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PIG PRODUCTION IN THE EC

Environmental policy and competitiveness

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Agricultural Economics Research Institute (LEI-DLO)
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ABSTRACT

PIG PRODUCTION IN THE EC: ENVIRONMENTAL POLICY AND COMPETITIVENESS
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Changes in environmental standards may largely affect cost structure in those regions within the EC which presently still have competitive advantages. The structure of pig farming has been examined in regions with high production levels of pigs and pork products. Five areas in different countries are selected that have the largest share in the pig production of the EC, i.e. the Netherlands, Bretagne, Belgium, Denmark and Niedersachsen.

The financial situation of farms with pigs is being analysed by making use of the Farm Accountancy Data Network of the Commission of the EC.

Major shifts in competitiveness of pig production might take place in the years to come due to changes in environmental policy and the adjustment processes required in the agricultural sector to compensate for the environmental standards. Competitiveness of pig production in Niedersachsen is relatively poor because the financial situation does not allow for major cost increases. On the other hand, the future perspective of pig farming is rather good in Bretagne, both because of the healthy financial situation and of the rather modest requirements to invest into environment-friendly equipment. The ability to meet major cost increases are identified to be sufficient in the Netherlands. The financial situation at farms with pig rearing and fattening combined is slightly worse than in Bretagne, Belgium and Denmark.

Pig farming/Environmental policy/Farm structure/Financial situation/ Competitiveness/EC/Manure

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FOREWORD

The Agricultural Economics Research Institute (LEI-DLO) was commissioned to undertake a project on the competitiveness of pig production within the European Communities in response to changes in environmental policy. Funds were made available by the Financieringsoverleg Mesten Ammoniakonderzoek (FOMA) in the Netherlands. This support is gratefully acknowledged. The report provides the basic achievements of the study.

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The Director,

The Hague, April 1993

L.C. Zachariasse

SUMMARY

Objective of the report

The basic objective of the present report is to examine how competitiveness of pig production in the EC might be affected in response to changes in environmental policy at the national level. Competitiveness of pig production might be negatively affected in case farmers in some countries meet cost increases which are substantially higher than elsewhere. The study has been divided into three interrelated parts which all contribute to the basic objective of the report. First, an overview will be given on the structural characteristics of pig farming, to be followed by a state-of-the-art review of environmental policy for pig farming. A distinction is made between present standards and standards which only become effective in the near future. Finally, some characteristics are given on the financial situation of pig farming. Structural characteristics of pig farming are important since they may indicate any differences in the way how farmers might respond to changes in environmental policy. Information on the financial situation of pig farming is important in the assessment of whether farmers are able to meet cost increases. The report focuses on five concentration areas of pig production, i.e. Niedersachsen (Germany), Bretagne (France), Belgium, the Netherlands and Denmark. The regions chosen are those that already achieved competitive advantages in the past.

Available data on the structure and economics of pig farming

Three major sources of information have been used in the study. First, the Farm Structure Survey (FSS) of the Statistical Office of the European Community, with information on the structural characteristics of farms. The second source used is the Regional Databank (REGIO) of the European Community with information on the final pig production. The third source of information that has been used is the Farm Accountancy Data Network (FADN) of the Commission of the European Communities. This data source includes information on the costs and outputs of agricultural practice according to farming types.

The Farm Structure Survey of 1987 has been used, as well as the Farm Accountancy Data Network for the period 1984-1989. Indicators on the financial situation of pig farming are averages of these six years. This period includes years with relatively high prices of pigs and years with rather low prices (i.e. 1987/88 and 1988/89).

The selection of concentration areas of pig production

Five regions in different member states have been chosen for this in-depth study. The areas selected are those ones, in different countries, that have the largest share in the pig production of the EC. The areas chosen (with their share in final pig production of EC-12 in 1987 between brackets) in successive order are the Netherlands (13%), Denmark (9%), Niedersachsen (8%), Bretagne and Belgium (both 6%). The Netherlands, Denmark and Belgium cover some 28% of the EC-total of final pig production and almost 80% of the import value of pigs and pork products in any of the member states. These three countries in total cover most of the trade of pigs and pork products among the EC-countries. Final pig production of Niedersachsen and Bretagne mainly contribute to national consumption.

Animal density of total livestock population is also high in these five regions, as well as a subsequent high excretion level of minerals from animal manure. The number of livestock units per hectare of utilized agricultural area in these regions is in the range between 1.4 (Denmark) and 4.0 (the Netherlands). Animal density in Niedersachsen (1.7) is only slightly higher than in Denmark; Bretagne and Belgium take a medium position with an average level of successively 2.6 and 2.9 LU/ha. The excretion of nitrogen from organic manure is assessed to be in the range between 87 (Denmark) and 257 kg of nitrogen per hectare of utilized agricultural area (the Netherlands), according to livestock population in 1987.

