



International trends in primary production and sustainability

Three case studies:
UK, Netherlands, Australia



Prepared for the Parliamentary Commissioner for the Environment
Te Kaitiaki Taiao a Te Whare Pāremata
PO Box 10-241
Wellington, New Zealand

This report and other publications by the Parliamentary Commissioner for the Environment are available free of charge on www.pce.govt.nz

This paper was written for the Parliamentary Commissioner for the Environment (PCE) by University College Dublin student Tim Carnus as part of his course requirement. The views expressed in this paper do not necessarily reflect those of the PCE.

Author

Tim Carnus, University College Dublin, Ireland

Editor

Gord Stewart, AQUAS Consultants Ltd, PO Box 8216, Tauranga

Design/Layout

Christine Prebble, Mosaic Consultants Ltd, Wellington

Bibliographic reference

Carnus, T. 2004. *International trends in primary production and sustainability. Three case studies: UK, Netherlands, Australia*. Background report prepared for the Parliamentary Commissioner for the Environment. Wellington: PCE.

September 2004

ISBN: 1-877274-46-1

Contents

Introduction	4
1 The United Kingdom	5
1.1 Introduction	5
1.2 Agricultural production systems	6
1.2.1 Arable	6
1.2.2 Dairy	8
1.2.3 Horticulture	10
1.2.4 Organic farming	10
1.2.5 Social context in rural areas	11
1.2.6 Economic context	11
1.3 Environmental impacts	12
1.4 Policy responses	13
1.4.1 Legislation	14
1.4.2 The government response to the Curry report	14
1.5 Future developments	14
2 The Netherlands	17
2.1 Introduction	17
2.2 Agricultural production systems	19
2.2.1 Arable	19
2.2.2 Dairy	20
2.2.3 Horticulture	20
2.2.4 Organic farming	21
2.2.5 Social context in rural areas	21
2.3 Environmental impacts	22
2.4 Policy responses	23
2.5 Future developments	25
3 Australia	27
3.1 Introduction	27
3.2 Agricultural production systems	29
3.2.1 Arable	29
3.2.2 Dairy	30
3.2.3 Horticulture	31
3.2.4 Viticulture	31
3.2.5 Organic farming	31
3.3 Environmental impacts	32
3.4 Policy responses	34
3.5 Future developments	35
Conclusions	37
Endnotes	38
References	41

Introduction

The focus of this literature review is on agriculture land use and its management in the UK, The Netherlands and Australia. It concentrates on selected primary production sectors relevant to the New Zealand situation, notably arable production, dairy farming and horticulture. The major environmental impact concerns are also touched on, as is government policy response. General trends and drivers are noted and provide elements of comparison for New Zealand.

The current intensification of New Zealand agriculture – in horticulture, dairying and sheep and beef farming – could seriously affect the long-term sustainability of agricultural production. The ways in which agricultural intensification and associated impacts on the environment have been dealt with in these case studies provide insights when examining the situation in New Zealand.

United Kingdom

1.1 Introduction

Agriculture in the United Kingdom today accounts for 18.4 million hectares (or 76 percent) of the 24.4 million hectares of total land. This is distributed among 230,000 holdings, with an average of about 80 hectares per holding. Pasture is the main agricultural land use (67 percent or 12.5 million hectares).¹ A total of 557,000 people are employed in agriculture in the UK, or two percent of the 29 million strong work force. As an industry, it accounts for only 0.8 percent of the nation's gross domestic product (GDP), although the food industry as a whole accounts for nearly eight percent of total GDP and 12.5 percent of total employment.² This shows a structural imbalance between the producer and processor parts of the food chain. The latter has tended toward complexity in the last decade, disconnecting the farmer from the consumer.

Government expenditure on agriculture rose from £3 billion in 2000/2001 to £4.7 billion in 2001/2002. This rise is attributed mainly to the foot and mouth disease (FMD) crisis. Expenditure in 2002/2003 was forecast at £3.1 billion. The European Union (EU) also provided £1.9 billion in direct subsidies for arable and livestock production and £555 million in market support.³

The UK is 62 percent self-sufficient in all foods, the lowest it has been since records began in 1988.⁴ Most imports come from the EU. They are often cheaper than British produce and hence undermine its sale through one of the four supermarket chains which control approximately 70 percent of all food sales. There is of course variation among sectors. Organic food demand is three

times what the sector produces, for example, while dairy production accounts for nearly all UK's needs. Even so, there is still significant trade. Overall, the UK imports twice as much as it exports. Exports amounted to £9 billion in 2002, up from 2001, when exports were affected by FMD.⁵

The current state of agriculture in the UK is the result of many factors. Internal factors having the biggest impact are surely the food safety and animal welfare issues that arose at the end of the 1990s and 2000/2001 (bovine spongiform encephalopathy, or BSE, and FMD in particular). These industry disasters have been a long time coming.⁶ Various factors have been identified as a part of the problem. These range from the unnecessary use of livestock-derived animal feeds in extreme bids to reduce costs to EU law against FMD vaccination purely for export reasons. It was only after the horrific repercussions of FMD became clear that action was finally taken with the establishment of a policy commission on farming and food.

Some argue that the EU's legal framework under the Common Agriculture Policy (CAP), with its production-orientated subsidy system, has been the main cause of intensification and its inherent rural environment, social and economical deterioration. Although the CAP reforms will have an immense influence on agriculture as a whole as they provide the necessary legal framework for progress,⁷ it is still up to the government to reassess policy and take action. The report of the Policy Commission on the Future of Farming and Food, entitled *Farming and food: A sustainable future* (and dubbed the Curry Report after the Chair of the Commission), lays out a fundamental rethinking of the whole food chain. The government's response, *The strategy for sustainable farming and food*, embraces the challenges identified in the Curry report and sets out the ways in which these new ideas will be taken forward, with particular emphasis on the reconnection of people with the land, and of consumers with producers.

1.2 Agricultural production systems

1.2.1 Arable

Total arable land in the UK is nearly five million hectares. The amount of land under crops has fallen by 1.6 percent over the last ten years. This reduction is a continuation of the trend started in the late 1960s by improved technologies, allowing for increased production per area. The current annual production for the UK is around 23 million tonnes of cereal. Average yield is seven tonnes per hectare, produced mostly from large monoculture-type farms with high inputs of fertiliser and pesticides. The UK is basically self-sufficient in cereal, producing as much as it uses in normal years. Other crops grown on arable land include oilseed rape (432,000 hectares at 3.33 tonnes per hectare), linseed (variable

production year in year out depending on rotation, market, etc.), sugar beet (169,000 hectares at 55 tonnes per hectare), and potatoes (159,000 hectares at 40.1 tonnes per hectare). Most of these commodities are produced to just below self-sufficient levels of around 80 to 85 percent, apart from sugar beet (63 percent) and linseed, which varies from year to year.⁸

Agricultural land under arable farming is found in the drier and lowland areas of the UK, mainly in the east where large industrial-type operations are run. This has not always been so, but the specialisation of higher production-based systems has meant that the majority of producers no longer practice traditional mixed farming. Crop production is primarily high input and intensive.

The biggest shift to intensification came directly after World War II with improving technology. Inputs such as fertiliser and pesticides were applied in prophylactic ways to act directly on yield. This created increasing monoculture landscapes with important loss of hedges, ditches, stonewalls and traditional buildings. Although this trend is seen as characteristic of the 1980s, it boomed unchecked during the 1970s, and therefore cannot be attributed entirely to CAP policy direct aids. The sector has been strongly influenced by the Arable Area Payment Scheme (AAPS) reformulated in the 1992 CAP reform to counteract the increasing conversion of lowland grassland to arable farming with a decline in mixed farming. In effect the scheme froze the area under crops, making reconversion to grassland extremely difficult.

It is only in the mid-1990s that, with the set aside clause to the AAPS, land was slightly released of its workload.⁹ To receive payment from the AAPS all arable holdings above 15.62 hectares must set aside ten percent of total cultivated land (for England, and differing slightly from EU country to country). These direct payment claims cannot be superimposed on land already under an EU scheme such as extensification premiums (i.e. stocking rates below certain levels for beef and sheep rearing and finishing), and suckler cow premiums. A number of schemes aimed at decreasing intensive agriculture can also be applied to arable farming. Further CAP reforms, centred on decoupling production and payments, could have both beneficial and detrimental effects on the state of arable farming and the environment.¹⁰

Producers today are more conscious of input costs relative to benefits. This is apparent in the reduction in fertiliser use and hence nutrient leaching, in an effort toward precision farming and environmental impact mitigation. More farmers are taking up integrated pest management (IPM) as a solution to pest management, but there is still an increasing use of pesticides in arable farming.

1.2.2 Dairy

In the UK dairying is mainly found in the western counties, in particular the southwest area of Devon and Somerset. It is also prevalent in the southwest of Scotland in Dumfries and Galloway, and southwest Wales in Carmarthenshire and Pembrokeshire.¹¹ These are wet areas, with annual rainfall averages over 1200mm. This climate allows for good grass growth, and the majority of production systems are grass-based.

There are 2.2 million dairy cows spread over about 29,000 holdings. The average herd size is currently 92 cows (excluding herds under ten cows), and 52 percent of herds have over 70 cows. Cow numbers have continued to drop throughout the 1990s while herd and holding size has increased. In spite of this, total milk production has remained stable due to an increasing average yield per cow, brought about by yield-selective breeding. The average cow produces 6530 litres of milk per year. This is about 1600 litres more than the dairy cow of 20 years ago.¹² Table 1 presents typical production parameters for the high input/output dairying systems typically found in the UK.

