

Agricultural intensification: Livestock farming in The Netherlands

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1.1 Introduction

Agriculture in The Netherlands represents one part of the most intensive agricultural production system in the world. The Netherlands, although one of the world's smaller countries in terms of its area, is the world's third largest exporter of agricultural products after the United States and France. In 1992, it accounted for 10% of world exports of agricultural products. As a consequence, The Netherlands is as densely populated with animals as it is with people. The number of pigs, for example, at 14 million almost equals the number of human inhabitants.

The agricultural production system in The Netherlands is based on a complex and extensive national infrastructure. It supplies feed, artificial fertiliser, farming machinery and fuel; it processes milk, meat and sugar beet; and it provides key services such as trade and transport. Imports also take place on a large scale. Six million hectares of agricultural land outside The Netherlands are needed to produce the raw materials for the feed consumed by Dutch livestock. This international dimension means that changes in Dutch agriculture and horticulture have a direct bearing on agricultural producers and traders elsewhere in the world. The effect on the environment of such an intensive production system demands action. Major national and international economic interests are at stake, however, and reconciling environmental interests, economic interests and agricultural trade policy with one another is no easy matter.

This chapter is in the form of a case study, focusing on an environmental problem in an advanced Western society. It demonstrates that even apparently localised or national environmental problems have much wider international ramifications. The case focuses on three aspects that arise out of intensive livestock farming. First of all, it addresses the question of *ecological and economic interdependencies*. The large number of animals involved in the agricultural production system accounts for vast

amounts of manure to be disposed of somehow. The traditional solution of using it as a natural fertiliser only offers partial solace: there simply is too much of it. As the manure surplus nevertheless is still largely applied to the soil, environmental pollution results. Indeed, closer inspection reveals that the Dutch manure surplus is an international problem too. Not only does pollution cross national borders, but the production of the required animal foodstuffs causes problems in developing countries. Moreover, possible solutions to the problems in The Netherlands in turn have economic and environmental effects elsewhere.

Second, both the definition of a problem and any attempts which are made to solve it involve numerous *conflicts of interest*. These problems come at all levels, from the local through the national to the international level. In part, these conflicts are ideological. 'General' interests (such as the economy, the environment, Nature, animal well-being) may collide but so may administrative interests, as between different governmental and public organisations. A sizeable fraction of conflicts, finally, concerns distributional issues: who benefits and who bears the costs of the problem or its proposed solutions?

The third aspect is the *role of technology*. 'Faith' in specific technologies is ideology-laden; it is connected with particular interests. The bearers of these interests are keen to portray the technical solution (in this case industrial manure processing) as being in the public interest. Others, however, argue that in the final analysis the technology has damaged socioeconomic and environmental interests.

The following section (1.2) describes intensive agricultural production and its environmental problems in The Netherlands. Section 1.3 deals with the international dimension of Dutch pig farming and discusses the international environmental, economic and political implications. From this discussion it becomes obvious that a solution needs to be found. However, all attempts to tackle a problem of the present proportions stumble upon a web of conflicting interests. Section 1.4 charts the main conflicts of interest, that are mainly of a national scale. Against the background of these varying and conflicting interests, section 1.5 presents three possible development scenarios for Dutch pig farming, with special attention to their political, social and technological consequences. The conclusion (1.6) summarises the discussion by listing the dilemmas facing the intensive livestock farming industry in The Netherlands.

1.2 Intensive pig farming in The Netherlands

Development of the sector

The pig population in The Netherlands has increased substantially since the 1960s. Figure 1.1 shows a six-fold increase since 1960, when the total was 2.5 million. The period between 1970 and 1980 saw the largest increase, 8% a year. The number of pigs has stabilised at around 14 million in recent years. The average number of pigs per agricultural holding rose during the same period from 20 in 1960 to 476 in 1990 (see Figure 1.2). The number of piggeries fell during this period from 146,000 to 29,000. There are two main branches of the pig-farming industry: breeding piggeries where sows produce a constant flow of piglets and farms where pigs are fattened until they reach the weight at which they are slaughtered.

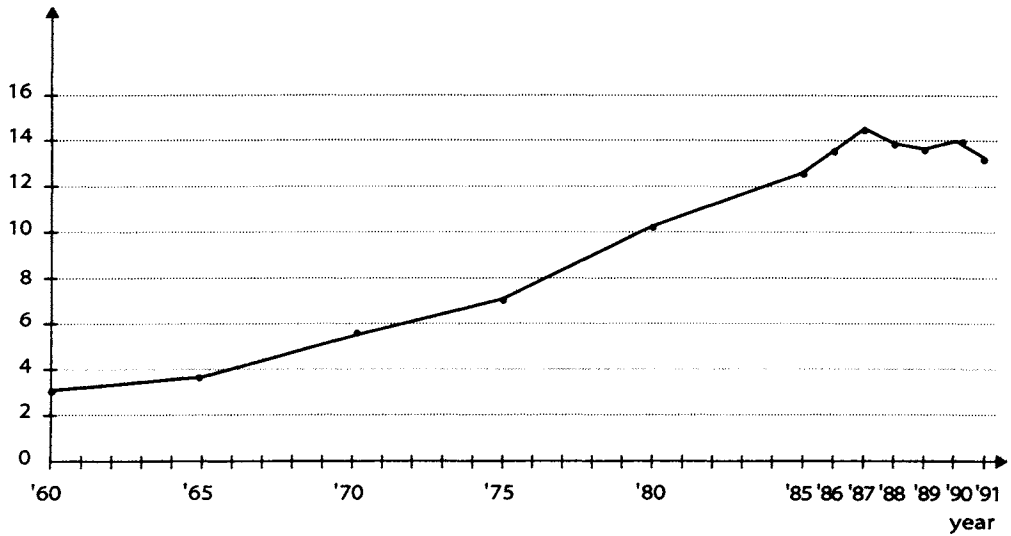


Fig. 1.1 Trends in the Dutch pig population in millions. Source: De Nederlandse varkenssector tot de eeuwwisseling [The Dutch pig-farming sector during the period up to the end of the millenium], P.V.V. report No. 9104A, p.50

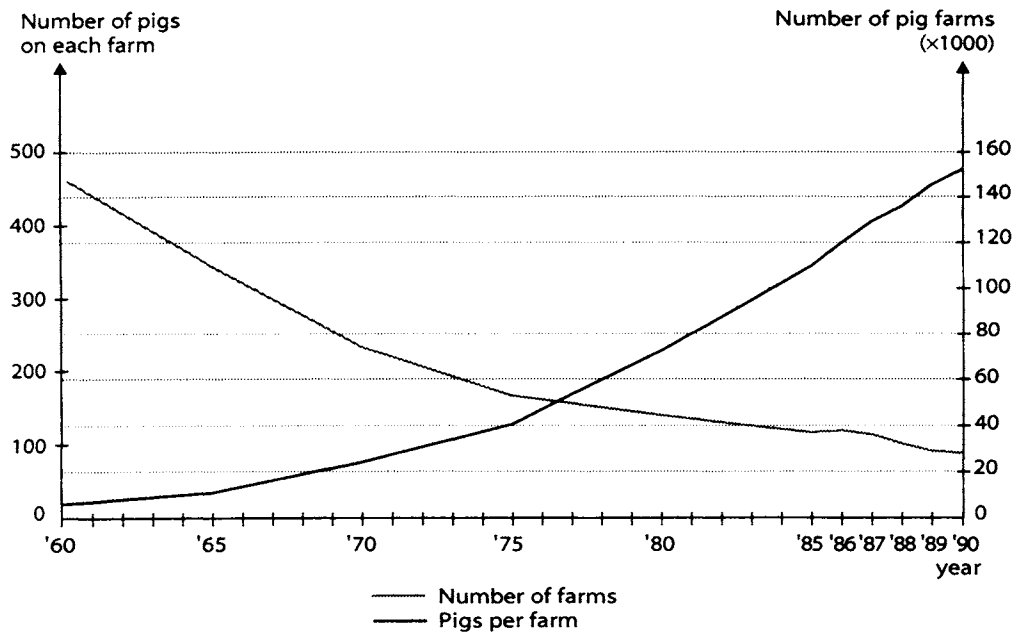


Fig. 1.2 Trend in the number of pig farms and the average number of pigs on each farm. Source: De Nederlandse varkenssector tot de eeuwwisseling [The Dutch pig-farming sector during the period up to the end of the millenium], P.V.V. report No. 9104A, p.50

Environmental problems as conflicts of interest

The 14 million pigs are not distributed evenly throughout The Netherlands. Intensive farming is concentrated in a number of areas, mainly the sandy soils of the Southern and Eastern regions of the country (54% of the pigs are located in the south alone). In the same regions farms are located that produce veal calves and chickens and keep dairy cattle. The reasons why Dutch pig farms have developed in size to such an extent are largely historical. The sandy soil is relatively infertile. By tradition, each of the children in a pig-farming family inherited an equal share of a small, mixed farm. This resulted in intensification. Imported livestock feed was another key factor, because it allowed the farms to become 'independent of the soil'.