The structure of pig farming

Differences among the regions are large regarding the structural characteristics of pig farming. Structural characteristics of such farms differ in terms of the number of pigs per farm, the size of utilized agricultural area per farm as well as the economic size of farms with pigs.

Farms with pigs in Niedersachsen on average have less pigs than those elsewhere. The average is between some 120 in Niedersachsen and around 400 in the Netherlands. These differences are mainly due to (i) the considerable share (around 50%) of pig population in the Netherlands which is located at farms with over 800 pigs and (ii) the large share of the number of farms in Niedersachsen (about 70%) that have less than 100 pigs. The

process of increasing specialization and concentration of pig production is staying behind in Niedersachsen, at least compared to what has taken place elsewhere. The economic size of specialist granivores on average is rather small in Niedersachsen, compared to the other areas considered.

Animal density of pig population also differs among the regions. The average number of pigs per hectare of utilized agricultural area on farms with pigs is in the range between 5 in Niedersachsen and 37 in the Netherlands. The averages for Denmark and Bretagne are only slightly higher than Niedersachsen. This wide range is due to differences in the number of pigs per farm and the size of utilized agricultural area per farm.

The average per farm of utilized agricultural area on specialist granivores is large in Denmark (29 ha) and small in Belgium and the Netherlands (successively 3 and 4 ha).

More than half of the total pig population in Bretagne, Belgium and the Netherlands and around 40 percent in Denmark are located on specialist granivores. In Niedersachsen and Denmark, considerable shares of pig population also are on farms with various crops and livestock combined.

Environmental policy and pig farming

The poor quality of water is one of the most important issues of concern in the regions considered, whether it is the quality of drinking water (Bretagne, Flanders, the Netherlands and Niedersachsen) or of coastal waters from the point of view of tourism or fisheries (Bretagne and Denmark). Policy responses to these issues primarily include standards on the application of minerals from organic manure, rules on the way to apply manure and the period of the year that spreading of manure is not allowed. Reduction schemes on the emissions of ammonia in order to diminish acidification of soils and water have only been agreed upon so far in the Netherlands and Flanders.

Standards to apply manure are rather severe in Denmark and to a smaller extent also in the Netherlands and Niedersachsen. Present standards are relatively mild in Flanders, which is mainly due to the small excretion level of phosphate in manure from pigs considered in the manure law. Bretagne takes a medium position. The standards themselves are important in this respect, but also the starting points on the excretion of minerals from animals. In Flanders for example, the excretion of phosphate by livestock, according to the assessment given in the manure law of 1991, is considered to be some 25 percent smaller than in the Netherlands. This implies that manure from less pigs is allowed to be applied in the Netherlands in case such starting points are considered.

Manure surplus is the amount of animal manure which cannot be applied at the farm, according to the standards for the application. Accord-

ing to present standards, manure surpluses exist at the farm level in all regions considered. Differences among regions are considerable on the options to get rid of these manure surpluses. The structural characteristics of the agricultural sector are critical in that respect. Manure surpluses presently are applied at relatively short distance in Denmark, Bretagne and Niedersachsen. The need to transport manure over longer distances is gaining importance in Flanders and the Netherlands. The option to process animal manure might become important in the Netherlands and is seriously considered in Flanders.

The need for investments in environment-friendly equipment is highest in the Netherlands and Flanders, and is mainly aimed to achieve a major reduction on the emissions of ammonia. Equipment is needed to diminish the emissions at the stage of spreading manure on the field as well as to reduce emissions in the stable. The need for environmental investments are rather small in Denmark. In that country, investments are mainly required to enlarge the capacity to store manure at the farm, up to a total of nine months. The need for additional investments are relatively modest in Niedersachsen and Bretagne, according to the standards known so far for the years to come.

Financial situation of pig farming

The financial situation of pig farming is important because it allows to examine whether farmers would be able to meet any substantial cost increase.

The financial situation of pig farming in *Niedersachsen* on average is identified to be insufficient to meet any substantial cost increases. Family farm income is low and net worth shows a steadily decreasing trend during a considerable number of years, and cash-flow is very low. The financial situation of pig farming in *Bretagne* on average is relatively strong, with a reasonable level of family farm income, a considerable increase of net worth during the 1980s and a high cash-flow. The position of farms with pigs to meet higher costs on average is good in *Belgium*. The financial situation is highest at farms with pig rearing and fattening combined. In *the Netherlands*, the ability to meet a considerable increase of costs at farms with pig rearing and fattening combined is identified to be slightly worse than those in Bretagne, Belgium and Denmark. The ability to meet an increase of costs is relatively good in *Denmark*. The financial situation of pig farming in Denmark on average is better at farms with pig rearing and fattening combined than at the other farming types considered.

