form); classical swine fever (hog cholera); foot-and-mouth disease; Newcastle disease (in its classical virulent form); rabies; rinderpest; screw-worm fly; swine vesicular disease; vesicular exanthema; vesicular stomatitis; and virulent avian influenza.

New Zealand

The occurrence of animal diseases is of significant concern in New Zealand. Amongst others, cattle tuberculosis and foot and mouth disease receive high priority. An extensive border protection system and other protection schemes against possibilities of an outbreak of foot and mouth disease and other disease are in place.

Conclusion

Veterinary requirements and conditions to control animal diseases are issues of concern in all the study countries, partly because of the high costs involved following an outbreak of animal disease. Human health concerns related to farm-level livestock health issues (e.g. disease control) are strongest in the EU, which appears partly the result of recent experience and sustained media attention.

2.1.8 Overview of findings

Figure 2.1 highlights the issues selected across the five countries. It identifies leading environment and health issues, on the basis of the available evidence and the views reflected in the national reports. Some evidence is clearly documented but there is also an important element of judgement. For example, there is widespread data indicating contamination of groundwater by pesticides in certain regions. The scale of public concern, reflected in the media, parliamentary debates et cetera is more difficult to compare between countries.

A simple ordinal scoring system is applied in the figure. It is not meant to provide an overall judgement regarding the state of the environment of any of the countries involved. In countries where issues are not perceived to be of major public concern, this would not imply that there is no problem, for example animal welfare is less of a public policy issue in the USA than in Europe and other countries. Mistreatment of farm animals housed and transported may occur in the USA, but broad sustained public interest remains limited. Where an issue appears both to be an issue of significant concern and there has been substantive response in the form of public policies or initiatives in the private domain, this is indicated by three stars rather than two. Thus, the figure distinguishes between the following categories:

- No issue;
- * Issue identified as a problem, but not of major concern;
- ** Issue identified as a problem, and of significant concern;
- *** Major issue with high priority in policy.

Issue	European Union	USA	Canada	Australia	New Zealand
Nutrient enrichment by nitrates and phosphates	***	***	*	*	*
Sediments	*	***	*	*	**
Pesticides (including drift and applicator safety)	***	***	*	**	*
Irrigation	**	**	*	***	**
Salinisation	*	*	*	***	-
Soil contamination	*	*	*	*	*
Soil erosion	**	***	*	***	***
Ammonia	**	-	*	-	-
Odour and nuisance	***	**	***	-	-
Crop burning	*	*	-	-	-
Biodiversity, landscape	***	**	*	***	***
GMOs	***	*	*	*	***
Animal welfare	***	*	*	*	*
Hormones (and animal feed ingredients)	**	-	*	*	*
Pesticide residues in food	**	***	**	**	**
Hygiene rules for dairy farming	**	**	**	*	*
Veterinary and animal diseases	**	*	*	*	*

Figure 2.1 Issues of concern in the five countries

2.2 Main features of policy and legislation

Following the identification of the main issues we explore some basic features of legislation in the EU by comparison with non-EU countries. The different approaches to implementing policy are discussed briefly. This includes some reference to legislative models. We also explore how legislation commonly is implemented and enforced, and where costs at the farm level are uncompensated or partly or wholly compensated, typically through investment aid, 'cost sharing' or incentive schemes. While it has not been possible to undertake an adequate analysis of how enforceable and how well enforced the relevant measures commonly are, this is clearly needed for a full comparison.

European Union

A range of policy instruments is used in Europe to set environmental and health related standards applying to agriculture. The great majority of measures adopted at EU level are in the form of binding legislation. This includes Regulations, which are directly binding on all Member States and are a widely used instrument for agriculture policy, and Directives, the primary instrument for environmental policy in the EU. Member States must implement Directives within a fixed period of time, often two years, but sometimes stretching over a longer period. Objectives and, frequently, specific standards are set out in Directives, but the Member States have some latitude in determining how they meet their responsibilities and the approach adopted may vary considerably. Legitimate differences may exist between farm level standards introduced in response to certain environmental Directives and implementation by national authorities is not always timely or completely satisfactory.

There are more than two hundred significant items of EC environmental legislation and their number is increasing. Many are concerned with air and water pollution, waste disposal, hazardous products (including pesticides), and wildlife protection. A minority are of major concern to farmers. Certain issues are primarily the responsibility of Member States, including landscape protection, land use planning and certain specific measures concerned with water quality. Primarily Member States handled the authorisation of pesticides in the past but an EU system is in the process of being implemented and there is an important EU Directive on the deliberate release of GMOs. Formally, the principles underlying EU environmental policy include the Polluter Pays Principle and the Precautionary Principle. This philosophy is associated with stringent standards in some areas - for example, pesticide residues in drinking water.

A further layer of binding legislation can be found at national level. Since several Member States have a federal constitution, powers to legislate in certain domains, for example nature conservation, may be reserved largely or wholly for regional/provincial authorities. The scope, form and ambition of environmental and animal health legislation varies greatly between Member States and to some degree, between regions/'Länder' in certain Member States.

Environmental policy instruments deployed at national level include widespread taxes on energy, especially liquid fuels, and much less commonly, taxes on other inputs such as pesticides. Codes of Practice are favoured in certain Member States, notably the UK, while voluntary agreements between the farming sector and government have been

developed, for example, in the Netherlands. Research, information and advice on environmental and related issues is available in most Member States, although the extent, structure and charging policy of extension services is far from uniform.

Land use planning procedures, development controls and consents (applying to buildings, infrastructure and certain activities) form an important element in the web of standards applying at farm level. Some general legislation applying to larger projects is in force at EU level but the majority of measures are national, regional or more local in character. Often there is considerable scope for local factors to influence decisions at farm level - for example the acceptability of new livestock buildings or even the introduction of an outdoor pig unit. The high density of population and close proximity of farms to villages, towns and individual dwellings gives local issues, including odour, noise, visual intrusion, landscape change and traffic creation, particular significance. Right to farm legislation is not found in Europe.

Incentives for environmental purposes are a relatively new policy in the majority of Member States. The single most important instrument is an EU measure (Regulation 2078/92) which became operational in 1993. This sets a framework for Member State measures aimed at assisting farmers committed to environmentally sensitive practices. These range from maintaining or introducing extensive production systems, including organic farming, to meeting precise habitat or landscape management requirements. Farmers are reimbursed costs on the principle of profit foregone, with a small incentive element permitted. Generally, half the cost of the payments is met from the EU budget, half by the Member State, but this can vary. Additional incentives are available for some forms of environmental investment under both EU and national schemes and some countries have additional incentive schemes outside the framework of Regulation 2078/92, most of which are very local. Environmental enhancement rather than maintenance of extensive farming systems is becoming a more pronounced objective of these schemes. Around 20% of the agricultural land in the EU is now subject to management agreements under Regulation 2078/92.

USA

Environmental programmes for agriculture in the USA have arisen largely because of documented problems, rather than as precautionary actions to prevent future damage. For example, the Endangered Species Act (ESA) only takes force when a species is under threat of extinction. Major exceptions to this rule apply to pesticide regulation to avoid human health problems and pressures on the environment. Other human health issues (e.g. hormones and antibiotics) and animal welfare problems do not receive as much policy attention as environmental issues. Federal, state and local governments set environmental and health legislation for agriculture. In many cases, the federal government sets minimum requirements or guidelines, and the design and implementation of programmes that enforce them are delegated to states. The control of environmental problems, such as zoning for land use conflicts, may also be delegated by states to local governments. State actions are often stricter than the federal standards.

Environmental policy and programmes for agriculture traditionally have emanated from the federal government. To illustrate, federal conservation and environmental programmes affecting agriculture, excluding research, totalled 43 in 1994 (US Congress,

1995). That pattern appears to be gradually shifting as state and local governments increasingly take action to control excessive risks and damages in their areas (Ervin and Schmitz, 1996).

The picture that emerges is a changing mosaic of a few federal programmes with standards, the gradual adoption of higher and more comprehensive standards for those programmes, and expanding state and local government initiatives. All of these will play out in a significantly changed agricultural policy context. Agriculture is undergoing 'deregulation' to market prices under the Federal Agricultural Improvement and Reform (FAIR), in the sense that it decoupled payments to farmers for specific crops and production levels. Still, transition, disaster and conservation payments continue, and have grown to over USD 10 billion in recent years. The CRP alone expends approximately USD 2 billion per year on land rental and related payments. FAIR is aiming to expand trade markets, government downsizing, a new wave of migration to rural areas, and robust public sentiment to control its negative environmental side-effects. At the same time, structural changes continue to shift production toward fewer and larger farms, which appear to have hastened the public's mood to favour more environmental regulation. Finally, new science and technology are improving the feasibility and efficacy of direct environmental controls.

Several states have, over time, approved voluntary-payment programmes to complement the federal programmes. For example, Missouri established a cost-sharing programme in the 1980s to help control erosion and related problems. Minnesota passed its 'Reinvest in Minnesota' programme in the late 1980s to leverage federal CRP resources and retire vulnerable farmlands on a more targeted and lasting basis. Many other states have programmes of education and technical assistance to assist farmers in meeting personal and public environmental objectives.

Environmental policy in the context of agriculture showed a major shift in 1985 with the introduction of the Conservation Reserve Program (CRP) and the conservation compliance measures. The CRP is a large land retirement effort, presently covering about 12 million ha, or 10% of total cropland in the USA. It originally related to soil erosion control, and used a voluntary-payment approach. In its current form, the CRP covers a broader area of environmental purposes, such as wildlife habitat preservation. The compliance programmes 'sodbuster', 'swampbuster' and 'conservation compliance' for highly erodible croplands broke tradition with traditionally voluntary efforts. They required farmers who received agricultural programme benefits to meet minimum conservation performance requirements or lose eligibility for those benefits. In some respects, they were the first steps toward regulating cropping practices that caused environmental damages off the farm.

The pattern of environmental policy and programmes appears to be gradually shifting as states and local governments increasingly take action to control excessive risks and damage in their areas. Many states are increasingly regulating agricultural activities to control such damage to the environment. Some states provide support - in addition to the CRP payments - to farmers to take land out of production for 10 to 15 years, which is generally designed to bring environmental benefits rather than to limit production.

In response to an increasing trend towards civil litigation for nuisance, many state and local governments have passed 'right to farm' (RTF) laws. The objectives of the laws are to '(1) strengthen the legal position of farmers when neighbours sue for private nuisance; and (2) protect farmers from anti-nuisance ordinances and unreasonable controls on

farming operations (American Farmland Trust, *ibid.*). The laws are intended to discourage neighbours from suing farmers for 'normal' production practices. Generally, farmers are protected from nuisance suits given that they preceded the neighbour by at least a year, if they use commonly accepted agricultural practices, and if they are in compliance with federal and state regulations. In some states, the Right to Farm law may not apply to confined animal feeding operations (CAFOs). In many counties and localities, agriculture is exempted from some local ordinances and in several states, counties cannot impose stricter standards on agriculture. If the Right to Farm laws become widespread and help farmers avoid significant costs, they could lessen environmental compliance costs compared to farmers in nations that do not use the laws.

The legal reach of the RTF laws is still open to question. Some state laws have been upheld of late in legal suits to challenge their constitutionality. However, in 1998, the Iowa Supreme Court declared unconstitutional a law that gives immunity from nuisance lawsuits to farms (such as large hog operations) in designated agricultural areas. Although the ruling dealt with an agricultural area regulation, the right-to-farm laws are expected to be challenged on similar grounds, i.e. taking property rights without compensation.

It is impossible to generalise about the motivations for - and effects of the RTF laws - they vary widely over states and among counties (Zinn, 1999). Some were prompted by livestock odour problems while others were intended to protect farms from urban encroachment and neighbours' complaints about normal farming practices. Experts on the subject believe that their effects are limited and exert most influence on farm operations near urban areas (Zinn, 1999).

Canada

Environmental regulation of agricultural production in Canada is undergoing dynamic change. While it is difficult to draw generalisations in the midst of such rapid change, certain themes can be identified. Environmental regulation involves a combination of actions under federal and provincial legislation and regulation, municipal zoning and permitting processes and common law litigation and liability with respect to nuisance, public nuisance and riparian rights.

The provincial governments are granted primary jurisdiction for environmental issues in Canada. In most of the provinces, enforcement of environmental agricultural standards is devolved to the municipal level. Provincial guidelines for agricultural codes of practice inform local bylaws, zoning policies and approval processes at the municipal level and criminal prosecution under provincial legislation acts as a backstop for local enforcement. Most municipal standards are compulsory and reinforced by substantial fines for non-compliance.

Furthermore, water and air quality degradation that occurs from producer actions that do not conform to applicable provincial Codes of Practice can be liable to criminal and civil penalties. In other areas, standards tend to be voluntary and also tend to be compensated. Some regional programs have been initiated based on cost sharing between governments and producers to address diffuse surface water quality problems from off-site erosion damage and excess nutrient levels from crop production or from runoff from manure from livestock operations.

In recent years most provinces have passed various forms of 'right to farm' legislation to clarify the standards for normal or reasonable farming practices, under which farmers can be held liable for nuisances, mostly for dust and odour, but limitations are conditional upon farmers following 'common agricultural practice', as defined in the codes.

The federal role has evolved to provide a national system for pesticide registration, for setting national water and air quality standards for selected contaminants and for providing financial assistance to regional agri-environmental projects and programs. Most provinces have Codes of Good Agricultural Practice, mainly regarding pesticides and manure management (for example minimum separation distances between farms and the nearest residential property, mainly to control odour and application of manure). Some of these codes are also incorporated into municipal bylaws, making them quasi-regulatory. Such Codes have become the standard against which negligence can be measured and civil action could be taken.

Australia

In Australia, environmental issues are not the province of any one sphere of government. Although the Commonwealth Government has powers to enact laws affecting the environment and sustainable development, the Australian Constitution does not specifically deal with environmental powers. Most environmental and food safety legislative responsibilities rest with state/territory governments and most decisions that affect the environment occur at the local level.

The state and territory governments are responsible for administering environmental legislation, covering among other subjects, pollution of land, water and air, protection of endangered species, forestry, wildlife, water and catchment management and natural resource usage. The Commonwealth Government guides, manages and co-ordinates state/territory and local governments. This mainly takes place through councils, programmes, inquiries and mutually developed policy strategies. Central government can only dictate policy to local states if the policy is part of an international agreement (e.g. agreement to reduce the emission of greenhouse gases).

A major policy trend during the 1990s has been the move away from an almost total reliance on the use of regulations. Economic instruments and property rights systems have complemented the regulatory approach. For example, property rights are being introduced to water in aquifers and in rivers. Likewise, they are established for salt discharged into rivers. Market mechanisms are currently being used in agriculture in the form of allowing world prices for inputs and products to send signals to producers. This also involves assessing total economic values for the costs and benefits attributed to environmental policies and government regulations. Guidelines are developed by the Council of Australian Governments to reduce the use of government regulations and to encourage 'minimum effective regulation'.

Land degradation is addressed through regulatory controls and legislation in most states and territories. They require that landowners take all necessary steps to prevent or minimise environmental harm. Commonly there are no legal consequences for not fulfilling such a duty. Legislation however is intended to encourage industry towards self-regulation through Codes of practice.

The most common policy response to land and water degradation problems is the promotion of information, education, community participation, dissemination of research and the development of codes of practice. Research and extension services on sustainable practices e.g. through 'Landcare', dominate the policy response in this country. Codes of practice are generally sector-based, providing guidance to specific industries on a range of environmental issues such as resource usage, emissions, waste generation and disposal, animal welfare, occupational or health hazards and regulatory standards. Codes of practice attempt to improve agriculture's performance by providing relevant information and suggesting management practices and production processes that individual producers can adopt.

The National Landcare Program involves farmers working together with the community and governments to address environmental problems too large for individuals to handle. More than one-third of Australia's farm population are members of Landcare groups. The Natural Heritage Trust (NHT) contributed AUD\$ 92.2 million to Landcare in 1998-99. Recent assessments conclude that the Program has been successful in using an integrated approach to natural resource management problems and in achieving genuine public ownership.

New Zealand

The Resource Management Act of 1991 provides a statutory framework for environmental planning in New Zealand. It replaced all or part of previous statutes and brings all activities relating to the management of land, water, air and coastal environment under one Act. The key themes of the new legislation are the sustainable management of natural and physical resources, the integrated management of resources, and the control of the adverse effects of activities on the environment. The Act moved away from the concept of direction and control of development, inherent in previous legislation, towards a more permissive system of management of resources, focused on control of adverse effects of land use activities on the environment.

The responsibilities under the Act are divided between central government, regional councils and territorial authorities. The functions of central government are the responsibility of the Ministers of Environment and Conservation. The Minister of Environment has the ability to impose national environmental standards through the making of regulations and also has the power to recommend the promulgation of national policy statements, which have binding effect at regional and territorial level. The Minister of Conservation has special responsibility for the coastal marine area including the issue of a New Zealand coastal policy statement, the approval of regional coastal plans and deciding applications for permits in the case of 'restricted coastal activities'. To date, no national environmental standards have been enacted at national level. However, several guidelines have been developed, some of which may be enacted as standards in the future. There is a New Zealand coastal policy statement, which was enacted in 1994.

Environmental standards, especially for water, soil and air are determined at the regional and local level (and therefore can vary between regions). There is therefore regional legislation in terms of Regional Air, Water and Soil Plans, which specify standards and policies to achieve them. While air and water are mainly managed at the regional level, land management is at the district or local level. Regional councils prepare policies for the

integrated management of resources and on the regionally significant effects of the use, development and protection of land. Together with inputs from communities, councils develop policies, define 'environmental bottom lines', and set directions for the regions. Each region has freedom, within the national policy statement, to chart their own direction. They have special responsibilities for the control of matters relating to water, geothermal energy and the discharge of contaminants. Control by regional councils of the use of land is limited to certain specific matters. They also have a role in the control of the coastal marine area and certain other functions. All this is spelled out in a regional policy statement, and a regional plan, which may or may not contain rules.

The principal responsibilities of the territorial authorities are the control of the effects of the use, development and protection of land and the control of subdivision and noise. Their responsibilities are reflected in a district plan, which contains district rules. The district plan shall not be inconsistent with any national policy statement or New Zealand coastal policy statement, any water conservation order or the regional policy statement or any regional plan of its region in regard to any matter of regional significance or for which the regional council has primary responsibility.

Rules and regulations faced by agriculture are developed at both the regional and district level and they vary from area to area. In environmental management several themes are common. They are sustainability, the precautionary principle, user-pays, and the minimisation of rules. Land use consents, subdivision consents, water permits, discharge permits and coastal permits are the main means to achieve management. Applicants for permits must identify the potential effects on the environment of the activity proposed (this will require an environmental impact assessment conducted and paid for by the applicants). Finally, approval of the permit is on the ability of the activity to mitigate, avoid or minimise adverse environmental effects.

Policies at the regional and local level include a large number of voluntary measures. Grassroot 'landcare' or community based groups have been established in many parts of New Zealand and a significant proportion of agricultural products are subject to producer protocols; these are voluntary standards to promote environmental and health related benefits.

There are several industry-led initiatives for sustainable agriculture in New Zealand (e.g. dairy, meat and fruit). Lists of sustainable management practices are compiled and indicators are designed to monitor their performance. Codes of practice have been developed by the pork industry, the logging industry, the kiwifruit industry, and by an agrochemical education trust initiated by leaders in the horticultural industry. There are many examples of farmers imposing constraints on themselves in order to gain market advantage, e.g. voluntary measures regarding 'kiwi green', which nowadays includes all kiwi fruit production. This was instituted both for market advantage, and in order to pre-empt any possible external controls on production.

The fertiliser industry is developing guidelines for responsible fertiliser use, and grazing guidelines are under development by leaders in the pastoral sector. In many of these cases, farmers are motivated not just by the desire to do the right thing, or the possibility of regulatory pressure if problems are not addressed, but also by market considerations. Farming leaders sense that consumers in New Zealand and in overseas markets are increasingly interested in how a product is produced, in addition to traditional

quality concerns. They are therefore supporting efforts to establish systems to ensure that their production practices are sustainable and that this can be demonstrated to consumers. Thus, in a variety of ways, steps are being taken to internalise the environmental costs and benefits within the production process. Government is still spending money on inspection (although some of that has been moved to a cost-recovery basis), quarantine and border control (with current debate about whether the cost of border control should be levied on incoming passengers), and pest control. Government intends to further develop user-pays policies, with the only assistance remaining in the areas of climatic disaster relief, animal and plant health, and government funded research.

Conclusion

The EU, the USA and Canada have a general framework of environmental and health legislation at the federal or country level, with principles implemented at state, regional or even municipal level. In many cases it is complemented with private sector actions and initiatives. The instruments applied and the operational constraints are commonly defined at sub-national level. In Australia, most powers to make environmental legislation rest with the states and decisions mainly occur at local level. A national framework for environmental planning exists in New Zealand. Standards can be imposed at national level, but in practice there are national guidelines and standards are determined at regional and local level. Australia and New Zealand are advanced along the private sector route, with extensive use of voluntary guidelines. Such guidelines put constraints on farming, even though they have a different legal status from regulations.

The great diversity of policy instruments used within countries implies that the on-farm constraints arising from a web of different measures will likely show a wide range as well. Regulatory approaches, as found more in the EU, USA and Canada, in principle indicate more rigid, binding standards but in practice this will not always apply at the farm level, especially where implementation and enforcement are weak. The study did not extend to an appraisal of farm level implementation and enforcement. This underlines the difficulty of comparing on-farm constraints by policy area.

2.3 Main areas of legislation affecting agriculture

The pattern of legislation and other measures in the five countries varies significantly as is clear from this brief synopsis.

European Union

The main issues addressed by legislation and other measures at EU and national levels are:

- water pollution by nutrients, livestock waste, pesticides;
- the use of pesticides, including authorisation of products, controls on use and disposal etc, reflecting concern about the health of farmers and consumers as well as the aquatic and terrestrial environment;
- the protection of wildlife and habitats, including individual species and a range of semi-natural farmed habitats;

- the protection and maintenance of landscapes, especially at a local level and in designated areas;
- air pollution, mainly in areas of intensive livestock farming;
- food safety, primarily related to animal production, with a major element at farm level (e.g. animal feed composition) as well as the marketing, slaughtering, processing stages;
- farm animal welfare, particularly for pigs and chickens - a leading issue in several northwestern European countries;
- soil erosion and contamination, with the former concentrated in drier Mediterranean zones.

USA

The main areas of environment and health-related legislation in the USA relate to:

- pesticide use and pesticide residues in food, with a particular concern for safeguarding human health;
- drainage and other modification of wetlands;
- protection of species which are threatened with extinction;
- water pollution and other environmental risks from certain crops and large animal operations (e.g. intensive indoor pig and poultry units and cattle feedlots); and
- soil erosion control, wildlife habitat provision, and other environmental purposes assisted through voluntary-compensatory schemes, such as the Conservation Reserve Programme (CRP) and the Environmental Quality Incentives Program (EQIP).

Voluntary approaches also play an important role, especially for federal government actions. Reasons underlying this preference for non-regulatory approaches include the difficulty and costs of implementing compulsory measures for nearly 2 million diverse farms spread across the country. Several states have programmes of education and technical assistance to support farmers in meeting environmental objectives.

Canada

The main issues that have received most policy attention in Canada are:

- human health and environmental protection provisions related to the use of pesticides;
- groundwater quality control to limit bacterial and nitrate contamination of groundwater used for drinking water purposes;
- off-site water quality degradation by soil erosion from crop land; and
- air quality (specifically odour) problems associated with intensive livestock operations.

Each of these issues is subject to a variety of legislative controls at federal or provincial level.

Australia

The environmental concerns currently receiving programme and/or policy attention are:

- water quality and water scarcity issues;

- soil erosion, soil acidification, dryland salinisation and soil structure decline;
- biodiversity loss; and
- introduced pests and plants.

New Zealand

The environmental concerns receiving most policy attention are:

- soil erosion;
- nutrient enrichment of ground and surface water (including nitrate);
- loss of biodiversity, particularly in relation to the impact of introduced pests and plants;
- GMOs.

2.4 Concluding remarks

- In all five countries there is a general framework of legislation at the federal, EU or country-level, with varying degrees of delegation of powers for specific policies to the state or more local (regional or even community) level. Private sector actions and initiatives also play an important part in setting effective standards for farms, especially in Australia and New Zealand.
- For a variety of historical, geographical and economic reasons, the economic development of agriculture has followed different paths in many of the countries considered in this study. These development paths have produced different types and degrees of environmental stress, human health and animal welfare concerns. In the EU a sizeable proportion of production originates from intensive farming systems but average farm size is small. In the other countries larger farms predominate including sizeable areas of low input arable or pastureland. However, they also contain significant intensive farming sectors, including large-scale livestock. Most industrialised countries have acted to internalise the external effects of agricultural production on natural and environmental resources to some degree, but they have acted in diverse ways.
- Most policies have been reactive in the sense that measures were introduced in response to perceptions of emerging or documented problems. Differences in culture and preferences account for some modest variation in the types or levels of remedial actions undertaken. Most countries employ a combination of technical and information assistance programs, voluntary programmes, cost sharing and producer compensation as well as criminal and civil sanctions. New Zealand (and to some extent Australia) stand out in that the cost-share programmes are very few, have limited funds and are primarily to encourage voluntary actions.
- This diversity of policy instruments and varying role of formal legislation in setting standards makes concrete comparisons of precise impacts at farm level very difficult. It is apparent that there are differences in the overarching philosophies and property rights governing policies in each country. Australia and New Zealand make less use of binding environmental legislation, but have advanced further along the private sector route with voluntary guidelines; this is linked to the very strong export-

orientation of their markets and the need to meet EU standards for several products. This approach is also consistent with a greater vesting of property rights in the environmental resource with the private sector. The European Union, USA and Canada show a mix of legislative procedures at different levels with a wider range of federal legislation in the USA than in the EU or Canada. There is considerable diversity between Member States in the EU and notable variations between states in the USA, although they share the same legal system, and their institutional structures and procedures are less diverse than in the EU. However, at sub-national level legislative controls, guidelines and planning controls/zoning laws are evident in all countries, especially in the EU.