Plate 1.1 Intensive pig farming in The Netherlands. Photo: Ron Giling/Lineair

Nowadays, virtually all the pig farms in the southern part of The Netherlands use mixed feed, the composition of which has changed considerably over the years. Grain (i.e. barley and maize) now accounts for only 10% of the feed. The rest of the feed consists of tapioca (30%) and by-products such as soy bean meal, which are known as grain substitutes (see Table 1.1 for the composition of pig feed). Ninety percent of the raw ingredients are imported. In 1960, imports amounted to around 1.5 million tonnes. Imports peaked at 7 million tonnes in 1988 and now fluctuate at around 6.5 million tonnes. The feed contains many additives, some of which are zoo-technical, i.e. designed to promote growth or prevent sickness, while others are technical additives such as emulsifiers and antioxidants. Additives which have been used by the original growers, such as heavy metals, and other substances such as fungi, bacteria, the seeds of poisonous plants and pesticide residues sometimes find their way into the feed. These substances can form a threat to human health.

Agricultural intensification: Livestock farming in The Netherlands

	1970/1971	1980/1981	1986/1987
Grain	43	17	10
Pulses	2	2	8
Tapioca	10	28	29
By-products of milling	} 37	14	7
By-products of sugar production		5	5
Corn gluten feed		4	5
Animal and dairy products	5	5	7
Other	3	4	7

Table 1.1 Average percentage composition of mixed feed for pigs (annual feed statistics published by Agricultural Economics Institute). Source: De Nederlandse varkenssector tot de eeuwwisseling [The Dutch pig-farming sector during the period up to the end of the millenium], P.V.V. report No. 9104A, p.79

In 1992, 2.6 million piglets were exported, 2.9 million pigs were shipped to foreign slaughterhouses and 900,000 tonnes of pork left the country, producing total earnings of 6.3 billion guilders (Agricultural Board, 1993, p.23). This figure represents only part of the sector's role in the Dutch economy, though. The production of livestock feed, the trade in livestock, the processing of pigs into pork, the transport industry, the construction of animal pens, climate control systems and related machinery and veterinary care are all linked to the sector.

The environmental problems

Livestock farming has numerous side effects. The buildings in which the animals are housed must comply with certain standards; they must be heated, for example. Special machines are needed to feed the animals and distribute the manure. Roads and physical space are required to accommodate incoming and outgoing products. Where the land is

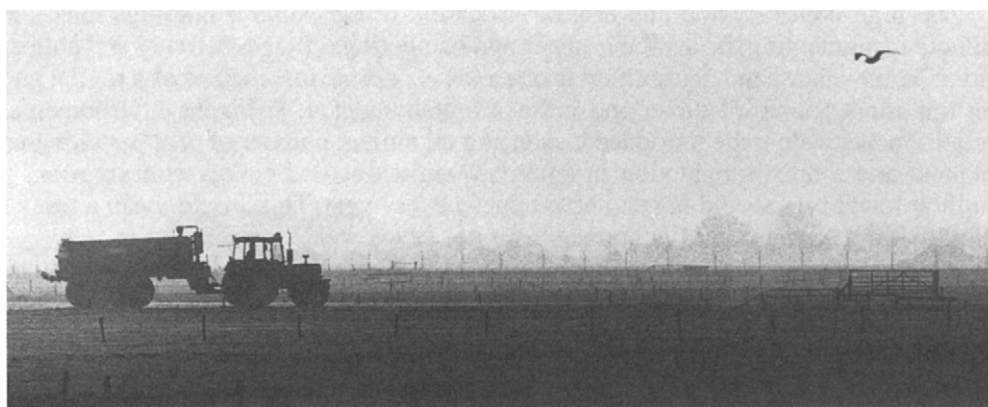


Plate 1.2 The fertilisation of agricultural land in The Netherlands with manure obtained from livestock farming. Photo: Ron Giling/Linear

marshy, the water level must be regulated so that heavy machinery can be used. Because the raw ingredients for livestock feed are imported, this generates a high concentration of minerals in a very small area, where the energy and minerals are converted into meat and manure. The majority of the meat goes abroad in the form of live animals and carcasses. A large proportion of the minerals are still present, however, in pig manure, which is a by-product of the pig-farming sector and affects the quality of the soil, water and air.

Intensive livestock farming not only has an impact on the soil, water and air, it also affects other types of land use. The odour creates serious problems for the living and working climate, not just in the vicinity of agricultural holdings but also in areas where the manure is distributed. The Dutch Environmental Protection Act has led to the creation of a system of *odour zones*, as a result of which it is now forbidden to build new housing in certain areas or further to develop certain villages. In some cases, such as in the Peel region (in the vicinity of the Southern city of Eindhoven), the concentration of intensive pig farming is so high that the countryside looks like an urbanised, industrial landscape rather than a rural area. The cornfields are among the main natural features during a large part of the year.

The odour from pig farming has meant that certain parts of The Netherlands are now less suitable for recreation and tourism than they used to be. Clearly, the attraction of water-related leisure activities tends to pale if the water in question is covered with algae because of eutrophication (i.e. a nutrient surplus). The economic viability of river and coastal fishing has been undermined by poor water quality and excessive algal growth. The pollution of water systems through nitrate leaching, both above ground and underground, affects the vegetation, fauna and drinking water for several decades.

The vitality of nature reserves and woodlands is affected by emissions of ammonia and the eutrophication of the water, especially in naturally low-nutrient environments. Biodiversity declines where heavy metals and other nutrients from animal feed enter the soil through manure. Organisms are damaged, as is the quality of agricultural products in the final analysis. The acidity of the soil may change to such an extent as to depress harvest yields.