Competitiveness of pig farming

An assessment has been made on competitive (dis)advantages in the five concentration areas of pig production. These regions did have competitive advantages in the past, and the question is how that might alter with changes in environmental policy. The competitive relations among the regions of pig production are likely to change with the adjustments in environmental policy, given present structure of pig farming and the financial situation of pig farmers.

The perspective of pig farming - on average - is identified to be good at the farming types considered in *Bretagne* and *Denmark*, as well as at the farms in *Belgium* with pig rearing and fattening combined. It is identified to be sufficient at the farms with mixed livestock which are mainly oriented at dairying and at farms with field crops and granivores combined.

The future perspective of pig farming is critical in *Niedersachsen* because of the difficulties to meet further increases in costs. The financial situation to compensate for major increases in costs are difficult. Major adjustment processes are likely to be required in order to rationalize pig farming. In that region there are a large number of farms with only a few pigs.

The future perspective in *the Netherlands* is identified to be critical at farms which are specialist in pig rearing. The future perspective on average is identified to be sufficient at farms with pig rearing and fattening combined, as well as at mixed livestock farms with granivores and dairying combined. The same holds for farms with specialist milk production. The investments required in the Netherlands are large at these farming types, but the actual financial situation to offset major cost increases is sufficient (specialist pig rearing and pig rearing and fattening combined) to relatively good (farms with specialist milk production and at mixed livestock farms with granivores and dairying combined).

1. INTRODUCTION

1.1 Environmental policy and adjustment processes in agriculture

Livestock population did increase rapidly over the past few decades in several member states of the European Communities. Rates of increase have been largest in intensive livestock production. Pig population in the Netherlands for example, more than doubled between 1970 and the late 1980s, from some six million animals in 1971 until more than fourteen million animals in 1987. In several other member states, the total size of pig population was rather stable at the national level, although concentration of pig production further increased at the regional level. The trend towards an increase of concentration and specialization mainly took place in areas with competitive advantages and the necessary infrastructure and know-how to stimulate a production rise. In France for example, the total size of pig population only increased slightly since the 1970s, i.e. from 10.7 until 11.8 million animals. Concentration of pig production however, increased in Bretagne. In this region, pig population more than doubled from almost three million animals in 1970 until around six million animals in 1988. Similar trends in concentration of pig production have taken place elsewhere, including West-Flanders (Belgium), Niedersachsen (Germany) and Lombardia (Italy). Concentration of pig production generally increased in areas that have good access to large harbours (e.g., Rotterdam, Antwerp, Ghent, Hamburg, Rouen, Brest and Le Havre) for the supply of material to produce feeding stuffs at low costs, and are close to the major urban centres of Europe. Also important in this respect were the economies of scale from the available infrastructure of the agribusiness complex. The various stages from the production of feed concentrates, holding of pigs at the farm and the processing of pigs and pork products, is increasingly seen as an integrated chain in the major concentration regions of pig production.

A subsequent effect of the increasing concentration of pig production was that animal density reached high levels in these regions. Deterioration effects on the environment also increased over the past decades. Some primary reasons for this are high application levels of minerals from

organic and inorganic sources and the subsequent losses to the environment (soils, water and air).

The notion of deterioration effects on the environment due to leaching losses of minerals is gaining increasing societal concern. The agricultural sector in this respect is one of the main contributors to the pollution of water (CEC, 1992). Leaching levels of nitrate of 50 mg/l (EC drinking water standard) and more occurs in about 25% of the agricultural soils in the EC, particularly in the Netherlands, Denmark, Belgium, Germany, the southern part of the United Kingdom, the Po area in Italy and western France. In another 45% the computed levels are between 25 and 50 mg/l, which is above the EC-target value of 25 mg/l (RIVM and RIZA, 1991). Other environmental issues of concern include the emissions of ammonia and the subsequent acidification of soils and water, leaching losses of pesticides towards groundwater, as well as the accumulation of phosphate and heavy metals in soils. These accumulation processes may continue until some threshold for storing such chemicals in the soils is reached. Deterioration effects on the environment start by the time that such chemicals get released.