- The EU and USA, in particular, seem to have made more widespread use of public funds to support environmental programmes which offer some financial rewards to producers in return for generating public benefits. By contrast, in New Zealand and Australia many issues are dealt with through voluntary advisory services, including the 'Landcare' approach. Such programmes aim to promote partnerships and co-ordinated action among governments, industries and communities in order to provide incentives to change land management practices.
- In all five countries regulation plays an important role in policies for pollution control (pesticides, water pollution, hygiene, and food quality). A far more diverse picture is observed in relation to policies for soil, nature conservation, landscape and issues related to recent public concerns about modern technologies (e.g. GMOs, antibiotics in animal feed, and hormones). With some exceptions, such as soil erosion control, the pattern of intervention appears heavier in the EU than elsewhere.
- Legislation and command-and-control measures are relatively widely used in the EU to protect physical resources, as well as to advance human-health and animal welfare objectives. Regulation is currently used selectively in the USA to control water pollution and, to a lesser extent, air pollution by the federal government and in most states. Regulation is mostly for large point source emitters. The medium and small farmers are largely exempted from water pollution regulations, but this is changing. Codes of Practice for protecting resources are rather common in Canada, Australia and New Zealand. However, often a producer can be sued if he or she is not in compliance with the relevant Codes. This makes the Codes 'binding' in a way not dissimilar to regulations.

Public concerns about the potential animal welfare issues surrounding modern production systems are rather widespread in the EU. By contrast, animal welfare is a less prominent issue in the other countries examined, and there is no evidence of broad public concern that animals are being abused in agriculture. Although transport distances for animals are lengthy in Australia for example there appears no major public concern about stress or mistreatment of animals during transport and slaughter.

3. Comparison of environmental and health-related standards

The foregoing chapter identified the differences regarding environmental and health-related issues in the countries under consideration. The main objective of this chapter is to identify the major differences regarding environmental and health-related standards imposed on agriculture in the EU and the other four countries. In so far as differences are apparent, an attempt is made to establish whether the EU standards are higher or lower than in those of the other countries under consideration.

The approach is thematic, following the same order as the issues identified in chapter 2. Where possible, farm level operational constraints are identified, for reasons discussed in chapter 1. Comparisons can then be made with due caution and in the light of existing environmental problems, animal welfare and human health issues in each country.

Several significant differences between countries were described in chapter 2. These include differences in the policy instruments adopted, the degree of reliance on regulatory or voluntary measures and the extent to which issues are addressed at national, regional or local scales. Many policies vary significantly between regions and they vary in scope with some applying only in highly specific areas. Effectively, there is a high degree of spatial variation in on-farm constraints within the countries analysed, such that some policies are implemented by a single national prescription while others are determined through a myriad of local rules. This is due to the extremely variable pattern of legislation and standard setting, much of which finds expression as a constraint on farming at the local level where the cumulative expression of local, regional, national and higher level standards apply. Therefore, the level of detail presented regarding on-farm constraints unavoidably differs between the issues discussed, and the national level of analysis can be an obstacle to the establishment of clear comparisons between farm level constraints among the countries under consideration.

3.1 Water quality and quantity

3.1.1 Nutrient enrichment by nitrates and phosphates

A wide range of on-farm constraints applies to farming in the five countries to meet the requirements of policies to control nutrient enrichment by nitrates and phosphates and associated pollution from livestock wastes and fertilisers. Many of these are multi-purpose.

Manure application requirements and limits on nutrient inputs

The application of manure to agricultural land is one of the most important and direct ways of creating potential pollution problems from nutrients. There is an increasing trend to seek

more control over manure application so as to limit the application of nutrients and control leaching of nutrients to the environment.

Manure application requirements at *EU* level result from the Nitrates Directive and are applicable to Nitrate Vulnerable Zones, but are not otherwise set at EU level per se. Action Programmes are formulated by Member States with mandatory measures for the Nitrate Vulnerable Zones. Manure may not be applied in amounts exceeding 170 kg of nitrogen per hectare. Some Member States or regions, particularly in Northern Europe, put restrictions on the maximum amount of animal manure which may be applied, restrictions on fertiliser application, and restrictions on spreading of animal manure. In Germany, for example, the application of livestock manure should not exceed 170 and 200 kg N/hectare on arable land or grassland, respectively. Several EU Member States have also put limits on the application of manure, for example in the form of stocking densities (e.g. Belgium, Denmark, Germany, the Netherlands, France and Italy), resulting in a range of different standards.

The situation is similar in the *USA*, where the states have developed various application standards with rules depending on local environmental problems. Generally, manure from large livestock operations is to be applied at no more than agronomically appropriate rate, based largely on the ability of the plants to take up the amount of nitrogen applied. Several states have established more specific standards with respect to manure application. Nebraska implements maximum nutrient application levels in areas where nitrate concentrations from crop and animal agriculture result in levels above the maximum permissible human health standard (10 mg N per litre). This triggers a series of remedial steps. However, there is no standard in terms of maximum amount of nitrogen per hectare. CAFOs however, must apply manure at N-based 'agronomic' rates; few states require P-based rates.

CAFOs are regulated under the Clean Water Act (CWA) permitting system and there may be additional permit requirements in certain states. In California for example, regional water quality boards operating under the State Water Resources and Control Board issue permits covering discharges to land, surface water, and ground water under the 1996 Porter-Cologne Water Quality Control Act. Again, the degree of enforcement is uncertain, and is probably variable, depending upon the severity of the problem and the public's concern about improvements.

Nutrient application rates are regulated in *Canada* through provincial Codes of Practice and indirectly through separation distances for indoor livestock units. Total nitrogen application reaches a level of 200 kg per hectare in extreme cases only, but normally would be a fraction of this amount. Approval of building permits is subject to separation distance requirements and these vary with the scale of the operation and so implicitly determine stocking rates and manure application rates. Several provinces have developed specific management guidelines and standards for manure application, which include rules on separation distances from watercourses, wells and public water supplies, soil testing before large-scale manure application, and seasonal restrictions. In conclusion, manure application approvals and regulations and separation distances impose indirect controls.

No maximum limits on nutrient inputs exist in *Australia*, where beef and dairy operations are based on pasture as the primary feed source. The national Dairy Guidelines recommend land application of effluent as the most efficient means of recycling valuable water, along with the effluent's nutrient and organic components. The amount of land re-

quired depends on a series of natural and cultural criteria. Before and during land application, scheduling and application rates based on the properties of the effluent, including its salinity and nutrient content, pH and BOD need to be considered and assessed seasonally. Maximum application rates for land treatment of effluent depend on site-specific conditions. In Queensland, pig producers taking advantage of land application as a means of effluent disposal are considered to have a moral and legal obligation to ensure that the application is carried out in an environmentally sustainable manner but there are no mandatory standards.

Guidelines exist for the application of livestock manure from pig production, but they vary by state. Documentation is required for manure application. Pig producers need to provide information on climatic conditions during application; they need an effluent and manure utilisation plan; and may need to comply with the rules relating to the irrigation method; a manure stockpile and manure spreading program; soil conservation plans; odour, dust, noise and visibility consents; animal care statement; and pest control system.

In *New Zealand*, the discharge of manure or effluent to land or water is a controlled activity requiring a resource consent. The Dairy Code of Practice specifies that animal wastes or offal may not be disposed of within 45 meters of the dairy farm (i.e. milking area, milk receiving area and milk storage area). This includes storage ponds, treatment ditches and places where effluent is applied to land. Regional Councils place limits on nitrogen applied through manure and artificial fertilisers, ranging from 150 - 200 kg nitrogen per hectare per year although various exceptions are permitted. The 200 kg per hectare limit is the maximum proposed and is only applicable for dairy farmers. In addition, the Dairy industry and the Fertiliser industry both advise farmers not to apply more than 200 kg per hectare per year. A Code of Practice for Fertiliser Use has been developed by the Fertiliser Manufacturers' Research Institute as a proactive measure.

Conclusion

Limits on the application of nutrients are comparable in the EU, USA and New Zealand. Maximum limits on the application of nutrient inputs to exist in the EU (170 kg of nitrogen from livestock manure), USA and New Zealand. They are implemented by several Member States (EU) and at state level (USA), and are introduced in light of the high incidence of excess nutrient problems in much of the north-western part of Europe and some states in the USA. New Zealand has limits in place at regional level, which range from 150-200 kg nitrogen per hectare, and voluntary measures also control the application of mineral fertilisers. No limits are in place on the amount of nutrients applied in Canada and Australia.

Production permits for intensive livestock facilities

Permits are applied to control the environmental impact of certain categories of livestock production and impose standards on producers. Such permits are often required for constructing new facilities only, but may also be needed for continuing an existing operation. More rarely, they impose constraints on current production units.

At *EU* level, the IPPC (Integrated Pollution Prevention and Control) Directive requires Member States to impose their own emission limits in environmental permits which are mandatory for potentially polluting plants of a given scale. The Directive is applicable

to installations for the intensive rearing of poultry and pigs with more than (a) 40,000 places for poultry; (b) 2,000 places for production pigs (over 30 kg) or (c) 750 places for sows. It is now coming into force for new buildings and will gradually also incorporate all existing installations. Investments are required by these producers so that they are able to apply 'Best Available Techniques', to control several forms of pollution in an integrated way. Water pollution and emissions of ammonia are both included for example.

Nearly all Member States have additional or more local controls on the construction of intensive livestock units, which may include specific permitting systems and/or procedures established under land use planning legislation. This legislation mainly limits the expansion of current production levels. In the Netherlands, where there is a particular concentration of livestock production, there is a kind of moratorium on new units and increases in livestock production units are limited to the equivalent of 125 kg of phosphates per hectare. Other examples are France, where an authorisation procedure applies to building new intensive livestock production units and Environmental Impact Assessments (EIAs) are required, and Austria, where a license is required in water protection areas if livestock production exceeds 3.5 Austrian livestock units per hectare.

In the *USA*, only large confined animal feeding operations, as defined by the Clean Water Act (CWA) as confined operations with more than 1,000 animal units, are subject to a permit system, except for a few states that have a more inclusive definition of CAFOs. The state and local laws usually require some or all of a series of requirements, such as construction permits that may include some siting requirements, operation permits that may include design standards on the structure and/or size, separation distances and land area requirements. Thirteen states require a permit to operate a CAFO. Looking at California, Iowa and North Carolina as the states with the strictest constraints the following can be observed:

- in California, restrictions arise from the federal, state and county levels. The state and counties regulate the siting of new dairy operations; counties can enact stricter regulations than the state's.
- in Iowa, the construction or expansion of large hog and cattle facilities, defined as those with more than 90,000 and 180,000 kg average weight capacity, requires approval by the state and the purchase of a construction permit.
- in North Carolina, several laws have been passed over the last three years, especially to regulate the booming hog industry. Since 1996, all swine operations with more than 250 head must have a permit and certain minimum distances from other buildings must be kept. Eight sign-offs are necessary to obtain a construction permit and new operations are subject to local zoning.

The state and local laws usually require some or all of a series of requirements on CAFOs, such as:

- a construction permit that may include some siting requirements or not;
- an operation permit that may include design standards on the construction and/or size, carcass disposal requirements, and manure management plans, which usually includes a waste management plan (treatment, collection, storage, allowable seepage from waste lagoons, transport);
- separation distances (to both water and properties);

- manure utilisation - usually through a nutrient management plan (for land application); and
- land area requirement.

Very few states have odour or air pollution requirements or groundwater monitoring or testing requirements. Design standards specify the size of the lagoon and sometime the type, and thus directly affect initial investment and operation costs. Strict manure management plans also may involve more lands or transporting manure further away, thus directly increasing operating costs.

Permits and mandatory requirements can be found at the state level only, for example in Nebraska. Regulations are mainly used as backup authority to other, usually voluntary programmes to control pollution, or to deal with extreme cases where no other programme exists.

In *Canada*, intensive livestock operations are regulated primarily at the municipal level, subject to a combination of provincial and federal water quality statutes, and provincial Codes of Practice; they are authorised by provincial enabling legislation. Permits are required at the municipal level in several states to construct, modify or expand livestock facilities. Building and other construction permits, issued at the municipal level, are subject to various conditions, including separation distances, requirements for manure storage capacity and building construction standards. Zoning policies are also applied at the municipal level and can play an important role in determining siting decisions for intensive livestock operations.

In *Australia*, application documentation is required and needs to be approved for the construction or expansion of feedlots, poultry, piggeries and dairy sheds. The details vary according to capacity. Feedlots with more than 50 head require information on most of the following: climatic data, site plan, pen layout, drainage plan, effluent and manure utilisation plan, traffic volumes and routes, water supply, bore locations, groundwater analysis, hydraulic balance, irrigation method, vegetation, nutrient and salt balance, manure stockpile, manure spreading programme, soil conservation plan, odour, dust, noise, visibility, animal care statement and pest control system. There are National Guidelines for Beef Cattle Feedlots providing recommendations for site location and buildings standards and Effluent Management Guidelines for Intensive Piggeries providing similar information regarding the protection of water resources.

In *New Zealand*, the 1991 Resource Management Act requires that all applications for a resource consent will need to be accompanied by an assessment of the impacts of the proposal on the environment. The Act provides guidance about the matters to be included in an assessment and the types of issues which an assessment should address. Further details may be spelt out in relevant regional or district plans. The District Councils formulate requirements for the positioning of some structures in relation to houses, roads and boundaries. Farmers who may wish to obtain a consent must arrange for the assessment and provide the relevant data.

Conclusion

Large new livestock production units are controlled through permitting systems in all the countries studied but the control of smaller units is generally determined at sub-national

level or by the Member States in the EU. Controls on units below a certain size threshold appear limited in some countries. In some Member States permits do not allow for an increase of production capacity of intensive livestock production units with high stocking rates. This constraint is not observed in the other countries studied. Most permits are multi-purpose designed to restrict negative impacts on air and water policy, odour, noise et cetera. Separate building regulations may also apply. In the USA and EU there are specific regulations for larger units (CAFOs) in the United States dating from 1978 and IPPC Directive in the EU coming into effect in 1999. The IPPC threshold is lower than that for CAFO. In both cases there is considerable scope for authorities at the regional/state level to set specific constraints on production. A less legalistic approach is evident in Canada, Australia and New Zealand where constraints apply through a variety of other mechanisms including codes of practice, regional district plans in New Zealand and guidelines for beef cattle feedlots in Australia.

On-farm nutrient budgets

Farm nutrient budgets are a tool used primarily to improve management of the input and output flows of nutrients by agricultural holdings. Such accountancy systems may guide the work of and the advice given from extension services. Alternatively, they may also be used as a basis for compulsory measures in case nutrient budgets exceed certain thresholds. Hence, there is a relationship between nutrient budgets and on-farm constraints.

There are no mandatory on-farm nutrient budgets required at *EU* level. However, they are now compulsory in some EU Member States, usually for holdings meeting certain livestock density or farm size criteria. An example is the Netherlands, where, as of 1998, a 'mineral declaration system' is required as a tool to identify mineral balances for all livestock holdings with livestock densities, which exceed 2.5 LU/ha. It will gradually move into an accounting system including all livestock and crop production systems in the Netherlands. Farms with excess amounts of manure need to dispose of surplus and many intensive livestock producers have to meet subsequent transport and disposal costs. Mineral balances also need to be developed on holdings in Germany of a size exceeding 10 ha, and also the supply of nitrogen from livestock manure exceeds 80 kg of nitrogen per hectare. Sanctions apply to holdings where spreading or disposal of manure cause damage to the environment.

The federal government currently does not require nutrient budgets in the *USA*, either for crop or livestock operations. For livestock production, state and local laws, in 11 of the 18 states reviewed during the study usually require, inter alia, manure, waste and nutrient management plans for certain large farms. In many cases these are a prerequisite for those seeking to obtain permits for large confined animal feeding operations (CAFOs) with more than 1,000 animal units. However, few states require and monitor the implementation of the plans. Mandatory nutrient budgets are only required of crop or livestock farmers in certain local areas to deal with serious water pollution problems. No federal permits are required for nutrient discharges from crops and no federal standards are mandatory.

The imposition of a nutrient management plan does put a constraint on farmers located in 'impaired waters', but the costs to crop farmers are slight since they receive technical assistance to improve their nutrient management. Some livestock producers will

need to undertake further processing of manure before application, or to buy or rent more land (farther away) to spread it on the land in order to meet permit conditions.

In *Canada* nutrient management plans are required for certain farms in some of the provinces. Nutrient budgets are being introduced as provincial policy in the province of Quebec and in municipal bylaws in Ontario. In Quebec, they are a condition for starting and continuing a farming operation. In Ontario, they are a condition for starting or changing an operation. Once the procedure is in place, effectively all operations will be covered.

In *Australia*, the maintenance of records documenting on-farm nutrient budgets is not generally a legislative requirement for agricultural activities. Nutrient loads (potassium, phosphorus and nitrogen amongst others) are monitored in rivers, streams and groundwater. Nutrient readings above normal levels and/or above national guidelines trigger investigations into causes and remedial actions. Voluntary water monitoring programmes play an important role.

However, before constructing an intensive piggery or expanding a beef feedlot (with more than 50 head), documentation on nutrient and salt balance is required from the farmer to show that the size of the application area is sufficient to handle the expected nutrient and salt levels.

In *New Zealand*, on-farm nutrient budgets are nowhere a requirement and there are no plans to introduce legislation on this subject. Current research on nutrient budgeting is only meant to provide farmers with information and to establish a basis for voluntary action. However, in most regions, the discharge of manure or effluent to land or water is a controlled activity requiring a resource consent.

Conclusion

Nutrient budgets need to be prepared by certain groups of farmers in the EU, USA, Canada and Australia. Nutrient budgets are however, not a uniform requirement in all these countries. They are required by large production units for rearing pigs and poultry in some parts of the EU and the USA, and the efforts required for providing such budgets are rather similar in these countries. In Canada and Australia, the provision of nutrient budgets is only required for starting (or enlarging) a livestock operation; it is not required in New Zealand.

Manure storage requirements

Storage of livestock manure in solid or liquid form is required because of constraints on the application of manure on the field (forbidden during part of the year due to the high leaching potential) or to control odour and emission problems. Manure storage requirements commonly are needed in countries where climatic conditions or environmental constraints are a limiting factor for the application of livestock manure during part of the year. Requirements may include a mandatory level of storage (expressed in months of production for example) or building and equipment standards.

Manure storage requirements are common in the *EU* and determined at the Member State level. Where there are explicit requirements typically they range between 4 and 10 months. Requirements on manure storage tend to be longest in regions with concentrations of intensive livestock production (mainly pigs and poultry), and tend to be in the range

between 6 and 10 months. There, rules that restrict manure application during part of the year require storage of livestock manure. However, in some Member States, there are no explicit manure storage requirements. Storage facilities are rather long in the northern part of the EU because of climatic conditions, which limit the application of livestock manure during a large part of the year. Manure storage regulations may include technical measures to reduce emissions of ammonia, which adds to the investment costs as well.

In the *USA*, requirements for manure storage are included in nutrient and waste management plans, which are required by most states as prerequisites for obtaining permits. The plans may specify maximum levels of application to meet agronomic standards, but the degree to which the standards are met is an open question.

In *Canada*, the manure storage requirements vary between the provinces and are often included in manure management or agricultural land use guidelines and codes of practice. They include requirements for covered manure storage to mitigate odour in Newfoundland; soil analysis procedures to evaluate sites for manure storage in New Brunswick; size, location, design and construction requirements for manure storage in Quebec and Ontario.

Australia has produced national guidelines for managing dairy effluent, which advise taking into account a set of factors when choosing a site and managing manure storage. Under these guidelines, farmers have, for example, a legal requirement to contain all dairy shed wastes within their farm boundaries. Effluent management systems must provide storage for the effluent until it can be used or disposed in a manner, which will not adversely impact on the environment. Storage tanks and treatment lagoons should be designed to safely contain their maximum operational load and to comply with local regulations.

In *New Zealand*, technical specifications for those dairy farms using slurry ponds are provided by the Dairy Industry Code of Practice and dairy farmers are expected to follow these and will be monitored for them. The Codes of Practice for managing farm effluent require that effluent from dairy, pig and poultry farms be contained either in pond system or a lagoon before being discharged or sprayed onto the land. The Regional Councils annually inspect these systems (and if found to be inadequate more regularly) at a cost to the farmer. Minimum storage capacity is not specified.

Conclusion

Manure storage requirements exist in all the countries studied, often associated with permits for livestock farms mainly in regions with a concentration of intensive livestock production (to control nuisance from odour and meet restrictions on manure application during part of the year). The constraints they put on agriculture are more stringent in some parts of the EU, such as Sweden, Finland and the Netherlands, relative to the other countries under consideration.

Buffer strips and cover crop requirements

Buffer strips are a constraint on agricultural land use designed to control nutrient leaching to surface water or in groundwater protection zones. Cropping/grazing may be constrained or prohibited.

There are varying requirements between *EU* Member States regarding the use of buffer strips and crop cover requirements. Neither is specified in EU legislation. Buffer strips are normally applied in water catchment areas close to wells, mainly to limit the application of nutrients from fertilisers and livestock manure. Farmers are strictly limited in their use of nutrients inside a zone of 3-5 meters along banks of a river and streams. Such buffer zones are normally required along watercourses in certain Member States, leaving the land uncultivated. Some northern Member States have introduced relatively stringent standards in recent years.

Cover crops are required in part of the EU to control nitrate leaching during the autumn or winter period. In Denmark, for example, the proportion of winter crops should exceed 65% on all farms, while in Sweden, at least half of the winter-grown land needs to have green cover during the winter period in the southern and central part of the country. Requirements are less stringent or absent in most other countries, although payments for buffer strips and cover crops are available under several agri-environment schemes, for example in Germany.

The federal government of the *USA* has implemented a major buffer initiative as part of the CRP to establish from 0.4 to 0.8 million ha of buffer strips for controlling polluted runoff and other environmental purposes. This program is voluntary and will pay participating farmers for the loss of productive use of their enrolled lands. Occasionally, buffer strips are required as part of the species recovery plan under the Endangered Species Act (ESA). This occurs infrequently and mostly in western states where grazing is causing sediment damages to instream water quality. Finally, buffers are required by some states to control water pollution risks associated with large animal facilities that spread manure on their fields and from leakage from their waste holding lagoons.

Buffer strips are compulsory in provinces of *Canada* (e.g. New Brunswick and Nova Scotia) where water quality deterioration has been deemed to be applied locally an important problem. Such strips are commonly part of the separation distances in some provinces (i.e. any separation distance for cultivation from a wetland or watercourses implies a buffer strip). Construction of buffer strips and the use of fencing to limit livestock access to watercourses have been encouraged by various voluntary or cost sharing programs.

In *Australia* there are buffer zones, exclusion zones and chemical control areas. Buffer zones, also called boundary zones, describe an area around a single point where spraying of chemicals cannot occur or where a special permit must be granted. The purpose of these zones is to protect people from nuisance or exposure to drift arising from a spraying operation under good conditions. In exclusion zones and chemical control areas specific chemicals are restricted year-round or for a set period. Reasonable buffer zones should be provided between feedlot complexes and watercourses. The use of cover crops is an optional conservation practice in Australia.

Buffer strips are required in *New Zealand* between the area of application and water course (at least 20 metres) or neighbouring property (at least 150 metres for pig production units near residences). Such zones are compulsory when applying agricultural effluent to land. The creation of riparian buffer for maintaining and enhancing existing water quality can be done on subdivision of agricultural land or created by voluntary means. Regional Councils are advocating and promoting the retaining and planting of riparian vegetation

through a variety of means including conditions on resource consents and voluntary agreements.

Cover crop requirements are not applicable to farming in most of New Zealand. Some guidelines have been drawn up in the east of the country where the problem of wind erosion can occur, but this is only a very limited area.

Conclusion

The use of buffer strips to control pollution runoff is rather common in the countries studied. The size of such strips tends to be limited to a few metres in the EU, which appears smaller than equivalents in the other countries studied. Obligatory buffer strips are relatively unused and it is more common for them to be combined with cost-sharing programs in the EU, USA and Canada.

Soil testing requirements

Monitoring programmes for water quality and testing of soils are important to identify progress made in achieving pollution policy objectives. Soil testing is commonly applied to measure the leaching of nitrates. In addition, monitoring programmes may exist to measure nitrate levels in water.

In the *EU*, testing of nitrate levels in water is required in the context of the Nitrates and Drinking Water Directives. Several Member States have a programme of soil testing on farms in relation to their own measures to implement the Nitrates Directive or other national legislation. Such tests are commonly undertaken by governmental agencies and do not put a constraint on farm holdings.

In the *USA*, some states require soil tests for some confined animal feeding operations (CAFOs).

In *Canada*, some provinces, for example Newfoundland, require soil testing before extensive manure application is undertaken. Others, such as New Brunswick, ask for a soil analysis to evaluate sites for manure storage facilities.

In *Australia*, on-farm testing and monitoring activities are imposed on farms, dairies and feedlots that obtain quality assurance status or Hazard Analysis Critical Control Points (HACCP) accreditation. All dairy and feedlot operations in Australia are attempting to implement some form of quality assurance scheme or HACCP. The national feedlot guidelines recommend that those feedlots that have caused significant environmental impact or which require consistently superior management practices as a consequence of siting or design/construction limitations should be required to submit a report on their environmental performance to the appropriate state/territory and/or local authority at least annually.

In *New Zealand*, soil testing is not a requirement, but effluent discharge facilities are monitored annually.

Conclusion

Although soil testing is a requirement in some parts of Canada and the EU and may be necessary in certain circumstances in the USA it is not a significant constraint anywhere. Other forms of monitoring and reporting can be noted too. Not unexpectedly soil testing is

most likely to be imposed in areas with major risks, e.g. soils vulnerable to the leaching of nitrates.

Rules on zoning/land use planning affecting livestock farms

Zoning and land use planning rules are applied to put constraints on production systems to control their environmental impact and location.