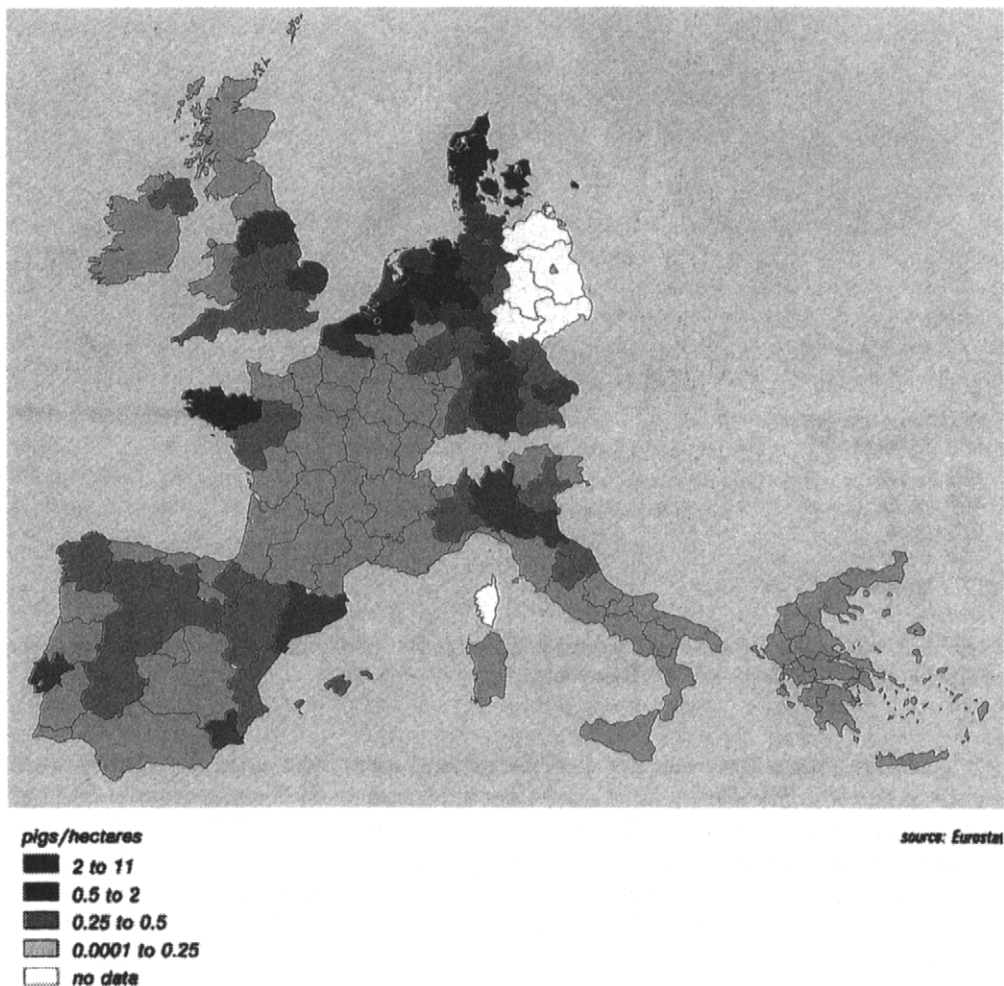
The high concentration and arbitrary location of agricultural holdings have the effect of fragmenting the available space and hampering efficient delivery and collection. On the other hand, agriculture is often the economic locomotive of a region and an important source of direct and indirect employment. If stringent environmental requirements were to be introduced, such as a maximum number of pigs per unit area of land and a drastic reduction in ammonia emissions and energy consumption, 5 million fewer pigs would have to be produced every year. This would mean a loss of 28,000 jobs (Agricultural Economics Institute, 1994).

The environmental effects of pig farming are particularly acute in the south of The Netherlands because of its high human population density (431 inhabitants per square kilometre) and high concentrations of chickens, beef cattle and dairy cattle. This has the effect of threatening other types of activity. The geohydrological composition of the soil (i.e. the type of soil and its drainage properties, the circulation rate of the water and the ability of the soil to neutralise dangerous chemical substances) is such that the environment is overburdened. If the high concentration of livestock farming continues, the only way to counteract the environmental impact will be by spending a great deal

of money, for example, on enclosed animal pens, fully industrialised manure processing and a further concentration of scattered businesses.

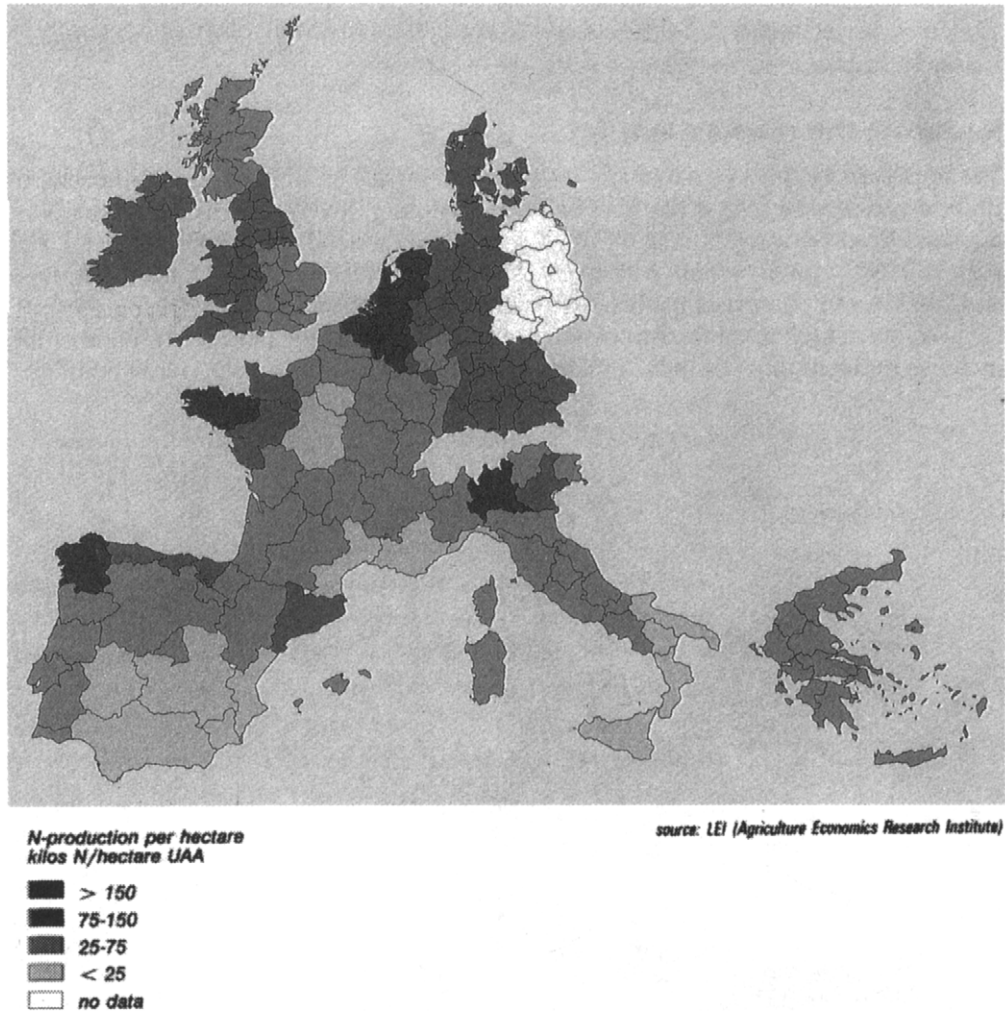
Reducing the manure surplus

The high density spots on a map of Europe that show the number of pigs per hectare in Europe correspond with areas with excessive nitrogen levels. The highest density of pigs and level of nitrogen is in the south of The Netherlands (compare Maps 1.1 and 1.2). In 1986, animal manure was responsible for the presence of 410 kilos of nitrogen and 240 kilos of phosphate per hectare of Dutch soil (Stolwijk *et al.*, 1992, pp. 28–30). Clearly, much higher values are encountered locally. Set against the background of the increase in the number of pigs, legislation on manure has been very late in coming.



Map 1.1 Number of pigs per hectare in each NUTS1 and NUTS2 region in 1988. Source: De Hamvraag, E.Bolsius. Ruimtelijke verkenningen, 1993, RPD-VROM, Den Haag

Environmental problems as conflicts of interest



Map 1.2 Nitrogen pollution in Europe. Source: De Hamvraag, E.Bolsius. Ruimtelijke verkenningen, 1993, RPD-VROM, Den Haag

For years, nutrients have leached into the groundwater; and toxic substances were stored in the soil. The Dutch have gradually tightened up their manure laws. In 1995 even stricter regulations were introduced, which also covered the dissemination of minerals through artificial fertilisers. Under these regulations, attempts were made to reduce soil pollution by establishing maximum levels per hectare. Measures to limit emissions of ammonia were also prepared. Discussions in the Dutch Parliament (September 1994) with the then new Minister of Agriculture, however, confirmed that all these regulations did not do enough to alleviate environmental pollution. The need for reducing the number of pigs therefore proved even more pressing. In section 1.4 we will go further into this matter.