Environmental policies did change rapidly over the past couple of years within the EC and elsewhere. Such policies also focus on the agricultural sector. National policies that affect livestock production primarily aim to diminish deterioration effects of mineral surpluses. Several types of adjustment processes could take place in order to meet the environmental standards. They depend, among others, on agricultural practice and the structural characteristics of farming. Farmers for example might have to adjust agricultural practice through investments in environment-friendly equipment (e.g., to reduce emissions). Alternatively, they might also have options to apply their inputs in a more efficient and effective way. Investments might also be required in this case.

The adjustment processes however are likely to affect operational results and the financial situation of farmers, since costs may increase, revenues might be reduced or the risk of income reduction might increase. Differences among countries might be large in this respect, because of (i) the differences in the structure of farms, (ii) differences in environmental standards and (iii) differences in the financial situation of farms and their ability to offset the higher costs. Assessments regarding the effects of environmental standards on farm income and cost structure might be elaborated at a national level or it might include an international perspective. The outcome between the two is likely to be different. This holds especially for those products that mainly depend on markets abroad, such as pig production. It needs to be mentioned in this respect that prices of pigs and pork products are primarily based on the balance within the EC between supply and demand. The price of pork on average is above world

market price, which reflect higher costs of production in the EC due to price support for cereals. There are several reasons for differences in assessments with a national or an international perspective. First of all, it is important to know whether producers abroad also have to consider cost increases in response to stricter environmental policies, and whether they are able to meet these costs. If that would be the case, an increase of production costs in these countries might either result in higher prices for final products and/or a move of some part of pig production to regions with less deterioration effects on the environment or less costs to compensate for the standards. Competitiveness of agriculture might however be negatively affected in case farmers in some countries meet cost increases in response to environmental policy which are substantially higher than elsewhere. Revenues of pig farming might be reduced in regions with competitive disadvantages due to cost increases and/or a move of part of the production to regions with competitive advantages. This concern is presently noticed among others in Belgium and the Netherlands. In the Netherlands for example, cost increases in intensive livestock production to meet environmental standards of the year 2000 are considered to be so high that continuity for about half of the farmers with intensive livestock production might raise difficulties (Van Os and Baltussen, 1992). The relatively large surplus in the balance of payments of pigs and pork products in the Netherlands, Denmark and Belgium is an important consideration in the competitiveness in response to changing policies. This is due to the rather strong market position of these countries in the export of pigs and pork products. The export of these products further increased during the 1980s in Denmark and the Netherlands. Self-sufficiency rates even decreased in others (e.g. Italy). Of similar importance in this respect are the large and rapid adjustment processes in agricultural practice which might take place in response to changes in cost structure. The last phenomenon is the well-known 'pig cycle'. The dynamic and innovative nature also are important characteristics which need to be considered.

1.2 Aims and scope of the report

The basic objective of the present report is to examine how competitiveness of pig production in the EC might be affected in response to changing environmental policies in the member states. This issue presently is of basic concern in those countries (among others, in Belgium and the Netherlands) where environmental policy is evolving very rapidly and major adjustment processes are required in farming practice. Pig farming has been chosen because this sector has a large contribution to manure surpluses and leaching losses of minerals. This is primarily the case in the

concentration regions of pig production in Europe. The pig sector will therefore likely have to meet a substantial share of cost increases in case policies change, among others regarding the emissions of ammonia, the maximum amount of manure to be applied on the field, and ways of spreading of animal manure. The primary focus of the present report is on policies which aim to reduce deterioration effects of mineral surpluses from agriculture. We will focus on present policies as well as policies that may become effective within the next couple of years but before the end of this decade. The reason for it is that both types of changes in environmental policy will require adjustments by farmers within the next couple of years. Cost structure will subsequently change.

The report is to be followed by six chapters that all contribute to the primary objective of the study.

First of all, some basic information is given on livestock population in the EC. The composition of livestock population among animal categories is presented for all twelve member states. A limited number of regions will be selected for further analysis. Two considerations are important in the selection of these regions. Pig production is concentrated in the regions considered and the total agricultural area in these regions is of about the same size. Livestock population is presented in chapter 2 at the national level and also at the regional level. This regional differentiation enables the identification of areas with a high level of animal density and a relatively large share of pig population in the EC.