Table 1. High input/output dairying system typical in the UK

Calving season	All year round with a bias toward spring
Feed strategy	High use of concentrates High use of fertiliser on grazing Buffer feeding used to allow higher stocking densities High use of maize silage for winter feed
Milking frequency	Twice daily
Size	Medium to large herds, often specialised
Indoor/outdoor	Indoor over winter, longer periods of housing in the north
Replacement strategy	Mostly closed herds (replacements bred from the herd), some use of 'flying herds' (replacements are not bred from the herd but bought)
Breed	Specialist dairy, usually bred for high milk yield (Holstein-Friesian)

Source: European Commission, 2000.

The UK is the third largest dairy producer in the EU, behind France and Germany, with around 14 billion litres produced annually in accordance with their milk quota of 14.24 billion litres.¹³ It is the largest sector of agriculture in the UK, representing 22 percent of production by value – the total value of milk

production in the UK being nearly £2.5 billion. This is in decline due to low world prices for skimmed milk powder, whole milk powder, and butter. The EU bought a large amount of intervention products in the 2001/2002 milk-year. Farm milk prices fell by two pence to 17 pence per litre as a consequence of high winter milk production and good grass growth (combined with the state of the world milk market) *and* in spite of the raise implemented by supermarkets on the retail price of milk.¹⁴

When the milk market was deregulated in 1994, over two-thirds of milk producers joined co-operatives or milk groups. This number has been declining since.¹⁵ The largest milk processor, Dairy Crest, is also a milk group, purchasing over 2.6 billion litres of milk a year. Their turnover in 2002 was £1,326 million and their profit before tax was £48 million.¹⁶

The National Dairy Farm Assured Scheme (NDFAS) was launched in 1997 to reassure the consumer regarding the quality, safety, and animal welfare value of the products they are consuming. Food safety and animal welfare are the main issues covered by this scheme and these are translated into on-farm practices in areas such as hygiene and food safety, housing, plant and equipment, feedstuffs and water, herd health, stockmanship, and training and contingency procedures.¹⁷ In 2001 the second edition of the hygiene standards was published and is now being implemented.¹⁸ This scheme is to be joined to the Assured Food Standards under their assurance scheme known as the Little Red Tractor Scheme. About 80 percent of British dairy farms now adhere to this assurance scheme making it a functional baseline standard.¹⁹

While just fully self-sufficient in milk, the UK is still involved in trade of milk products. This is primarily with other EU countries, but also with the rest of the world (exporting to Africa and America and importing from New Zealand). The UK is a fairly large market for other EU countries, particularly France, Germany, Ireland and Denmark, importing about 100 tonnes of butter and 240 tonnes of cheese annually. The UK is the largest export market for New Zealand in Europe, and the fourth largest behind Australia, USA and Japan. In 2002, 38 million tonnes of butter and 11 million tonnes of cheese were imported from New Zealand.²⁰

Due to quotas, the focus is on maximising output versus input costs; constraints are more economical than physical.²¹ DEFRA sees the future of dairy production in Europe as entirely free of quotas and market support. This would be attainable through direct aid to producers to help them handle the transition.²² The Agenda 2000 CAP reform is set to phase out support of the dairy market over three years and increase milk quotas by 15 percent per year, beginning in 2005/2006. Quotas will be kept until at least 2008 (Council regulation (EC) 1255/99 and 1256/99).²³

Although the dairy sector is not supported by direct CAP payments, it is affected by specialisation. This has resulted in intensive grassland management, the loss of boundaries with the amalgamation of farms into bigger enterprises, and a growing demand for forage with its high requirements in chemical inputs. Intensive grassland management has put great pressure on pasture because of associated farmyard manure problems and nutrient leaching and runoff.²⁴

1.2.3 Horticulture

The horticulture sector employs 25-30 percent of all agricultural workers. It accounts for nearly £2 billion in production value. The total area under horticultural crops was 176,000 hectares in 2002, three-quarters of which was under open field vegetable crops. Vegetables are valued at £946 million, a third of which is in mushroom production. In terms of self-sufficiency, the UK produces 66 percent of its vegetable requirements and imports the remainder, primarily from the EU.²⁵

The area under fruit has decreased from 51,000 hectares in 1985 to 34,000 hectares in 2001. Fruit production was valued at £257 million in 2002. However, the UK produces only nine percent of its total needs in fruit and therefore imports a great deal – a little under half of it from the EU. It is cheaper for supermarkets to purchase fruit from overseas due to high production costs in the UK.

The horticulture sector, although still a big energy user, has reduced its consumption by 25 percent over the last ten years. Wetland and natural habitat conservation in the horticulture sector is evident through incentive type schemes.²⁶

1.2.4 Organic farming

Many see organic farming as the future of farming in the UK. In December 2002 there was 724,523 hectares of organically managed farmland, managed by 4,057 organic farmers (including farms with conversion status). Two-thirds of the farms are already fully organic certified.²⁷ This high rate of conversion from conventional to organic farming is attributable to the recent Organic Conversion Scheme set up to help the sector meet national demand.

Certification standards are based on three major idioms dealing with soil fertility, low chemical inputs, and animal welfare. The major certification body is the Soil Association, which accounts for 80 percent of organic certified food. Its standards are based on a two-year conversion period under organic management, and include:

- a ban on chemical fertilisers or chemical pesticides (except for organic approved pesticides such as sulphur)

- the sourcing of animal feed from 90 percent organic sources
- conservation and enhancement of the environment
- good management of livestock numbers, stocking densities, and housing
- the total absence of genetically modified organisms (GMOs).²⁸

1.2.5 Social context in rural areas

Rural communities in the UK are no longer solely driven by agriculture. The past 20 years has seen the number of people employed in farming fall by 45 percent, and although in the more remote areas there is still an average of 15 percent rural employment in agriculture, the average employment rate for farming in rural districts is four percent. There is an average net migration of 100,000 people a year into rural areas from urban areas.²⁹ This counter-urbanisation has led to rising rural property prices and an increase in the average age of the rural population. During the last two decades there has been a shift in rural employment away from agriculture, other primary industries, and manufacturing, toward service sectors, which now make up 71 percent of rural employment.³⁰

Collaboration is low between farmers, leading to weak negotiating powers and low competitiveness. The government, under its Strategy for Sustainable Farming and Food, is encouraging the formation of co-operatives, bringing to small farm holdings the benefits of large businesses. Under England Rural Development Programme (ERDP) schemes such as the Rural Enterprise Scheme, capital grants will be available to help set up co-operatives. The Agricultural Development Scheme (ADS) will also provide resources to improve co-operative standings.³¹

The countryside is in the hands of the farmers, and a well maintained rural environment has a direct economic value – countryside tourism is worth an estimated £13.8 billion annually to the UK economy.³²

On-farm labour is a recurrent problem. The Seasonal Agricultural Worker Scheme currently provides a substantial number of seasonal workers, both resident and from other countries, mostly Eastern Europe. Worker number quotas have increased over the past six years, alleviating some of the short-term labour problems.³³

1.2.6 Economic context

Farm incomes reached their lowest point in 2001. There was a slight increase in 2002, but incomes remained 62 percent below the high of 1995. This significant drop has been attributed to various factors, in particular declining world commodity markets and a strong pound exchange rate with the Euro.³⁴

Subsidies to mitigate the low commodity market prices and maintain a positive balance have in fact created a rigid production environment where the farmer is completely disconnected from the market. Indeed, under the CAP, farmers are not market responsive due to the buffering effects of price support.

At present, 60 to 70 percent of all food in the UK passes through four main supermarkets: Tesco, Sainsbury's, Safeway and Asda. This huge control of the food chain allows these supermarkets to set prices and supply levels forcing farming toward industrialisation. This has a further effect of disconnection between producer and consumer, exacerbated by the general complexity of the entire food chain.

Under the CAP, farmers are not directly in touch with market volatility. The control exerted by the EU on prices has in fact distorted the markets on a long-term basis. This means that farmers don't deal directly with financial risks. With looming CAP reforms, and eventual withdrawal of production support, risks up to now dealt with by Government are going to fall back on the farmer. Farmers are now realising that more profitable, added-value products are becoming essential. Labelling and local market sale of their products is seen as a way to a more profitable *and* sustainable future.

The growth in farmers' markets since 1997 is proof of this development. Today, 450 regular markets are run throughout England and Wales, with a turnover of £166 million.³⁵ As with organic farming, this sort of solution to the problem of sustainability is in its infancy. But with greater public awareness and government support they can play an increasingly significant part in agriculture's new revolution. For example, the Big Barn organisation has created an internet site through which consumers can locate and contact local producers. This project was set up with the help of a Rural Enterprise Scheme grant.

1.3 Environmental impacts

The production-based subsidy system of the CAP has been the principal cause of the overall intensification of primary production in the UK.³⁶ This has put tremendous pressure on the environment and, although some indicators show a levelling off in certain sectors, other indicators show an aggravating problem.

In general across agriculture, there has been a decrease in fertiliser use in comparison with the early 1990s when prophylactic applications were still widespread. With emphasis placed on maximising benefits, a more precision farming approach is now apparent (particularly with arable which still, however, remains the biggest fertiliser consumer). Currently in the UK, 70 percent of nitrogen surface water pollution and 50 percent of phosphorus pollution is attributable to agriculture.

Pesticide use, although increasing slightly overall, seems to be used more wisely. This is reflected in fewer monitored sites failing Environmental Quality Standards tests, although the number of sites that fail is still high.³⁷

It is estimated that 80 million tonnes of farmyard manure (FYM) are mechanically applied annually. In addition to this, waste directly applied by livestock to pasture is estimated at 120 million tonnes.³⁸

A wide array of organisations is active in promoting good farming practice and encouraging environmental approaches. One such example is the LEAF (Linking Environment And Farming) organisation, established in 1991. It is the major proponent of integrated farm management (IFM) in the UK.