Zoning and land use planning probably continue an important constraint on farm development in the *EU*, particularly with respect to the construction of large livestock units. Rules apply at the local level. Rules on zoning contribute to the control of water pollution problems from nitrates and phosphates, and its other problems including noise, odour, visual intrusion, et cetera. There is no common tradition of land use planning in the different Member States and the existing planning and development control systems are not based on simple rules. However, they do affect the acceptability of certain farming practices including the keeping of significant number of livestock indoors, waste disposal practices or construction of new buildings. They limit development on farms, especially close to settlements.

In the *USA*, the power to zone land is delegated by states to local governments. Some local governments do indeed zone agricultural land to minimise environmental conflicts, but it is a rare occurrence.

In *Canada*, zoning or planning constraints are applied through the system of minimum separation distances, which will limit farm development close to settlements and prevent the spatial concentration of intensive livestock production.

In *Australia*, zoning is applied by some states to separate livestock operations from dwellings, and primarily to solve land use conflicts.

In *New Zealand*, separation distances apply to new buildings and proposed manure storage facilities. Most regions have set standards for separation distances from watercourses and wetlands, as well as for neighbouring residences.

Conclusion

Land use planning rules are common in the countries studied, but they are mainly applied at sub-national level. Separation distances are applied to livestock production units close to watercourses and residences in North America and Australia. Constraints on farming and the cost implications may be biggest in regions with intensive livestock production units, with high population densities or close to urban settlements. On-farm constraints of this type tend to be stricter in the *EU* relative to the other countries studied.

Taxes on fertiliser or surplus manure and discharge consents

Charges and taxes on fertiliser use are economic instruments, which are intended to improve the efficiency with which these inputs are used or to generate revenues for environmental expenditure.

There are no taxes at *EU* level. As for the individual Member States, Austria and Finland abolished taxes during accession to the *EU*. There remains a tax on cadmium in fertilisers, rather than a general fertiliser tax, in Sweden. This is levied per gram, above 5

grams of cadmium per ton of phosphate, in phosphate fertiliser. In addition, some Member States have introduced levies to control excess amounts of nutrients. In some countries, regional water authorities add charges to farmers for discharges of pollution from point sources, but these vary greatly and do not apply at all over large areas.

Several States in the *USA* impose excise or sales taxes on nutrients as they do on many inputs used in agriculture, and a few States impose special charges on fertilisers, which commonly are in the order of USD 1-4 per tonne, and mainly used to cover environmental expenses. Those charges are to raise small amounts of revenue for program administration, or to support special programs.

Large confined animal feeding operations (CAFO) also need a discharge permit under the Clean Water Act, and are subject to regulation. State and local laws usually require construction permits, operation permits with design standards on size and manure management, separation distances, manure utilisation and land area requirement.

No taxes on fertilisers are in place in *Canada*.

No taxes on fertilisers are in place in *Australia*.

No taxes on fertilisers are in place in *New Zealand*. Consent is required for all farmers discharging effluents. Dairy, pig and poultry farmers are affected most.

Conclusion

Charges and taxes on the use of fertilisers imposed on agriculture currently do not exist in the EU, although some countries have introduced levies to control excess of manure and there is a fertiliser tax in Sweden. Elsewhere, taxes on fertilisers only exist in the USA. Such charges do affect farm resource allocation to a limited extent only. Levies on surplus manure only exist in some areas with intensive livestock production units in the EU. They do not exist outside the EU.

3.1.2 Pesticides

The use of pesticides on farms is subject to a variety of on-farm constraints relating to the products available, permissible doses, target crops, timing, application techniques, applicator safety, product disposal, contamination of water, soil and vegetation, residues in food et cetera. From the farmers' perspective the restrictions on the use of a particular substance, generally printed on the label and varying considerably between substances, is likely to be of particular significance.

Because of the large number of active ingredients in use and the even larger number of commercial products in which they are incorporated, it is a major exercise to compare label restrictions for individual products between countries. Any such comparison would need to take into account variations in climate, crops and other conditions between countries, since these will influence the approach taken by national authorities in setting label requirements. A comparison based on specific active ingredients used on an individual crop, such as wheat or oranges, might reveal significant differences in standards applying at the farm level, with possible cost and competitiveness implications. However, it is beyond the scope of this study, which is confined to more generic measures.

The focus here is on the broader pattern of on-farm constraints from use of pesticide rather than on individual products.

European Union

Within the EU, the majority of on-farm constraints are set at Member State level. Certain policy targets are determined at EU level including maximum acceptable concentrations of pesticides in drinking water, maximum recommended levels of pesticide residues in food and animal feed and outright bans or restrictions on certain highly toxic ingredients, principally mercury and organochlorine compounds under Directive 79/117. The authorisation procedure of pesticide active ingredients is applied at the EU level, with a common system for evaluating their efficacy and impact on the environment and human health. The 'authorisation Directive' 91/414 provides a legislative framework for this process for agricultural pesticides.

A measure of strategic importance in the EU is the drinking water Directive (98/83), as amended, which sets strict standards for maximum concentrations of pesticides, both individually and for all individual pesticides detected and quantified during the specified monitoring procedure (see table 3.1). This measure sets more stringent standards than in the other countries considered here. It also affects the authorisation procedure under Directive 91/414 which, inter alia, seeks to protect water from contamination. In addition, it has influenced the pattern of legislation at Member State level where a range of different policies is in place. All Member States have legislation and labelling procedures but some have more extensive policy measures, including water protection zones, where pesticide use is restricted, blanket controls on certain application systems, pesticide reduction programmes, and, in certain cases, taxes on pesticide sales.

Standards for pesticide residues in food (MRLs) are set at EU level and will influence pesticide use at on-farms.

USA

The USA has a large degree of standard setting at the Federal level. This includes:

- national controls on the authorisation and use of pesticides, with associated legislation and labelling requirements. This is administered by the Environmental Protection Agency (EPA) under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). Labelling requirements are likely to become more restrictive for certain pesticides, including the widely used atrazine as part of a new proposal to protect groundwater. Pesticides are classified either as 'general use' or 'restricted use'; in the latter case they can be applied only by a person with an authorised certificate.
- certain high-risk pesticides are subject to special review; this may lead to tighter restrictions, use reduction, additional packaging requirements et cetera.
- the Safe Drinking Water Act required states to prepare Well-Head Protection Programmes, covering a range of potential contaminants and pesticides, although not all pesticides were assigned a maximum limit. The Maximum Contaminant Levels (MCLs) that can be found in the waters of the US vary by pollutant as can be seen in table 3.1.
- permissible residues in raw agricultural commodities are limited by the EPA through a system of 'tolerances'. These tolerances are due for review and revision under the new Food Quality Protection Act (FQPA) to be implemented in the next few years.

Generally, the restrictions for certain classes of compounds could be tighter than under the FIFRA, although final decisions have not been made.

The US Congress passed landmark legislation in 1996 to review and reregister all pesticides for food quality protection purposes. The effects of the review decisions will extend to water quality.

In addition, there is further standard setting at state level, with varying degrees of intervention and rigour. For example, the Groundwater Protection Act in Iowa has resulted in conditions on atrazine use in 'pesticide management zones' and Kansas is also starting to designate such zones. California and Arizona have some of the most comprehensive pesticide use programmes.

Canada

There is a federal system of pesticide authorisation and control. Pesticide registration also includes a value assessment, which examines efficacy, as well as an evaluation of the registration decision on competitiveness and sustainability. The registration of pesticides require data on acute toxicity, short-term toxicity, long term toxicity, genetic toxicity and metabolism and toxicokinetics in humans. Neurotoxicity studies are required for products that have the potential to affect nerve tissue. Endocrine disrupter risk is evaluated based on data from the reproduction, teratology and short and long term toxicity studies. The provinces regulate commercial and custom applicators, storage of pesticides and container disposal. Canadian standards for environmental risk assessment from pesticide use in agriculture and forestry have been harmonised with US standards and are similar to other pesticide regulatory systems in the industrialised countries.

Australia

As in the USA, there is a system of controls at the national level centred on the procedure for registering, reviewing and establishing labelling rules for all authorised pesticides. This is under the control of the National Registration Authority for Agriculture and Veterinary Chemicals. However, the system is relatively new, having superseded a state level authorisation arrangement in 1995. A variety of pesticides are now being reviewed, presenting an opportunity to alter authorisations and labelling requirements as necessary. Withdrawals and severe restrictions have applied to some of the most toxic products, including mercurial fungicides and certain organochlorines. A national plan for phasing out methyl chloride has been adopted. The Australia New Zealand Food Authority (ANZFA) sets residue levels. Agricultural products have limits and are tested each year. They are examined for residues of chemicals - such as insecticides, fungicides and antibiotics - used in food production. Also tested are environmental contaminants such as metals and for chemicals - such as DDT - that are no longer used in agriculture but can persist in the environment.

New Zealand

Again there is a national system of pesticide registration, authorisation and labelling under the 1979 Pesticides Act and 1996 Hazardous Substances and New Organisms Act. Certain hazardous pesticides, notably organochlorines, have been de-registered. General conditions

for the use of the products are specified on the label but may be supplemented by local rules developed by Regional Councils. Maximum residue limits (MRL) are set by ANZFA (see also table 3.1). However, since many products are exported, all these products must satisfy the MRL of the importing country. The MRLs do vary from country to country and so an extensive data base is kept of all the MRLs and the various industries (such as dairy, kiwi fruit, apple, meat, et cetera) are well familiar with the levels and produce accordingly.

Conclusions

Given the impracticality of comparing the precise authorisation and labelling restrictions for individual pesticides, a more general impression of varying standards can be gained from table 3.1.

Table 3.1 Standards for maximum pesticide concentrations for individual pesticides in drinking water g/litre or ppb

	EU	Australia	Canada	New Zealand	United States
Type of Standard	Mandatory Maximum Acceptable Concentration (MAC)	National water Quality Guidelines for raw water	Water Quality Guidelines for Drinking water (MAC)	Guideline values for Drinking water (MAV)	National Primary drinking water standards
Alachlor	0.1	3	Banned	0.02	2
Aldrin	0.1	1	?	.00003	No
Atrazine	0.1	?	60	0.002	3
Glyphosate	0.1	200	?	Not mentioned	700
Lindane	0.1	10	4	0.02	0.2
Simazine	0.1	?	?	0.002	4
2,4-D	0.1	100	100	0.03	70
Cumulative maximum of all pesticides	0.5	Currently establishing	None	Currently establishing	None

MAV (maximum allowable value, in mg per litre).

The table compares maximum permissible levels of certain pesticides in drinking water, although these are not mandatory in each case. Other aspects of standard setting are provided in the following. No standard exists on aldrin in the USA, because it was banned in 1974. Residues remain to be observed in water sometimes.

No cumulative maximum of all pesticides exists in the USA. The Food Quality Protection Act (FQPA), however, may change for classes of compounds that act similarly, for example endocrine disrupters. In Australia, guidelines for cumulative maximum of all pesticides are under development as are guidelines for atrazine (0.5 is proposed) and simazine (0.9 is proposed). Rules on a cumulative maximum do not exist in Canada and New Zea-

land. Australia and New Zealand are currently establishing a cumulative maximum for pesticides.

Number of active ingredients authorised

The authorisation procedure applied may reduce the number of active ingredients available for agricultural use. Products could be banned for specific use following a procedure to approve or reject active ingredients. Depending on the result, this may limit the availability of pesticides for farming, and put a constraint for agricultural production. Any on-farm constraints that might result from the number of active ingredients authorised remain difficult to assess. Some active ingredients on the list of authorised compounds, for example, may hardly be used in agriculture, and the use of authorised active ingredients may be highly restricted.

Around 850 active substances (organic and inorganic) are authorised for use in the *EU*. There is a downward trend in the available substances, which does reach a critical limit in some countries (e.g. Germany), especially for growing crops that are limited and the market of these pesticides is small. A review system at the EC level is in operation.

In the *USA*, about 315 were applied to major field crops and fruits and vegetables. In total 876 active ingredients were registered in 1995, while 1400 were registered in 1985 showing a decline in the number of active ingredients. FQPA's special review of high-risk pesticides is also leading to the registration of less dangerous pesticides. However, the eventual outcome of this re-registration process, and the constraints they eventually put on farming, remains uncertain.

As of January 31, 1999 approximately 550 active ingredients and 7700 pesticide products were registered for use in *Canada*. The total number of active ingredients registered for use in Canada varies between 500-600. The number of active ingredients tends to increase, but they are becoming more selective and targeted for specific crops and application methods.

In *Australia*, there are some 769 active ingredients registered for use in agriculture (situation June 1999). The total number of active ingredients registered for use is increasing. Review programmes are conducted to ensure those pesticides do not pose unacceptable risks to human health or the environment. Pesticides in Australia are relatively expensive, since a large proportion of pesticides is imported, and because it is a relatively small market. Also, the available products are not developed specific for the Australian conditions.

The number of active ingredients has increased during this decade. About 325 active ingredients are registered in 1999 for use in *New Zealand*. The total number of active ingredients authorised is some 20% above that during the early 1990s. Currently, no phase-out actions are in process. New Zealand imports a large proportion of pesticides and because it is such a relatively small market, farmers face relatively high prices.

Conclusion

The number of authorised active ingredients in the EU and the USA shows a downward trend, mainly due to the re-registration procedure. The constraints that such authorisation procedures put on farming remains uncertain, but the impact is potentially big. The number

of active ingredients is increasing in Australia and New Zealand and the compounds are relatively expensive; it also tends to increase in Canada. While the number may be growing in Australia, many others are also being banned, de-registered or highly restricted.

Restrictions on use of pesticides

The usage of pesticides faces a wide ranging of restrictions across the countries under consideration. They range from applying Good Farming Practices to strict control and prohibition of certain pesticides in specific zones.

The great majority of restrictions on the use of pesticides in the *EU* apply at national or sub-national levels. Under EU legislation, pesticides must be used in accordance with the principles of good plant protection practice, et cetera Mandatory inspection of spraying equipment is applied in several Member States. Major variations exist between Member States concerning restrictions on the use of pesticides. The use of pesticides is prohibited or severely restricted in environmentally sensitive areas (e.g. water catchment areas) in most of the EU, as well as along streams and lakes. Some Member States also ban the use of certain substances or even establish spray-free zones in water protection areas. Such zones commonly increase labour costs or, alternatively reduce revenues from agriculture. Cost-sharing programmes exist in several countries to farmers with zones along water-courses, which must be unsprayed.

Pesticides, which are classified under 'Restricted-use' must be applied in the *USA* by a certified applicator who must keep a 2-year record of the kinds and amounts applied, uses, dates, and application rates of these restricted pesticides.

Restrictions on the use of pesticides in *Canada* mainly apply at national level. 'Best Management Practices' are formulated at provincial level, suggesting practices to reduce contamination of water courses may be at province level. Such practices do not allow filling the sprayer directly from the well or from surface waters. A vegetation buffer strip also needs to be maintained, and spraying needs to be avoided if heavy rain is foreseen. Drift through the use of large drops of high water volumes needs to be reduced, and spraying is not recommended if winds are higher than 8 km per hour.

Restrictions on the use of pesticides in *Australia* are mainly determined at national level. Specific laws vary across States. For example, offences are set out in Victoria for use that differs from recommended dosages (maximum rates, frequency) and failure to observe the withholding period for that use.

The use of pesticides is restricted by product in *New Zealand*, since only registered pesticides are allowed to be used. Such rules are formulated at national level. Spraying is normally permitted, but best practices must be adopted to prevent or minimise any adverse effects, and any contamination entering surface water shall be avoided. Applicators must be qualified and spray plans must be available for perusal by Regional Councils. Water catchment areas are often controlled by Water Authorities and are often in native bush and so restrictions on those are not relevant.

Conclusion

Rules on safety and on-farm constraints on the use of pesticides read all very much the same and there is not very much difference across the countries examined. Dosages are

commonly recommended regarding use (when, where, how, application rates). In addition, several Member States of the EU put restrictions to farmers, limiting the use of pesticides in environmentally sensitive areas. Cost-sharing programmes exist in several Member States to farmers in zones along zones where the use of pesticides is banned.

Taxes on the use of pesticides

Taxes and charges on the use of pesticides exist either to contribute to reduction targets or to generate revenues for supporting production methods that require fewer pesticides, or to create revenues for national legislation (provision of support to reduction programmes or the registration procedure).

There are no taxes at *EU* level, but some countries have taxes (Finland, Sweden, Belgium, Denmark and the UK), ranging from a few percent up to a third on retail price in Denmark. Where existing, the instrument is primarily introduced to reduce use of pesticides or to support input reduction programmes. They are partly being used to finance national legislation.

In the *USA*, California has a small, but nominal pesticide tax. Since 1971, California has collected a pesticide tax to cover its Department of Pesticide Regulation activities. California's local agencies record pesticide use and sales to assess and collect a mil tax. Several states impose excise or sales taxes, or special charges on pesticides. Those charges raise small amounts of revenues for programme administration, or to support special programmes for sustainable agriculture.

In *Canada*, the province of British Columbia has a charge on pesticides, which amounts to CAD 1.20 per litre and revenues are to fund the Residual Stewardship Programme including depots.

In *Australia*, imported pesticides are subject to tariffs and whole sale tax (app. 17%), similar to VAT.

No taxes apply to pesticides in *New Zealand*.

Conclusion

Taxes on use of pesticides exist in the EU, the USA and Canada. No environmental taxes apply to the sales of pesticides in Australia and New Zealand. Where existing, the tax tends to be small, and mainly aimed to generate revenues for supporting legislation. Taxes on pesticides are a few percent only in most of the EU. The tax is high in a small number of Member States, and amounts to a third of retail price in Denmark, where it is part of a national programme to achieve reduction targets.

Generic rules on aerial spraying

Aerial spraying of pesticides is mainly controlled to limit spray drift and reduce pollution effects of pesticides use in the air and water.

Not at *EU* level but the control of aerial spraying of pesticides and periodic inspection of pesticide equipment is required in some countries. Aerial spraying is prohibited in some countries (e.g. Austria, Greece, Sweden) and tightly controlled in most other Member States. Some Member States require permits with constraints on spraying (e.g. minimum

surface to be treated, under certain climatic conditions only) or limit aerial spraying to cases where the application of pesticides is otherwise not possible. Notices have to warn of spraying.

In the *USA*, restrictions on the rate, time and method of application are crop and product specific and part of the registration or label requirements for use. Some States such as California have stricter standards than the rest of the country.

Starting January 2000, in *Canada* only products with use instructions for aerial application may be applied and only for the use listed on the label. A restricted use means that products must not be applied by air unless they are specified for the specific use on the areas on the label. The applicator must have a provincial or a territorial pesticide education certificate, and the Ministry of the Environment must license them.

State/territory legislation in *Australia* prohibits agricultural spraying which injuriously affects any plants or stock outside the target area or any land outside the target area. Pilots carrying out aerial spraying must hold an operator licence. Accurate records must be kept and appropriate insurance held.

In *New Zealand*, all spraying has to occur according to a spray plan, which the farmer needs to have and which must be available for inspection by the Regional Authority and any neighbours. All aerial applicators need to have followed a course in the application of pesticides, teaching best practices. This course needs to be refreshed every three years. The person must hold a current Growsafe Registered Chemical Applicator Certificate, and where applied within 1 kilometre from a road or railway, notice must be given in newspapers or door-to-door. In other places, notice needs to be given to owners or occupiers within 50 metres from the field. This is only to inform, and not to modify the spraying programme.

Conclusion

Aerial spraying of pesticides puts one of the most restricted constraints on pesticide use. It is prohibited in parts of the EU and Australia. Rules read all very much the same in terms of conditions, but it still is in the USA, Canada and New Zealand a permitted use. It is controlled in all countries examined, and is mostly applied through hired labour. Special rules apply on teaching of best practices and a licence is commonly needed for carrying out aerial spraying.

Restrictions on the use of pesticides in watercourses

Spray drift to surface water and is considered a very important diffuse source of water pollution from pesticides. Different measures are required to take mitigation action, including the use of buffer or no-spray zones, low drift application technology.

In the *EU*, such restrictions on the use of pesticides in watercourses are mainly determined at national level or sub-national level. Several Member States control spraying of certain pesticides within a certain distance of any watercourse, or prohibit cultivation of the land (e.g. Denmark) in a zone of 2 metres along a watercourse. Restrictions on use (for example some products are banned) also apply to groundwater protection zones.

Some states in the *USA* have made initiatives with restrictions on the use of pesticides in watercourses. There are no restrictions at Federal level. Kansas is starting to

designate pesticide management zones, limiting use of atrazine within 150 metres of public water supplies, 30 metres of public drinking water supplies and 15 metres of all wells. Farms in Maryland within 40 metres of the Chesapeake Bay or its tributaries, or farms benefiting from a public drainage, must have an individual soil conservation and water quality plan, including best management practices for nutrients, pesticides and sediments.

Buffer zones exist in *Canada*, which apply between sites receiving pesticides and bodies of surface water. Buffer zones for aerial spraying depend on whether the application is from fixed-wing or rotary aircraft. Zones vary across the country.

Australia uses buffer zones, exclusion zones and chemical control areas to protect watercourses. Distances vary across the country and the season. Such exclusion zones are areas wherein specific chemicals are restricted year-round or for a set period. They also include land used agriculturally, such as vineyards and watercourses. The distance of the zones, the time periods and the type of chemicals and application methods vary depending on the individual circumstances of each zone.

Buffer zones are developed in *New Zealand* as a guide only, to suggest minimum distances for various application methods (e.g. aerial application with shelter requires a buffer zone of 100 meters).

Conclusion

The use of pesticides is restricted within a certain distance of watercourses in the countries studied, either through mandatory measures (EU, USA, Canada and Australia) or voluntary measures (New Zealand). Where existing, such buffer zones commonly are wider than in the EU.

Restrictions on the use of atrazine

The use of atrazine is a commonly used pesticide, which is increasingly restricted following the detection of this pesticide in waters. Such restrictions also put pressure on farming in case alternatives are limited or would increase production costs.

Restrictions at national or sub-national level in the *EU*, rather than at Community level. The use of atrazine is banned in several Member States (e.g. Denmark and Germany), requiring farmers to search for more expensive alternatives to treat maize. Specific controls apply to the use of atrazine in some Member States.

In the *USA*, no major restrictions apply to the use of atrazine at Federal level. Restrictions exist on the use of atrazine in protected groundwater areas in a few states. Since 1990 in Iowa, the rate of application of atrazine has been limited to slightly less than 1.7 kg per hectare in Pesticide Management Zones (PMZ). This is half the label recommendation for the rest of the state. Iowa can also take legal action to force farmers to adopt alternative practices if voluntary measures fail to achieve the desired outcome. The combined use of atrazine and simazine is banned only in 6 Pesticide Management Zones (PMZ). The use of atrazine is also prohibited in zones close to drinking water supply wells in the State of Kansas.

No special constraints apply to the use of atrazine in *Canada*. Atrazine is registered for use on corn, lowbush and triazine-tolerant canola.

All users of atrazine require an Agricultural Chemical User Permit in *Australia*. It includes the need to complete an approved training in effective risk management and appropriate action in case of poisoning.

In *New Zealand*, no special restrictions apply to the use of atrazine in any of the regions.

Conclusion

Atrazine is a pesticide, which is widely used in the countries studied. It is banned in several Member States of the EU and in protected groundwater areas in a few states of the USA. It is registered for use in Canada, Australia and New Zealand. Control on the use of atrazine is strictest in the EU and the USA, relative to Canada, Australia and New Zealand.

Restrictions on the use of organo-chlorides

The use of organo-chlorides has been increasingly controlled and put constraints to farming practices.

Several organochlorides (e.g. aldrin, DDT, and dieldrin) are banned in the *EU*. The use of other organochlorines lindane is heavily restricted and authorised for specific treatments only (e.g. seed treatment, soil treatment for growing sugarbeet) only. Organophosphates are permitted for use on specific crops. Buffer zones apply to the use of organophosphates in some Member States.

In the *USA*, like all pesticide compounds, organochlorides and organophosphates are under review for re-registration under the Food Quality Protection Act (FQPA). The outcome of this re-registration process remains uncertain.

Standards for risk assessments in *Canada* are harmonised with US standards.

Some organo-chlorides are banned or restricted in *Australia*. Restricted means where they can be used, how much can be used and who can apply them.

In *New Zealand*, organochlorides were de-registered in 1991; none can be imported and sold. The organochlorides still in the country can be used with a permit. Hardly any permits still exist in agriculture. Organophosphates are not banned or de-registered. They are still used.

Conclusion

The use of organo-chlorides are strictly controlled in the EU and Australia (several compounds are banned in these countries), as well as in New Zealand (where they all were de-registered in 1991). They are currently under review in the USA. Standard risk assessments apply to them in Canada.

Safety rules on application

Safety rules on the application of pesticides are common since occupational exposure is most likely to occur while handling these chemicals during preparation, loading, cleaning and application.

Mandatory training and certification is required in some Member States of the *EU*, by all those who apply pesticides. Periodic approval of the types of spraying equipment used is also required in some Member States.

Pesticides, which are classified as 'Restricted use', can only be applied in the *USA* by trained operators.

Provinces regulate commercial and custom applicators of pesticides in *Canada*.

An Agricultural Chemical User Permit is required in *Australia*. It includes the need to complete an approved training in effective risk management and appropriate action in case of poisoning.

In addition to the rules in *New Zealand* for the application from aerial spraying, localised application using a hand-appliance, the application should not contravene manufacturer's instructions, there is no discharge to water and no spray drift results in adverse effects beyond the target property boundary.

Conclusion

Safety rules on the application of pesticides exist in all countries, and mandatory training of pesticides use is commonly used.

Constraints on storage and disposal of pesticides

Controls on storage and disposal of pesticides are mainly to serve occupational health. Also, disposal of containers may pose serious risks for the environment and human exposure.

In the *EU*, constraints apply to disposal and rinsing of packaging. Take-back programmes exist for active ingredients, which are expired, and not authorised for use. Contaminated packaging need to be delivered at chemical waste sites in most Member States. Containers also need to be cleaned before they can be collected by a household waste system.