1.3 The international dimension

Intensive livestock farming in The Netherlands is connected with *international interests* in numerous ways. Imports of raw materials for animal feed affect the interests of Thai cassava producers, soy producers in the United States, Brazil and Argentina and arable farmers in Western Europe. Exports of livestock and meat affect the interests of livestock farmers and meat-processing companies in Italy, France, Germany and Denmark. Dried poultry manure and granulated animal manure are exported to France, where they are used by arable farmers and wine growers. A high percentage of the ammonia in Dutch animal manure is exported abroad, where it contributes to the acidification of the environment in countries like Germany (see Chapter 5). The pollution of the groundwater and surface water by nitrates from livestock farming ultimately affects the quality of the water in the North Sea. This section deals more closely with these international aspects of the problem.

Animal feed imports

Pigs are fed with specially grown crops or by-products of crops produced for other purposes. The fodder is mixed so that it contains sufficient energy-producing raw materials (such as tapioca, maize and wheat bran) as well as proteins (such as the by-products of soy and citrus fruits, copra and fish meal). This feed compares favourably with grain cereal in terms of quality and is cheaper than European grain feed despite the cost of transport.

The prices of raw materials on the world market affect the composition and price of animal feed in The Netherlands. Most incoming shipments arrive at the port of Rotterdam, from where they are taken by inland waterways or by road to the livestock farming areas. Imports of grain substitutes are not handicapped by high *tariff barriers* at the borders of the European Union (EU). Some EU member states, notably France, are pressing for external tariff barriers to help dispose of the sizeable surplus of grain produced in the EU. In 1992, the EU reduced internal grain prices and this depressed grain substitute prices on the world market. Prices could be set to fall to a level that would make it impossible to export the products to the EU and cover the costs. Rising transport costs, due to rising energy prices, could place suppliers of raw materials in an even more difficult position in the future.

Many of the by-products used in mixed feed are from the United States (40%). The rest comes from developing countries, including Brazil and Argentina, as do the specially cultivated crops. Thailand is the biggest supplier of tapioca. The developing countries are extremely dependent on EU demand. Other countries, such as the states of the former Soviet Union, Russia and others, and Japan, are only interested in high-protein substances such as fish meal and soy bean meal.

The changes in EU policy have had a particularly sharp effect on developing countries and their ability to trade with the West. Many non-governmental organisations (NGOs, i.e. organisations of citizens concerned about the fate of the environment, the peoples of the developing countries, etc.) welcome the end of the trade. In their view, European agriculture makes too heavy a demand on scarce agricultural land which developing countries need to produce food for themselves. Additionally, the



Plate 1.3 Tapioca cultivation in Thailand. Tapioca is a raw material for animal feed, and The Netherlands is one of its main importers. Photo: Ron Giling/Linear

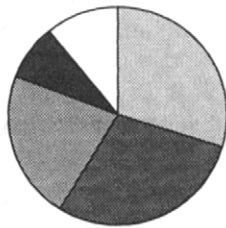
increased production of raw materials for animal feed in Thailand, Brazil and Argentina has resulted in large-scale *deforestation* (see also Chapter 4). The cultivation of soy beans in the South and South-east of Brazil is said to have led to serious nutrient depletion and soil pollution resulting from the use of pesticides.

Another reason for welcoming further trade restrictions is the manure surplus in the EU, which contains many fertile elements from the soil in the developing countries. We have already mentioned that a number of developing countries are highly dependent on the foreign currency they earn from this trade. It is not so much the countries which produce by-products like soy bean meal or citrus pulp which suffer, but rather those which export primary raw materials for animal feed. In Thailand, for example, production is in the hands of small farmers. Some 700,000 families earn 40% of their income from the cultivation of tapioca (Sprang *et al.*, 1990, p.17). Whether their production methods are sustainable is open to debate (soil nutrient depletion is an additional problem on top of deforestation and erosion), but they have no alternatives. In all fairness, it should be added that pig feed consists to a large degree of by-products that would otherwise be wasted such as soy bean meal, maize bran, sugar beet pulp and brewery waste. It thus solves an environmental problem for exporting countries.

Animals and meat

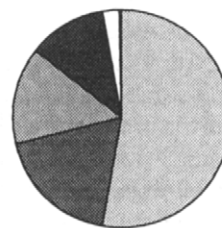
The Netherlands is a leading producer of live pigs. The main export markets are Italy, Spain, France, Belgium, Luxembourg and Germany (see Figure 1.3). The southern part of The Netherlands tends to specialise in the supply of piglets, partly because of certain unintended side effects of the legislation on manure. In 1987 legislation came into force which included a ban on the expansion of livestock together with restrictions

Piglets, live
total number: 2,636,000



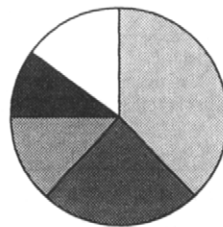
Destination	%
Spain	29.9
Italy	29.2
Belgium & Luxembourg	22.0
France	8.2
Other countries	10.8

Pigs, live
total number: 2,878,000 (porkers)



Destination	%
Germany	52.8
Italy	18.4
France	14.3
Belgium & Luxembourg	11.8
Spain	2.4
Other countries	0.2

Pork
total: 899,500 tonnes



Destination	%
Germany	37.9
Italy	24.0
United Kingdom	13.1
France	10.1
Other countries	14.8

Fig. 1.3 Exports of pig farming sector 1992. Source: Vee, vlees en eieren in beeld [Cattle, meat and eggs in view], P.V.V. report 1993, p. 23

on switching from one type of livestock to another. It has produced a situation in which the large-scale production of fattening pigs has been replaced by the production of piglets. The rationale behind this was in the phosphate production of the livestock and not in considerations of profitability.

The main countries to which meat from The Netherlands is exported are Germany, Italy, the United Kingdom and France. Large-scale exports have been facilitated by the Common Agricultural Policy of the EU and the absence of internal trade barriers. For example, exports to the United Kingdom rose substantially in the years after Britain joined the EC in 1973. The EU also operates a system of export rebates or price subsidies for agricultural products sold outside the EU. The idea is to stimulate exports on the world market, although some people regard the practice as dumping. Intensive dairy cattle farming in The Netherlands has taken wholesale advantage of this scheme but new trading arrangements under the General Agreement on Tariff and Trade (GATT) have put a stop to the practice (see also Faber, 1996).

Transported meat is usually refrigerated and severe hygiene standards are imposed. However, the transport of live animals is subject to much less stringent rules. It involves problems connected with the animals' physical welfare, such as exposure to extreme temperatures, lack of food and water for lengthy periods while travelling long distances and stress during transport. Disease is more of a problem with exports of live pigs and piglets than with meat exports. Clearly, the more live animals are imported the greater the risk of disease. The risk is also greater if the animals are moved between agricultural holdings. Exporting regions may also be penalized if it is established that a disease has been transferred to another region or country. For instance, Brussels is empowered to ban exports and countries and regions can close their borders to one another. In 1994, Brittany and Spain closed their borders to imports of Dutch pigs in order to prevent the spread of swine vesicular disease.

The instability of an export-orientated pig production system is greater the more live animals are moved from place to place, the higher the absolute number of pigs per hectare (because the consequences of an outbreak of disease are more serious) and the less strictly hygiene regulations are observed. For these reasons, it has been suggested that The Netherlands should not export any live animals to southern Italy.

The international dimension of the manure problem

Some of the manure from areas in The Netherlands where there is a high concentration of livestock farming is supplied to arable farmers in other parts of the country under long-term contracts. The regulations allow them to use some of it on their own land, but the rest must be industrially processed. As policies are tightened up, a higher percentage of the manure will have to be processed. Industrial plants separate the nutrients from the water using a process that requires a great deal of energy. The clean water is discharged into the surface water. The nutrients are converted into powder or granules and are then fit for reuse. Unfortunately, these products cannot compete with artificial fertiliser in terms of price.

Many ideas have been put forward over the years about how to deal with the 'manure mountain'. Dumping it at sea and incinerating it are among the least environmentally friendly options. If it is fed to chickens, the nutrients enter a new cycle, but the problem

remains in The Netherlands. Another suggestion is to export the manure to the developing world countries so as to prevent nutrient depletion in soil which is being used to grow raw materials for animal feed. This would be an extremely inefficient and expensive way of practising agriculture, however. It would be better to raise pigs in Thailand and transport the meat from the other side of the world. The manure granules could be sold to French wine growers, as is already done with dried chicken manure. But if the entire manure surplus which cannot be used in The Netherlands were to be processed industrially, many more granules would be produced than the wine growers could possibly use in the short term. Moreover, the end product must be able to compete with the cheaper artificial fertiliser which has been used to date.