1.4 Policy responses

Subsidies linked to environmental quality are becoming an important part of the direct payment system in the UK under the recent CAP reforms. A total of £245 million was spent on these schemes in 2002. This has seen a steady increase over the last decade, as direct payments are decoupled from production and as more of the EU's budget is aimed at environmental protection.

These schemes include the Voluntary Set Aside Scheme aimed at arable land, where the farmer voluntarily sets aside an area of land on top of the obligatory ten percent under AAPS; the Environmentally Sensitive Areas Scheme (ESAs) encompassing all sectors of agriculture, aimed at conserving areas of particularly high landscape, wildlife, or historic value. There are 22 ESAs in the UK today covering ten percent of total agricultural land.

The Nitrate Sensitive Areas Scheme (NSAs) identifies areas where water contains or is at risk of containing more than 50mg per litre of nitrate. This program designated eight percent of England as nitrate sensitive in 1996. The UK's program, however, only designated land that directly affected drinking water catchments and, in 2000, the EU Court of Justice deemed that the UK's plans for fulfilling the requirements under the NSA scheme were not sufficient. The UK must now find a way to comply with EU directives or face non-compliance charges.

Stewardship programmes such as the Countryside Stewardship Scheme and the Arable Stewardship Scheme aim to improve overall connections between farm management and conservation of the features that define an attractive countryside. The organic farming sector with all its benefits in terms of environmental conservation and enhancement is also given a boost through the Organic Conversion Scheme. Energy crops can also attain subsidy-based income. In particular areas where habitats of interest are identified, moorland and woodland schemes are available for their conservation and enhancement.

1.4.1 Legislation

Relevant legislation includes the Voluntary Set Aside Scheme, Environmentally Sensitive Area Scheme, the Nitrate Sensitive Area Scheme and the Organic Farming Conversion Scheme. Current regulations are focused on specific elements involved in agriculture (e.g. the Nitrates Directive). Although this has advantages in terms of targeting specific problems, a broader approach, encompassing the farm as a whole, would create a more sustainable production environment.

Numerous pieces of legislation control pesticide use in the UK. These include the Control of Pesticide Regulations 1986, the EC Directive on Dangerous Substances (and its 'daughter' directives which include Statutory Environmental Quality Standards for eight specific pesticides), and the EC Directive on Drinking Water, which limits individual pesticides in drinking water to less than 0.1 microgrammes per litre.

Proposed new legislative tools to control environmentally damaging activities include groundwater regulations, a climate change levy, waste regulations, a landfill directive, a water bill, a pesticides tax, and Local Environmental Risk Assessments.

The Assured Production Scheme (APS) or Little Red Tractor Scheme is a promising element of food production in the UK. For it to become truly effective, it needs to be implemented as the baseline standard for *all* agricultural produce. It has great promise – 70 percent of fruit, vegetables and salads grown in the UK are under the APS. Nearly 4000 growers across the UK, with more than 220,000 hectares under production, now belong to the scheme.

1.4.2 The government response to the Curry report

The Strategy for Sustainable Farming and Food produced by DEFRA in response to the Curry report was launched by the government in December 2002. An independent implementation group is overseeing its delivery. Group members include representatives from Sainsbury's, the NFU, Farmcare, and the Economist and Complaints Commissioner. Arguably the UK has developed policy in a crisis response manner, taking a serious event like the FMD outbreak for things to evolve.

1.5 Future developments

Farmers' decisions have been concentrated on maximising direct payments rather than on market considerations. CAP Mid-Term Review reforms aim to change this frame of mind by decoupling production and subsidy, enticing the farmer to take into consideration environmental aspects rather than sheer

production optimisation. Also, to obtain better profit, the farmer will need to have a more economically viable approach to production. The Common Agriculture Policy has evolved somewhat since its beginnings where it drove higher and higher production through yield-based subsidies. Agenda 2000 identifies the need to cut back on market intervention allowing more competitiveness of products in both internal and external markets. This reduction in intervention is to be implemented in stages and compensated through direct payments to farmers, in order to maintain reasonable incomes.

The key elements of this reform include:

- a single farm payment, independent from production ('decoupling')
- linking those payments to the respect of environmental, food safety, animal welfare, health and occupational safety standards, as well as the requirement to keep all farmland in good condition, ('cross-compliance')
- a stronger rural development policy with more money, new measures to promote quality and animal welfare, and help farmers to meet EU production standards
- a reduction in direct payments ('degression') for bigger farms to generate additional money for rural development and the savings to finance further reforms.³⁹

Overall UK agriculture is showing the following trends:

- an increase in subsidies – though these are tending to have more of an environmental focus
- steady milk production since quotas, i.e. the UK can't produce more than its quota without heavy penalties
- an increasing use of contractors, driven by a shortage of farm labour
- a decrease in farm maintenance carried out by the landlord/occupier. They are taking more of a business manager role
- a decrease in fuel/oil and general energy usage. This is mainly due to a decrease in fertiliser and pesticide use and the development of lower energy input systems such as minimum tillage.

Drivers behind UK's agriculture reform include:

- changing market and consumer demands in an increasingly open world economy with cheaper imports undercutting UK products. World commodity prices are not reflected in prices paid to producers

- a major structural imbalance in the size of farmers' and growers' businesses compared with those in the rest of the food chain. A supermarket system that determines contracts and looks for cheapest produce
- increased public awareness of food safety issues plus media attention to organic farming, use of pesticides, etc
- growing lack of understanding about how the food chain works – total disconnection of producer and consumer with changing food habits and hence the complication of the food chain (more processing)
- regulatory pressures and consumer demands for ever-lower levels of risk in all areas of life
- urban encroachment/involvement in the countryside through counter urbanisation
- changing expectations from society and interest groups on the environment and animal welfare
- climate change and growing demands for renewable energy
- currency fluctuations in a more open market
- enlargement of the European Union and a single European market. Continuing reform of the CAP
- political pressure to control public spending and reduce support linked to agricultural production
- international pressure to reduce direct subsidies, lower protective barriers and eliminate export subsidies.

On a final note, the general consensus in the UK on genetically modified (GM) crops and their use and importance in the future of farming lies in the 'wait and see' basket. Trials and tests are still going ahead and any decision made will be on a sound scientific base. However, consumer acceptance is very low. In 1999 all UK supermarket chains took GM food off the shelves and there has been no change to this policy since then. The EU as a whole remains strongly opposed to any imports that could contain GMOs.

The Netherlands

2.1 Introduction

With a land surface area of 3.4 million hectares, and a population of around 16 million, the Netherlands is one of the most densely populated countries in Western Europe, with an average of 459 inhabitants per square kilometre. In spite of the high population density, agriculture has an important place in the Dutch economy. Indeed the Netherlands is the third largest gross exporter of agricultural produce in the world (behind France and the USA) exporting a total of 75 percent of all its agricultural products. Eighty percent of exports stay within the EU, Germany the biggest customer. Total exports were valued at Euro 45 billion in 2001, with the largest export product being ornamental plants. The agricultural trade surplus for 2001 amounted to Euro 19 billion making the Netherlands the largest net exporter of agricultural products in the world in front of Australia, Argentina and France.⁴⁰

Of the Netherlands total land area, 69 percent of is dedicated to agriculture, 16 percent to woodland and nature reserves, and 15 percent to habitation. There is an increase in urban areas, which is encroaching on valuable agricultural land.⁴¹ Three main soil types (sandy, clay and peat) are found in the Netherlands with their associated general agricultural use. Intensive livestock farming is associated mainly with the sandy soils of the south/southeast for example, while arable farming is associated mainly with marine clay type soils.

The Netherlands has the highest livestock density in the world and also the highest yields per hectare. This implies high inputs of fertiliser, pesticides and

energy. Indeed, intensive production systems allow the Netherlands to produce so much from so little space. Imports of feed for animal production are an important part of trade with other countries (80 percent of feed concentrate is imported). There are also strong imports of exotic products, such as cocoa, tea and coffee, which fuel one third of the food processing industry's production.⁴²

There are about 100,000 agricultural holdings on two million hectares of land, with the average farm size around 20 hectares. Half the total area of farmland is in pasture, mostly dairying, and 300,000 hectares is devoted to fodder crops, primarily maize (220,000 hectares). Farm size has been increasing, and farm numbers and head of livestock decreasing. In parallel to this trend there has been an increase in production per hectare and per animal through improvement-aimed breeding programmes and technology. These signs indicate a strong agricultural sector at the epitome of intensity.

The agro-food sector accounts for 12 percent of the nation's GDP and employs ten percent of the total workforce. The total primary production workforce is 292,000 (agriculture and fisheries), accounting for 3.5 percent of employment. Its share of GDP is three percent. This is in slight decline from the early 1980s when primary production employment was 5.4 percent and GDP share 3.5 percent. The fall in farmer numbers is largely attributed to farm amalgamations and a shortage of young farmers coming into farming.⁴³

The food and beverage industry is the largest in the Netherlands, worth Euro 20 billion in 1999. The four biggest supermarket chains control 90 percent of the food market. Albert Heijn and Laurus have a 27.4 percent and 25.3 percent share of the market respectively, while Superunie and Trade Service Netherlands (TSN/Schuitema) have 21.3 percent and 15.1 percent. These giant food chains are in intense competition with each other and this, coupled with the emergence of discount retailers, maintains low prices leaving little chance for specialist stores to survive.⁴⁴

Food safety has become a big issue with Dutch consumers. Dioxins in animal feed, the Classical Swine Fever epidemic of 1997/98, BSE and FMD in 2001, and the Avian Flu outbreak in March 2003 have all had a deep impact on the general population in terms of food safety concerns. Through media attention to the subject and the scale of control measures (pre-emptive culling in particular), consumers have had their awareness of animal welfare issues raised significantly. Traceability, certificates of animal welfare and environmental consideration guarantees all play an important role in food selection. These issues are taken in under the Commodities Act, or Warenwet. This law is the

backbone of Dutch commodity legislation and although it doesn't set specific standards, it provides basic objectives. These objectives are:

- health protection
- guarantee of product safety
- provision of adequate and correct information to the consumer and discouragement of misleading information, and
- promotion of fair trade.