In *USA*, rules on storage and disposal of pesticides are applied via labels on each product.

Provinces regulate commercial and custom applicators, storage of pesticides and container disposal. According to the Best Management Practices, it is suggested in *Canada*, to rinse and clean the sprayer away from surface water.

Label instructions should be followed in *Australia*. All containers should be emptied, rinsed and disposed. Rinsing water must not be used to drain into groundwater or water supplies.

In *New Zealand*, labels specify standards for equipment, storage and disposal of pesticides. Efforts are taken to dispose old packages and containers from farms.

Conclusion

Storage and disposal of pesticides are restricted in the study countries, including either rules to dispose containers of pesticides via take-back programmes of industry or government, or through rules to rinse containers.

3.1.3 Sediments

Mitigation actions may be taken by agriculture to limit or control sediments in water and their potential risk for economic off-farm damages.

European Union

No rules on sediments apply to farming in the European Union.

USA

Some states require the adoption of best management practices for sediments, nutrients and pesticides on certain cropland where erosion is a principal cause of sediment. Minimum controls are mainly required on highly erodible lands as part of the farm bill compliance provisions.

Canada

No rules on sediments apply to farming in Canada.

Australia

National guidelines in Australia advise that no more than 10% in seasonal mean concentration of suspended particular matter and turbidity. Guidelines are formulated to protect the aquatic ecosystems and the quality of water for irrigation purposes. The guidelines are binding in the sense that if aquatic ecosystems are damaged the producer(s) responsible are liable to substantial fines and lawsuits. There are cases where producers (dairy operators) have been prosecuted.

New Zealand

Certain limitations on vegetation clearance (to control the destruction of vegetation by cutting, burning, clearing or spraying) and soil disturbances are the only relevant rules that apply to farmers in New Zealand. Clearing activities commonly are permitted uses (with some limitations). On sloping areas, all rules are discretionary activities, which need approval of the Regional Council.

Conclusion

On-farm constraints to control sediments in water apply to farming in the USA, Australia and New Zealand. Rules are mainly to adopt better land management practices. No constraints apply to farming in the EU and Canada.

3.1.4 Irrigation

The extraction of water for irrigation purposes competes with other water uses (industry, domestic water supply, tourism, et cetera) as well as having potentially significant impacts upon the environment, particularly in arid regions where water supplies are scarce. Various measures are taken in both EU and non-EU countries to control water abstraction from agriculture, mainly for irrigation.

European Union

There are no rules at the EU level to restrict the quantity or quality of water used in irrigation, but a variety of policies are in place in different Member States, generally reflecting the degree to which water shortage is an issue and irrigation is common. In many Member States, water is viewed as a public resource and permits are required to abstract water for agricultural use; however there are some regions where private abstraction is unregulated. Most state authorities can place restrictions on abstraction during critical periods of shortage. Charges are generally limited to the cost of water administration (e.g. issuing permits, maintaining infrastructure). Few Member States' charges reflect the opportunity cost of water for irrigation, though France and some regions of Spain are now starting to do so. Cost-sharing grant programmes and extension services exist in many regions to encourage more efficient use (e.g. adoption of drip systems, water metering). In one area of Spain, farmers are receiving payments for reducing their consumption of irrigation water under an agri-environmental scheme designed to protect an internationally important wetland.

Some countries have general prohibitions on all activities capable of destroying, altering or modifying wetland, marshes, springs and watercourses but it is unlikely that these impose significant operational restrictions on irrigating farms outside a few very sensitive areas.

USA

Irrigation is not regulated at federal level in the USA, and few states or areas have imposed water-quantity restrictions. California, where agriculture is highly dependent upon irrigation, is beginning to restrict irrigation water rights in cases where their use may conflict with endangered species recovery plans under the ESA or state endangered species legislation. California has also instituted water rights trading in some irrigation districts. The adoption of more efficient irrigation systems is generally voluntary and usually cost-shared. Drip irrigation is widely used in areas where water is expensive (for example Florida and California). This irrigation system involves high investment and thus substantial operational costs to enhance efficiency. Water quality standards for irrigation also apply to some states. However, these and other regulations appear to have had much less effect on farming practice than the trend in some states to higher water extraction and use costs.

Unlike the western part of the country, in Florida the water belongs to the state and 5-10 year permits must be obtained to use water. These consist of:

- water use permits which specify the amount of water that can be extracted;
- well construction permits for drilling a new well or plugging an existing well;
- environmental resource permits for the construction and operation of new surface water management systems.

Canada

In Canada there are no federal controls on the quantity of water used in irrigation. Control is mainly applied through water quality standards, which commonly apply to surface irrigation for several provinces. This control applies, for example, when liquid manure is spread by surface irrigation. In such case, minimum distances apply between fields and watercourses and the separation distance between the spreading site and a residence.

Australia

Direct constraints upon the quantity of water used for irrigation exist at farm level in Australia, via controls set at catchment level. However, in many areas licenses, permits and charges are used, which act as a warning to producers of water shortages and encourage voluntary restraint. In some areas, binding controls on water use apply. Specific policies include tradable water rights, maximum levels for water extraction, licenses for extraction of groundwater and water use charges. Voluntary 'landcare' programmes also address these issues in many areas. Policies have encouraged farmers to invest in water saving technologies, reduce irrigation, and shift to crops requiring less water, for example out of pasture and into vines. Water is nevertheless a small part of farm costs and rising output prices means that the policy tools may fail to achieve sufficient reductions in water use in some areas.

New Zealand

Water extraction by agriculture is regulated in New Zealand. Water permits are required for all taking of water, damming, diversion or use, except for purposes of reasonable domestic and stock watering. Water permits (consents) are now hard to obtain in some regions for new ventures and water availability for agriculture has reduced in recent years, as the relative value of in-stream waters for recreational and aesthetic reasons has increased.

Water management plans are developed for individual catchments and minimum stream flows defined. The residual water available is the maximum amount that can be made available for abstraction. Regional councils define these maximum amounts, and the consents specify individual amounts permitted and when and where water can be taken. They also specify any water storage requirements, controls on technology, restrictions on field drainage and/or requirements for flood control practices. All consents are time limited and can apply for 1-25 years. Fees reflect the size of the consent (i.e. the administrative costs involved to deal with it), and vary from a few hundred dollars to many thousands of dollars. They comprise an initial application fee of between 300 - 600 dollars, plus an annual administration fee ranging from 50 - 150 dollars per year. The charges are increasing and are now intended to recover the full costs associated with processing applications and monitoring compliance. However, charges for water use are unlikely to include full environmental costs in all cases. Tradable water rights may be introduced in future.

Conclusion

Absolute quantitative restrictions to limit the extraction of water for irrigation purposes do not apply at national level in any country but they may apply in those regions of each country where water is particularly scarce. Irrigation use is increasingly based on time-limited permits. Quantitative restrictions on extraction are usually aquifer-specific and generally appear tighter in New Zealand and Australia than in other countries. Charges appear to be lower than opportunity costs in most cases, where they apply. The EU does not appear to apply more stringent standards than elsewhere, but the trend in several countries is towards increasing costs to more adequately reflect externalities.

3.2 Soil quality and soil erosion

3.2.1 Salinisation

Salinisation of soils occurs in several regions of the EU, USA and Australia, usually where irrigation is applied. It is not an issue in Canada or New Zealand. In the former three countries, voluntary measures have been taken by the agricultural sector to address these problems. Other controls which may affect the salinity of soils are described under 3.1.4 above, and in relation to Australia, under 3.2.3 below.

3.2.2 Soil contamination

Soil contamination from heavy metals and other toxic substances partly occurs from agriculture itself, since fertilisers and livestock manure contain trace elements including metals and salts. A major source of cadmium contamination is the use of phosphate fertilisers. Animal manure also contributes to heavy metals in soils such as copper or zinc, where these elements are often concentrated from animal feed - for example, copper is added to compound feed for rearing pigs. In addition, industrial wastes and sewage sludge used in agriculture can be an important source of pollution from heavy metals.

European Union

EU legislation requires that sewage sludge should be treated before use on farmland. Provisions exist with limits for heavy metals such as copper, nickel and lead, as well as the more toxic elements like cadmium and mercury (table 3.2). Harvesting should not take place less than three weeks after sludge has been spread and there are much tighter restrictions applying to its use on soils used for fruit and vegetable crops. Where limits are breached, sludge may not be applied and the system must be in place to ensure that heavy metal accumulation does not exceed the maximum loads.

Several Member States have adopted Codes of Practice for the use of sewage sludge on agricultural land. Most of the recommendations in codes of practice are made in respect of those who undertake to apply the sludge to farmland and in the majority of cases this will be a water company or their contractors, rather than the farmer. This may be expected to affect the price at which sewage is supplied to the farm (in that it will include the impact of these extra costs), but generally, sludge is regarded as a relatively low cost option among the choice of fertilisers available to agriculture. Often, it is free.

USA

Restrictions apply to the application of sewage sludge in the USA, in terms of the concentration of various chemicals in the sewage and the cumulative chemical loading to a hectare over a year. Maximum pollutant loading rates for agriculture are provided in table 3.2. Sewage sludge must be applied at a nitrogen-based agronomic rate and may not be applied:

- where it is likely to affect endangered species or their habitats;
- to flooded areas, frozen or snow-covered ground, or where it can enter a wetland; or
- within 10 meters of any waters.

Sewage sludge must be labelled for its content and records of application kept for five years. Sites where sewage sludge is applied must also be monitored at a frequency that increases with the amount of sludge applied. Records of application and monitoring must be kept and a statement must explain how these requirements are met.

Canada

Restrictions apply to the application of municipal sewage on agricultural land in Canada. The controls in Ontario are described for purpose of illustration. The application of municipal sewage sludge is subject to various constraints and approval procedures. Detailed standards have been developed at the provincial level to ensure that the application of municipal sewage sludge to agricultural land, a practice that does not occur widely, does not threaten those agricultural lands with contamination (table 3.2). Rules vary across provinces, and the main rules for Ontario are presented here as a typical example of constraints for using sewage sludge on agricultural land:

- producers of potentially usable waste materials require approval prior to application;
- all sludge must be 'stabilised' before being spread on agricultural land, and municipal anaerobic and aerobic digestion processes provide that stabilisation.

In addition to water quality concerns, these standards are also directed at heavy metals.

Australia

Concern about Cadmium is such that authorities limit dietary intake, including:

- Reducing the level of Cadmium allowed in phosphoric fertilisers;
- Eliminating the feeding of phosphate supplements containing high levels of cadmium to cattle;
- Banning the sale of offal from aged sheep and cattle;
- Regulating the disposal of industrial wastes into urban sewerage systems to minimise contamination of agricultural lands by cadmium;
- Monitoring cadmium levels in fertilisers, soils and commodities by Commonwealth and state or territory agencies.

Rules on the application of nutrients also take into account nutrients from sewage sludge. In addition, farmers with animal feedlots must provide documentation showing that the application area is sufficient to handle the salts expected in effluents.

New Zealand

No on-farm constraints apply to farming in New Zealand regarding the quality and quantity of inputs. Guidelines are formulated to control the composition of sludge for land application and which prescribe the amount and method of application.

Conclusion

The EU, USA and Canada have limits for heavy metals in soils (table 3.2). Such limits affect the composition of sewage sludge and their price for farmers.

Table 3.2 Limits for heavy metals in soils (mg per kg)

Metal	EU	USA	Canada
Cadmium	1-3	1.90	1.6
Copper	50 -140	75	100
Nickel	30 - 75	21	32
Lead	50 - 300	15	60
Zinc	150 - 300	140	220
Mercury	1 - 1.5	0.85	0.5

Several constraints on sewage sludge will affect on-farm activities in an indirect manner only, because the constraints put to the application of sewage sludge primarily affect those who undertake to apply sludge. This is normally not done by farmers. Constraints on Cadmium in inputs apply in Australia and these may increase costs of inputs used. Controls on salts from feedlot effluents in Australia may also affect farm costs.

3.2.3 Soil erosion

Soil erosion is an issue in certain regions of all the countries studied. A variety of measures are applied to farms to prevent erosion and the deposition of soil sediment in water (e.g. land management, erosion control measures and crop rotations), some of which are voluntary. Sediments in water have significant potential to cause economic off-farm impacts.

European Union

There are no soil erosion standards set at a European level and few standards exist at Member State level, despite the fact that this is an issue of significance to some, particularly southern Member States. There is some consideration of introducing a soil protection standard at EU level within the next few years. No specific farm-level rules on sediments in water apply in the European Union, although buffer zones and habitat protection measures may also reduce sedimentation in many cases (see sections 3.1.2 and 3.4). Soil conservation practices may be incorporated in voluntary farm assurance standards imposed by food processors and retailers for certain crops, and the issue is covered in Codes of Good Agricultural Practice which may be advisory in some Member States (e.g. UK) and quasi-regulatory in others (e.g. Germany).

USA

Restrictions only apply to farmers on highly erodible crop lands, with physical (e.g. slope length, particle size) and climatic constraints. Farmers receiving federal agricultural program funds on highly erodible crop lands must implement a soil conservation plan for croplands that are vulnerable to erosion. They also need to implement Best Management Practices to reduce erosion. Required practices often include conservation tillage and residue management, but not structural measures. Farmers also must have a plan to prevent sedimentation or damage to off-site properties in several States. A number of States have

instituted laws to control erosion and sediment loading, which do not exempt agriculture. Some states require the adoption of Best Management Practices for sediments, nutrients and pesticides on cropland where erosion is a principal cause of sediment. There are no effective sanctions to farmers on highly erodible crop lands who do not claim funds under the federal agricultural programmes.

Canada

No on-farm constraints exist to control soil erosion or sediments in water.

Australia

In addition to rules related to irrigation, Australian farms are affected by the following policies:

- feedlots must provide detailed data showing the suitability of soils for intended purposes;
- control plans for crop residues and green cover are recommended on a voluntary basis;
- education and community involvement (through programmes such as Landcare) attempt to achieve permanent change in soil quality and management practices;
- Codes of Good Practice and a 'duty of care' is to be applied to all activities that may impact on natural resources (including soil erosion and sediments). This requires the owner of land to take 'all reasonable steps' - i.e. identify harmful practices and take remedial actions - to prevent degradation of land. The steps taken depend on the location and circumstances, and many include limitations on irrigation at certain times of the year, or changing crops and cultivation practices;
- national guidelines in Australia advise no more than 10% as a seasonal mean concentration of suspended particular matter and turbidity, in water. These guidelines are formulated to protect aquatic ecosystems and the quality of water for irrigation. The guidelines are binding in the sense that if aquatic ecosystems are damaged the producer(s) responsible are liable to substantial fines and lawsuits. There are cases where producers (dairy operators) have been prosecuted.

New Zealand

Regional and district plans both contain rules for land disturbance; however, the rules do not automatically imply regulation. Clearance of indigenous and exotic vegetation (e.g. burning, cutting) and soil disturbance (e.g. earthworks, wetland modifications, stream crossings) are generally described as permitted activities in most plans, meaning that they can be carried out without having to apply for specific consents, but such activities are nevertheless subject to conditions. Conditions will be checked and if not followed, farmers can be penalised. There is great variation among Regional Councils in the application of these rules and in some regions clearance and disturbance activities may be discretionary, requiring specific approval by the Regional Council. On sloping ground, all activities are discretionary and require specific approvals.

Conclusion

Farming practice is restricted to control soil erosion and sediments in the USA, Australia and New Zealand. Proper land management to control soil erosion is required in the USA to be eligible for payments on highly eligible land. There are few standards at Member State level to control soil erosion or sediments in the EU and no on-farm constraints of this kind in Canada. However in all countries, incentives, farm extension services, codes of practice or voluntary industry standards may be in place to improve land management practices.

3.3 Air quality

3.3.1 Odour, ammonia and noise

Control of odour, ammonia and noise may involve constraints upon intensive livestock production units. It was decided to treat these issues together, because they are commonly controlled by similar measures at farm level.

European Union

Preventive measures need to be taken against pollution by large intensive livestock production units, in particular through the application of best available techniques (BAT), adapted to local circumstances and taking into account contributions to transboundary pollution. Such techniques are designed to reduce emissions of ammonia, and may involve building standards, e.g. for pig housing. In the low countries - Netherlands, Flanders and Denmark - northern Germany, some areas of north-western France and northern Italy, the use of shallow and deep injectors, trailing shoe spreaders and band spreaders is commonly. Such equipment is more expensive relative to more traditional approaches to spreading manure, allow to the immediate incorporation of manure into soils, which contribute to lower emission of ammonia and odour nuisance. Odour is mainly dealt with by a variety of national and local planning laws, at Member State level. Permits are required for new installations, which will gradually be introduced for all operations, and these are generally given subject to conditions designed to minimise damage to air quality, including ammonia. Conditions may include the specification of slurry capacity, requirements for on-farm treatment facilities, etc, which may give rise to significant on-farm costs.

USA

Several states control odour from livestock producers. These controls are applicable only to large, confined animal feeding operations (CAFOs). There are a very limited number of CAFOs in the country (less than 10,000), and only a fraction of them are affected by the odour standards. Thus, on-farm constraints of these standards are judged to be slight in the short run, although they may become more serious in the future. Odour control methods are mainly applied by requiring adequate distances and buffers between properties, slurry lagoons and livestock housing; requiring manure processing or the construction of larger lagoons, any of which can add substantially to investment costs for producers. These control methods must also be used in some states when handling manure, and new or

expanding operations must adopt odour such methods and technology to prevent air pollution in order to obtain a permit.

Canada

Minimum distance separation guidelines are formulated to mitigate nuisance problems arising from odour. Ammonia from livestock manure is also addressed through separation measures to regulate odour. Separation distances vary with the scale of operation and also across provinces, so it is not possible to generalise about a standard distance. A typical pig production unit with a capacity of 2,000 pigs per year would require more than 1 kilometre from an residential area, at least 100 metres from the nearest property boundary and some 150 metres from the nearest road or road allowance.

Australia

Guidelines on distance and siting exist to protect communities from odours generated by feedlots, dairies and pig operations, and focus on quality constraints of effluent discharge, type of effluent treatment systems applied. Pig operations need to keep a record of all odour complaints as part of their management plan. This plan should also include any remedial action taken to rectify the problem.

New Zealand

Preferred minimum buffer distances between sheds and other features are conducted through guidelines. These guidelines provide the nature of the conditions that might be attached to pig holdings (for example distance to the nearest community should be at least 2.5 kilometres, and at least 600 metres to any off-site residence in case the number of pigs exceeds 4,500 animals).

Conclusion

Distance and siting rules constitute the principal on-farm constraints to control air quality, mainly to limit odour and noise, and to a lesser extent also to limit emissions of ammonia, in Canada, Australia and New Zealand. Additional on-farm constraints in the form of conditions on planning consents for livestock installations are quite significant in the European Union, partly reflecting its higher population densities and the greater proximity of agricultural and settlement areas. Similar conditions apply only to a relatively small number of very large installations in the USA. In the non-EU countries more emphasis is given to air quality aspects related to odour and nuisance while ammonia has been an important concern in the EU. Constraints also apply to farmers in the EU during the application of manure, to reduce emissions of ammonia and control odour nuisance. Such constraints are less strict or non-existent in the other study countries.

3.3.2 Crop burning

Burning of crop residues such as straw can cause significant nuisance to nearby settlements. Measures are therefore taken in several countries to control such nuisance.

European Union

Several countries apply restrictions at a local level to ensure safe burning of crop residues. A total ban on the burning of cereal straw and stubble, as well as the residues of oil seed rape and field beans and peas in arable fields, applies in Germany, the UK and several other Member States.

USA

Oregon has phased out the burning of grassland seed straw and California called for the ban of rice straw burning in part of that State by the year 2000. Burning permits can be obtained for a fee if no other economically and technically feasible alternatives are available to control diseases.

Canada

No on-farm constraints to control crop burning in Canada.

Australia

In Australia, most communities provide guidelines related to the fire risk management practices of crop residue burning. Permission may be required in areas close to populated centres.

New Zealand

Burning of crop residues is a permitted activity in most regions of New Zealand, conditional that it should not impede visibility on nearby roads.

Conclusion

Crop burning is being phased out mainly in the EU and the USA. When applied in Australia and New Zealand, guidelines exist to prevent nuisance or management of fires. It is not controlled in Canada.

3.4 Nature conservation, biodiversity and landscape

The issue of biodiversity and landscape includes endangered species, habitat conservation, cultural heritage, ancient monuments and protected landscapes. In all four of the New World countries there are significant areas of 'natural' or relatively wild habitat in which the integration of productive agriculture with traditional landscapes has not applied. It is usually these areas that are seen as a principal refuge for biodiversity, as well as important scenic landscapes that should be preserved. By contrast in the EU the majority of valuable habitats and species, as well as important landscapes, occur on land which has been farmed for many centuries where biodiversity and landscape quality depend upon the maintenance of some kind of active management, usually through appropriate agriculture or forestry. At the micro scale, farmland areas in all five countries include 'interstitial areas' of rough land or semi-natural habitats, which can provide important sites for wildlife. At the macro scale, Europe is relatively unusual in having large areas of farmed land where a great proportion

of its important species and valued landscapes are uniquely found. These differences are reflected in the degree of on-farm constraints in the different countries.

Protection of non-farm habitat

European Union

Most Member States have legislation designed to protect remaining examples of non-farmed, valuable natural habitat, including the core areas of those European national parks which meet the IUCN category 1 and 2 definitions (this does not apply to all EU Member States' national parks), wetlands of international importance (e.g. RAMSAR sites) and other key sites. Most of these areas will be included in the priority habitats listed in Annexes to the habitats and birds Directives (92/43 and 79/409 respectively), which Member States are required to take action to protect. Controls will generally include requirements for environmental impact assessment and a presumption against both agricultural and non-agricultural development of these areas, except in cases of overriding national interest. However in terms of their extent, these sites are less important in many Member States than those sites and species occurring on farmed land. Sweden and Finland, which still have a predominance of non-farm habitat, would be the only notable exceptions to this rule.

USA

Strict controls exist to protect wilderness areas from conversion to agricultural use as well as from other kinds of development. The US national parks are all strictly protected in this way and there is legislation to protect existing wetlands and other key natural habitats at Federal level.

Canada

Pre-existing local planning standards protect wetlands and restrict severance from existing farm properties.

Australia

In Australia, recent legislation intended to protect the nation's biodiversity resources has greatly limited vegetation clearance, even on private land. In South Australia, consent is required to clear any native vegetation and no broad acre clearing has been approved since 1991. Queensland has set up a satellite monitoring program to enforce its new land clearance rules, while Victoria requires permits to clear any block greater than one hectare. The National Landcare Program has played an important role in developing evolving land use legislation at the state/territory and community levels.

New Zealand

In New Zealand, the conservation estate (8 million hectares) is outside the farming sector and owned and controlled by the Government. On private land, habitats are being protected (controlled) through government and private-funded covenants and other mechanisms (such as reserves, protected private land and resource consents provisions), and less for-

mally, through the initiatives of individual landowners who choose to fence off and maintain remnants of bush, riparian margins and wetland on their land (Department of Conservation, 1998). Some areas in New Zealand, which are covered under indigenous forest of scrub, cannot be cleared for agricultural purposes.

Conclusion

In this respect, the policies of all the countries are similar in nature, and are generally unlikely to result in significant on-farm constraints.

Endangered species and alien species

Another relatively common feature of biodiversity policies in all countries is measures to protect particular indigenous flora and fauna from damage, and to control the introduction or subsequent spread of undesirable alien species.

EU

Under the EC's habitats and birds Directives Member States face obligations to take steps to protect all plant and animal species of community interest which are listed in annexes to the Directives, as well as the habitats upon which they depend for feeding and breeding. These species include both terrestrial and marine, indigenous species and important migrants, identified because they are rare, threatened or vulnerable at European level. Protection measures include direct prohibitions on capture/collection, killing, disturbance and the taking of eggs or live specimens from the wild, and measures to protect the habitats of these species through the establishment of Special Protection Areas (in the case of birds) and Special Areas of Conservation (in the case of other species) under the two Directives. Once designated, these areas and the wider countryside must be subject to measures determined by the Member States that will ensure the maintenance of 'favourable conservation status' for all listed species. Such measures are enacted at Member State and at regional and more local levels. They commonly include a mix of regulations to prevent deliberate and irreversible damage to habitats and control direct damage to species, incentives to encourage appropriate management of habitats and species in the form of public-funded compensation schemes to farmers and other land managers, and advice from a variety of public and private sources. The costs of species protection on farmland will generally be shared between the public purse and landholders but the uncompensated cost to farmers is unlikely to be very high, in the majority of cases, since many Member States allow for compensation wherever such costs are significant.

Member States are also required to consult the Commission on any proposals to introduce alien species into the EU, under these Directives.

USA

In the USA, the Endangered Species Act, passed in 1973, protects endangered and threatened species from federally funded, implemented, or authorized activities, including pesticide use and wetlands alteration. Species (including subspecies of plants or animals and any distinct population segment of any vertebrate) protected by the ESA may be listed as endangered or threatened. Once listed, the species and its habitat are protected either by

the US Fish and Wildlife Service or the National Marine Fisheries Service (responsible for marine and anadromous species).

The US has the largest number of threatened species of the OECD countries. Of the 663 species listed as endangered, 380 are listed, at least in part, due to agricultural activities. Eighty percent of these species rely on private land for their habitat and so far compensation for restrictions has not been paid. While the costs to few farmers can be large, the restrictions have not been imposed widely according to the available data. Exposures to fertilizers and pesticides have contributed to the listing of 115 of these species. Though few listings have affected agriculture to date, restrictions on private property to preserve endangered species habitat has the potential to affect states in the Midwest and Pacific regions considerably. The potential economic impact of protecting threatened species will depend on the distribution of these species by land type and region. The US Forest Service reports that rangelands contain the most listed species. Geographically, western rangelands and eastern forest ecosystems contain the most listed species. Hawaii, California, Texas, and southwestern Appalachia contain 90% of all the endangered species in the US.