Industrial manure processing is only viable if it is heavily subsidised. It has even been suggested that the Sahara could be made fertile with the aid of Dutch manure granules or that liquid manure should be exported to India, dried in the sun and sold. The response by Indian farmers to this idea confirms that conflicting interests are at stake, as Box 1 indicates.

Farmers in India angry over plans to import Dutch manure

(Wednesday) Angry farmers brought traffic to a halt in parts of New Delhi as they marched in protest against plans announced by a Dutch businessman to export manure worth millions of guilders to rural India. The farmers claimed that the Indian government was willing to pay an annual figure of 5.5 million guilders for the manure and that this was a complete waste of money.

'We wish to make clear that there is no need to import manure,' said Rajiv Vora of the Ghandi Peace Foundation. He accompanied the hundreds of fist-shaking farmers, assembled in a long procession of carts and lorries. 'It is a ridiculous proposal,' he added.

Men and women raised handfuls of manure in protest. For centuries, dried manure has been used in India as a fuel and as a construction material for huts and floors. It is also an important trading commodity. Villagers smear manure mixed with straw on the walls of houses; it is claimed that the chemicals in it act as disinfectants and protect public health.

Mr P. Hamoen of the Dutch embassy in New Delhi confirmed that Mr H.P. Prins of the Dutch Seaswan company was investigating the possibility of shipping surplus manure to India. The plan was intended to make good use of the manure surplus that existed both in The Netherlands and elsewhere in Europe. He pointed out that manure was used in India in many other different ways. In addition, he said that cows in India were not fattened to the same extent that they were in The Netherlands. The Indians regarded them as sacred animals and did not eat their meat.

The union representing 200,000 cow and bull owners in the vicinity of New Delhi claimed that there was enough manure, but not enough money to distribute it over the country. A spokesman said that their cattle produced 1500 tonnes of liquid manure every day, but that the owners had no way of disposing of it.

The well-known activist Ms Niru Vora accused the Indian government of plotting with international aid organisations to solve the Dutch manure problem.

Source: Reuters, New Delhi.

Environmental problems as conflicts of interest

Finally, European environmental policy has a significant bearing on the Dutch manure problem. Despite the promptings of the European Parliament, the EU has decided, partly because of pressure from The Netherlands, not to force intensive livestock farmers to adopt a fixed animal-to-land ratio as is the case in Denmark. The imposition of such regulations would have sounded the death knell for Dutch pig farming. However, a *nitrate directive* has come into force which establishes an upper limit for permissible levels of nitrates in ground and surface water (50 mg per litre). Compliance with the directive is also required as part of the commitments under the *Rhine and North Sea Action Programme*, but it is extremely unclear as to whether The Netherlands will succeed in meeting the nitrogen requirements. The pollution of ground and surface water from agricultural sources will continue to rise for a number of years despite the lower manure utilisation standards, because the nitrate takes a long time to leach away (Ministry of Agriculture, Nature Conservation and Fisheries, 1982). Years of overfertilisation mean there are already high concentrations of nitrates in the soil. Sooner or later, they will end up in the water.



Plate 1.4 Algal bloom in the Wadden Sea, a wetland off the Northern coast of The Netherlands. Extensive studies have shown increased algal bloom caused by the run-off into the sea of nutrients from farms and sewage treatment plants. Photo: Mark Edwards/Lineair

We have now sketched both the national and international economic and ecological dimensions of Dutch intensive livestock farming. They form the backdrop to the stage on which the conflicts over the environmental impact of manure are played out. Box 2 summarises the resulting picture as a balance of negative and positive effects.

2

The economic and environmental effects of Dutch pig farming in a national and international perspective

	Positive	Negative
National	Employment (in the agricultural, industrial and service sectors) Revenues Revenues from foreign currencies Absorption of waste products Supply of animal manure	Water and soil pollution Exacerbation of acidification Damage to flora and fauna caused by ammonia Foul smell Damage to landscape
European	Supply of piglets and pigs Supply of pork Supply of animal manure (granulate)	Pollution of North Sea Export of ammonia
International	Supply of pork Purchase of foodstuffs Absorption of waste products	Soil erosion/nutrient depletion Deforestation Pesticide, etc. pollution

1.4 Conflicts of interest

The Dutch agricultural model

The climate, the soil, the proximity of major sales areas, a highly developed infrastructure, the availability of advanced water management technology and agricultural know-how are some of the factors which have contributed to the economic success of Dutch agriculture. One clearly important factor which is sometimes described as the *secret of Dutch agriculture* is the social, economic, institutional and political organisation of the agricultural sector or the *Dutch agricultural model*.

The model is characterised by a high density of organisations and a high degree of organisation. Virtually every important part of the agricultural sector which includes interests extending beyond those of individual enterprises is organised. Many issues, ranging from the health of animals to the amalgamation of scattered plots of farmland, from quality control to the supply of labour in the case of illness, are handled on a

collective basis. Issues which are not dealt with by private farmers' organisations and professional bodies are handled by the Agricultural Board, to which all Dutch farmers and market gardeners pay an annual levy. The Agricultural Board is a statutory body which is empowered to lay down binding collective regulations.

The degree of organisation is also high in economic terms. On average, every agricultural producer is a member of four co-operatives involved in deliveries, marketing, processing, services, etc. The co-operatives include several huge agro-industries. They are owned by farmers; many directors of agricultural organisations are also directors of co-operatives. The interests of the co-operatives are therefore easy to reconcile with those of the farmers. A strong sector ideology has developed; the agricultural industry and agricultural trade are both part of the agricultural sector, which has its own sectoral interests to uphold in society, for example in relation to the environmental movement. Another feature of the agricultural model is the characteristically Dutch combination of elitism and pragmatism. The leaders of the farmers' organisations (which are established along denominational lines like much of Dutch society) find it relatively easy to do business with one another and with the government because their members are so passive. Consultations at the highest level are pragmatic, concern technical and economic problems and rarely degenerate into political conflict.

This brings us to the final feature of the Dutch agricultural model: the symbiosis between the highly organised agricultural sector and the government in the shape of the Ministry of Agriculture. For a long time, the agricultural sector was regarded as the Ministry's mainstay of support. There was consensus between the government and the industry on how agriculture in The Netherlands should develop and on agricultural policy. The most important issue was regarded as being the maintenance of the international competitiveness of an industry which depends on exports to survive. Market and pricing policies, as well as sectoral policies, were designed to develop the most productive businesses operating at the lowest cost. The government and agricultural organisations worked closely together to prepare and implement agricultural policy with this objective. For a long time, they encountered virtually no problems from 'outsiders' such as representatives of non-agricultural interest groups, ministries other than the Ministry of Agriculture or members of Parliament other than agricultural specialists closely associated with the agricultural sector. This tightly organised and relatively isolated stronghold, the heart of which was formed by the Ministry of Agriculture and the Agricultural Board, has often been described as the Green Front.

Conflict on the manure problem

For a long time, the Green Front turned a deaf ear to warnings about the manure problem. As early as the late 1960s, agricultural experts had warned against overfertilisation with manure and the dumping of animal manure (Frouws, 1993). They pointed to the danger of nitrogen leachate and eutrophication of the soil and groundwater. 'Critical' agriculturists and the environmental organisations which emerged in the early 1970s suggested that the number of animals per hectare should be limited and that this should also apply to intensive livestock farming (i.e. pigs, poultry, calves and red meat production). Other agricultural research workers, the government and agricultural organisations refused to see the dangers. They insisted that manure

surpluses were a regional problem which would disappear by transporting the excess to areas where there was a shortage. Manure 'banks' were set up in the early 1970s for this purpose.