Specific standards are set by royal decree under the Warenwet or one of the other two general Acts, the Landbouwkwaliteitswet (Agricultural Quality Act), which concerns primary agricultural products, and the Vleeskeuringswet (Meat Inspection Act), which concerns slaughterhouses.⁴⁵

2.2 Agricultural production systems

2.2.1 Arable

In the Netherlands there are 800,000 hectares of arable crops (41 percent of all agricultural land). Arable land is found largely in the northern region, the mid-west of the country (on reclaimed polders⁴⁶), and in the southwest region of Zeeland. During the 1980s, arable land expanded, largely through grassland. This increase in area under crops tapered off in the late 1980s to the current level and has since then, fluctuated around that mark. A drop in specialist arable farm numbers (17,560 in 1985 to 13,860 in 1999) suggests an increase in farm size. Indeed, average farm size rose from 41 hectares in 1985 to 58 hectares in 1999. Approximately 38,000 holdings are involved in arable production as mixed farms. These are mainly dairy farms producing silage maize for fodder.

Major crops grown include potato and sugar beet, wheat and barley, green maize, grain maize and onions. Of these crops, potato is the most important in terms of production value. Cereals aren't as important economically as potatoes or sugar beet, but they play a role in livestock production as animal feed. In general, cereals are grown as rotation crops with potatoes, or because soil conditions are too heavy for root and tuber crops.⁴⁷

Income on arable holdings averaged around Euro 32,000 in 2001. This was on a rise after recovery from a low platform of incomes in 1999/2000.⁴⁸ Dutch arable farmers rely on subsidy through the EU Arable Area Payment Scheme (AAPS). The scheme was initiated to reduce arable over-production through obligatory land set-aside, but also to check the increase in conversion of grassland to arable farming associated with specialisation in the 1980s. In effect, the set aside scheme has not had a great influence on production.⁴⁹

Arable farming has seen a slight decrease in production. This is due to negative economic factors such as falling wheat prices, and stricter manure and ammonia policy.⁵⁰ With the MINAS (Minerals Accounting System) policy, arable farms have effectively become manure sinks, accepting surplus manure from livestock farms.

2.2.2 Dairy

There were 25,500 dairy farms in the Netherlands in 2001. They produce the fourth largest amount of milk in the EU behind France, Germany and the UK, with a quota of 11 billion litres.⁵¹

The dairy sector was in full expansion from the 1960s until 1984 when EU regulations, introducing the quota system, drastically checked the increasing numbers of dairy cows. Since then, dairy cow numbers have declined from 2.4 million in 1985 to 1.5 million in 2002.⁵² The Government is striving for a more market-orientated dairy industry. The legislative framework for the termination of price support will come from the pending CAP reforms under the Agenda 2000 Mid-Term Review.

The system of production follows the standard European model, with April to October grazing on grass, and winter housing. Winter-feed is centred on grass silage, but is shifting toward more concentrated feeds such as maize silage and grain. There is also more individual cow dieting, where cows are assessed in terms of milk output, body condition, and age, and given specific diets. Milking is twice daily and herds average about sixty cows.⁵³ This is not seen as labour intensive, but the use of milking robots, claimed as having been developed in the Netherlands, is growing. Today more than 500 robotic milking sheds are successfully operating in the Netherlands.⁵⁴

The dairy industry is an important part of total agriculture production, with milk products accounting for 30 percent of all agricultural added-value products. It is a highly concentrated milk-processing industry, with 13 companies sharing 61 factories. Dairy exports are valued at Euro 3.5 billion a year, taking the largest share of the total value of the dairy industry (Euro 5.7 billion).⁵⁵

2.2.3 Horticulture

In 2000, there were 101,200 hectares of land under horticultural production.⁵⁶ There were approximately 9,700 growers, including 1,300 vegetable growers, 2,700 flower bulb growers, and 2,000 fruit cultivation holdings. In addition, there are 11,000 hectares of glasshouses in the Netherlands, with 7,400 holdings averaging around 1.5 hectares each. Main production includes bulbs, ornamental plants and vegetables. Dutch floriculture controls the world's flower production. Holland is not only the largest producer of cut flowers and bulbs,

but is also the hub of ornamental plant trading, with world prices often determined in Dutch auction houses.

Government support for the horticulture sector has been strong in the past through research, information, and education. It is now taking more of a regulatory role, yet it still supports innovation and facilitates trade. The use of chemicals in the horticultural sector was checked in the 1990s. Regulations concerning pesticides were implemented and a significant reduction in their use has been noted.

2.2.4 Organic farming

Organic farming has more than doubled in the past decade – a response to growth in consumer demand nationally and within the EU, and also due to increased support for conversion to organic production. Over 29,000 hectares are now farmed organically in the Netherlands, but organics are still a niche market occupying less than four percent of the total food market and two percent of food consumption.⁵⁷ However, organics are gaining importance as an export, in particular to booming markets in the UK and Germany.⁵⁸

SKAL is the official certification body covering labelling and standard application, under government legislation, for all organic production and processing. These standards are recognised by the European EKO label. The Netherlands is the only country in the EU to have a single organic certification body. Biologica, started in 1992 is the umbrella organisation encompassing all matters organic in the country. The government recognises the role organic agriculture can play in improving environmental conditions and, under EU policy, subsidies are available for conversion to (and the practice of) organic farming. The sector is organised, structured, and focused on export.⁵⁹ Most major co-operatives now have an organic sector, and organic co-operatives are establishing themselves as viable enterprises. The Dutch co-operative Campina, for example, now has 40 percent of the country's organic milk market.

2.2.5 Social context in rural areas

Fifty-five percent of all Dutch people live outside of the 20 main urban centres. Of this number, only a small fraction work on farms. This gives rural areas a residential dimension.

In 1998, 292,000 people worked in agriculture, 71 percent of which were family members of the holding owners. The majority of external labour is found in horticultural businesses (77 percent). On half of farms, 25 percent of the income is external to farm production.

By 2001, the overall number of people working on farms was 269,000. The proportion of external workers had increased, and 77 percent of these were still

being employed by the horticulture sector. Two-thirds of agricultural land is farmed by the property owner. With prices rising steeply, the amount of tenanted farmed land is slightly decreasing.⁶⁰

With the increasing weight of retail and processing companies in the agricultural business, Dutch farmers are finding benefits in forming production networks, and hence producing and marketing products in co-operation. The concept of human and social capital is finding its place in rural communities and farmers' minds. They are becoming aware of the importance of collaboration through networks of trust and sound communication. Collaborative learning and dissemination of information and new technology are an integral part of the Dutch rural system. This allows for a more direct implementation process. Feedback from the farm to government is an integral part of that relationship.⁶¹

2.3 Environmental impacts

The major problem faced by agriculture in the Netherlands over the past ten years has been disposal of manure. The shortage of land and high stocking densities have meant that more manure is produced than can be absorbed efficiently by the soil without pollution of water and air. This has been fuelled by intensive production of fodder and grass for feeding by using high inputs of fertiliser. Many Dutch soils are phosphate saturated. Also the sandy nature of Dutch soils is particularly prone to nitrate leaching, which is a particular problem under intensive livestock production.

High use of crop protection agents, associated with intensive production, has been the cause of contamination in many areas. The aim of the 1992 Reduction in Pesticide Use plan, to reduce by half the mid-1980 amounts by 2000, was reached in 2001. However, crop production and horticulture are still very much dependent on chemical agents in terms of weed and fungal disease protection.

Greenhouse gases emitted by agriculture account for an estimated ten percent of total Dutch emissions. This rises to 15 percent when processing and transport emissions are added. Reduction by 12 percent in total emissions has been higher than the original goals set for the sector. This is attributed to a reduction in livestock numbers and a push for glasshouse horticulture to reduce its energy consumption.

The obligatory injection of manure directly into the soil and grass sward as the first step in reducing manure problems such as nitrogen volatilisation and emission of ammonia was introduced in the early 1990s.

Under the Nitrate Directive, the whole of the Dutch territory is classified as Nitrate Sensitive. The Netherlands is one of six countries in the EU to designate

their whole territory as nitrate sensitive, the others being Austria, Denmark, Sweden, Luxembourg, and Germany. Written up in 1991 to combat high nitrate pollution of waters in the community, the directive has taken time to be implemented. It relies on a code of good practice implemented on a voluntary basis by farmers. The MINAS is a direct follow-up of the directive by the Dutch government.

As in all intensive agricultural systems, biodiversity has been drastically reduced in the Netherlands. This is apparent not only at the agricultural level, where monocultures and dominant single breeds are used, but also with wild native species. The simplified ecosystem of intensive agriculture has been the major cause in reducing wild species biodiversity – directly through destruction of habitat for agricultural use and indirectly through pollution or destruction of food sources (insects, etc).⁶²

In general it can be said that Dutch farmers have an immense impact on the environment. For the most part they are aware of their role in shaping not only the farms but also the wider surrounding landscape and waterways. The Valuable Man-made Landscapes (VML) Scheme is designed to highlight the special areas of Holland where agriculture has shaped the landscape in a particular way. There are eleven such areas. The government provides the framework and subsidies, and local councils determine rural policy. The goal of a more sustainable agriculture sector is to be reached through reducing tensions between agriculture, nature, landscape and recreation activities, and development plans, with a bottom-up approach. In the past decade the environment has improved across the board. Water quality and pesticide residues have seen particularly good improvements, but this from the dire state of affairs of the late 1980s and early 1990s.