Australia

In Australia, significant damage can be caused by the importation of alien species which can upset natural ecosystems; hence there are strict controls on importation and measures to control already-introduced aliens. These policies may have cost implications for farming by restricting the production choices of farmers. However, their direct effects at farm level are generally likely to be insignificant, and in some cases, as for example with rabbits, the control of alien species can bring benefits.

New Zealand

Similar to Australia, there are strict controls on importation and measures to control already-introduced aliens. These policies may have cost implications for farming by restricting the production choices of farmers. However, their direct effects at farm level are generally likely to be insignificant, and in some cases, as for example with rabbits, the control of alien species can bring benefits.

Conclusion

There appear to be species protection measures in all five countries although the emphasis in New Zealand and Australia seems to be more on alien species control. In the USA and EU, farm level constraints tend to be limited to small areas, and/or compensated for.

Policies to protect habitats and landscapes within the farmed area

European Union

The level of on-farm measures applied to EU agriculture for reasons of biodiversity and landscape protection is particularly apparent. Many EU policies seek directly to modify farming practices in order to conserve biodiversity, protect species and maintain landscapes. The EU's Habitats and Birds Directives place an obligation on all Member States to identify and maintain at 'favourable conservation status' a large number of important habitats and species, many of which are found on farmland. To date, most Member States are

in the early stages of devising measures to address this obligation fully, and it seems likely that compensation will be required in most cases to achieve the goals of the Directives.

Many of the EU's agri-environmental programmes, funded through the Common Agricultural Policy, support the maintenance of traditional, extensive forms of farmland management in order to maintain semi-natural habitats such as heathland, permanent unimproved grassland, grazing marshes and extensive dryland arable systems. The prevailing economic trends towards farm enlargement, specialisation and intensification on the best land, and abandonment at the margins, has threatened many such habitats and public payment is used to maintain their economic viability and ensure their sensitive management. In an effort to reverse the significant decline in the extent of these habitats in recent decades, many agri-environment schemes also offer payments for habitat restoration and creation on farmland.

In addition, some EU Member States have imposed obligations upon farmers without compensation. For example, in the Netherlands farmers must not plough valuable meadowlands, which are managed for agriculture. In the UK, the most important hedgerows on farms are now protected from deliberate removal through legislation. Legislation is also in place to protect margins alongside watercourses in several Member States, and in some Regions there are specific local regulations to preserve landscape character, such as protection measures for trees, prohibitions on ploughing grassland and landscape conditions controlling the erection or style of new farm buildings. In Germany, some regions have lists of key 'biotopes' which must not be damaged by agricultural intensification, and these include managed as well as 'wild' habitats.

USA

In addition to non-farm habitat protection through federal and state legislation, the USA also offers support to farmers who enter their land into conservation schemes. For example, in the USA the Wetlands Reserve Programs offset some potential losses from habitat protection regulations, by paying farmers to protect existing or to restore converted wetlands (USDA, 1997). The WRP transfer cultivation rights for wetlands to the US government for specified periods, in exchange for federal payments. The Wildlife Habitat Incentives Program (WHIP) provides cost-share to landowners who develop habitat for upland and wetland wildlife, threatened and endangered species, fish, and other types of wildlife, on their farms.

The US Conservation Reserve Program (CRP) encourages farms to voluntarily set aside areas of land for environmental purposes, in return for land rental payments and limited practice establishment cost-sharing. The CRP has been particularly effective in promoting the diversion of cropland into wildlife habitat and has significantly enhanced wildlife populations in the areas in which major acreage has been retired.

The level of enrolment in the WRP does not effectively constrain farm land use in the aggregate. The CRP at nearly 12 million hectares is much more likely to constrain overall production. Both of course are voluntary, and thereby do not effectively constrain producers. However there may be indirect effects upon land prices, since the enrolment of land into a CRP effectively removes it from the supply of land for productive agriculture and thus the CRP may put a 'floor' into the land market.

Canada

The implementation of the federal action plan on biodiversity relies on voluntary co-operation or compensates producers for participation in demonstration projects such as shelterbelts or grass waterways.

Australia

Much voluntary conservation activity on farmland is undertaken through the 'landcare' programmes which receive public support and involve co-operation between farmers and local community interests to agree adjustments to farming practices that will bring benefits for wildlife and landscapes.

New Zealand

In the South Island, landscape features in some areas are protected and farmers are not allowed to plant forests on the skyline. In addition, the widespread application of voluntary produce assurance standards can be expected to bring knock-on benefits to on-farm wildlife and interstitial habitats through, eg, reduction in pollution and the use of pesticides.

Conclusions

Governments at federal and provincial/state level in all five countries have legislated to protect remaining valuable non-farm habitats such as wetlands from drainage, or bush or forest from clearance, for farming. All countries implement legislation to control protected and alien species, and the evidence here suggests that this may lead to more on-farm constraints in the USA, Canada and the EU. In addition, many EU measures exist to protect extensive areas of valuable farmland habitat and many threatened species which are dependent upon specific kinds of farming activity, while this phenomenon is mainly confined to more limited examples in the other countries. However, compensation is offered in a proportion of these instances.

3.5 Genetically modified organisms

In the five countries examined here, various definitions of GMOs are applied, and there are significant differences in the extent to which GMO use on farms is permitted. Genetically modified herbicide tolerant crops will likely decrease costs of weed control and may facilitate the adoption of minimal tillage. Herbicide resistance and new weed species problems that arise as a result of this technology will be dealt with by traditional methods. However it may be too early to assess the competition effects of these differences, given rapidly changing consumer preferences in each country, and ongoing developments as regards environmental responses to GMO use.

European Union

GMOs are defined in the EU as organisms in which the genetic material has been altered in a way that does not occur naturally by mating and/or natural recombination. EC legislation requires that all GMOs and GMMOs (micro-organisms) in the EU must be approved for release before they can be marketed or used. The uptake remains very small. There is a

system of controls over authorised use of GMOs at EU level. Several actions are required in the EU before the commercial release of a genetically modified organism on the market is allowed:

- Prior consent is required from the competent authority in the country where the product is intended to be used. The notification should contain a technical dossier of information, including an environmental risk assessment, appropriate safety and emergency response, and in the case of products, precise instructions and conditions for use, and proposed labelling and packaging. Consent can only be given by the competent authority once it is satisfied that the release will be safe for human health and the environment;
- Member States must undertake all appropriate measures 'to avoid adverse effects on human health and the environment' which might arise from the release or placing on the market of the product (Article 4 of Directive 90/220);
- Once these steps have been taken, Member States act as reporters and can recommend approval of a GMO product to the European Commission. A qualified majority of Member States takes decisions on market approval for any recommended GMOs, which should then be authorised throughout the EU.

A Recommendation was adopted by the European Commission in 1997 on the compulsory labelling of foods containing GMOs. This has been amended more recently and it is now proposed that all GMO contents in foodstuffs should be labelled wherever they constitute more than one percent of the ingredients of that product. This legislation is likely to affect costs to food processors and retailers, particularly where they commonly use a significant proportion of imported ingredients from countries like the USA, where GMOs are commonly grown.

In response to consumer concerns, many major EU retailers and processors have begun to make pledges not to use any GM ingredients in their products and have taken steps to replace GM sources with GM-free sources. These are rational market responses which could have cost implications for farmers in that they could significantly reduce the on-farm constraints of restricted access to GM varieties.

USA

The definition of GMOs applied to the USA refers to the use of recombinant DNA to crops and animals. Genetically modified animals have already been developed in the USA through the implantation of foreign DNA into fertilised eggs. GMOs are defined as crops or animals produced with recombinant DNA or plant tissue culture (often called transgenics). Although initial developments on GMOs in the USA were oriented towards enhancing production, e.g. reducing pesticide costs, new developments are aimed at consumption, such as retarding ripening, improving taste, or increasing nutritious qualities of the food product. Biotechnology crops have been adopted more rapidly than any previous agricultural technology. Part of the reason for their rapid introduction and spread is that about half the time and some 20% of the cost are required to approve a new biotech product, compared to approval of new chemical pesticide compounds.

On-farm constraints on the use of GMOs are virtually all private, imposed by the seed or chemical companies trying to protect the value of their products and investments,

such as limits on the size of refugia and prohibitions on farm-saved seed. Once the GMO products pass through the review by the Food and Drug Administration, the Environmental Protection Agency and the US Department of Agriculture, they are free to be marketed without significant on-farm constraints. This is reflected by the wide uptake of these crops in the US. Rather, the private supplier promulgates constraints as part of the contract in selling the product to the farmer, such as the size of the refuge for growing non-GMO crops and the retention of all seed.

Canada

Since 1988, plants with novel traits have been released into the environment under confined conditions in Canada (conditions under which plants are prevented from reproducing or pollinating related plants). In 1996, there were 155 submissions for 665 confined field releases of plants with novel traits. A significant portion of the 1997 canola area was seeded with varieties possessing novel traits. Major delays have been encountered in obtaining the required EU approvals, and Canada is increasingly concerned that it will not be able to export canola to the EU.

Australia

In Australia, a genetically modified organism (GMO) is an organism produced by genetic manipulation and whose resultant genetic make-up is unlikely to occur in nature. These do not include organisms obtained by conventional techniques and traditional breeding methods. There have been 112 field trials of genetically modified organisms in Australia, which ranks the country eighth among OECD countries. Australia has had three releases of commercial genetically modified crops: insect resistant (Bt) cotton in 1996; a carnation in 1994 with improved vase life; and a carnation in 1996 with an altered colour (blue).

No GMOs or GMO products have yet been imported or exported under the Wildlife Protection (Regulation of Exports and Imports) Act 1982 (WPA). Species, organisms, groups of organisms or products covered by the Act would be regulated regardless of whether they were genetically modified or derived from GMOs. Australia imports soybean seed from the United States for processing in vegetable oil and protein meal. As a result of the regulatory decision in the US, from late 1996 these imported soybean seeds contain a proportion of transgenic seeds.

New Zealand

No commercial GMO crops are grown in New Zealand. So far only 21 field trials have been approved. With regard to genetically modified food, there is currently no legal obligation to notify the Ministry of Health prior to putting a new food on the market. No legal requirements exist for pre-market assessment or testing of any GMFs. Standards are currently developed for labelling of foods produced using gene technology and foods containing genetically modified ingredients are expected.

Conclusion

Controls on the authorisation of GMOs are very strict in the EU and New Zealand, whereas the application is most advanced in the USA and Canada. It is slowly gathering uptake in Australia. This is primarily related to consumer attitudes, the political decision making

process and awareness of potential risks than to biophysical differences between the countries. However, it is not apparent that the competition effects of these differences in standards is negative for EU and New Zealand producers since there is a growing market for GM-free foods, particularly in the EU.

3.6 Animal welfare

3.6.1 Housing

The provision of animal welfare issues focus on production systems applied. Requirements on housing mainly apply to laying hens, calves and pigs. On-farm constraints for laying hens and pigs are presented in this section.

Laying hen cage systems

Battery cages are the dominant method to maintain laying hens in the EU- and non-EU countries.

European Union

More than 90% of all laying hens are grown in battery cages in the EU. The legal space requirement of a battery cage system is at least 450 cm² per bird, measured in a horizontal plane, and which may be used without restriction. Also, a feed trough is required, and its length shall be at least 10 cm per animal in the cage. Also, each battery cage shall have a continuous drinking channel of the same length as the feed trough. Battery cages shall be at least 40 cm high over 65% of the cage area, and not less than 35 cm at any point. These EU standards are to be changed as a result of legislation being adopted in July 1999. More space per bird will be required and there is now an agreement to effectively phase out battery production over the coming decade.

USA

Animal welfare issues do not play large roles in the USA, and are not expected to lead to serious on-farm constraints in the near future. Indeed, the trend is to reduce the reach of states' anti-cruelty laws. Animal welfare issues in the USA are addressed through a series of voluntary codes of practice and recommended guidelines of husbandry practice. Practices in the guidelines in the US are the 'common' practices and thus exempt producers from the states' anti-cruelty laws. Battery cages are the dominant method to maintain laying hens. Recommended guidelines for the size of battery cages is 312 cm² per bird. Debeaking (layers and broilers), forced moulting of laying hens, no access to nest box or housing that does not allow full-body range of motions (layers), and disposal of male chicks are common practices for fowl in the USA.

Canada

Animal welfare issues in Canada are addressed through a series of federal and provincial voluntary codes of practice and recommended guidelines of husbandry practice. National

and provincial producer associations support these Codes. Abusive treatment of animals is subject to criminal prosecution at the provincial level. Canadian standards in the voluntary Codes recommend minimum cage sizes for chickens housed in cages to be 410 cm² for an adult bird weighing 1.8 kg (equivalent to 4.4 gram per cm²) and 450 cm² for an adult bird weighing 2.2 kg (equivalent to 4.9 gram per cm²).

Australia

All states and territories in Australia require a minimum cage floor space of 450 cm² per bird for chickens weighing 2.4 kg or less, and 600 cm² per chickens weighing above 2.4 kg. Breaches of these requirements can be prosecuted.

New Zealand

Recommendations and minimum standards for the welfare of laying hens are formulated in New Zealand in the Code of Practice for Chickens and Poultry. Codes include recommendations, which are similar to the current standards applying to battery cages in the EU. The standard requirement is that the floor size is 450 cm², and total cage size would be for 5 or 6 birds, that seems to be the rule at the moment. Advice on welfare aspects should be sought when new cages or equipment are being purchased, constructed or existing buildings modified. Floors and other surfaces must be designed, constructed and maintained so as to minimise the risk of injury and disease, and to support the hens adequately. Laying hen cage systems should be constructed to enable support for each forward pointing toe and the slope of the floor in all new cages installed after 1 January 1997 must not exceed 8 degrees. In cages, hens should be able to stand erect without cage features restricting upright posture. The height of all new cages installed after 1 January 1997 must be at least 40 cm over 65% of the cage floor area and not less than 35 cm at any point. The design and size of cage openings and doors must be such that hens can be placed in them and removed from them without causing injury or unnecessary suffering. All new cages for laying hens installed after 1 January 1997 and which have front opening doors must have the doors effectively opening the full height and width of the cage front. Multi-deck cages must be arranged so those hens in the lower tiers are protected from excreta from above.

Conclusion

Housing constraints in the EU and New Zealand are comparable. Space requirements, which apply to battery cages in Australia are similar to those in the EU, but stricter rules are introduced in Australia to growing heavier hens. Recommended guidelines for battery cages in the USA are much smaller than required size in the EU. However, layers used in America are smaller than the European brown layer. White laying hens in the USA on average are about 1.6 kg, whereas in the EU these figures are 1.9 kg (brown laying hens) and 1.7 kg (white laying hens). This implies that the living weight per unit of space in the US (5.1 gram per cm²) exceeds that of the EU (4.2 gram per cm² for brown hens and 3.8 gram per cm² for white hens). Stocking density limits in the EU (in terms of live weight per unit of space) are substantially below that of the US. Animal welfare constraints to grow laying hens in Canada are between those in the EU and the USA.

Free-range chicken

European Union

The free range system in the EU applies to hens that are kept for free-range egg production:

- hens need to have continuous access to the outdoors during the days;
- housing conditions need to have at least 15 cm of perch space to be provide for each bird. Also, at least a third of the available floor area need to be covered by litter material such as straw, wood shavings, sand or turf. Also, a sufficiently large part of the floor area is used for the collection of bird droppings;
- hens must have continuous access during the day to an open air run, which must have a stocking density that does not exceed one hen per 10 m². The outdoor area must also be mainly covered with vegetation.

In the EU, some 3% of the laying hens are currently grown in such systems, and their harexceed 10% in Denmark, United Kingdom and Ireland.

USA

No commonly accepted definition of free-range chicken exists in the USA.

Canada

All commercial egg farms in Canada use either the cage or floor system. Free-range production, while possible in spring and summer is not possible in winter months, making it impractical and too costly to implement on a commercial basis in Canada.

Australia

In Australia, free-range chickens need to meet the following requirements:

- hens have permanent access to a weatherproof house with a deep-litter or slatted floor, and equipped with feeders, drinkers, nest boxes and perches;
- the stocking rate of the house does not exceed 5 birds per square metre of deep-litter floor space or 10 birds per square metre of slatted floor space;
- housing, space allowance, equipment, lighting, ventilation, temperature, food, water, health and management practices are within the limits of the Model Code;
- hens have access to open-air runs during daylight hours;
- hens must be protected from predators at all times;
- the ground to which hens have access is mainly covered with palatable vegetation and has some shade;
- the stocking rate of the runs does not exceed 1.5 birds per 10 m²;
- beak-trimmed stock (hens and pullets) must not be used; and
- induced moulting must not be practised.

New Zealand

No commonly accepted definition of free-range chicken exists in New Zealand.

Conclusion

Free-range production systems are used in the EU and Australia. No commonly accepted definitions of such production systems exist in the USA and New Zealand. The system is not applied on a commercial basis in Canada. Differences between the EU and Australia reflect the housing conditions. Climatic conditions in Australia allow animals to be kept outdoors throughout the year. Free-range chickens need to be provided sufficient shelter to prevent pain upon the animal. Also, in the EU, hens need to have continuous access to the outdoors during the day. Stocking density limits of such runs in the EU (1,000 hens per hectare) is lower than that of Australia (1,500 hens per hectare).

Pigs

European Union

Minimum space requirements to grow pigs in groups in the European Union (m² per pig). No assistance is provided in the EU to compensate farmers to meet the constraints they face. Space requirements, which apply to all holdings in the EU from 1 January 1998, are:

Up to 10 kg: 0.15 m²

85 - 110 kg: 0.65 m²

>110 kg: 1.00 m².

In addition, additional constraints also apply to housing systems for pigs. Tethers are phased out to grow pigs in the EU.

USA

Recommended pen floor space for to grow pigs in the USA are not binding constraints, unless it is by voluntary agreement of producers to access special consumer markets for humanely raised pigs and hogs. Minimum recommended space allowance to grow pigs in groups in the USA:

5.4 - 13.5 kg: 0.15 - 0.23 m²

67.5 - 108 kg: 0.72 m²

Adults: 1.26 - 1.44 m².

Canada

Recommended pen floor space apply to rearing pigs in Canada. They are also based on weight and differentiate according to production system (fully slatted system, partially slatted system and solid bedded system). Figures presented are applicable to fully slatted systems. Recommended floor space is higher for the two other systems concerned:

10 kg: 0.16 m².

100 kg: 0.76 m²

110 kg: 0.81 m².

Australia

In addition, additional constraints also apply to housing systems for pigs. Tethers is also an unacceptable practice in Australia to grow pigs. Minimum recommended space allowance to grow pigs in groups in Australia:

Up to 10 kg: 0.11 m²
60-80 kg: 0.56 m²
80-100 kg: 0.65 m².

New Zealand

Minimum recommended space allowance to grow pigs in groups in New Zealand:

Up to 10 kg: 0.11 m²
60-80 kg: 0.70 m²
80-100 kg: 0.85m².

Conclusion

Buildings with pigs in the EU, Australia and New Zealand must comply with certain minimum space allowances for rearing pigs in a group; in contrast, they are based on recommended space allowances in the USA and Canada. Significant space differences exist for growing pigs. Space allowance for pigs of around 100 kg are more restrictive in New Zealand (0.85 m² per animal), Canada (0.76 m² per animal) the USA (0.72 m² per animal), relative to the EU and Australia (0.65 m² per animal).

3.6.2 Transport of farm animals

Rules apply to the transport of farm animals, and may include requirements regarding journey times, resting times, feeding and watering intervals and space allowances during transport.

European Union

The transport of farm animals in the European Union is subject to EU legislation. The following requirements apply to the transport of cattle, pigs and poultry:

- Journey times for animals shall not exceed 8 hours.
- The maximum journey time may be extended where the transporting vehicle meets the following requirements:
 - sufficient bedding on the floor;
 - sufficient feeding for the animals transported for the journey time;
 - there is direct access to the animals;
 - adequate ventilation is possible, which may be adjusted depending on the temperature;
 - there are movable panels for creating separate compartments;
 - vehicles are equipped for connection to a water supply during stops; and
 - sufficient water is carried for watering during the journey in case of transport of pigs.

Pigs may be transported for a maximum period of 24 hours, on condition that, during the journey, they must have continuous access to water. Other animals need to be given a rest period of at least one hour after 14 hours of travel, sufficient for them to be fed and to be given liquid. They may again be transported for a further 14 hours.

- The main provisions that apply to the transport of farm animals are:
- only healthy animals may be transported.
 - it is prohibited to transport an animal in conditions liable to cause it unnecessary suffering.
 - if necessary, undergo emergency slaughter in a way, which does not cause animals any unnecessary suffering possible.

Inspections will no longer be carried out at the internal frontiers but during transport, at staging points, at the place of destination, et cetera This simplifies documentation requirements for certain journeys.

USA

The federal law regulating livestock transportation (the 'Twenty-Eight Hour Law of 1877') stipulates that animals cannot be transported across state lines for more than 28 hours. Transport of animals by a rail carrier, express carrier, or common carrier (except by air and water) would be not allowed unless the animals are being unloaded for at least five hours of rest, watering, and feeding. The law does not apply if livestock are not transported across state lines; if the vehicle is equipped to provide animals with water, food, and a place to rest; or if animals are transported by air or water. Upon request, the period can be extended to 36 hours.

Some states do have transportation requirements but, as for rearing, the transport of animals for food and food products is exempt from the anti-cruelty law. The period animals can be transported is 18 hours by truck in Vermont. Most states allow a 28 hour transport journey by rail or truck. In Washington, animals can be transported by rail for up to two days without water, food, or rest. Connecticut, Pennsylvania, Rhode Island, Vermont, and Wisconsin have a special provision prohibiting the inhumane transport of poultry. The specific restrictions on the producer and transport carrier vary by state.

Canada

Voluntary codes of practice apply to transport of animals in Canada.

Australia

In Australia, abattoirs are usually located on the coast, making transport problems such as lengthy time and distances inevitable. For transportation, the recommended maximum living weight densities for growing and adult chickens are 55 kg/m² under hot and/or humid conditions and 60 kg/m² for other times. Transport guidelines exist for beef, sheep, poultry and other animals. These are not considered to cause cost constraints for producers.

New Zealand

The responsibilities for livestock rest with different people at different stages of transportation. The farmer is responsible for the careful selection of livestock for loading on to the road vehicle. All actors at different stages of the transportation process will be held responsible for the animals and they can be prosecuted for animal cruelty in the civil court. It is the owner's responsibility to select only fit and health animals for travel, and the nature of

the journey should be considered when determining the degree of fitness required. Proper and sufficient food and water needs to be supplied.

Conclusion

Requirements for the transport of farm animals restrict practice of primary producers to a limited extent only. Restrictions for the transport of animals do mainly rest with other persons at the stage of transport. Constraints on journey time are more restrictive in the EU relative to the USA and Australia. Livestock producers need to provide animals, which are fit and healthy for travel. This should also consider the nature of the journey.

3.6.3 Slaughter

Animal welfare issues for the protection of animals at the time of slaughter put down rules such that animals must be spared any avoidable pain or suffering during slaughter.

European Union

In the European Union, the construction, facilities and equipment of slaughterhouses, and their operations, shall be such as to spare animals any avoidable excitement, pain or suffering. Rules are applicable to solipeds, ruminants, pigs and poultry brought into slaughterhouses for slaughter. Special provisions apply to slaughter according to certain religious rites. The religious authority in the Member States, on whose behalf slaughter is carried out, shall be competent for the application and monitoring of the special provisions.

USA

Rules on slaughter in the USA are specified under the 1958 (and 1978) Humane Slaughter Act. This Act states that livestock must be killed with methods that render the animals insensible to pain by a single blow or gunshot or an electrical, chemical, or other means that is rapid and effective before being shackled, hoisted, thrown, cast, or cut. The exact methods are (1) gunshot, (2) captive bolt, (3) electrical stunner, and (4) carbon dioxide. Both national and foreign processing plants must use humane methods of slaughter to receive the USDA stamp of approval. The law also prohibits dragging of conscious non-ambulatory animals. However, the law applies only to slaughterhouses under federal meat inspection and excludes chickens. Twenty-seven states have humane slaughter laws, but 9 of these do not prohibit manual stunning with a sledgehammer, and 4 do not have assigned enforcement authority.

Canada

Voluntary codes of practice apply to slaughter of animals in Canada.

Australia

Since December 1996, it has been compulsory in Australia for meat from all species slaughtered for export or domestic use in Australia to be tested for some 90 chemicals by NRS, under the Australian Standard for the Hygienic Production of Meat for Human Consumption. Abattoirs are inspected by independent auditors from quality assurance programs, HACCP, and from agencies appointed by the European Union, Japan and the

United States. Costs are borne by the industry. Legislation mandates slaughterhouses to have HACCP-based quality assurance plans.

New Zealand

Rules on slaughter in New Zealand also are very much determined by the requirements of their major markets (European Union and USA) and the large abattoirs and meat slaughtering plants are all audited by inspectors from the EU. Farmers pay the majority of these inspection costs.

Conclusion

Rules on slaughter of animals primarily restrict the equipment and facilities of slaughterhouses and put constraints to primary production to a limited extent only. Primary producers commonly pay inspection controls of animals. Rules on slaughter are broadly similar in the EU, Australia and New Zealand, since the large abattoirs and meat slaughtering plants are audited periodically by inspectors from the EU.

3.7 Human health

3.7.1 Hormones and animal feed ingredients

Hormones are used to promote the growth of production of livestock; additives are provided to animal feed to prevent production losses. The use of such compounds are restricted in some study countries because of the potential human health effects.

Hormones (e.g. Bovine Somatotrophin, BST)

European Union

The placing on the market and the administration of BST is prohibited in the EU, and Member States need to ensure that the placing on the market of BST to dairy cows is not authorised. The use of growth-promoting hormones in beef production is banned in the EU. The ban is applicable to the use of six hormones, including 17 β -oestradiol, oestradiol, progesterone, testosterone, zeranol and trenbolone. The import of beef from the USA and Canada is banned, because of the potential risks from the permitted use of 5 hormones in beef production.