In hindsight, the political and social climate at the time was not ripe for tackling this growing environmental problem. The animal sector and allied industries were a source of increasing prosperity and employment. There was a great deal of faith in technical solutions, i.e. not just manure distribution, but also a better utilisation of animal feed and manure processing, by oxidation, for example. The critics, especially the agriculturists among them, were accused of indoctrination. Genuine attempts at dealing with the manure problem were postponed in various ways. Research was carried out into the nature and size of the manure surplus and potential technical solutions. A succession of committees of civil servants and advisory committees in the private sector were set up to consider policy measures. A fierce and extremely lengthy struggle was waged with the Ministry of the Environment about who should be responsible for which aspects of the manure legislation. The combined efforts of the Ministry of Agriculture and the Agricultural Board sometimes succeeded in preventing information about manure surpluses and possible manure utilisation standards from being made public. Clearly, ideological conflicts were at the roots of such administrative conflicts. Box 3 describes a typology of these conflicts.

3

A typology of conflicts

Conflicts of interest about the manure issue have an ideological component in that they involve a clash between *environmental interests* (i.e. clean water, energy savings and nature conservation) and *economic interests* (i.e. employment and export revenues), both of which are justified by invoking the common good. The administrative dimension of conflicts of interest is a matter of authority (i.e. who regulates what), the stringency of rules, and the expediency with which measures are taken.

With the manure problem, as with any environmental problem, the allocation of costs and benefits leads to distributional conflicts. These are played out at an international level (for instance, between the suppliers of foodstuffs inside and outside the European Union), at a national level (for instance, between the fertiliser industry and the industries responsible for processing and distributing manure), at a regional level (for instance, between the cattle farmers in areas with a manure surplus and those in areas with a manure shortage) and at a local level (for instance, in relation to plans for expanding a particular farm or disposing of manure).

However, the pressure placed on the agricultural sector was gradually intensified. It was difficult to ignore the results of research which confirmed that serious environmental damage would result from overfertilisation. The Ministry of the Environment could no longer be placated. Having introduced environmental legislation to deal with air and water pollution, it decided to tackle the third and remaining area, i.e. soil pollution. Pressure was growing in society (from environmental organisations, the media and scientific research institutes) and in political circles, where the environment was developing into an important issue. The trend was accentuated by alarming

developments in the early 1980s, such as the nitrate pollution of drinking wells and an explosive growth in the number of pigs and chickens.

Policy development

The first regulations that came into being as a result of the growing pressure consisted of interim legislation to halt the growth in the number of livestock. In the short term, this government intervention actually exacerbated the problem. Pig and poultry farmers made extensive use of provisions that allowed them to expand if they had obtained a municipal permit or made investment commitments before a certain date. As a result, in the three years after the announcement of the interim legislation, the number of pigs went up by 28% and the number of poultry by more than 16%.

All the legislation on manure which was enacted after the interim legislation announced in late 1984 was prepared by the Ministry of Agriculture acting in conjunction with the Ministry of the Environment. It was difficult for the ministries to work together to begin with. Each part of the legislation produced a fierce struggle, whether about the level of the standards of enforcement, the arrangements regarding when and how manure should be spread, or 'manure bookkeeping'. The result of this first period of policy development was, apart from a considerable delay, legislation with a clear agricultural bias (see Box 4).

4

The development of legislation on manure

After a long tug-of-war, it was decided in the mid-1980s to approach the problem of manure in stages. Stage 1 (1987–1990) centred on stabilisation or restraint and was designed to prevent the problem from getting any worse, and to find solutions in the form of livestock feeding, manure distribution and manure processing techniques. In 1987, an upper limit for phosphate production by agricultural holdings was established, thereby creating manure production rights. Regulations were introduced to prevent an increase in manure production. Limits were imposed on the quantities of animal manure which could be spread on the land and on the periods when this could be done. However, the limits were so generous that it was possible to dispose of all the manure produced throughout the country without exceeding them. The manure surplus had been defined out of existence.

The aim of stage 2 (1991–1994) was gradually to reduce the impact on the environment by tightening up utilisation standards. The idea was to adopt a timetable so that the manure surplus resulting from the tightening up of regulations could be dealt with by the solutions that were being developed (such as manure processing). Stage 3 (1995–2000) seeks a further tightening of standards so as to achieve balanced fertilisation in due course, at which stage the mineral quantities added to the soil by animal manure and artificial fertiliser will equal those taken from the soil by crops, taking acceptable losses into account. It was not clear at the end of 1994 what the final levels would be. However, it has become increasingly apparent that industrial manure processing is not developing fast enough to handle the additional manure surpluses which are being produced as a result of the gradual tightening of standards. A reduction in livestock numbers is therefore inevitable.

The manure utilisation standards were very flexible to begin with, the transitional period leading to less and eventually no overfertilisation was very long and there was initially no question of reducing livestock numbers. In fact, only excessive overfertilisation was halted and a definitive solution to the manure problem was made dependent on the availability of technical instruments such as improved methods of distribution, better use of animal feed and industrial manure processing, some of which still had to be developed. The Green Front succeeded in channelling hundreds of millions of guilders of government funds into the stimulation of technical solutions.

The Green Front achieved its 'victory' because of its ability to represent the interests of the agricultural sector, the power of the economic argument and its superior knowledge of fertiliser and livestock issues as compared with the environmental lobby. But its triumph was short-lived. The confrontation with such an extensive environmental problem as manure brought the Green Front into serious difficulties. Development and distributional issues were at stake which not only divided environmental and agricultural organisations, but also created conflicts of interest between the government and the agriculture lobby, as well as within the agricultural sector.

The *development problem* is about the nature and size of the intensive livestock farming system. There are numerous related issues. What standards must the system comply with as regards the degree of environmental pollution? What losses of minerals into the soil and groundwater are acceptable under which circumstances? What levels of ammonia emissions are permissible in which areas? What restrictions should be imposed on transport (of animal feed, animals and manure) and energy consumption (for heating animal pens, producing animal feed, transport and manure processing)? What standards should apply to the health and welfare of animals, the smell and the use of space? There are no objective answers to these questions, for they all involve the reconciliation of conflicting interests and hence political debate.

Ultimately, one has to make choices, for example between the value attached to the quality of woodlands and to the economic activity associated with pig farming. What is more, potential solutions to the manure problem can work against one another, so that here too priorities must be established. An example of a measure which has raised many questions is the method of mixing manure directly into the soil using turf spreaders and manure injectors. It limits ammonia emissions from the distribution of manure, but also has unintended effects which clash with the aims of government policy on environmental protection and nature conservation. The leaching of nitrates into groundwater is exacerbated by working manure deep into the ground, whilst on grasslands, birds' nests are destroyed by the machinery used to mix in the manure.

Furthermore, any solution to the development problem will involve sharing the costs and benefits to some extent. The development issue is therefore inextricably linked with the *distribution* issue. If it is decided to make drastic cuts in the pig sector, the immediate question is: which enterprises will have to go and which can or may continue to exist? For example, the pollution of groundwater by minerals can be counteracted by limiting the amount of manure which is spread on the land or by removing phosphates and nitrates at water treatment plants. In the former case, it is the farmers who foot the bill; in the latter case, the consumers of drinking water. The next section outlines these conflicts with reference to policy options, some of which have already been realised in part and some of which are still being developed.

Sharing the costs and benefits

The subject of reducing or restructuring the number of livestock has been a virtual taboo for many years. However, shortly after a new government came into power in the autumn of 1994, it became a serious option. The reason was, among others, that it became clear that other solutions such as large-scale manure processing would not make enough difference. Many interests are at stake here, often conflicting ones. The agricultural organisations have always fiercely rejected reductions by saying they would be contrary to the sector's interests. Now that some form of restructuring is unavoidable (either by allowing market forces to prevail or with government support), some farmers' leaders are prepared to start thinking about what would be the most desirable form. The *ideological* conflict that initially concerned the reduction in the number of livestock has now been followed by a *distributional* conflict.