2.4 Policy responses

Agriculture policy in the Netherlands is governed by three main themes outlined in the priority plan *Change and Renewal* published in 1995. The three themes are:

- market orientation and competitiveness
- changes in the rural areas
- research, development and education.

The approach taken by the Dutch government to implement agro-environmental policy has been based on a user-pays system of taxation. This covers the incentive, but there has also been a focus on increasing farmers' understanding of the farm ecosystem. The farmers are then capable of adapting general ideas to their own particular situation. This assumes a

commitment to environmental issues on the farmers' part. Experts facilitate customised problem solving rather than advise general ready-made solutions. This 'teaching' is carried through study groups, within co-operatives and farm level research resulting in demonstration type situations.

At the farm level, good practice is framed by legislation such as a ban on fertiliser and manure applications during the winter months. In areas where irrigation is necessary during the drier summer months, particularly where maize is grown, irrigation plans are imposed. These plans involve careful monitoring of water amounts and soil humidity, and they reduce waste of water and possible leaching from over irrigation.

The government, along with other EU countries such as the UK, generally supports further reform of the CAP. The Netherlands believes that stronger, more direct, market forces applied on farmers with the shift of subsidy away from market and production support will help push agriculture toward a more sustainable future.⁶³ The Netherlands is also urging the EU to adopt more egalitarian environmental monitoring system across the member states.

Agenda 2000 CAP reforms state that the Netherlands will need to address certain issues for cross compliance. In the arable sector these include plans for erosion, nutrient, pesticide, water, and nature management. Technical conditions include general machinery maintenance, prevention of fertiliser drift and prevention of spray drift. Physical conditions include 2m field boundary strips and non-crop habitat as a percentage of the farm.

The arable sector in the Netherlands is very intensive and still relies heavily on chemical pesticides. This is not without risks for people and the environment. Three objectives have been formulated for crop protection policy between now and 2010 in order to realise the goal of sustainable crop production. These are:

- a further reduction of chemical pesticide use
- a further reduction of emissions to the environment
- improving compliance with current pesticide regulations to protect public health, the environment and workers.

The rural development program for 2000-2006 outlines the main themes for policy in agriculture. These include:

- a 'Green Spaces' scheme, noting agriculture doesn't have absolute rights in rural areas (i.e. focus on other things as well as food production, e.g. landscape)
- water conservation – through water storage and limiting losses through reducing dehydration

- confining intensive livestock production and glasshouse horticulture to certain areas.

The Mineral Accounts System (MINAS), installed partially in 1998 and fully in 2001, seems to have succeeded in decreasing minerals loss from excessive manure production and fertiliser applications. There is a maximum limit of permitted mineral loss. Levies are imposed on farms exceeding these standards. These standards should be tightened in 2003, and the levy brought up to Euro 2.30 per extra kilogram of nitrogen.⁶⁴ The system requires farms to register their mineral inputs (e.g. synthetic fertiliser) and outputs (e.g. milk, harvested crops).

In addition to the accounting system, the Netherlands has developed a system of contract disposal of manure. It is a complementary plan to the MINAS, whereby a farmer must be able to apply the manure produced to their land or if the amount produced exceeds the limits, finds suitable buyers.

The MINAS has permitted the Dutch to fulfil the requirements of the Nitrates Directive and set standards encompassing both chemical fertiliser nitrogen and manure nitrogen. It is in concordance with the user-pay approach of the Dutch government on environmental policy whereby excesses are taxed through levies.

The National Ecological Network launched in 1990 is a plan to link natural and semi natural ecological structures (woodlands, waterways, grasslands, etc) through a network of corridors. By 2018, 700,000 hectares are to be managed for the purpose of this green network. By 2000, two-thirds of this total was already acquired for the plan or under management contract. The contract binds the farmer to practice conservation methods and integrate them into their agricultural production system. There is a large number of people (11,000 by 2000) taking part in these contracts and an increasing area of land is under natural reserve.

By 2001, 90,000 hectares of farmland were under conservation schemes. Compensation for these areas amounts to Euro 440 per hectare, but on average this is still minimal, making up only two percent of total farm incomes.

2.5 Future developments

Nature for people, people for nature seems to be the main policy guideline document for the Dutch Ministry of Agriculture, Nature and Food Quality. Published in 2000, it sets the goals for nature, forest, landscape, and biodiversity policy out to 2020.

With sustainable agriculture as a goal, Dutch agricultural policy is striving for target situations where:

- restructuring has facilitated sustainable agricultural production in line with environmental, nature, landscape and social constraints
- new agricultural crops and products have been developed and the added value of the products has increased
- the agriculture sector has developed new outlets
- there is optimum co-operation throughout the chain
- agriculture has long-term protection against extreme situations
- non-forward-looking and high-risk holdings have been redeveloped in favour of forward-looking holdings
- holdings producing non-sustainably or in unsustainable locations have been redeveloped
- environmental measures addressing the sources of problems have been implemented and are functioning optimally
- agriculture takes proper account of region-specific features.⁶⁵

On the issue of biotechnology the Dutch government maintains an observer approach while being involved in substantial research in the area. A committee was set up in 2001 to educate the Dutch people on genetic engineering and feedback was generally against it.

With the Nature Policy plan the objective is for sustainable development and sustainable restoration of ecological and landscape values. The VML scheme is set to reorient agriculture in certain areas by stimulating farmers to produce regional products in a sustainable manner, and perform nature management tasks.

There is scepticism as to the role the CAP can play in solving environmental problems. These problems are often local and differ from region to region. The Dutch government has not waited for the CAP to deliver and has taken the initiative at a national level and will continue to do so as outlined in its own environmental management plan. However, the Framework Regulation proposed with the Agenda 2000 reforms is deemed to be more compatible to the Netherlands' rural policy, particularly with its approach to integrated rural development.

Dutch agricultural success is due to high quality training, top research and particularly, an efficient information delivery system. Productivity is currently at an optimum, but the agriculture sector has put great pressure on the environment as it intensified. Although the focus of agricultural policy has shifted to the environment, with a gradual increase in public awareness over the past decade, there are still many challenges faced by Dutch agriculture.

3.1 Introduction

Around 59 percent of Australia's land area – 456 million hectares – is used for agriculture. This is largely taken up by extensive grazing livestock production, notably sheep and beef cattle.⁶⁶ More intensive forms of agriculture are limited to those areas where soil resources and climate are best suited to plant growth. Indeed, Australian soils are generally very poor in nutrient and organic matter contents, and cultivated land effectively takes up ten percent of agricultural land. This is evenly divided up between crops, and sown pastures and grasslands.

With agricultural activities largely limited to where soils and rainfall are the most favourable, the coastal fringes and inland coastal fringes harbour the majority of crop production (both arable and horticulture) and intensive pasture-based dairy production. These are also the areas where the majority of the Australian population lives (82 percent are urban dwellers). The cities and conurbations are situated on or near the coastal fringes. As these urban centres expand, rural areas are being encroached upon and land use conflicts are arising. The deterioration of water resources through agricultural activities is also affecting urban water supply. The pollution of waterways and rivers by excess nutrient and pesticides is causing concern. The increasing concentration of salt in water tables and the huge sediment loading of rivers from erosion is of particular concern to water quality in major cities.⁶⁷

Half a million people work in the food industry, and as a whole, this industry is vital to the Australian economy accounting for 45 percent of retail turnover. It contributed 28.3 percent to export trade, bringing in \$24.3 billion in export value for the 2000/2001 year. This was well above the previous decade's average.⁶⁸ The farm sector accounts for 2.7 percent of GDP and represents 4.5 percent of the total work force. The part agriculture plays in total employment is declining as the sector becomes more competitive and as the Australian economy moves toward services and retail, and away from manufacturing and production.⁶⁹

A total of 138,917 farms divide up the immense area of land used for agriculture – 25 percent of these are beef cattle farms, and the number is increasing. Sheep farms are dwindling but still account for a huge area, with just over 13,000 farms in 2001. Sheep and beef farm numbers are also falling – down 25 percent in the ten years to 2001. The general trend is decreasing farm numbers and increasing livestock numbers in all sectors except sheep. Cropping farms have increased, particularly wheat farms, which have more than doubled in number since the late 1980s.⁷⁰

The drop in government support across agriculture in the 1980s with the deregulation of financial markets, the dropping of statutory marketing arrangements (which had controlled farm commodity prices in many cases since before WWII), and the floating of the Australian dollar, instigated rapid change across agricultural production in Australia. Competition and market forces now dictate farm business. Farms are bigger and more efficient than ever. Higher production levels are being attained in all areas except sheep-based products.⁷¹

Irrigated production is particularly important to some regional economies. These include the Murray-Darling Basin (cotton, rice, dairying, fruit, vegetables and grapes), the southeast of South Australia (irrigated pasture and wine grapes), and the mid-north coast of Queensland (sugar). Irrigation is also locally important in Western Australia and Tasmania. In all these regions there is considerable scope for improving industry profitability through improvements in irrigation technology and the efficiency of water distribution systems.⁷²

Overall, the more intensive production systems are increasing in importance while farm numbers are decreasing. Irrigation is the big word in Australian agriculture. It allows increased production in less-suitable areas and the establishment of agricultural systems with high water demand in areas where conditions had previously not allowed such systems to function. Agriculture is the country's biggest water consumer, accounting for 70 percent of total water consumption. The irrigated area makes up only about 5 percent of the total cultivated agricultural land while producing a quarter of the gross agricultural production value for Australia.⁷³

3.2 Agricultural production systems

3.2.1 Arable

Arable grain is a big part of Australia's agricultural production. Total exports are valued at \$5 billion a year. The main crop is wheat. It accounts for \$3.5 billion in export value and 17 percent of the world wheat trade. Australia is the third biggest wheat exporter behind the USA and Canada. Other grain crops include rice, barley, maize, oats, sunflowers, chickpeas and sorghum. Other arable crops are grown, most importantly sugar cane and cotton, for both seed and lint. Cotton exports were worth \$1.6 billion in 2000 while sugar production exports were valued at \$1.1 billion. The arable sector, as with most of Australia's agriculture production, produces more than the needs of the country. This is reflected in the large proportion of produce exported.⁷⁴

In 2001/2002 Australia produced 24.6 million tonnes of wheat from 11.6 million hectares, 73 percent of which was exported. Over 90 percent of cotton production in 2000/2001 was exported, while over 70 percent of total refined sugar cane produce was exported.⁷⁵

Wheat is by far the biggest arable crop in Australia, though average yields are low at just over two tonnes per hectare. There are similar low yields for most other cereal crops. This is mainly due to the low fertility of Australian soils and recurring water shortages. There is however a continuing improvement on yields, attributed to improved technologies and breeding. In the Australian context, the use of judicious rotations such as lupin, and soil improving cultivation methods (minimum tillage), have also played an important part. Main producing regions are Western Australia and New South Wales.