USA

Recombinant bovine somatotrophin (rBST), the genetically modified version of BST, is injected into dairy cows in the USA to increase production. It was approved by the Food and Drug Administration (FDA) in 1993 and is presently used on 30% of dairy herds in the US, reducing costs per unit of production. In the short run, rBST gives farmers an advantage over farmers in trading countries, but because the human and environmental costs of this technology has not been studied carefully, the long-run story might be different. The use of growth-promoting hormones in beef production is permitted in the USA.

Canada

BST has not been approved for use in the dairy industry in Canada, and animal health concerns were cited as the reason that approval was not granted in that country. The use of growth-promoting hormones in beef production is permitted in Canada.

Australia

BST is not allowed in Australia. Growth hormones in beef are permitted. Record keeping is mandated so exports are allowed to countries banning imports of meat produced with growth hormones. Auditing costs are covered by Australian producers.

New Zealand

BST is not registered as an acceptable compound in New Zealand and hence its use is illegal; this is mainly to meet restrictions on the import of dairy products in the EU. Beef growth hormones are allowed, but the meat from beef cows treated with growth hormones is kept separate from non-growth hormone treated beef.

Conclusion

The use of BST is prohibited in the EU, Canada, Australia and New Zealand. This puts constraints to individual producers because the use of BST would enhance production. BST is approved for use in the USA, and it is currently applied on 30% of dairy herds in this country. The ban on using BST is introduced, either because of public concerns about the risks to human health (EU); animal health concerns (Canada) and because of restrictions put by the EU for the import of dairy products (Australia and New Zealand).

The use of growth-promoting hormones for beef production is banned in the EU. It is allowed in the USA, Canada, Australia and New Zealand.

Animal feed ingredients

European Union

Four antibiotics are forbidden as feed additives in the EU from the beginning of 1999, including bacitracin zinc, spiramycin, virginiamycin and tylosin phosphate. The ban on these products reduce growth promotion of livestock and also diminishes feed efficiency.

The products are allowed in circulation until the middle of 1999. Three EU Member States have already implemented bans of their own. Sweden has a total ban on the use of anti-microbial feed additives. The Danish farmers' union established voluntary programmes in 1997 to ban use of anti-microbial feed additives for all poultry, cattle and fattening pigs. Finland had banned two products, for example spiramycin and tylocin phosphate prior to the EU legislation.

USA

Three out of the four antibiotics that are banned in the EU (tylosin, bacitracin and virginiamycin) are currently used in the USA. The following antibiotics are in use in US feed for livestock and poultry: chlortetracycline, procaine penicillin, oxytetracycline, tylosin, bacitracin, neomycin sulphate, streptomycin, erythromycin, lincomycin, oleandomycin, virginiamycin, and bambarmycins. Also, arsenical, nico-furan, and sulfa compounds are often

used in animal feed. Antibiotics are regularly used at a rate of 2-50 grams per ton to improve performance in animals. The levels are increased to 50-200 grams per ton when specific diseases are targeted.

Canada

Three of the four antibiotics (bacitracin zinc, virginiamycin and tylosin phosphate) are approved for use in Canada. Spiramycin, however, is not.

Australia

Rules on the prohibition of antibiotics in Australia are rather similar to the ones applied in the European Union. Registration of tylosin phosphate and spiramycin expires on 30 June 1999, but renewal is automatic unless a review is requested and accepted. Bacitracin zinc and virginiamycin are not registered for use in Australia.

New Zealand

In New Zealand, all of the above four antibiotics are available for application in premium calf boosters (bacitracin zinc), for dogs and cats only (spiramycin), for treatment of horses and for pig/poultry and turkey rations (virginiamycin) and for several purposes (tylosin phosphate).

Conclusion

Rules on the use of additives in compound feed are rather restrictive in the EU and Australia. Such bans will increase production costs per unit of output marketed. Several of the antibiotics, which are currently banned in the EU, are approved for use in the USA, Canada and New Zealand.

3.7.2 Pesticide residues in food

The quality of food is controlled mainly through the provision of limits on the amount of pesticides in food. This can be achieved either by limiting the application of pesticides or by ensuring that the pesticides are broken down sufficiently before the food is sold.

European Union

Maximum levels are defined for pesticide residues in and on fruit and vegetables, cereals and foodstuffs of animal origin. With certain exceptions, the limits apply to exports as well as the EC market. To reinforce compliance with the Directive there are obligations on Member States to inspect produce by check sampling and to draw up forward programmes laying down the nature and frequency of inspections.

USA

EPA registers pesticides for agricultural and other uses, and limits residues through 'tolerances,' defined as 'the legal limit[s] of a pesticide residue allowed in or on a raw agricultural commodity and, in appropriate cases, on processed foods' (NRC, 1993, p1). Tolerances must be established for any pesticide used on any food crop. Once approved for distribution, the pesticide compound must have a label that specifies the rules under which

it is to be applied, such as wind conditions and applicator protective clothing to protect human health. These federal rules may be supplemented by state regulations for residues and applicator safety.

Canada

Provincial legislation provides inspection standards for agri-food products, including among others, dairy, meat (including meat hygiene), fresh fruit and vegetables. These responsibilities include provision of regulatory and advisory services regarding farm facility standards, recommended production practices and dairy inspection. Provincial governments also provide educational support and distribute information packages on safe food handling practices.

Australia

The National Registration Authority (NRA) for Agricultural and Veterinary Chemicals recommends Maximum Residue Limits (MRLs) for chemicals in food commodities to the Australia and New Zealand Food Authority (ANZFA). MRLs are designed to reflect good agricultural practice and are based on the residue levels expected if producers follow the label recommendations. They are adopted into the Food Standards Code, which automatically becomes part of all state/territory food laws. With the exception of Tasmania, the Australian Capital Territory and the Northern Territory, all states have established monitoring programs for agricultural and veterinary chemicals, and some selectively survey for heavy metals as well.

New Zealand

For pesticides (including fungicides and herbicides) MAF maintains a MRL database showing the pesticide residue standards established by New Zealand's trading partners. This data base covers all the pesticides registered for sale in New Zealand. Food exporters in New Zealand must comply with these MRLs as a condition for access to these markets. Likewise, food imported into New Zealand must comply with the specific MRLs listed in New Zealand Food Standards, or comply with Codex Alimentarius MRLs; or comply with the Australian Food Standard A14.

Conclusion

The level of on-farm constraints generally is very low. There are very few clear differences across countries, and most conform broadly to International standards.

3.7.3 Hygiene rules for dairy farming

The extensive range of legislation on food hygiene in the EU applies mainly to the storage, processing, transport and marketing of food rather than at farm level. The pattern is similar in other countries. However, the dairy hygiene rules are an important example with farm level implications.

European Union

Hygiene rules apply to the production and trade in milk and milk products. Member States may amend or introduce national hygiene provisions that are more specific than those laid down at EU level. This however is conditional that such provisions are no less stringent than those applying to the EU, and do not constitute a restriction, hindrance or barrier to trade in foodstuffs produced in accordance with the hygiene rules on milk and milk products.

Requirements apply to all enterprises involved in the production, processing and marketing of milk and milk products derived from cows, sheep and goats milk up to the point of retail. They are applicable, among others, for cooling tanks, water use and herd standing:

- animal health requirements for raw milk (e.g. raw milk from cows should be free of tuberculosis and should not show symptoms of infectious diseases communicable to human beings);
- hygiene of the holding (raw milk must come from holdings which undergo regular veterinary inspections);
- hygiene in milking, the collection of raw milk and its transport from the production holding to the collection or standardisation centre or to the treatment establishment or processing establishment - these rules stipulate the materials used and standards required in milking parlour construction, milk storage facilities and cleaning requirements for buildings, equipment and animals;
- hygiene of staff, specifically regarding persons performing milking and handling raw milk, who should wear suitable clean milking clothes;
- standards to be met for collection of raw milk from the production holding or for acceptance at treatment or processing establishment.

USA

Milk hygiene rules are rather strict, and include a wide range of on-farm constraints. The cow's teats must be washed with sanitizing solution or (wet) cleaned and dried prior to milking. The milk must be picked up at least every 3 days; the milk must be refrigerated within 2 hours of milking. Tuberculosis is not a concern because dairies must be in a tuberculosis free area or otherwise certified tuberculosis free; cows are also tested for BT every year. A sample of milk is taken every time the milk is picked up and tested with a milk truck test. The milk is tested for bacteria at random once every two months and for butter every month. State health and federal inspectors visit at random, but inspectors from dairy co-operatives visit and enforce the regulations more regularly. Brucellosis can be tested in the milk but has not caused a health problem.

Canada

Milkhouse sanitary regulations are similar for all Canadian provinces. The farm level standards for Ontario are illustrative of the types of regulations applied at the farm level:

- no producer may sell milk from an animal that is suffering from an illness or infected by a disease that adversely affects the quality or flavour of the milk or cream. No producer shall sell milk that is not clean, that shows evidence of being flaky, coagulated, thick or adulterated. Milk must be cooled in a farm bulk tank in proper

working condition so that it cools milk to a temperature of 4°C or lower within two hours of milking.

- when animals are in stables they must have short hair on udders, flanks and tails.
- buildings where animals are milked must be kept as clean as possible, from insects and dust and adequately lighted.
- milking utensils must be rinsed in luke warm water and thoroughly cleaned, and stored on clean racks before usage.
- a person must wash their hands immediately before milking and keep his/her hands clean during the milking.

Dairy plant operators are responsible for ensuring their plants operate in compliance with regulatory requirements, and dairy products are safe and wholesome.

Australia

All food businesses are required to have a food safety plan based on HACCP principles. There is a phasing-in of this requirement for different sectors of the food industry. Hygiene rules in Australia are in line with those for European Union dairy activities.

New Zealand

Dairy producers in New Zealand apply standards similar to EU farmers for their export to Europe. Directive 92/46 is the major comparative document on which the dairy industry bases its policies. 300 herds are sampled annually and their milk is tested for 130 residues (according to rules established in the context of EU legislation for placing on the market of milk, heat-treated milk and milk-based products).

Conclusions

The on-farm constraints are apparently broadly consistent between the countries studied, covering a similar range of considerations to control hygiene and diseases. Hygiene rules in Australia and New Zealand are in line with those for European Union dairy producers. Dairy producers in these countries apply standards similar to EU farmers for their export to the European Union. The main incentive approaches used for the agricultural sector tend to focus on the adoption of management practices, the provision of training and advice. The measures are either public funded or primarily market-driven.

3.7.4 Veterinary requirements and conditions to control animal diseases

Several countries have compulsory measures; others have voluntary codes, to control animal diseases. These measures might in practice imply the same constraints to farmers.

European Union

The EU has several programmes to control the occurrence of diseases in live animals and animal products:

- salmonella is controlled either on a voluntary basis (e.g. in the Netherlands) or compulsory (e.g. Sweden).

- E coli is controlled in some countries. Farm sampling would be required in case E coli is observed on the holding. Government covers the costs of sampling.
- control of the New Castle disease, either through compulsory or voluntary vaccination policies. Financial aid of the Community is provided for the operation of the Community Reference Laboratory for this disease.

USA

Controls at the farm level to reduce risks posed by microbial pathogens are not common. Occasionally, outbreaks of foodborne illness or disease, such as E-coli and salmonella contamination, lead to calls for better oversight of food safety. These concerns have, to date, mainly affected the food-processing industry.

Canada

There is an extensive system of animal health monitoring and inspection, including live-stock quarantine provisions. This system has been very successful in the control of livestock disease, which are mainly off-farm.

Australia

Operational responsibility for the control and eradication of animal diseases are with state government. Each state therefore administers its own emergency disease control programme. Cost-sharing agreements are used to fund the eradication of exotic animal diseases, including among others, African swine fever; classical swine fever, foot-and-mouth disease, Newcastle disease and rinderpest.

New Zealand

An extensive system of border protection and other protection schemes against possibilities of an outbreak of foot and mouth disease and other disease are in place.

Conclusion

All five countries have programmes to control diseases in livestock to protect the public from any health hazards that might arise from diseased livestock. Systems of animal health monitoring inspection are in place. Control over the outbreaks of disease, eradication programmes, vaccination policies, slaughter policies et cetera may be defined at the regional/state rather than the federal level in some cases but it is not clear that farm level constraints are substantially different. Naturally, constraints arise when outbreaks of disease occur and remedial measures are needed. Such costs do not indicate systematically higher standard in a particular country however.

3.8 Concluding remarks

The high level of concern about food safety, farm animal welfare, landscape and nature conservation, nuisance created by more intensive livestock farms, GMOs, growth promoting hormones and certain other technologies creates a significant weight of policy interventions in the EU which goes beyond that experienced in the other countries - al-

though the panorama of other issues covered by legislation is not dissimilar. Different public preferences clearly play a part in this distinctive approach but the reliance on intensive practices in many regions, the close proximity of farm and urban environments and the relative lack of wilder areas play a part too. The policy interventions in the EU clearly generate farm level constraints on a corresponding scale. Quantifying these in an effective way remains difficult, not least because of the variations within the EU as well as between the five countries.

In certain cases, direct comparisons can be made, for example between the rules concerning use of a particular pesticide. In the case of pesticides, it would be possible to undertake a major study making direct comparisons for a range of key products, as illustrated in this chapter for atrazine. This would require a separate study of its own. It would remain necessary to place the results of such an inquiry into the environmental and agronomic context of each country. A relatively restrictive set of conditions on the use of a pesticide in one country may in practice have less impact at farm level in another if production conditions are entirely different.

The constraints within the EU at farm level are founded partly on the rather wider range of concerns suggested in chapter 2. The tendency to rely on regulatory and command and control policy measures in the EU may give rise to more formal constraints than in countries relying on codes of practice, voluntary procedures et cetera but the level of implementation needs to be taken into account before firmer conclusions are drawn with regard to competitiveness.

Where there are similar concerns, with respect to nitrate pollution of water for example the underlying standards often broadly comparable between countries, even if the policies associated with the standards are different. This needs to be seen in light of the much higher incidence of excess nutrient problems in much of northwestern Europe compared to the other countries in the study. There are certain areas where EU standards are more restrictive particularly with regard to landscape, GMOs, growth hormones and farm animal welfare (housing systems for rearing laying hens). It is particularly difficult to quantify the significance of constraints related to landscape because many of them arise from local land use planning, zoning and development control procedures. By contrast restrictions on GMOs are tighter in the EU than in North America.

4. Impact of standards on the relative competitiveness of EU agriculture

This chapter explores the economic implications in the various countries of the policies identified, by relating their impacts to the size and composition of agricultural production in each country. The key questions to be addressed are:

- which agricultural products are affected most in the EU, by the apparent differences between countries in their prevailing or upcoming standards for the commodities selected;
- how do the identified standards influence the relative competitiveness of EU agriculture vis-à-vis main competitors in the world market?

The analysis in this chapter is based on five subsequent stages:

- summarising the main apparent differences in standards (as expressed in on-farm constraints) between the EU and non-EU countries. This part of the analysis compares environmental and health-related standards in the EU and the four other countries studied, taking account of differences in environmental and health-related context, which might affect the appropriateness of standards;
- linking these differences in environmental and health constraints to particular agricultural sectors (text discussion and figure 4.2). This part identifies those sectors which might face much stronger on-farm constraints in the EU relative to the non-EU countries studied, or vice versa, once differences of context are taken into account;
- identifying which sectors are likely to be most relevant for the EU in terms of production value, international trade, export or import (table 4.1). The current position of the commodities on the world market is shown (table 4.2). This part identifies regions in the world where both EU and non-EU countries have trade;
- qualifying the impacts of standards for sectors. This part assesses the potential trade implications of standards through their impacts on production costs.
- assessing the potential implications for the relative competitiveness of EU agriculture vis-à-vis main competitors in the world market.

Stage 1: Main differences in standards

Chapter 3 has identified on-farm constraints arising from environmental and health-related standards which attempt to internalise external costs of agricultural activity. Differences in the level of constraints between countries can often be explained by reference to the environmental context in each country. Excess nutrient problems in water, for example, are more acute in the EU than they are in the other countries studied, and these measures have implications for on-farm costs.

Figure 4.1 highlights the policy areas across the five countries, and attempts to identify the main constraints they place upon farming, based upon the comparative assessment in chapter 3. It identifies leading policy areas which put major constraints upon farming, on

the basis of the available evidence as presented in this report. A simple ordinal scaling system has been applied in the figure, to indicate relative levels of constraint. We have focused on those policies that internalise an external cost attributable to agricultural production. The figure distinguishes the following categories:

- No apparent constraint upon farming and no obvious policy in place in relation to agricultural practices;
- * Policy in place, but not considered to imply a real constraint for farming;
- ** Policy identified as a constraint upon farming but unlikely to be a major cost to the sector as a whole (e.g. limited geographical coverage or low-cost implications);
- *** Policy indicated as a major constraint upon farming which implies significant on-farm costs

A qualitative judgement is given on the differences between EU and non-EU countries. Differences in on-farm constraints could be major or limited. The intermediate categories have been introduced where the differences in on-farm constraints appear to impact farming to a limited extent only. No reference is made to impacts where producers are subject to the same legal constraints or where no constraints apply to farming.

Issue	European Union	USA	Canada	Australia	New Zealand
Nutrient enrichment by nitrates and phosphates	***	**	*	*	*
Pesticides	***	***	***	**	*
Sediments	-	**	-	**	**
Irrigation	*	*	*	**	**
Salinisation	-	-	-	**	-
Soil contamination	**	**	**	*	-
Soil erosion	*	-	-	**	**
Odour, nuisance, ammonia	***	**	**	*	*
Crop burning	*	*	-	-	-
Biodiversity, landscape	***	*	*	*	*
GMOs	***	*	*	**	***
Housing (laying hens)	**	*	**	**	**
Transport	**	*	*	*	*
Slaughter	*	*	*	*	*
Hormones and animal feed ingredients	***	*	*	**	*
Pesticide residues in food	*	*	*	*	*
Hygiene rules in dairy farming	**	**	**	**	**
Veterinary requirements, control of animal diseases	*	*	*	*	*

Figure 4.1 Constraints upon farming which internalise external costs to environment and health

As can be seen, there are some areas where differences between the countries are not readily apparent. These would include pesticide residue standards for food, standards re-

lating to the slaughter of animals, hygiene rules for dairy farms, and veterinary requirements and conditions to control animal diseases.

In other areas, there appear to be differences but these are considered unlikely to affect costs significantly, across the principal agricultural sectors. This would apply to standards affecting soils – erosion, sedimentation, contamination – as well as sediments, irrigation, crop burning, and animal welfare standards concerning housing and animal transportation.

This leaves the following areas where significant differences are indicated:

- nutrient enrichment of water;
- pesticide authorisations and permitted levels in the environment;
- odour, nuisance and ammonia levels in air;
- biodiversity and landscape constraints;
- GMOs and policies on hormones and animal feed constituents.

It must be stressed that these apparent differences emerge from the strategic assessments made in chapter 3, which aim to achieve a qualitative appraisal of on-farm constraints based upon a range of information gathered at national and sub-national level to illustrate the situation in each country. In order to make a more accurate assessment of differences, it would be necessary to undertake a more thorough and exhaustive survey of on-farm constraints at regional and local levels for most of these issues.

Considering the influence of the environmental and health contexts in each country, we can see that to a certain extent, differences in on-farm constraints can be rationally explained as similar degrees of policy response, once set in the context of different environmental or health conditions in each country.

In the case of nutrient enrichment of waters, tighter on-farm standards may be necessary in the EU for consumer protection reasons, because its farms are usually closer to, and have a more direct impact upon, other water users and in particular, drinking water supplies. However, the quality of the aquatic environment may suffer in all countries, including those without such constraints, even though their farms are located far from centres of population and the water affected by agriculture is not critical for drinking purposes. However, in a country such as New Zealand where the rate of water flow through the environment is generally claimed to be faster than would be common in much of Europe, the environmental impacts of nutrient enrichment of waters could indeed be lower than it would be elsewhere. This study would suggest that the differences between countries in respect of these standards, and their on-farm constraints, would be worthy of more detailed investigation.

For pesticides, differences in standards between countries are unlikely to be greatly tempered by environmental context. In all five countries, the potential impact of pesticide use upon flora and fauna is likely to be equally significant. It therefore suggests that differences between countries do not simply reflect differences in environmental context.

By contrast, issues related to air quality, including odour, nuisance and ammonia discharges, are partially context-related. Odour and nuisance controls are directly related to perceived disbenefits to nearby households, and these are more likely to be a problem in a densely-populated country such as the EU than they would be in any of the other countries considered. While ammonia production by intensive agricultural installations may be

similar in all five countries, the need to impose standards specifically for farming depends upon the proportional contribution of farming to overall ammonia production and to related concerns about acid rain. These are highly regionally specific and vary according to other factors including the degree of industrial pollution experienced in a particular area. Thus the relative importance of applying ammonia reduction targets to agriculture is likely to vary greatly between the countries in this study.

It is very difficult to determine, using the information from this analysis, the extent to which differences in farm-level constraints related to biodiversity and landscape conservation are context-dependent or not. Firstly, all countries have a significant number of species that are in decline or threatened, but the degree to which these species are affected by on-farm practices varies significantly between countries. It seems clear that farmland practices can significantly affect biodiversity and landscapes in all five countries but whether the micro-level policies reflect micro-level differences in the agri-biodiversity interface cannot be assessed within the resources available to this project.

We recommend that this would be one area where differences in on-farm constraints appear to be notable, and are therefore worthy of further investigation in order to analyse more precisely how they relate to environmental contexts and therefore whether they truly represent differences in standards.

Finally, in relation to differences for GMOs, hormones and ingredients in animal foodstuffs it seems clear that these relate to a heightened consumer awareness or concern in the EU as compared to certain other countries in this study, most notably the USA. From the US viewpoint, greater EU consumer concern may be largely a reflection of 'scaremongering' tactics by environmental pressure groups, combined with the particular history of the BSE epidemic in Europe. However many EU stakeholder groups would claim that their caution reflects an appropriate assessment of risk while the response of the US has given inadequate consideration to the issues of long-term and imperfectly-understood impacts upon human health and the environment. The intermediate position of Canada, Australia and New Zealand in these respects appears to reflect either similar approaches to risk-aversion (e.g. for Canada, in respect of hormones) or greater export-orientation in setting standards (e.g. for Australia and New Zealand). These factors mean that they are more likely to match the more cautious approach of the EU, in their standards.

Stage 2: Linking standards to sectors

This study has identified a very wide range of environmental and human health-related standards, which may affect the farm-level constraints faced by the agriculture sector as a whole. There are some standards that potentially affect all sectors of farming, such as those related to pesticides and water quality, but many others that are likely to have greater effects upon some sectors than on others.

Cross-country differences in on-farm constraints have different impacts on agricultural sectors. Figure 4.2 identifies sectors that might face the largest restrictions as a result of the differences in on-farm constraints in the EU relative to the USA, Canada, Australia and New Zealand. The figure links the apparent differences in on-farm constraints, as assessed in figure 4.1 with those production sectors that might be affected most.

Issue	Differences in on-farm constraints and their impacts on sectors
Nutrient enrichment by nitrates and phosphate	Constraints on intensive livestock production (pigs, poultry and eggs) are more strict in the EU relative to the USA, Canada, Australia and New Zealand. Limited differences likely for dairy and beef sectors
Pesticides	The degree of constraints show some differences between the EU, the USA and Canada. Constraints in the EU are more strict relative to Australia and New Zealand. A lot of similarities, however, are observed in the control of pesticides. Impacts of any differences would be likely to have significance for arable crops, horticulture, permanent crops and some specific livestock sectors such as sheepmeat (from insecticides used to prevent parasite infections). In considering main export commodities selected for this report, differences could be important for wheat, silage maize, apples, oranges, tomatoes and wine
Sediments	No on-farm constraints apply in the EU and Canada; constraints mainly exist in USA, Australia and New Zealand. Impacts for arable crops and horticulture as well as some permanent crops. Considering the key sectors for export, these would include wheat, silage maize and wine.
Irrigation	The EU does not appear to apply more stringent standards than in the USA and Canada. Restrictions upon farming practices mainly apply to Australia and New Zealand; the EU does apply less stringent standards relative to these countries. Impacts may apply to all irrigated produce, but in relation to export commodities these would be most significant for silage maize, apples, oranges and tomatoes. In the case of wine, many quality wines specifically prohibit irrigation so the impact would be only on lower-quality and lower value trade.
Salinisation	No constraints in the EU, USA, Canada and New Zealand. Constraints apply to Australia, because of the control of salts on water used in irrigation. Impacts could theoretically affect production costs for irrigated crops, as discussed above
Soil contamination	On-farm constraints on the application of sewage sludge are limited. Largest difference with New Zealand because no restrictions apply to the quality and quantity of inputs applied. Impact mainly for arable crop production (wheat and silage maize), since health-related controls on horticulture will generally minimise the use of sewage sludge on these outputs.
Soil erosion	Farming practices are more constrained in the Australia and New Zealand than in the EU. The constraints on farming practices will primarily have impacts on crops vulnerable to soil erosion such as horticulture, vines and maize.
Odour, nuisance and ammonia	Constraints are more restrictive in the EU relative to intensive livestock production units (pigs, poultry and eggs), than in the USA, Canada, Australia and New Zealand. They may also have a greater impact upon beef production, particularly in intensive systems.
Crop burning	Burning of crops is heavily restricted mainly in the EU and the USA. It is controlled in Australia and New Zealand; no restrictions apply to crop burning in Canada. This mainly affects production of arable crops including wheat but the standards appear similar.
Bio-diversity and landscape	Constraints to farming appear stricter in the EU than in non-EU countries. However, a proportion of these measures are voluntary so that farmers costs are compensated through government programmes. The principal impacts of these standards will be greater for land-based farm production, and particularly grazing livestock enterprises, including dairy, beef and sheep. However some species and feature-related constraints will also apply to arable production, including wheat and maize.
GMOs	Constraints are very strict in the EU and New Zealand, whereas the application is most advanced in the USA and Canada. It is slowly gathering uptake in Australia. These rules will affect the production costs mainly for arable crops including wheat and

	maize, and horticultural crops, including tomatoes, as well as potential future applications for vines and citrus fruits.
Housing	Space requirements for rearing laying hens are more restrictive in the EU and New Zealand than they are in the USA. Rules in Australia are similar to those in the EU. Constraints in Canada are between those in the EU and the USA. These differences impact upon the production costs of eggs. Space requirements for rearing pigs are more restrictive in New Zealand, Canada and the USA, relative to the EU and Australia.
Transport	Constraints on journey time are more restrictive in the EU relative to the USA and Australia. However, restrictions impacts upon primary production costs are likely to remain limited. In theory they could affect sheep and beef production in particular, since these are most likely to be located far from slaughter points.
Slaughter	Rules on slaughter are broadly similar in the EU, Australia and New Zealand. Constraints for primary production are in place to a limited extent only.
Hormones and animal feed requirements	Major differences are observed between the EU and the USA regarding the use of BST for dairy cows. Similarly, the ban on growth-promoting hormones for beef production in the EU is not existent in the USA, Canada, Australia and New Zealand. Differences on the use of antibiotics in animal feed also are large between the EU and the USA, Canada and New Zealand. These differences will mainly impact upon intensive livestock production units (pigs, poultry and eggs), as well as beef and dairy products.
Residues in food	The level of on-farm constraints is generally very low and there are few clear differences across countries regarding standards on residues in food, since most conform broadly to International standards
Hygiene in dairy farming	The on-farm constraints are broadly consistent between the countries studied. By definition, the on-farm constraints apply to dairy producers
Veterinary requirements	Standards are broadly similar in each of the countries studied

Figure 4.2 Sectoral impacts of differences in on-farm constraints in the EU vis-à-vis the study countries

Overall, the findings of this study appear to indicate the following:

- in relation to *nutrients and other water issues*, it appears that livestock farms, particularly intensive indoor units, may face the biggest cost differentials between the EU and other countries. The most onerous obligations on producers will tend to be those that relate to manure use and handling, which is related to the provision of storage facilities, building requirements and other capital expenditure items on livestock farms. Measures are introduced in the EU to internalise these problems. Although the on-farm constraints related to irrigation, sediments and salinisation would undoubtedly fall more heavily upon crop farms than livestock farms, the study indicates that these constraints are generally less widespread and less onerous than the other kinds of constraint identified in relation to water issues.
- *Soil issues* will probably impact more heavily upon cropping farms than livestock farms, although soil erosion from maize, grown as a fodder crop, is a particular concern in some areas of the EU. However, the on-farm constraints identified in this study in relation to soils are relatively weak in the EU and stronger in Australia, New Zealand and the USA, although many such measures will be partially compensated under various government conservation programmes. There are clear differences in programme approaches here, but their cost implications are less clear.