A drastic reduction in the total number of animals in The Netherlands would appeal to pig and poultry farmers with good prospects because they would have more scope to dispose of their manure and the cost would therefore go down. Clearly, a reduction would damage the interests of suppliers (of animal feed and buildings for animals) and service firms connected with pig farming and poultry farming (e.g. contractors, the cattle trade, transporters of raw materials, manure, animals, etc.). If a reduction in the primary sector were accompanied by a reorganisation of the economically weak slaughterhouse sector, it would certainly benefit the surviving slaughterhouses and meat-processing companies. At an international level, a reduction in intensive livestock farming in The Netherlands would mean greater sales opportunities for competing production areas in France and Denmark and pig producers and meat companies in Central and Eastern Europe in the longer term.

It is not inconceivable that The Netherlands will be prepared to make trade policy concessions in relation to this sector, which is in an awkward competitive position because of its environmental problems, in exchange for trade policy benefits for other agricultural or non-agricultural sectors. However, less pig and poultry production in The Netherlands will inevitably mean a shrinking sales market for raw materials used in animal feed obtained from Thailand, Brazil and the US. Finally, there is the problem of the way in which the reorganisation of the industry should be achieved and financed. Major interests are at stake, which means that there is again plenty of scope for conflict. The issues here are the degree of government intervention, the scale of government support and the degree to which the pain (caused by the reductions) and the costs (for example, of a fund to buy up production rights from the market) should be distributed over the sector as a whole and within the category of primary producers in particular.

A second option which is similarly accompanied by major conflicts of interests concerns the organisation and financing of manure distribution and processing. The 'surplus' levy used to finance research into manure processing and to support the manure bank created conflicts from the outset between the areas where there was a manure surplus and those where there was a shortage. Livestock farmers and organisations in the North and West of The Netherlands were against paying the levy because they felt they were being asked to foot the bill for a manure problem caused by livestock farmers in the areas with a surplus. On the other hand, the view in areas with a high concentration of intensive livestock farming was that the problem was a

national one and that large-scale processing increased the opportunities for individual farms with a surplus in the shortage areas to dispose of manure. The conflict of interest clearly emerged in the dispute about the proposed 'manure centre.'

Farmers and organisations in the South of the country took the view that all livestock farmers in the areas with a manure surplus should be obliged to offer their surplus manure to a central organisation known as the manure centre. The centre would charge the same price, irrespective of the destination of the manure, and would manage the flows of manure as efficiently as possible, thereby saving money on transport and processing. This system would prevent livestock farmers from competing with one another to dispose of their manure. Competition would have forced up the price and would have benefited the arable farmers who received the manure. This is the reason why, in the first instance, the arable farmers were fiercely opposed to the compulsory nature of the manure centre. They saw their competitive advantage taken away from them. But there was also opposition from livestock farmers who had solved their surplus problems by extending their storage facilities, reducing the volume of manure on their farms or by entering into long-term contracts to sell manure to arable farmers.

The funding of large-scale manure processing has revealed yet other conflicts of interest. The artificial fertiliser industry was opposed to the subsidisation of the manure-processing plants by means of a system of levies. In other pig-producing areas of the European Union, these kinds of subsidies were regarded as distorting competition. The European Commission therefore only allowed the imposition of a *destination levy*, to be paid by farmers in areas with a high concentration of livestock farming to get rid of their manure surpluses, for a very limited start-up period.

The final conflict of interest relates to groundwater protection areas and the application of the *polluter pays principle*. Voluntary agreements have been reached between farmers in areas where water is extracted and the water companies to the effect that livestock farmers will be subject to stricter regulations than those in force in the rest of the country as regards the use of fertilisers and the distribution of manure on the land. The level of the payment they receive in return has been the subject of disputes between the agricultural organisations on the one hand and the water companies, the provincial authorities and the environmental organisations on the other. The latter have taken the view that consumers of drinking water are having to foot too much of the bill.

1.5 Possible solutions: the role of politicians and technology

In this section, we shall discuss the pig-farming industry as it may aptly serve as the main model for what many people refer to disparagingly as *the bio-industry*. Whenever the complex and long-lasting problem of manure comes up for discussion, the finger of accusation is immediately pointed at pigs. It should be kept in mind, however, that poultry and cattle make a sizeable contribution to the manure mountain too. In fact, cattle manure is the main agricultural source of ammonia emissions in The Netherlands.

In exploring the potential solutions for the environmental problems raised by pig farming in The Netherlands, it is possible to envisage three distinct scenarios or

models, each of which has distinct developmental and environmental implications (Bolsius, 1993, pp.11–69). The first, which may be called the *global scenario*, involves concentration of production in an industrialised setting. The second is based on a *regional cycle* of manure and animal feed. Finally, the *local scenario* assumes maximum distribution, so there is no longer a region with a high concentration of livestock farming. After describing each of the scenarios, we shall give a brief analysis of the political and technological conditions which are required in order to put them into practice and describe the conflicts of interest which they involve.

The global scenario

In the *global scenario*, animal feed is imported on a large scale and converted by pigs into meat. The meat is supplied to consumers, who may live at a considerable distance from the production area. There is too much manure for it to be disposed of in the immediate vicinity so it must be processed at a central location or removed elsewhere and disposed of outside the region. If the incoming and outgoing flows are properly managed, there is in theory no limit to the number of pigs which can be concentrated in a small area. The costs of the environmental pollution are gradually passed on to producers and consumers. And although Dutch producers invest a great deal in order to comply with environmental regulations, by doing so they raise their production costs considerably and their competitive position deteriorates.

In a global scenario, raising pigs requires large-scale operations which manage incoming and outgoing flows efficiently. The model necessitates massive investment in buildings, infrastructure and allied environmental facilities in order to combat the smell, treat effluent, process manure on a large scale and market the meat. Large-scale operations of this kind should be located on industrial estates close to deep water and not in rural areas.

Transferring pigs to industrial estates does not produce any space gains in the sense that more land immediately becomes available. But it does mean that there are more opportunities for developing nature reserves, the recreation industry and drinking water supplies, because there is less pressure on the environment. A reduction in manure production indirectly creates more opportunities for other forms of land use. This model foresees attempts to reduce costs to a minimum by maximising the scale of the operations. The primary objective is high quality and homogeneous bulk production. There is little likelihood of the rural economy in the regions reaping the benefits of this kind of industrial process. Theoretically, the production chain could even be managed by multinational companies.

This global scenario has the effect of completely unfettering intensive livestock farming. It can easily move to areas where animal feed is produced or where processed manure is marketed, if that would improve the cost/benefit ratio. In it, productivity is maximised and is supported by an efficient distribution system between the various stages in the production chain and between the end stage of the production chain and the consumer market.

In political and administrative terms, the global scenario requires a business location policy that is subject to strict central controls so as to resolve numerous disputes about how space should be used and about the quality of the environment in a broad sense. It will result in an industrial sector consisting of a number of pig-producing

businesses with employees on their payroll. It will mean restructuring the existing pig-farming industry and eliminating existing family businesses. Any policy which expressly seeks to achieve this objective will be unacceptable to the farmers' organisations, which still rate family businesses highly.

The question of animal welfare and related ethical aspects of this industrial form of livestock farming will result in critical public attitudes. The need for large-scale manure processing makes the global scenario highly dependent on energy prices. The model also requires the sustainable development of land in other countries which is used to produce raw materials for animal feed. Tariff barriers must not be erected against imports of raw materials and the more expensive European grain will not be used as animal feed.

Stringent technological conditions will have to be met in addition to political ones. The new pig farms will have to be far enough away from one another and the transport of live animals will have to be kept to a minimum in order to prevent diseases from spreading. The farms will be 'closed' establishments where piglets are born and pigs are fattened for nearby slaughterhouses. Productivity will have to be very high in order to produce a bulk product that can be sold at competitive prices in spite of the high cost of environmental measures such as emission-free pens, manure processing, etc. These requirements will reinforce the industrial nature of the farms even further. The ultimate question is whether Western European consumers will accept such industrially produced meat.

The regional scenario

An alternative scenario is provided by a *regional model*. Here, the feed comes from the region itself, possibly supplemented by grain from the closest grain-producing region. This scenario therefore creates problems for the producers of grain substitutes in the developing countries and elsewhere. The manure is not distributed any further than the area which supplies the feed, although the meat is exported much further afield.