Large dams built in the 1960s and 1970s in south Queensland and north NSW allowed irrigation-based cotton production systems to develop. Today most Australian cotton is grown in these areas. Dryland cotton production is decreasing due to higher returns from irrigated crops. The industry is a big consumer of pesticide and fertiliser. Combined with inefficiently managed irrigation systems (i.e. spray and flood irrigation) these create problems in waterways. An increasingly high amount of cotton is genetically modified Bt (*Bacillus thuringiensis*) cotton. It currently account for a quarter of all cotton crops.

In 1997 irrigated arable production included all rice production (130,000 hectares), 250,000 hectares of cereals and other grain, as well as relatively important areas of sugar cane. Arable crop production as a whole accounts for 23 percent of Australia's total water consumption and this is increasing quite rapidly as irrigation systems improve and farmers generally strive for lower risk agriculture in a sector so reliant on rainfall.

Problems arising from arable production are appearing to have increased impact on farmers as their awareness toward resource degradation issues grows. There are more farmers implementing best management practices that take into consideration wider environmental values. There is also an increase in the use of private consultants and research-based, decision support systems. Innovations and the development of cropping systems suited to Australian conditions could be an answer to the widespread degradation of soils.

3.2.2 Dairy

The total number of dairy cows has increased significantly in recent years, from 1.65 million in 1989/1990 to 2.37 million in 2001/2002. Predominantly family owned and operated, dairy farms numbers have dropped substantially over the last 25 years (from 22,000 in 1980 to 15,000 in 1990, to a recent census count of 12,918).⁷⁶ These trends indicate the intensification of dairy farming, with fewer farms accommodating more animals. Bigger, more efficient farms are a result of dwindling government support and regulation and increasing market exposure. From 85 heads per herd in 1980, the average farm today holds 210 dairy cows per herd. Huge corporate-type operations are also now appearing, where one holding will accommodate half a dozen big herds of 500 to 1000 head.

Dairy production is confined to those areas providing the best climate and resources for pasture-based systems with year-round grazing. Victoria has the best conditions in terms of rainfall and resources for productive pasture. Each state, however, produces enough liquid milk for its own consumption. Accordingly, the highly productive region of southeast Australia has a large percentage of its milk destined to processing and export.⁷⁷

The developing use of irrigation on pasture in inland New South Wales and North Victoria is detaching dairy production a little further from climate and proving popular for risk-conscious farmers. Generally pasture irrigation is of the flooded type but this is increasingly identified as an important cause of salinisation and a wasteful use of water.⁷⁸ Systems such as drip irrigation, already well established in crop production, could have an important role to play in the future of pasture irrigation.

Australia is ranked third in dairy produce world trade with a 16 percent share. Over three-quarters of total dairy exports go to Asia. Farm-gate value of dairy production was \$3.7 billion for the 2001/2002 year. It is the most important agricultural product in value behind wheat and beef.⁷⁹

The internal milk market has been entirely deregulated since 2000. This means that milk pricing and sourcing are now free from legislation, in place in the past to ensure year-round supply of quality milk to consumers and income

guarantees for producers. Effectively the deregulation process has meant that the smaller less productive holdings have had to leave the industry, while bigger producers expanded.

3.2.3 Horticulture

Horticulture in Australia has grown by 142 percent in the past decade. It represents 18 percent of total agricultural production while taking up less than 2 percent of total cultivated land (excluding grassland). About 23,773 agricultural holdings are involved in this sector, employing around 80,000 people in production and a further 11,200 in processing directly related to horticultural production.

The biggest single sector is grape growing (see next section). Fruit and nut production are also important as are vegetable and nursery products. The total gross value of production for the Australian horticultural industry was \$5.5 billion in 1999/2000.⁸⁰ Horticultural exports for the 1999/2000 year were \$720 million.

3.2.4 Viticulture

A total area of 143,373 hectares is dedicated to wine grape growing. This number is continually increasing as irrigation and drainage systems improve. The Australian wine industry is booming, with wine exports worth \$1.6 billion in 2001. Major export markets (by value) are the UK, USA, Canada and New Zealand.

Three main regions are identified as wine growing zones of Australia: the lower Murray River in South Australia, the Big Rivers zone of New South Wales and the North West Victoria zone. These three areas produce 68 percent of total wine production and all have good irrigation possibilities.⁸¹

3.2.5 Organic farming

Australia has 10.5 million hectares of land in organic farming. Most of it is in the extensive livestock grazing sector. Organic farming has experienced a great increase in the past decade in conjunction with farmers taking up management practices aimed at reducing land degradation. In the ten years to 2001, organic farming grew by 20 percent on average per year. Average turnover reached \$200-250 million a year by the late 1990s. This expansion has come from increasing demand from consumers becoming aware of issues in agriculture such as pesticide use, and also the concern by farmers for dwindling resources and the unsustainable manner in which land was being farmed. Soil degradation has been a major instigator of the movement.

Organic farming is not a major player in Australian agriculture – representing less than two percent in value and human capital. However, the idea of ‘taking it easy on the land’ is more widespread and a consciousness is growing. The vast expanses of grazing land with minimal livestock stocking densities are easily altered, to have little impact on the land. This is more difficult with the more intensive production systems but an intensive monitoring network has been developed and farmers are actively taking part in land care programmes as their awareness grows.

3.3 Environmental impacts

Australia has seen agriculture develop on its soil since colonisation by the British Empire. The first farmers applied European farming systems to the land. Wide-scale clearance of native trees was deemed necessary to allow for expanding agricultural areas. The production systems were not fundamentally modified to suit the land, but rather the land was adapted to suit the agricultural systems. As a direct and far reaching consequence, soils were widely depleted, losing much of their fragile fertility. This problem was alleviated with the application of mineral fertilisers.

Today soil degradation is a major problem and it is increasing as monitoring and general understanding of the forces at work show. Agriculture plays a central role in this degradation. And even as the biophysical processes are better understood, complex interactions between economic, social, physical, and biological processes mean that the problems are not being addressed rapidly enough to prevent further degradation.⁸²

High sodium levels in soil is a major problem, leading to two types of land degradation – soil salinity and sodicity. Dryland soil salinity occurs when rising water tables dissolve subsoil salt minerals, carry them to the surface and, through evaporation, increase the salinity of the upper soil. Before land was cleared for agriculture, the water table did not rise up far enough to deposit minerals near the surface (trees regulated the water table’s movements by affecting both rain interception and discharge of water through evapotranspiration). Southwestern Australia is the most affected area as it has been cleared for the longest time. While dryland salinity occurs on land not under irrigation, land under irrigation can also be affected by soil salinity, termed irrigated land salinity.⁸³ Currently 2.5 million hectares of cultivated land is affected by dryland salinity with a further 0.7 million hectares of land affected by irrigated land salinity. This total 3.2 million hectares represents about 0.7 percent of all agricultural land but is having increasing economic impact on the agricultural sector by affecting the highly productive irrigated areas. There is a further nine million hectares of land at risk of developing high salinity if action is not taken immediately.⁸⁴

The other soil degradation problem linked with high soil sodium concentration is sodicity. This is a wider-reaching problem than salinity, affecting 109 million hectares or 23 percent of Australian agricultural land. Farmers may be operating on sodic soils without being aware of the problem. Sodic soil clay particles, through their incapacity to bind with each other, are more prone to erosion, water logging, and crusting, as well as poor penetration of water into the soil.⁸⁵

Soil acidity is an increasing problem as well. The minimal limit for optimum soil pH is about 5.5. Highly acidic soils cover extensive areas (up to 24 million hectares), severely affecting production in high rainfall/high production regions. A further 55 million hectares of farmland is classified as moderately acidic and is at risk of continued degradation. In terms of the total area affected and the cost to the economy, soil acidification is more important than any other type of soil degradation.⁸⁶

Farming tends to make soils more acid through pasture improvement and fertilisation of crops with nitrogen. All this has added to the problem of originally acidic soils by increasing rates of acidification. The application of lime, which neutralises the acidity, can help maintain production. However, lime added to land used for grazing is generally uneconomic unless it is in intensive dairy production where higher returns can justify higher inputs. Also, the benefits of liming in arable production are well established. About two million tonnes of lime are applied to agricultural land each year and this has been on an increase over the past decade across all sectors. Farmer awareness of soil acidification and its consequences on production is low. Adaptive farming practices such as using acid tolerant plants are also increasingly being used in systems where liming costs are not justified by the returns.