- *Air quality problems* related to odour, nuisance and ammonia is a major and emerging environmental externality in developed country agriculture, at least in the demonstrated preference sense of which problems get the most immediate and forceful action. Distance and siting rules to control odour and nuisance put constraints on livestock production units in Canada, Australia and New Zealand. Odour apparently is one of the most important environmental externalities in Canada, and primarily controlled through separation distances between farms and residential areas. Distance and siting rules also put significant constraints to livestock installations in the EU, mainly in the form of conditions on planning consents. In relation to air issues, these measures impact predominantly upon livestock production and particularly indoor units for pigs, poultry and cattle, or cattle feedlots in the US. They will mainly affect building standards and planning consents/site location issues. Cost implications may be significant but may largely reflect differences in population densities and settlement patterns between the different countries, rather than differences in the standards that would be applied under similar circumstances.
- *Bio-diversity and landscape issues* appear likely to have greater impact upon farms in the EU than in other countries, and to affect both crop and livestock enterprises of all types.
- Differences in consumer acceptance of *GMOs*, which exist between all countries in the study, with the USA most accepting, and the EU and New Zealand least so, are likely to fall heaviest on the cropping sector, including horticulture, so far.
- *Animal welfare issues* clearly affect only animal producers. It seems apparent that rules on laying hen cage systems is one area of difference between EU and New Zealand, on the one hand, and the USA, Canada and Australia on the other, where there will be some cost implications. Minimum space requirements to rear pigs are more restrictive in New Zealand, Canada and the USA, relative to the EU and Australia. The cost implications of any different housing systems for pigs may be significant. Constraints on the transport of farm animals are more restrictive in the EU relative to the USA and Australia. The requirements on transport restrict practice of primary producers to a limited extent only. Rules on slaughter of animals are broadly similar in the EU, Australia and New Zealand. They restrict primary production to a limited extent only.
- *Hormone use and the use of animal feed additives* is another area where there are differences between countries. These uniquely affect livestock producers. A ban on the use of BST in dairy production in the EU, Canada, Australia and New Zealand is restrictive to dairy producers relative to the USA. A current ban on the use of growth-promoting hormones in beef production in the EU puts constraints to producers relative to the other countries studied.
- *Hygiene rules for dairy farming* appear broadly consistent between the countries studied.
- *Veterinary requirements and conditions to control animal diseases* appear broadly consistent between the countries studied.

Stage 3: Importance of sectors for international trade

Comparing the influence of standards on the relative competitiveness of EU agriculture requires an investigation on the importance of key traded commodities, both domestically and on the global market. We will first explore the role of agricultural commodities on the international market. Table 4.1 identifies the main destination countries of the export flows for the EU, the USA, Canada, Australia and New Zealand, for a bundle of key commodities selected to represent the range of agricultural outputs and to include some of the most important traded commodities by volume and value. This is relevant to identify any areas where both the EU- and non-EU countries have trade.

Information on production and trade of agricultural commodities is vital to qualify the 'teeth' the cost increases may have for production and trade. Table 4.2 shows the main relevance of the commodities in the EU and the non-EU countries (in terms of their shares in total production value). Shares in total EU production value are given, and the relevance of commodities in national production value are identified in simple ordinal terms for the non-EU countries (small, medium and high). In addition, we also qualify the importance of international trade. This table identifies the current position of the commodities on the world market, mainly in relation to the study countries examined. A commodity is considered to be of major importance for EU agriculture when the export value to non-EU countries exceeds \$1 billion. It is significant when export to non-EU countries is in the range between \$ 200 and \$ 1,000 million per annum.

Table 4.1 Relevance of sectors on the international markets (1996); export value to third countries (EU) and total export value of the commodity for the other countries (USD)

Commodity	EU (export to third countries; imports from outside the EU)	USA	Canada	Australia	New Zealand
Dairy	5,600 million, mainly to the Russian Federation, Saudi Arabia and the USA. Import mainly originates from Switzerland and New Zealand, and is around 800 million	480 million, mainly to Mexico, Japan and Canada	245 million, mainly to Mexico, USA, Algeria and the UK	1,370 million, mainly to Japan, Philippines and Malaysia	2,325 million, mainly to the UK, Japan and Malaysia
Beef	1,190 million, mainly to the Russian Federation, Egypt and Iran. The import of beef is slightly below export value and mainly originates from Argentina, Brazil and Uruguay	2,375 million, mainly to Japan, Canada and Korea Rep.	495 million, mainly to the USA, Japan and Korea Rep.	1,620 million, mainly to Japan, the USA and Korea Rep.	680 million, mainly to the USA, Canada and Japan
Sheep	30 million. New Zealand has by far the largest share of the import market for sheepmeat. Import from New Zealand is worth almost 600 million per annum	7 million	1 million	400 million, mainly to Japan, the USA and Saudi Arabia	980 million, mainly to the UK, Germany and France
Pigs	1,530 million, mainly to Japan, Russian Federation and the USA. Imports of pig meat are limited, and amount to around 100 million per annum, primarily from Hungary	915 million, mainly to Japan, Russian Federation and Canada	625 million, mainly to the USA, Japan and the Russian Federation	25 million	Less than 1 million
Chicken meat	1,030 million, mainly to the Russian Federation, Saudi Arabia and Hong Kong. The import of poultry is around 600 million per annum (mainly from Hungary and Brazil)	2,305 million, mainly to the Russian Federation, Cuba, the USA and Hong Kong and Mexico	40 million, mainly to Hong Kong	12 million	1 million

Table 4.1 *Continue*

Commodity	EU (export to third countries; imports from outside the EU)	USA	Canada	Australia	New Zealand
Eggs	220 million, mainly to Switzerland, Japan and Hong Kong. The import of eggs is also very limited, and amounts to less than 50 million per annum	205 million, mainly to Japan, Canada and Hong Kong	40 million, mainly to the USA, Japan and Germany	5 million	2 million
Wheat	1,505 million, mainly to Egypt, Morocco and Cuba. The import of wheat mainly originates from Canada and the USA	6,300 million, mainly to Egypt, Japan and China	2,840 million, mainly to China, Iran and the USA	3,125 million, with areas of destination not specified	Less than 1 million
Maize	100 million. Total imports are around 600 million, mainly from the USA (400 million) and Argentina (200 million)	8,625 million, mainly to Japan, Korea Republic and Mexico	100 million, mainly to the USA, Cuba and Italy	5 million	2 million
Apples	320 million, mainly to the Russian Federation, Czech Republic and Norway. Imports exceed 500 million, mainly from Chile, New Zealand and South Africa	Export value is 380 million, mainly to Canada, Mexico and Indonesia	Less than 1 million	20 million	250 million, mainly to the UK, other EU countries and the USA
Oranges	440 million, mainly to the Russian Federation, Poland and Switzerland. Imports are around 600 million, and mainly originates from Morocco, South Africa and to a lesser extent from Israel and Argentina	300 million, mainly to Japan, Canada and Hong Kong	No export of oranges	100 million, mainly to Malaysia, Hong Kong and Singapore	1 million
Tomatoes	235 million, mainly to the USA, Russian Federation and Poland. About 90% of total imports from outside the EU (100 million) are from Morocco	100 million, mainly to Canada, Belgium and Mexico	40 million, mainly for the USA	7 million	Less than 1 million

Table 4.1 *Continue*

Commodity	EU (export to third countries; imports from outside the EU)	USA	Canada	Australia	New Zealand
Wine	3,360 million, mainly to the USA, Switzerland and Japan. The import of wine is 1,000 million, with Australia as the main country of origin (300 million), to be followed by the USA, South Africa and Chile (total of 150 million)	300 million, mainly to the UK, Canada and Japan	4 million	430 million, mainly to the UK, the USA and New Zealand	45 million, mainly to the UK, Australia and Sweden

Table 4.2 Relevance of commodities in national production value and the position of the EU and non-EU countries in international trade by commodity

Commodity	Share in total EU production value (%)	USA	Canada	Australia	New Zealand	Importance of commodity for EU agriculture. International trade of commodity and the position of the EU vis-à-vis other countries
Dairy	18	High	High	High	High	Major importance for the EU. Similar markets with New Zealand
Beef	10	High	High	High	High	Major importance for the EU. No competing markets are observed
Sheep	2	Small	Small	High	High	Limited importance to the EU. Import from New Zealand is significant
Pigs	12	High	High	Medium	Small	Major importance for the EU. Similar export market (i.e. Japan) with the USA and Canada
Poultry	6	High	High	Small	Small	Major importance for the EU. Similar export markets (i.e. Russian Federation and Hong Kong) with the USA0
Eggs	3	Small	Small	Small	Small	Limited importance to the EU. Some common export to Japan by the EU, the USA and Canada
Wheat	5	High	High	High	Small	Major importance for the EU. Major import levels from the USA and Canada
Maize	2	High	Small	Small	Small	Limited importance for the EU. Significant imports from the USA
Apples	4 (fresh fruit)	Medium	Small	Medium	High	Significant importance to the EU. New Zealand being a major exporter to the EU
Oranges	2 (citrus fruit)	Medium	No export	Medium	Medium	Significant importance to the EU
Tomatoes	9 (fresh vegetables)	Medium	Small	Small	Small	Significant importance to the EU
Wine	6	High	Small	High	Medium	Major importance for the EU. High export levels to the USA and Japan. Significant import from Australia and the USA

Stage 4: Strategic assessment of impacts and sectors

The relative competitiveness of EU agriculture may be affected in cases where on-farm standards clearly differ between countries, and where the costs of compliance with on-farm standards exceed those in the non-EU countries. As long as producers of a certain product are subject to the same constraints at farm level, these will not affect competition between them. However, where producers of different countries produce under different on-farm constraints, while competing in the same markets, the effects on competition may be significant.

Differences between the study countries for livestock production are observed primarily for five areas, including (i) nutrient enrichment by nitrates and phosphates, (ii) pesticides authorisations and control, (iii) odour, nuisance and ammonia, (iv) biodiversity and landscape, (v) hormones and animal feed requirements. Three of these (i, iii, and v) will have the most significant effects upon intensive livestock production (pigs, poultry and eggs, as well as intensive beef), while the effects of biodiversity and landscape policies could also be significant for extensive livestock in some areas (beef and sheep).

The picture is more diverse for crop production. A range of policy areas where significant differences in the EU relative to the other countries studied is indicated, including pesticides, biodiversity and landscape and GMOs. For these policies, it seems that on-farm constraints are more significant for the EU than the non-EU countries. Other constraints however, may be more severe in non-EU countries. Constraints to control sediments, for example, do not put major limitations upon crop production in Europe, whereas they may involve some constraints upon crop production (including key commodities such as wheat, maize and wine) in the USA and New Zealand. It is therefore difficult to assess whether crop producers, including those producing permanent crops and horticulture as well as arable, are more or less affected by on-farm constraints in the EU than elsewhere.

Stage 5: Assessing competitiveness effects

We now present a more detailed consideration of possible effects, sector by sector, focusing upon the key traded outputs as used in stage 3.

Dairy products (milk, cheese, butter, skimmed milk et cetera)

Constraints on the use of BST may affect the relative competitiveness of EU dairy production vis-à-vis the USA. Differences on constraints to control nutrient enrichment by nitrates and phosphates may also have a limited impact on the relative competitiveness of EU dairy production vis-à-vis the non-EU countries. Noise, ammonia and nuisance differences may also be significant, as well as animal feed requirements. Further work would be needed to assess the degree to which variations in landscape and biodiversity policies particularly affect the dairy sector, but this seems likely. Given the importance of this sector for EU trade, these differences may merit further investigation.

Beef

The ban on the use of growth-hormone to produce beef will differentially affect beef production in the EU relative to the USA, Canada, Australia and New Zealand.

Differences in on-farm constraints to control nutrient enrichment, nuisance and ammonia may affect beef production in the EU vis-à-vis the USA, Canada, Australia and New Zealand. Increased production costs for intensive units will probably affect relative competitiveness of European beef producers to a limited extent only, however, since a large proportion of beef produced in the EU is still extensively reared and therefore less affected by such constraints.

By contrast, the effects of any significant differences in landscape and biodiversity policies may particularly affect the extensive sector. There are no major markets where both the EU and the other study countries operate at present; however this is related to the phenomenon of BSE and in the longer term, beef is likely to be a sector of increased importance for EU and non-EU trade. It could therefore be an area worthy of more detailed investigation.

Sheep

On-farm constraints to control sheep production are limited mainly to pesticides and to some biodiversity, landscape and animal welfare controls, which may differ between EU and non-EU countries. However, these differences are not considered likely to lead to major cost differentials in a sector where production costs are already highly variable between countries due to environmental conditions and farming systems. Therefore the relative competitiveness of sheep production seems unlikely to be affected to a major extent by these particular standards.

Pigs

This is one area where most of the countries' production systems are similarly intensive. The control of nutrient enrichment by nitrates and phosphates has put major constraints upon pig production in the EU relative to the USA, Canada, Australia and New Zealand. Also, rules on the use of animal feed requirements are likely to put constraints upon pig production in the EU relative to the USA, Canada and New Zealand. This may affect the relative competitiveness of pig producers in the EU relative to the USA and Canada. The impact of landscape and biodiversity policies, and pesticides policies, is less evident for this sector.

Because of the importance of this sector to the EU in international trade terms, particularly in Japan, apparent differences in constraints such as those indicated here would seem to be an area worthy of further investigation.

Poultrymeat

The control of nutrient enrichment by nitrates and phosphates is likely to impose some constraints upon poultry production in the EU relative to the USA, Canada, Australia and New Zealand. Also, rules on the use of animal feed requirements also put constraints upon poultry production in the EU relative to the USA, Canada and New Zealand.

This is an important sector for the EU in which its main competitors are the USA and Canada. The constraints identified here may affect the relative competitiveness of poultry producers in the EU, particularly in relation to exports to Hong Kong.

Eggs

The control of nutrient enrichment by nitrates and phosphates implies constraints upon the production of eggs in the EU relative to the USA, Canada, Australia and New Zealand. Rules on laying hen cage systems in the EU are more restrictive relative to the USA, Canada and Australia. Also, rules on the use of animal feed requirements also put constraints upon the production of eggs in the EU relative to the USA, Canada and New Zealand.

This could affect the relative competitiveness of egg producers in the EU relative to the USA, primarily because an increase in production costs in the EU may influence the export markets to Japan and Hong Kong. However, it should be noted that the total value of egg exports is relatively low by comparison with other products and that this international trade sector is currently of minor importance to the EU.

Wheat

Constraints to control the use of pesticides apply to the production of wheat in the EU, the USA and Canada. There, they are more restrictive relative to wheat production in Australia and New Zealand. Also, some constraints are likely to apply to arable production in the EU due to different controls on biodiversity and landscape. Constraints on GMOs appear stricter in the EU and New Zealand relative to the other countries studied, which could potentially affect production costs fairly significantly relative to the USA, Canada and Australia.

Differences in constraints to control sediments in the USA, Australia and New Zealand may have a limited impact on wheat production in these countries relative to the EU. Constraints on irrigation mainly restrict farming practice in Australia and New Zealand and may also contribute to an increase of production costs relative to the EU. However, the combined magnitude of all these impacts is difficult to assess.

Increased production costs for wheat due to these constraints will probably have a limited impact on the competitiveness of wheat production in the EU relative to its main competitor, the USA, since other factors will have a much greater impact upon cost differentials (for example land values and economies of scale). So, despite the importance of this sector to the EU in trade terms, a comparison of standards in more detail for this sector may not be merited.

Maize

Constraints to control the use of pesticides apply to the production of maize in the EU, the USA and Canada. There, they are more restrictive relative to maize production in Australia and New Zealand (very limited in both countries). Also, some constraints apply to maize production due to EU controls on biodiversity and landscape. Also, controls on GMOs appear stricter in the EU and New Zealand relative to the other countries studied. Differences on constraints to control sediments in the USA, Australia and New Zealand may also have a limited impact upon the costs of maize production in these countries.

An increase of production costs will probably have a limited impact on the relative competitiveness of maize production in the EU relative to the production in the USA, since the production costs of maize in the USA are already much lower due to other factors (e.g. land prices, economies of scale).

Apples

Constraints on the use of pesticides will apply to apple production in the EU, the USA and Canada. They are more restrictive in these countries relative to apple production in Australia and New Zealand, although in New Zealand voluntary initiatives commonly ensure similar standards.

Differences in production costs due to standards will probably have a limited impact on the relative competitiveness of apple production in the EU vis-à-vis the non-EU countries, since much of the current trade is organised around seasonality considerations.

Oranges

Constraints to control the use of pesticides apply to the production of oranges in the EU, the USA and Canada. There, they are more restrictive relative to orange production in Australia and New Zealand. Also, constraints on GMOs appear stricter in the EU and New Zealand relative to the other countries studied, which could potentially affect production costs relative to the USA, Canada and Australia. By contrast, irrigation constraints may affect orange production more in the USA and Australia than they do in the EU.

This product is of significant importance to the EU, but there are no major markets where both the EU and the other study countries operate.

Tomatoes

Constraints to control the use of pesticides apply to the production of tomatoes in the EU, the USA and Canada. There, they are more restrictive relative to the production of tomatoes in Australia and New Zealand. Nutrient enrichment constraints upon intensive horticulture may be slightly greater in the EU than elsewhere, but constraints on irrigation may be more stringent in the USA and Australia than in the EU.

There are no major markets where both the EU and other study countries operate. The import by EU Member States from the non-EU countries studied is very limited because 90% of the import originates from Morocco.

Wine

Constraints on irrigation mainly restrict farming practice in Australia and New Zealand and may also contribute to an increase of production costs relative to the EU. However, this will mainly affect low-quality wine because irrigation is commonly prohibited in high-quality wine within the EU. Also, constraints to control soil erosion could increase other countries' production costs relative to the EU.

Although this sector is important in terms of international trade to the EU, the trade is fairly segmented, and other factors will probably affect relative competitiveness of EU producers much more than the kinds of standard considered here.

Discussion of cost implications of differences in standards

A body of cost studies in relation to particular standards and sectors were examined in the country reports. However, it is not appropriate to use these studies to gain meaningful insights into competition effects because:

- costs data is highly dependent upon farm structures and management practices in each country or region and these may vary considerably. For example, most dairy production in New Zealand involves cows living out of doors all year, while this practice would be comparatively rare in other countries. Average herd sizes also differ considerably. There are thus difficulties in attempting to use the data for comparative purposes between similar sectors in different countries;
- variation within countries, in terms of both farm structures and environmental constraints, may be significant. Exporting producers may be largely concentrated in particular parts or sectors within each country (e.g. pig producers in Denmark, CA-FOs in the USA) and these areas may face quite particular standards which may not be reflected in studies, which are often based upon industry averages.

A few examples of material from such studies are presented in the Annex to the report.

One general conclusion from the majority of country studies has been that overall, the magnitude of costs applying to agriculture as a result of environmental and health-related standards is relatively small in all but a few sectors and cases, usually representing no more than 5% of total costs. If this is so, then we could expect the competitive effects of differences in standards to be relatively small, also.

However, the material presented in this report also highlights the uneven impacts of costs at sub-national level. This is often overlooked in cost studies which tend to aggregate producers and make calculations based upon regional or national averages.

It has not proved possible in this study to make any firm predictions of the magnitudes of costs, and therefore competition effects, of the differences in standards that we have documented. Thus it would be fair to say that nothing that we have presented here would be sufficient to challenge the thesis of most cost investigations, namely that environmental and health-related standards generally cannot be demonstrated to have significant impacts upon the competitiveness of one country's agriculture vis-à-vis its main competitors in world markets.

Such a challenge would require a much more detailed and exhaustive analysis than has been possible within the constraints of this project. However, the particular issues highlighted in this chapter would appear to be those which are most promising for further investigations of this nature.

5. Conclusions and outlook

This chapter distils the insights generated through this study and will therefore set out possible avenues for future, more detailed research into competitiveness and standards. But it must also address the extent to which the teams conclude that the net effect of the combination of standards examined here is likely to be relatively insignificant, for agricultural trade as a whole. The chapter will also discuss the major methodological issues highlighted through this project, the information gaps identified in the context of the study and key considerations, which we recommend should temper any future work in this area.

Key issues of concern in the EU

The most important environmental and health-related issues, which are of major concern in the EU and with high priority in policy are:

- nutrient enrichment by nitrates and phosphates, which also is a major issue in the USA;
- pesticides (including pesticide drift and applicator safety), which also is a major issue with high priority in policy in the USA and Canada;
- odour and nuisance, which also is a major issue with high priority in policy in Canada;
- biodiversity and landscape, which is important in Australia and New Zealand but which is tackled very differently in each case;
- GMOs, which also is a major issue with high priority in policy in New Zealand;
- animal welfare, which has a lower ranking in the other countries.

Other issues also are identified as a problem in some countries studied:

- irrigation, which is of similar importance in the USA and New Zealand, and has higher priority in policy in Australia;
- soil erosion, which has higher priority in policy in the USA, Australia and New Zealand;
- ammonia, which has more priority in the EU. Ammonia also is a problem in Canada, but for reasons of odour;
- hormones and animal feed ingredients, which has much more priority in the EU;
- pesticide residues in food, which has higher priority in the USA and has similar relevance in all the other countries studied;
- hygiene in dairy farming has similar relevance in all countries;
- veterinary requirements are less of a problem in the other countries than the EU.

Costs of compliance on average are low

One of the main difficulties the study faced was the very limited detailed number of studies that have been made on the relative costs for particular sectors of agriculture in the five

countries. The main problem faced in the study is that the coverage of the available literature does not include all the relevant commodities and some countries have more than others. In addition, international comparison of cost estimate is problematic because of things like exchange rates and differences in production practices unrelated to environmental regulation.

A general conclusion that we can draw from the available assessments is that the costs of environmental compliance in primary agriculture, at least as indicated by the available evidence, are not particularly high. When producers are allowed flexibility in selecting the means by which they can achieve various environmental objective targets, the available analyses indicates that compliance costs are generally less than 3-4% of gross revenue.

Livestock production is more likely to be affected by differences in these standards relative to crop production

Costs in agriculture may be somewhat higher than the available studies for other sectors (e.g. manufacturing, services, and chemical), but they do not appear to be large enough to drive location of production decisions generally. In crop production, we did not find evidence to suggest that compliance with environmental regulations has been or will be a driving force determining the location of production.

With respect to livestock production, it may be a different story. The costs of compliance with nutrient regulation and measures to control odour and nuisance from intensive livestock production units are increasing in several parts of the world (e.g. EU, USA and Canada). It is primarily a question of finding a location for a facility that reaps the available size economies and at the same time is far enough away from adjacent land uses. And here, there are significant differences within and among countries. The compliance costs of producing pigs and poultry have increased during the past ten years in the EU, USA and Canada, and this may have a significant effect on the location of production in the future.

Large similarities are observed in the use of standards to control environment and health concerns

Most policies have been reactive in the sense that measures were introduced in response to perceptions of emerging or documented problems. There are many more similarities than differences in approaches to control environment and health concerns across the study countries, e.g. many voluntary approaches and relatively few binding constraints compared to the level of environmental constraints upon non-agricultural sectors. However, there are very real differences in approach to resolving the problems, such as the mostly voluntary approaches with federal payments in the USA and Canada, the reliance on industry voluntary compliance in Australia and New Zealand, and a greater mix of regulatory and voluntary approaches in the European Union. Moreover, there are dynamic changes occurring in the approaches developed within countries, such as the rise of state and local programs in the USA and the trend toward more regulation as policy devolves to those levels.