The development opportunities for this system will depend on the claims made by other types of land use. Consultations will need to establish which land is to be used by each sector and the environmental quality which must be maintained will be laid down in the form of increasingly strict standards. The required level of investment will be high and will continue to rise, but will only be worthwhile if sufficient added value is created. A shift from bulk production with a low added value per unit of product to a method which does little damage to the environment and which offers a higher added value would be the best solution.

One way of achieving this would be by severing the link between pig breeding and the fattening of pigs for slaughter, i.e. by using specialisation to achieve greater economies of scale. However, this approach would conflict with the aim of creating closed farms and limiting the transport of pigs. Another way would be to raise the added value at all the stages in the production chain and to develop a variety of end products, especially for meat. In the regional scenario, it would be difficult to keep disease under control, which means a great deal of preventive vaccination would be required. Hygienic controls would have to be very strict; a certain degree of stress on the animals would be unavoidable.

If the regional model is used as the starting point, the environmental requirements will be stricter and the authorities will have to set limits for the number of pigs in each region. If there are transferable manure production rights, bigger farms will buy up the manure quotas of smaller farms. Environmental investment will be subsidised in exchange for the stricter requirements and farms will be given financial incentives to cease operating. The transportation of manure over long distances will be discouraged. Fixed contractual relationships between breeders, fatteners and processors will have the effect of keeping animal health problems to a minimum. This form of pig farming will make a major contribution to the socioeconomic sustainability of rural areas as a source of regional economic activity and income, but is clearly not without its problems.

The local scenario

A third scenario is offered by a *local model*. It centres around a purely land-based type of farm which is more or less extensive, i.e. a mixed farm with free-range animals. As pigs live in groups they could, for instance, be used in the subsidised management of semi-natural landscapes and forests. The feed comes from the immediate vicinity, which means that this model also has an adverse effect on producers of grain substitutes in the developing countries and elsewhere. Manure is also disposed of in the immediate vicinity. In principle, the pigs can make use of space out in the open air. The meat is sold at high prices because of the quality label it carries, which is why the farmers can afford to operate this type of system, with their income supplemented if necessary by income from other sources.

This system is entirely land-based, which means that the cost of land is the highest item of capital expenditure. For lack of food, pigs will be less concentrated and their numbers will be kept low. The impact on the environment of these types of farms therefore stays well below accepted environmental limits and virtually no investments are required to ward off or compensate for environmental damages. The system is also almost unaffected by energy prices and hygiene-related, stress-related and epidemic diseases are rare. However, additional income may be needed from other sources, such as the exploitation of the landscape and natural features, recreation and afforestation. The regional model also requires strong pig breeds capable of spending long periods in the open air.

In political and technological terms, the local scenario represents the most radical break with the established system of intensive production. It presupposes a drastic reduction in primary and secondary activities connected with pig farming. The volume of production is only a fraction of that at present. A system of local quality marks could guarantee that the pork had been produced with real concern for the welfare of the animals. It could stress that the pigs were raised with a guaranteed access to enough space both indoors and in the open air, as well as opportunities for natural behaviour and without the use of antibiotics.

1.6 Conclusion

In all likelihood, none of the scenarios described in the previous paragraphs will ever be achieved in its entirety. Each of them is a model which is designed to illustrate the development issues and different interests that are involved. If the models make anything clear, it is that restructuring intensive livestock farming with its detrimental effects on the environment is an enormous undertaking in both political and technological terms. A drastic form of intervention is more or less unavoidable, but the question is: how should it be done?

The government is facing a dilemma in this respect. An enormous effort will be required to resolve the manure problem within the foreseeable future, whatever course of action the government adopts. If it does not provide substantial support, not only will there be a serious risk of widespread social unrest among the pig farmers who are forced out of business, but the surviving businesses will also try to recoup high levels of expenditure (on manure processing and/or modifying or moving their operations) in all kinds of ways, which will make it extremely difficult to enforce environmental regulations. At the same time, if the government organises and supports a restructuring process which gives viable pig farms sufficient scope to produce along environmentally acceptable lines without incurring excessively high costs, the funding required from general funds may be so high as to be regarded as unacceptable outside the agricultural sector and possibly even outside the intensive livestock farming sector.

The dilemma we have described has not yet been resolved. The government and leaders of the sector are making urgent appeals to the livestock farmers' sense of responsibility and resourcefulness and are urging joint initiatives, not just from pig farmers but from all those involved in the production chain. One idea, for example, is to use a '*mineral bookkeeping*' system, with levies and premiums to encourage livestock farmers to minimise the leaching of phosphates and nitrates into the environment. Farmers are also being encouraged by means of grants and licences to make joint plans for their own regions for the storage, transport and processing of manure (albeit on a small scale) and for reductions in overall ammonia emissions. As part of the sectoral debate described in section 1.4, a scenario has been proposed (Bens *et al.*, 1994) in which the added value at all the stages in the production chain would be raised by intensive co-operation between all the firms involved in the production of pigs and pork. Slaughterhouses and meat-processing companies are being asked to consult with one another and make arrangements for ceasing mutual competition. This would also involve entering into long-term contracts with both pig farmers and their customers. Exports of live piglets and pigs could decline and market prices could stabilise at a higher level. It would then be easier to finance environmental expenditure with the additional income.

A co-operative approach requires a degree of private planning and regulation which is difficult to reconcile with the spirit of free enterprise and free trade which is relatively strong in the pig-farming sector. An example of a collective initiative, the 'manure centre,' has already failed. One is still no nearer to defining what the future of the Dutch pig-farming industry will be. The question is decided by forces both inside and outside the sector. But how much more time and space will the politicians and the public give a sector which is balancing on the knife edge of government regulations as regards environmental pollution, hygiene and animal welfare?

Things are further complicated by the sector's close involvement in a number of international conflicts of interest. In the context of the EU and GATT, there is pressure on grain prices, which could eradicate the competitive edge enjoyed by Dutch pig farmers as a result of importing cheap grain substitutes. The interests of tapioca exporters such as Thailand, which would probably side with the Dutch, does not seem to count for much in this situation and may well be bought off with support for local food production in these countries. Additionally, growth in exports from Central and Eastern Europe in the next few years could represent a threat to bulk pork production in The Netherlands. Competition from Western European production areas, for example Denmark and Brittany, where the environmental problems are less acute and extensive, forms a further threat. Besides international interests, there are the international environmental problems. Large-scale soy bean cultivation, especially in the south and south-east of Brazil, has already been described as an ecological disaster (Besselink *et al.*, 1994). It is virtually impossible to comply with European standards on the quality of groundwater, surface water and the North Sea. And the opportunities for finding foreign markets for the Dutch manure surplus should not be overestimated.

For a long time, 'faith' in the technology of large-scale manure processing kept many people under its spell. A sizeable number of farmers, however, are apparently unwilling to submit themselves to a collective organisation that would co-ordinate manure transport and its financing. The distressed pig-farming sector cannot afford the high costs of this technology. It is clear once again that the role of technology can only be considered in its socioeconomic context. By clinging obstinately to the technological option of industrial manure processing, society has effectively blocked the promotion of other options, such as small-scale manure processing techniques and the gradual restructuring of the entire cattle and meat sector. In retrospect, both the cattle farmers and the environment in the areas of concentration have suffered from this technological optimism.

A drastic reduction in the number of agricultural holdings is expected, the impact of which will be softened by government support. The pollution of groundwater by minerals which are in the system as the result of years of overfertilisation (therefore necessitating the treatment of the groundwater before it can be used for drinking purposes) will remain a problem in The Netherlands for many years to come. For the time being, the competitiveness of the surviving pig-farming sector will also be under pressure as a result of the cost of dealing with the problems of manure and ammonia.

Alongside the large-scale, mainstream pig-producing companies, a subsector could develop which produces 'ecological' pork aimed at a limited segment of the domestic market. The strict environmental conditions under which they will have to produce mean that price differences need not form an insuperable problem.