Environmental impact can be largely attributed to the following:

- historically, for economic and social reasons, natural resources were 'mined' and their use was not sustainable
- agricultural systems have largely been adapted from European ways of farming and are not suited to Australia's climate variability
- extensive tree clearing was necessary to prepare land for cropping and has led to changes in water balance, dryland salinity, and sodicity problems
- overgrazing of native pastures led to soil erosion, increased sediment and nutrient loads in rivers, and deteriorated water quality.⁸⁷

Water quality is severely affected by agriculture and soil degradation. Rising water tables, dissolving salt minerals from the soil and causing salinity, are also flowing into rivers, increasing their sodium concentration. The Adelaide water

supply, for example, may be in jeopardy in the years to come as the Murray River's salt content increases as a direct consequence of the rising salinity of the Murray-Darling Basin. This large catchment area provides the resources for and corresponds to 75 percent of Australia's irrigated agriculture.

3.4 Policy responses

The Natural Heritage Trust (NHT) was set up in 1997 to restore and conserve Australia's environment and natural resources. It is administered jointly by Environment Australia and the Ministry of Agriculture, Forestry and Fisheries.

The National Land and Water Resources Audit was set up under the NHT, to assess the state of natural resources under seven different themes:

- surface and groundwater management, availability, allocation, use, and efficiency of use
- dryland salinity
- vegetation cover, condition, and use
- rangelands monitoring
- land use change, productivity, diversity, and sustainability of agricultural enterprises
- capacity of, and opportunity for, farmers and other natural resource managers to implement change
- waterways, estuarine, catchment, and landscape health.

Under the National Action Plan for Salinity and Water Quality, the Commonwealth, State and Territory Governments are committing \$1.4 billion over seven years to find solutions to salinity and water quality problems at a regional level. Government, community groups, individual land managers and local businesses will work together to reduce salinity problems and improve water quality.

A series of audits for agriculture sectors and regions have been ongoing under various plans. Their aim is to collect relevant data on sustainability and environmental impacts of farm operations at a local, regional and national level. This data will help determine problem areas. After identifying the main areas of concern in agriculture/environment interactions, local governments, in co-ordination with the different industry bodies and interested organisations, have set out codes of good practice for each sector and in different regions.

At the industry level, and indeed the farm level, there is a definite movement toward more sustainable agriculture. Along with the uptake of on-farm

monitoring by many farmers, good management practice schemes spanning most sectors are being implemented. These schemes are seen to be successful because they are primarily industry led, implemented on a voluntary basis, and strongly supported by external organisations. But most important, they are flexible, simple to use, with clear and achievable objectives, and focused on practical issues. Furthermore, they promote gradual implementation, which is often more accessible to farmers than total overall changes.

3.5 Future developments

The National Framework for Natural Resource Management Standards and Settings will constitute the broad operating guidelines for resource management across Australia. It identifies the requirements and principles for adequate resource management, particularly the regional applications of natural resource management under the National Action Plan for Salinity and Water Quality and the National Heritage Trust. It is also a directory to guide investment into these plans.⁸⁸

So far the story with Australian agriculture has been that:

- climate, soil quality, topography, and the availability of irrigation water determine agricultural land use patterns and production potential.
- development of agriculture has had to overcome constraints imposed by an unreliable and generally semi-arid climate, and often fragile and infertile soils.
- irrigated agriculture has expanded markedly in recent decades to over two million hectares. It now contributes a quarter of the gross value of national agricultural production.
- agricultural land use systems and farming practices have evolved and continue to move toward being more efficient in resource use and sustainability.
- agricultural development has disturbed the rate and sometimes the direction of the ecological processes at work in natural landscapes. Some types of degradation (e.g. soil loss by erosion and dryland salinity) have long-term or irreversible consequences, other forms (e.g. leaching of nutrients, surface acidification) can be remedied to a certain extent with appropriate actions.
- many Australian soils do not naturally have the qualities needed for sustained agricultural production without significant management and monitoring of inputs.

The future of Australian agriculture lies in taking all these factors into account and, with further understanding, adapting the production systems to the less-than-favourable conditions. It is no longer a matter of 'conquering' the land, but rather of accommodating its physical limits.

Conclusions

The general findings of the review are that:

- There are some trends toward more environmentally friendly agriculture, based on the sustainable use of natural resources and development of best management practices. The implementation tools vary but generally, change is associated with farmers' active involvement in the developments of the blueprints.
- In parallel, there is a move toward quality and safety of food products, including a big push for organic farming, and labelling, particularly in Europe. This focus comes from food safety concerns and, increasingly, animal welfare issues.
- Policies have been developed that take into account the multiple functions of farmers and agricultural land with an increasing awareness of the values of rural and natural landscapes amongst wider communities.
- There is a continued push for more market responsive agricultural production and a shift of support toward conservation plans in an effort to comply with increasing WTO pressure for a liberalised agricultural world market.
- Beyond each case study, a comparative analysis of the three different socio-economic and ecological situations with the New Zealand situation would be recommended. This would expose more clearly ideas relevant to sustainable agriculture in New Zealand.

Endnotes

- ¹ DEFRA, 2003: Ch 3.
- ² DEFRA, 2003: Ch 2.
- ³ DEFRA, 2003: Ch 9.
- ⁴ DEFRA, 2003: Ch 2.
- ⁵ DEFRA, 2003: Ch 1.
- ⁶ MAFF, 2000; DEFRA, 2002f.
- ⁷ European Commission Directorate-General for Agriculture, 2003.
- ⁸ DEFRA, 2003: Ch 5.
- ⁹ Joint Nature Conservation Committee, 2002: Section 3.4.
- ¹⁰ Centre for Rural Economics Research, 2002.
- ¹¹ www.milk.co.uk
- ¹² *ibid.*
- ¹³ DEFRA, 2001.
- ¹⁴ DEFRA, 2003: Ch 5.
- ¹⁵ DEFRA, 2002g.
- ¹⁶ Dairy Crest, 2003.
- ¹⁷ The founding organisations of the NDFAS are the National Farmers Union (NFU), the Dairy Industry Federation (now known as the Dairy Industry Association Ltd or DIAL), the Federation of Milk Groups (FMG) and the British Cattle Veterinary Association (BCVA).
- ¹⁸ National Dairy Farm Assured Scheme, 2001b.
- ¹⁹ National Dairy Farm Assured Scheme, 2001a.
- ²⁰ Foreign Agriculture Service data from the United States Department of Agriculture.
- ²¹ CEAS Consultants (Wye) Ltd and the European Forum on Nature Conservation and Pastoralism, 2000.
- ²² DEFRA, 2002a.
- ²³ DEFRA, 2002d.
- ²⁴ Joint Nature Conservation Committee, 2002.
- ²⁵ DEFRA, 2003: Chs 3 and 5.
- ²⁶ National Farmers Union Public Affairs, 2002.
- ²⁷ <http://www.soilassociation.org.uk>
- ²⁸ <http://www.soilassociation.org/web/sa/saweb.nsf/standards/index.html>
- ²⁹ DEFRA, 2002e.
- ³⁰ *ibid.*
- ³¹ DEFRA, 2002h: Section 2.1.2.
- ³² DEFRA, 2002b: Section 2.1.6.
- ³³ Home Office, 2002.
- ³⁴ DEFRA, 2003: Ch 2.
- ³⁵ National Association of Farmers Markets, 2003.

- ³⁶ Joint Nature Committee, 2002; DEFRA, 2002c.
- ³⁷ Environment Agency, 2002.
- ³⁸ National Farmers Union estimates
- ³⁹ European Commission Directorate-General for Agriculture, 2003.
- ⁴⁰ Agricultural Economics Research Institute, 2002a.
- ⁴¹ MinLNV, 2000c.
- ⁴² *ibid.*
- ⁴³ *ibid.*
- ⁴⁴ Foreign Agricultural Service/USDA, 2002.
- ⁴⁵ *ibid.*
- ⁴⁶ Flat tracts of coastal land reclaimed from the sea and protected from inundation by artificial embankments (dykes).
- ⁴⁷ Terp Advies, 2001.
- ⁴⁸ Agricultural Economics Research Institute, 2002a.
- ⁴⁹ Terp Advies, 2001.
- ⁵⁰ Agricultural Economics Research Institute, 2002a.
- ⁵¹ Agricultural Economics Research Institute, 2002a: Section 5.6.
- ⁵² Agricultural Economics Research Institute, 2002b.
- ⁵³ MinLNV, 2000b.
- ⁵⁴ *ibid.*
- ⁵⁵ Milk Netherlands, 2002.
- ⁵⁶ Statistics Netherlands, 2001.
- ⁵⁷ <http://www.skal.com/English.htm>
- ⁵⁸ Melita, 2001.
- ⁵⁹ MinLNV, 2000a.
- ⁶⁰ Agricultural Economics Research Institute, 2002a: Section 4.2.
- ⁶¹ MinLNV, 1993.
- ⁶² MinLNV, 2002.
- ⁶³ MinLNV, 2000c.
- ⁶⁴ Agricultural Economics Research Institute, 2002a.
- ⁶⁵ MinLNV, 1999.
- ⁶⁶ Australian Bureau of Statistics, 2002.
- ⁶⁷ Sinclair, 1999.
- ⁶⁸ Department of Agriculture, Fisheries and Forestry – Australia, 2002.
- ⁶⁹ National Land and Water Resources Audit, 2002: Key findings – People.
- ⁷⁰ Australian Bureau of Statistics, 2002.
- ⁷¹ NSW Farmers' Association, 2003.
- ⁷² Australian Bureau of Statistics, 2003.
- ⁷³ National Land and Water Resources Audit, 2001: Setting the scene.
- ⁷⁴ Australian Bureau of Statistics, 2003.

⁷⁵ *ibid.*

⁷⁶ Australian Bureau of Statistics, 2002.