At this point, it is hard to substantiate a claim that the costs of environmental regulation and standards in agriculture are significant for most issues, and in total, in most countries. As evidence, there are no apparent large shifts of industrial location from one country to another, i.e. land bases have stayed fairly constant. There have been shifts within countries, such as for confined animal operations in the USA. Intensive livestock production also tends towards a further concentration within the EU.

The trend is toward more regulation and binding constraints, but not wholesale across the industry, such as for large animal units in the USA but not small ones. This trend will continue as the industry is transformed into larger farm units and the demand for EQ rises further from income growth. Hence, the need to search for low cost approaches.

Some of the most striking differences, such as EU controls on GMOs, animal welfare, and animal feed are reflections of country preferences and attitudes towards risk, for different types and levels of environmental protection. Hence, it is debatable whether they should be seen as trade barriers or distortions.

Empirical limitations faced in the study

- Estimation of the environmental compliance costs in agriculture is in its infancy. The current study represents the first systematic effort to characterise the structure of the environmental and health regulatory regimes within which the agricultural sector operates in the EU, the USA, Canada, Australia and New Zealand.
- The study is the first attempt to compare constraints to farming of environmental and health-related standards. The relative competitiveness of EU agriculture vis-à-vis those of some key competitors is affected by the accumulation of on-farm constraints. This is not examined in the context of the study because of the limited detailed studies that allow for direct comparison between countries.
- Competitiveness of EU agriculture is examined by comparison of on-farm constraints by policy field. Competitiveness also needs to consider innovation strategies of farmers to meeting constraints resulting from legislation.

Resource limitations faced in the study

- It became rapidly apparent during the course of the study that the variety of environmental and health related standards at sub-national level within all the countries studied, was going to place severe constraints upon our ability to achieve a thorough comparative analysis at country level.
- Our approach has therefore been illustrative and qualitative, and we have been unable to conclude with a concrete assessment of cost differentials and competitiveness effects, however, indications of broad areas where standards seem likely to have the most significant impacts upon sectors, have been provided.
- A much larger and more exhaustive study would be necessary in order to provide thorough analysis of these issues, but we hope that by highlighting the most promising avenues for further investigation we can assist in the targeting of future resources to this area.
- Future studies should, in our view, be focused on a narrow range of key sectors and might also be most usefully confined to the production structures, which are most export-oriented, within each country. Issues of environmental context, financial

compensation and voluntary initiatives, and other non-environmental constraints upon production costs will continue to be essential considerations for these studies.

General lessons from this study about the relationship between regulation and trade

- The available assessments indicate that the share of environmental compliance costs per unit of output are not particularly high, which implies it likely has only a modest effect on trade;
- Environmental regulations (by any level of government, or by civil liability) that legitimately internalises an external costs (e.g. nuisance, riparian rights) does not distort trade unless such external costs occur in the economy of some other trading partner and those costs are not being internalised;
- Different countries, by virtue of differences in standards of living, preferences, technology or geography, can legitimately apply different standards to determine whether something is a non-internalised external costs.

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Appendix A: Comparison of standards in the study countries

	EU	USA	Canada	Australia	New Zealand
Nutrient enrichment by nitrates and phosphates	Control of livestock production (mainly pigs and poultry) through a detailed system of permits that put zoning constraints to farmers, and a wide range of measures to control the application of livestock manure in areas with nitrogen pollution problems	Operating permits and siting requirements are required for large confined animal feeding operations (with more than 1,000 animal units). Such permits may include detailed requirements to nutrient and waste management	Zoning policies apply to intensive livestock production units that also need building and construction permits. The permits include separation distances, requirements for manure storage and building construction standards.	Construction and expansion of feedlots require efforts to control emissions and reduce pollution. Zoning is applied to separate livestock operations from dwellings	A resource consent requires farmers to include an assessment of the impacts on the environment. Rules apply to the disposal of effluents from dairy and pig farms
Pesticides	Standards apply for the maximum concentrations of pesticides, both individually and for all pesticides detected. Control on the use of pesticides and their emissions, drift and spraying	The USA has a greater degree of standard setting than in the EU. Restrictions on the use commonly are crop and product specific. High-risk pesticides are subject to tighter restrictions	Registration of pesticides is harmonised with the USA. Restrictions are in place on the application of pesticides to control pollution and reduce drift	Procedures for registration and labelling of all authorised pesticides. Buffer zones are used to protect watercourses. Spraying which is harmful to plants outside the target area is prohibited	Procedures for registration and labelling of all authorised pesticides. The use of pesticides is restricted by product and best practices need to be adopted to prevent any adverse effects
Sediments	No restrictions apply to farming	Land management practices are required	No restrictions apply to farming	Guidelines on exist to protect the aquatic ecosystems	Certain limitations on land management apply to farmers
Irrigation	No rules at EU level, but permits are required in different countries to abstract water. Restrictions apply to the extractions in periods of shortage	No rules at federal level, but water-quantity restrictions exist in a few states and trading of water rights exist in some States	Irrigation control is mainly applied through water quality standards, which commonly apply to surface irrigation	Direct constraints at farm level, which get in place if problems become evident. Permits and licenses exist.	Permits are required for taking of water. Consents are granted, which also put constraints on field drainage and flood control

Salinisation	No restrictions apply to farming	No restrictions apply to farming	No restrictions apply to farming	Records are needed to show that the effluent use for irrigation does handle salts properly	No restrictions apply to farming
Soil contamination	Restrictions on the use of heavy metals. Sewage sludge needs to be treated before use on farmland. Codes of Practice for the use of sewage sludge	Restrictions on the concentration of chemicals in sewage. Records of application must be kept	Restrictions on the concentration of chemicals in sewage. The application of sewage is subject to control and approval	The level of Cadmium is reduced (fertilisers) or eliminated (feed)	No restrictions apply to farming. Guidelines on the use of sewage sludge
Soil erosion	No restrictions apply to farming at EU level, and few standards exist at Member State level	Soil conservation plans need to be implemented for croplands that are vulnerable to erosion	No restrictions apply to farming	Codes of Good Practices require the owner of land to take all reasonable steps to prevent degradation of land	Most of the rules apply when changes are made in land use. Soil disturbance is described in a plan; it could be penalised if not treated properly.
Odour, ammonia and noise	Production permits are required for larger intensive livestock production units; BAT is required. Equipment is needed to reduce emissions of ammonia with manure application	Odour controls are applicable to large production units. Permits to expand production commonly include measures to control odour.	Minimum distance separation guidelines apply to control nuisance problems from odour	Guidelines on distance and siting exist to control nuisance problems from odour	Guidelines exist with preferred minimum buffer distances between pig holdings and any off-site residence
Crop burning	Burning of crop residues such as straw is banned or controlled in several Member States	Phase out of the burning of grassland seed straw. Burning permits can be obtained for a fee	No on-farm constraints	Guidelines apply to fire risk management practices	Burning of crop residues is permitted, conditional that it does not impede visibility on nearby roads
Biodiversity and landscape	Protection of land with valuable landscapes	Controls to protect wilderness area from conversion to agriculture	Local planning protect wetlands from existing farm properties	Landcare programmes involve co-operation between farmers and local community groups	Limitations to clear indigenous forest of scrub for agricultural purposes

GMOs	Strict controls on the authorisation and the commercial release on the market	Application is most advanced in the USA	The technology was adopted rapidly in Canada	GMOs are slowly gathering uptake	Strict rules apply to the commercial release of GMOs on the market
Housing	Space requirements for laying hens and pigs	Recommended space allowances exist for battery cage size and for growing pigs	Minimum cage size for chicken, and recommended floor space for rearing pigs	Space requirements for laying hens, and minimum recommended space allowance to grow pigs	Minimum recommended space allowance for laying hens and for growing pigs
Transport	Producers need to provide animals that are healthy for transport	Farm practices apply minimally to the transport of live animals	Farm practices apply minimally to the transport of animals	Transport guidelines are not considered to cause on-farm constraints	Farmers are responsible to select only fit and healthy animals for travel
Slaughter	No restrictions apply to farming	No restrictions apply to farming	No restrictions apply to farming	No restrictions apply to farming	Constraints are limited to inspection and farmers normally pay such costs
Hormones and animal feed ingredients	The use of BST to dairy cows is not authorised. The use of growth hormones is banned in beef. In addition, four antibiotics are forbidden as feed additives	BST is approved for use in dairy. Growth hormones are allowed to be used in beef production. Three out of the four antibiotics that are banned in the EU are currently used in the USA	BST is not approved for use in dairy production. Growth hormones are allowed to be used in beef production. Three of the four antibiotics that are banned in the EU are approved for use in Canada	BST is not allowed in Australia. Growth hormones are allowed to be used in beef production. Several antibiotics that are forbidden in the EU are not registered for use in Australia and rules on their prohibition are rather similar to the EU	BST is not registered as an acceptable compound and its use is illegal. Growth hormones are allowed to be used in beef production. All of the four antibiotics that are forbidden in the EU are available for several livestock production purposes
Pesticide residues in food	Low level of on-farm constraints	Low level of on-farm constraints	Low level of on-farm constraints	Low level of on-farm constraints	Low level of on-farm constraints
Hygiene in Dairy farming	Detailed on-farm constraints apply for cooling tanks, water use and herd standing. Also, cows should not show symptoms of infectious diseases	Rather strict milk hygiene rules. Focus on milking requirements, cooling of milk, periodic controls at the farm	Standards for milking include hygienic requirements during milking and cooling	Hygiene rules are in line with those for EU dairy producers	Hygiene rules are in line with those for EU dairy producers

Veterinary	Programmes to control diseases				
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Appendix B: Cost implications in the European Union

The estimated sectoral impact assumes that non-recurring costs are depreciated over 10 years. Accordingly, the recurring costs are added to one-tenth of the non-recurring costs to get the figure used. Taking the ratio of the relevant total farm output values and net farm incomes derived estimated net farm income. The figures were published by MAFF in the annual Farm Business Survey. This was done for each of the years 1994/95, 1995/6 and 1996/7, and the average taken. The resulting average ratio was then applied to the relevant affected sectoral output figures.

Table B.1 Estimated impact of implementation of the Nitrates Directive in the UK

	Poultry	Pigs	Beef	Dairy
Total sectoral output, 1996 (UKP 1,000)	1934	1316	1962	3514
Estimated sectoral impact (UKP 1,000)	360	1686	134	1910
No. of affected holdings, 1996	235	555	422	310
% of total holdings	0.78	2.9	0.6	0.8
Value of affected output (UKP mn)	135	132	24	95
% of total sectoral output	7	10	1	1
Est affected net farm income (UKP mn)	15	15	3	20
Impact as % of total sectoral output	0.02	0.13	0.01	0.05
Impact as % of total affected output	0.3	1.3	0.6	2.0
Impact as % of estimated net farm income	2.4	11.3	4.5	9.6
Ave impact per holding (UKP)	1532	3038	317	6161

Source: Wilkinson (1998)

Table B.2 Estimated impact of the UK Welfare of Livestock Regulations

	Laying hens	Pigs
Total sectoral output 1996 (UKP mn)	437	1316
Estimated sectoral impact (UKP mn)	16.7	7.9
No of affected holdings, 1996	750	4000
% of total holdings	2.7	41
Value of affected output (UKP mn)	387	1250
% of total sectoral output	91	95
Estimated affected net farm income (UKP mn)	43.5	140
Impact as % of total sectoral output	3.8	0.6
Impact as % of affected output	4.2	0.63
Impact as % of estimated net farm income	38.4	5.6
Average impact per holding (UKP)	22,267	1975

Source: Wilkinson (1998)

Appendix C: Cost implications in the USA

The following table presents a summary of estimated production and environmental costs by commodity, including data from the national review and the 'upper bound' state analyses, along with the government subsidies (PSE).

Several observations emerge from this table. First the variation in regulation across commodities is large, with the hog and dairy industries most affected, followed by cattle, corn, and wheat, and then by the poultry sector, with fruit and vegetable production largely unregulated. In the livestock industry, the dairy sector has the highest absolute and most variable compliance costs. Cattle follow with a variation of USD 2 to USD 30 a head and swine generally have compliance costs of less than USD 9 per hog. As a percentage of production costs, the upper bounds for dairy and grape compliance costs lead with up to 25 and 67%, respectively. Swine and maize follow with compliance costs representing up to 6 and 5% of total costs, respectively. Compliance cost information for sheep and poultry are not readily available because they have not been widely regulated. However, we know that close to 6000 poultry farms and 326 million birds, and 189 sheep farms and 2 million sheep are eligible to be regulated under the CAFO rule.

For the same commodity, compliance costs can range from near USD 0 to thousands of dollars per unit, such as for dairies. This variation is due to 1) site specific biophysical characteristics, 2) the media being protected, 3) geographical/cultural variation in regulation levels, 4) the methods by which the media is being protected, 5) the size of the farm being regulated, and (6) the amount of R&D allocated to agri-environmental technological innovation. The range of values in the table starts from a cost of zero, but some studies have shown that after nutrient and/or pesticide management is implemented, long-term profits sometimes go up.

The table does not reveal that some farms, especially smaller farms, have negative economic returns. These farms have a very small margin of 'profit' and the smallest increase in cost may put them out of business. Government subsidies are highest for the dairy industry, followed by wheat and maize. All other supports are less than 9%. Support to fruits varies from a low of 5.5% for grapes to a high of 8.6 (for disaster relief) for citrus. Tomatoes, poultry, and cattle receive the lowest support, varying from 3 to 4.2%, while swine and sheep receive 5 and 6%, respectively.

In 1997, it cost USD 1 per kg to raise piglets to 22.5-kg feeder pigs and USD 0.89 per kg from feeder pigs to finished hogs, while it cost USD 1 per kg from farrow-to-finish hogs in Iowa. At the end of 1996, hog producers made USD 15 per head on feeder-to-market hogs. That number dropped to a USD 33 loss at the end of 1997. Profits decreased despite a fall in corn price because the price for hogs dropped from USD 1.20 to USD 0.89 per kg from December 1996 to December 1997, and to USD 0.80 in August 1998. Many reasons are given for this drop in price, including the recent increase in capacity, high imports from Canada, and the Asian economic problems that reduced export demand.

Surprisingly, few studies were found that estimate the compliance costs for hog producers to meet environmental standards. Heimlich and Barnard estimated that swine operations with concrete floors had lower compliance costs to meet potential CZARA standards than operations with open yards. The costs varied from USD 1.44 per head per

year in the Northeast for small operations under the cutoff, to USD 3.56 on the Gulf Coast for smaller operations with concrete floors above the cutoff.

Compliance costs for operations with open yards varied from USD 2.14 per head per year in the Great Lakes region for operations just under the cut-off, to USD 9.24 on the Gulf Coast for operations just above the cut-off. Whether a hog operation is under 200 pigs or not and whether it is a confined versus an open yard operation makes a large difference in its compliance costs.

US GAO (1995) estimated that the costs of a 140-head operation to meet the current CAFO requirement are between USD 1,400 and USD 3,200 with the retention pond and irrigation system, and between USD 900 and USD 1,800 for the filter strip option. Swine farms with 2000 head had costs varying from USD 7,500 to USD 23,600 for the retention pond and irrigation system, and between USD 4,600 to USD 12,100 for the filter strip option. The lower range values are for southern locations with low rainstorm events, and the larger values are for northern locations that may receive 25.4 cm of rain in 24 hours. These costs translate into annualised costs of USD 4,216 for a 2,000-head farm or USD 2.11 per head.

The table overleaf presents the estimated costs of complying with proper waste-management regulations in different states. Note that the compliance costs reflect state conditions where studies were conducted, and not upper bounds. In general, it costs approximately USD 1 to USD 2 per head for small confined operations, and between USD 2.50 and USD 3.50 per head for large confined operations. For open yard operations, it costs USD 2 to USD 4.50 per head for small operations, and USD 3 to USD 9 for large farms. If a market-ready hog is assumed to weigh 112.5 kg, the cost varies from USD 0.009 to USD 0.018 per kg for small operations and USD 0.02 to USD 0.03 for large confined operations. The compliance costs for open-yard operations vary from USD 0.018 to USD 0.04 per kg for small operations, and USD 0.03 to USD 0.80 per kg for large units. These costs range from 0.5 to 5% of the total economic costs of swine production.

Table C.1 Commodity production and environmental costs and subsidies, 1997

	Production costs (\$/unit)		Social (% of private)	Production % PSE	Subsidies		Coverage	
	Private	Social			Environmental %	Animals (M head or ha)	Farms	
Dairy (head)	2815	20-691	.7-24.5	47	0-75	4	2,257a)	
Poultry (bird)		0-.13		3		326	3,890	
Cattle (bredcow)	757.94	1.8-30	.2-4	4	0-75	26	6,024	
Swine (head)	145.28	.3-9.2	.2-6.3	5	0-75	37	5,540	
Sheep b' (lamb)	84.00	--	0-5.4	6	0-75	2	189	
Maize (hectares)	876.2	0-52.50	0-0.05	17	75	30.2	na	
Wheat (hectares)	451.2	0-?	0-	32	75	23.5	na	
Apples (hectares) c)	6,343	87.50	0-1	6.5	small	0.24	na	
Grapes (hectares) d)	6,403	33-4,310	7.5-67	5.5	small	0.4	na	
Oranges (hectares) e)	8,918	30	0-0.003	8.6	small	0.4	na	
Tomatoes (hectares) f)	4,435	50	0-0.01	4.2	small	0.16	na	

a) Includes farms and dairy cows on farms with more than 500 head (700 head needed for 1000 AU); b) 1992 feeder lamb budget, high concentrate diet, Pennsylvania; c) PSE for deciduous trees in California 1994-96 from Sumner and Hart (1997); d) PSE for grapes in California 1994-96 from Sumner and Hart (1997); e) PSE for citrus and olive in California 1994-96 from Sumner and Hart (1997); f) PSE for tomatoes in California 1994-96 from Sumner and Hart (1997)

Table C.2 Estimated annual compliance costs per hog by farm size and region, USA

Heimlich et al's regions					
Farm Costs and Returns Survey	Great Lakes	Northeast North	West	Gulf South	South-east
Value of production-cash exp. (/cwt 97)		11.6		11.9	
Return to management and risk (/cwt 97)		-9.1		-10.6	
Economic costs (\$/cwt gain 97)		72.76		72.33	
per head					
Small concrete floor					
140 pigs	1.7	1.7	1.8	2.2	1.8 a)
300 pigs	1.4	1.4	1.5	1.9	1.5 a)
Large concrete floor					
140 pigs	2.3	2.4	2.7	3.6	2.8 a)
300 pigs	2.0	2.0	2.3	3.0	2.4 a)
650 pigs	1.7	1.7	1.9	2.6	2.0 a)
1000 pigs	1.6	1.7	1.8	2.4	2.0 a)
2000 pigs	1.9	1.9	2.0	2.5	2.1 a)
Small open yard floor					
140 pigs	2.5	2.5	2.8	4.6	3.0 a)
300 pigs	2.1	2.2	2.5	4.1	2.7 a)
Large open yard floor					
140 pigs	3.5	3.9	5.7	9.2	6.5 a)
300 pigs	4.0	4.2	5.1	8.0	5.5 a)
650 pigs	3.4	3.6	4.3	6.9	4.8 a)
1000 pigs	3.2	3.4	4.0	5.7	4.6 a)
2000 pigs	3.5	3.6	3.7	5.2	4.2 a)
BMP costs for 2000 head b)				2.1	US GAO, 1995
Delivery of manure, slurry basin, incorporated (surface)					
<3300 head		1.4 (1.3)			c)
3300 head		1.9 (1.5)			c)
6600 head		2.5 (2.1)			c)
9900 head		3.0 (2.5)			c)
13,200 head		3.4 (2.9)			c)
16,500 head		3.8 (3.2)			c)
19,800 head		4.1 (3.5)			c)
Delivery of manure, slurry, incorporated (surface)					
<3300 head		3.3 (2.7)			c)
3300 head		4.2 (3.4)			c)
6600 head		4.6 (3.8)			c)
9900 head		4.8 (4.0)			c)
13,200 head		5.1 (4.2)			c)
16,500 head		5.3 (4.4)			c)
19,800 head		5.5 (4.6)			c)

a) Heimlich et al., 1998; b) For a non-northern operation with retention pond and irrigation system enough to handle runoff associated with storms of up to 15.2 cm of rain in 24 hours, USD 4,216 annualized divided by 2,000 head. Not deflated because the 1997 deflator was almost identical to the 1994 deflator; c) Fleming et al, 1998.

Table D.1 Average abatement costs for excess nitrogen for three manure handling systems with various policy instruments for a dairy farm in Ontario (CAD)

Manure System:	Slatted Floor			Flush			Alley Scraper		
	Whole farm average compliance Cost (CAD) a)	Nitrogen leached (mg/L) b)	Average Abatement Cost c) (CAD/mg/L)	Whole Farm Average Compliance Cost (CAD)	Nitrogen leached (mg/L)	Average Abatement Cost (CAD/mg/L)	Whole farm Average compliance Cost (CAD)	Nitrogen leached (mg/L)	Average Abatement Costs (CAD/mg/L)
0,70 tax on commercial fertilizer	5,374.00	34.54	n/a						
Unrestricted (base) Limit of 5000 kg on fertilizer purchases	0.00	21.91		0.00	16.47		0.00	21.2	
Limit of 7000 kg on fertilizer	661.00	13.2	75.89						
0,58 tax on commercial fertilizer	4,720.00	12.94	526.2						
0,68 tax on commercial Excess nitrogen limit	5,394.00	11,47	516.67						
Excess nitrogen tax of 1.00/kg N	1,177.00	10	98.82	334.00	10	51.62	1,039.00	10	92.77
Excess nitrogen tax of 0.47/kg N	3,408.00	9.07	265.42						
Excess nitrogen tax of				1,387.00	9.99	214.04			
Excess nitrogen tax of							2,943.00	9.97	262.06

Source: Based on VanHam (1996), Tables 6.2-6.25 (pp 123-166)

a) Compliance cost is defined as the farm income for the optimal solution ignoring excess nitrogen, which we will call the base solution, minus the farm income when a given policy instrument is applied. Farm income is based on a 140-ha farm with a stocking rate of 1.3 animals/ha; b) Estimated groundwater nitrogen concentration (includes denitrification); c) The abatement cost per mg/L nitrogen reduction was calculated by dividing the whole farm average compliance cost by the nitrogen leached with the base solution minus the nitrogen leached when a given policy instrument is applied.

Appendix E: Cost implications in Australia

Environmental compliance costs related to water, air and chemical use are only a small proportion of total costs. For those cases where input costs are small yet this input is essential, producers tend to find new ways to offset increases eg, taxation options, corporate restructuring; leasing water rights instead of purchasing water (since payments to lease water is fully tax deductible).

One crude way to view the relative importance of water, fertilisers, and pesticides in total expenditures is presented in the table below for five industries at the national level. The costs associated with water use, pesticide use and fertilisers together make up 13% of total expenses for fruit producers; 15% for vegetable growers and around 24% for grain crops. For beef and dairy, the proportion of water, fertiliser, pesticides and veterinary costs in total costs make up just 4% and 14%, respectively. At 1996/97 price levels, if compliance with environmental regulations had simultaneously doubled water costs, pesticide costs, fertiliser costs and veterinary expenses, net returns would still have been positive for every industry except vegetables.

Australia's water sector reforms have significant implications across sectors, commodities, and geographic regions. By contrast, each of the other five issues (soil, air, nature conservation, animal welfare and human health) are likely to have much smaller cost implications and apply to relatively few Australian producers.

Table E.1 Farm business expenses: Industry averages 1996/97 (percentage of total expenses)

Expenses	Fruits	Vegetables	Grain	Beef	Dairy
Water	2.1	0.6	1.1	0.5	2.3
Fertiliser	5.1	8.1	12.9	2.6	7.3
Pesticides	5.0	6.4	10.5	0.7	0.6
Veterinary products	0.2	0.3	0.7	2.3	3.8
Livestock purchases	0.6	2.4	3.8	24.1	2.2
Seeds	1.9	6.4	1.9	0.6	1.2
Fodder	0.4	0.3	0.9	9.1	22.0
Marketing expenses	16.1	12.4	13.2	4.8	7.7
Electricity	2.6	2.7	0.9	0.8	2.5
Fuel	3.0	6.0	8.0	4.6	3.6
Contractors	6.6	3.6	6.6	2.3	2.4
Repairs	7.3	8.3	9.3	6.5	9.2
Leasing expenses	2.6	2.6	1.7	1.8	3.3
Rates and taxes	1.7	1.2	1.9	3.3	1.7
Insurance	2.3	1.7	2.6	1.8	1.4
Wages	24.3	18.6	5.9	9.6	8.1
Interest	5.7	5.5	8.4	10.1	9.1
Other expenses	12.5	12.9	9.8	14.6	11.6
Total expenses	100.0	100.0	100.0	100.0	100.0
Ratio of total expenses to total revenue	0.87	0.96	0.72	0.92	0.80

Source: ABS, 1998, Agricultural Industries Financial Statistics.

Appendix F: Cost implications in New Zealand

To estimate the cost imposed on the dairy sector of policy measures for water quality, the assumption has been made that all New Zealand dairy farms will utilise a land-based effluent disposal system. Depending on climate, soil type, and terrain, this will either be a travelling irrigator system, or tanker spread effluent from pond storage systems. Total costs for all New Zealand dairy farmers to convert to a land-based effluent disposal system have been calculated as NZD 39.4 - NZD 67.8 million. Therefore with some 30% still to comply, further costs to the dairy sector of complying with environmental regulations is estimated to be between USD 11.8 and NZD 20.3 million. The cost to the dairy farmer of these policy measures has been estimated as between 2.0% and 3.2% of the farmer's total costs.