⁷⁷ Australian Dairy Corporation, 2002.

⁷⁸ Dairy Research and Development Corporation, 1999.

⁷⁹ Australian Dairy Corporation, 2002.

⁸⁰ Australian Bureau of Statistics, 2003.

⁸¹ *ibid.*

⁸² Australian Academy of Science, 2002; National Land and Water Resources Audit, 2002.

⁸³ Australian Academy of Science, 1999a.

⁸⁴ National Land and Water Resources Audit, 2002.

⁸⁵ Australian Academy of Science, 1999b.

⁸⁶ National Land and Water Resources Audit, 2001: Soil acidification; Hamblin, 2001: Part 4 – Secondary salinity and acidity.

⁸⁷ National Land and Water Resources Audit, 2002.

⁸⁸ Natural Resource Management Ministerial Council, 2003.

References

- Agricultural Economics Research Institute (LEI). 2002a. *Agricultural economic report 2002 of the Netherlands*. The Hague: LEI.
- Agricultural Economics Research Institute (LEI). 2002b. *Development of dairy farming in the Netherlands in the period 1960-2000*. The Hague: LEI.
- Australian Academy of Science (AAS). 2002. *Feeding the future – Sustainable agriculture*. Canberra: AAS.
- Australian Academy of Science (AAS). 1999a. *Monitoring the white death – Soil salinity*. Canberra: AAS.
- Australian Academy of Science (AAS). 1999b. *Sodicity – A dirty word in Australia*. Canberra: AAS.
- Australian Bureau of Statistics (ABS). 2003. *Year Book Australia 2003*. Canberra: ABS.
- Australian Bureau of Statistics (ABS). 2002. *Year Book Australia 2002*. Canberra: ABS.
- Australian Dairy Corporation (ADC). 2002. *Australian dairy industry: In focus 2002*. Victoria: ADC.
- *Bureau of Rural Sciences (BRS). 2001. *Landuse change, productivity and diversification*. Final Report of Theme 5.1 to the National Land and Water Resources Audit. Canberra: BRS.
- CEAS Consultants (Wye) Ltd and the European Forum on Nature Conservation and Pastoralism. 2000. *The environmental impact of dairy production in the EU: Practical options for the improvement of the environmental impact*. Brussels: European Commission. <http://europa.eu.int/comm/environment/agriculture/pdf/dairy.pdf> [Accessed September 2003].
- Centre for Rural Economics Research. 2002. *CAP reform: Decoupling arable payments*. Cambridge: Centre for Rural Economics Research, University of Cambridge.
- Dairy Crest. 2003. *5 year review*. <http://www.dairycrest.co.uk/ir/5year.shtml> [Accessed July 2003].
- Dairy Research and Development Corporation (DRDC). 1999. *Improving efficiency of water use. Research Note 69*. Victoria: DRDC.
- Department for Environment, Food and Rural Affairs (DEFRA). 2003. *Agriculture in the United Kingdom 2002*. London: DEFRA.
- Department for Environment, Food and Rural Affairs (DEFRA). 2002a. *Agenda 2002*. <http://www.defra.gov.uk/foodrin/milk/Quotas/agen2000.htm> [Accessed July 2003].
- *Department for Environment, Food and Rural Affairs (DEFRA). 2002b. *Agri-environment schemes framework document: A consultation on the future of agri-environment schemes*. London: DEFRA.

- Department for Environment, Food and Rural Affairs (DEFRA). 2002c. *Analyses of the environmental effects of Common Agricultural Policy direct aids*.
- Department for Environment, Food and Rural Affairs (DEFRA). 2002d. *Common organisation of the market*. <http://www.defra.gov.uk/foodrin/milk/commonmarket.htm> [Accessed July 2003].
- Department for Environment, Food and Rural Affairs (DEFRA). 2002e. *Key drivers of economic development and inclusion in rural areas*. London: DEFRA.
- Department for Environment, Food and Rural Affairs (DEFRA). 2002f. *Origin of the UK Foot and Mouth Disease epidemic in 2001*. London: DEFRA.
- Department for Environment, Food and Rural Affairs (DEFRA). 2002g. *The dairy industry*. <http://www.defra.gov.uk/foodrin/milk/dairyindustry.htm> [Accessed July 2003].
- *Department for Environment, Food and Rural Affairs (DEFRA). 2002h. *The strategy for sustainable farming and food: Facing the future*. London: DEFRA.
- Department for Environment, Food and Rural Affairs (DEFRA). 2001. *Milk Task Force report*. DEFRA: London.
- Department of Agriculture, Fisheries and Forestry – Australia. 2002. *Australian food statistics 2002*. Canberra: Commonwealth of Australia.
- Environment Agency. 2002. *Pesticides 2001: The Environment Agency's pesticide monitoring programme*. Bristol: Environment Agency.
- European Commission Directorate-General for Agriculture. 2003. *Reform of the Common Agricultural Policy: A long-term perspective for sustainable agriculture: Impact analysis*. Brussels: European Commission.
- Foreign Agricultural Service/USDA. 2002. *The Netherlands exporter guide annual 2002*. GAIN Report #NL2053. The Hague: Foreign Agricultural Service/USDA.
- Hamblin, A. 2001. *Land, Australia State of the Environment Report 2001 (Theme Report)*. Canberra: CSIRO on behalf of the Department of the Environment and Heritage.
- Home Office. 2002. *Review of the seasonal agricultural workers' scheme*. London: Home Office.
- Joint Nature Conservation Committee (JNCC). 2002. *Environmental effects of the Common Agricultural Policy and possible mitigation measures*. Peterborough: JNCC.
- Melita, F. 2001. *Organic farming in the Netherlands*. http://www.organic-europe.net/country_reports/netherlands/default.asp [Accessed July 2003].
- Milk Netherlands. 2002. *Dutch Dairy Board*. <http://www.produivel.nl/> [Accessed July 2003].
- Ministry of Agriculture, Fisheries and Food (MAFF). 2000. *BSE information: Chronology of events*. London: MAFF.
- Ministry of Agriculture, Nature and Food Quality (MinLNV). 2002. *Biodiversity and the Netherlands*. The Hague: MinLNV.

- *Ministry of Agriculture, Nature and Food Quality (MinLNV). 2001. *Manure and the environment*. The Hague: MinLNV.
- Ministry of Agriculture, Nature and Food Quality (MinLNV). 2000a. *An organic market to conquer*. The Hague: MinLNV.
- Ministry of Agriculture, Nature and Food Quality (MinLNV). 2000b. *Dutch dairy farming and dairy products*. The Hague: MinLNV.
- Ministry of Agriculture, Nature and Food Quality (MinLNV). 2000c. *Facts and figures 2000: Highlights of Dutch agriculture, nature management and fisheries*. The Hague: MinLNV.
- *Ministry of Agriculture, Nature and Food Quality (MinLNV). 2000d. *Nature for people, people for nature*. The Hague: MinLNV.
- Ministry of Agriculture, Nature and Food Quality (MinLNV). 1999. *Rural development programme: The Netherlands 2000-2006*. The Hague: MinLNV.
- Ministry of Agriculture, Nature and Food Quality (MinLNV). 1993. *The structure plan for the rural areas in the Netherlands: They're worth it!* The Hague: MinLNV.
- National Association of Farmers Markets. 2003. *National Association of Farmers Markets*. <http://www.farmersmarkets.net/> [Accessed July 2003].
- National Dairy Farm Assured Scheme (NDFAS). 2001a. *Background to the NDFAS*. http://www.ndfas.org.uk/pdfs/factsheet_b.pdf [Accessed July 2003]. Reading: NDFAS.
- National Dairy Farm Assured Scheme (NDFAS). 2001b. *Hygiene and food safety*. http://www.ndfas.org.uk/standards/hygiene_v2.asp [Accessed July 2003]. Reading: NDFAS.
- National Farmer's Union (NFU) Public Affairs. 2002. *Growing Great Britain: Horticulture facts and figures*. London: NFU.
- *National Land and Water Resources Audit (NLWRA). 2002. *Australia's natural resources 1997-2002 and beyond*. Canberra: NLWRA.
- National Land and Water Resources Audit (NLWRA). 2001. *Australian agriculture assessment 2001*. Canberra: NLWRA.
- Natural Resource Management Ministerial Council. 2003. *National framework for natural resource management standards and targets*. Canberra: Natural Resource Management Business Unit.
- NSW Farmers' Association. 2003. *The Primary Report: Farming changes*. Sydney: NSW Farmers' Association.
- *Policy Commission on the Future of Farming and Food. 2002. *Farming and food: A sustainable future*. London: Cabinet Office.
- Sinclair, I.W. 1999. *Is there a future for Australia's agricultural land?* Paper presented to RAPI National Congress, 19-23 September 1999, Darwin. <http://www.ruralplanning.com.au/library/papers/rapinat99.pdf> [Accessed July 2003].
- *Sociaal-Economische Raad. 2001. *Recommendations on the Fifth Policy Document on Spatial Planning*. The Hague: Sociaal-Economische Raad.

Statistics Netherlands. 2002. *Key figures: Horticulture in the open*. Voorburg/Heerlen: Statistics Netherlands.

Terp Advies. 2001. *Evaluation of the impact of community measures concerning set aside. Regional study: The Netherlands. Annexe 20 du rapport d'évaluation*. <http://europa.eu.int/comm/agriculture/eval/reports/gel/ann20.pdf> [Accessed July 2003]. Amersfoort: Terp Advies.

** The main references used for each country are included in the Reference List. These principal reference documents have not been referenced in the text as they were used extensively and it would not have been practical. Also, the main ideas derived from these documents are of a general nature, rather than specific findings. More information can therefore be obtained by referring to these documents directly.*