Five regions will be chosen which in total cover a substantial part of the pig population in the EC. The subsequent part of the report then will only focus on pig production in these five regions. Information is required on several items in order to arrive at a proper assessment on the competitive (dis)advantages of pig production in any of the countries of the EC, in response to adjustments in environmental policies. They depend (i) on the structural characteristics of pig farming, as well as (ii) on the environmental standards that farmers need to meet and finally (iii) on the financial situation of pig farming, and the ability of farms with pigs to meet a major increase of costs. These three items will successively be discussed in chapter 3, 4 and 5. First of all, some characteristics on the structure of pig farming are discussed in chapter 3. The structural characteristics of farms with pigs are important since they may indicate any differences that farmers might have in offset stricter standards. Any of the new standards might affect the way how animal manure could be treated in response to environmental policies. Several options are available in this respect. Manure might be applied at the own farm, it might be applied at short distance of the farm, it might be transported at long distance (also including the option of export to abroad) or be processed in factories. The farmers' choice for any of these options among others depend on the structural charac-

teristics of the farms. Of similar importance as the structure of farms with pigs, of course, are the standards that farmers have to meet and the investments which might be required to meet them. A summary of the environmental policies that are critical to pig production is presented in chapter 4 of the report. This overview shows how the treatment of animal manure might respond to changes in environmental policies, and the investments that are required to compensate for standards.

Some major characteristics regarding the operational result of pig production and the financial situation of farms with pigs are presented in chapter 5 of the report. This kind of information is also critical to the options that farmers have in order to offset either cost increases of the investments in environmental-friendly equipment, or other kinds of adjustments which affect farm income and the financial position of farmers.

The question of how competitiveness of pig production in the European Community might respond to changes in environmental policies is discussed in chapter 6 of the report. Some concluding statements and major findings regarding competitiveness of pig production in the EC are given in the final chapter of the report.

1.3 Available data sources of the European Community

The study is elaborated through the data sources that were available at the regional level, and cover all member states of the European Community. Three major sources of information have been used. First, the Farm Structure Survey (FSS) of the Statistical Office of the European Community. This source provides information on the structural characteristics of farms, i.e. the size of livestock population, the size and utilization of agricultural land, and other structural characteristics of pig farming. This type of information is available at the regional level and at the level of farming types. The Farm Structure Survey includes all farms except the small ones. The minimum size of farms for inclusion in the survey however differs among the member states. This source of information was available for the year 1987. The second source of the European Community is the Regional Databank (REGIO) with information on the final pig production. This type of information was available for several years, both at the national as well as the regional level. We made use of information for the period between 1980 and 1987.

The final source of information was the Farm Accountancy Data Network (FADN) of the Commission of the European Communities (CEC, 1989). This data source includes information for accounting years on the costs and outputs of agricultural practice according to various farming types. It only enables to assess averages of costs and output at the level of

farming types according to farm size, which limits the possibilities to analyse the financial position of pig farming. It is for example not possible to quantify accounting results for the pig sector as a whole since the information available from FADN only provides averages for farming types. No individual farm data have been available in this respect. Accounting results are based on a sample of farms which in total is considered to represent the characteristics of farming types. The FADN accounting system does not represent farms which are smaller than some minimum level. These minimum levels also differ among countries in this case. Information on profitability and the financial situation of pig farming is required in the study in order to assess the impact of environmental policies on competitiveness of pig farming in some concentration regions of the European Community. FADN provides this type of information. The availability of FADN data in practice might be limited for some regions and/or accounting years. Also the number of farms that are in the sample might be too small for some farming types in order to represent it properly. The number of farms in the sample of FADN is given by farming type in the annex of the report. The annex also gives details on the number of farms that are represented by the sample. Any of the limitations identified before may depend on the relative importance of farming types in specific regions and/or accounting years. Information used in this study includes the accounting years 1984/85-1989/90. This period of six years does include years with relatively high prices of pigs and years (i.e. 1987/88 and 1988/89) with rather low prices. Averages over this period are therefore considered to cover a proper reference for the actual state on the financial position of pig farming.

The subdivision of the European Community includes 86 regions. This regional differentiation has been chosen because information is available at this level, from the Farm Structure Survey, the Regional Databank and from the Farm Accountancy Data Network. Although information was available from the Farm Structure Survey at a more detailed spatial level, no further distinction was made into subregions. This was due to the availability of information from FADN. Also important was the fact that the regions identified should fit the level of administration to formulate environmental policy.

2. LIVESTOCK POPULATION IN THE EC

2.1 Introduction

The main objective of this chapter first is to examine the size of total livestock population in the European Community and its distribution among countries and regions. The second objective is to identify a limited number of regions in different countries with a high concentration of pig production. The concentration regions selected for further analysis should in total cover a considerable share of the pig population in the EC. Information on the size of livestock population is first presented at the national level (section 2.2). The same section also provides information on the relative composition of animal categories in national livestock population and animal density per hectare of utilized agricultural area. Similar information is then being provided at the regional level (section 2.3). Regions with a high concentration of pig production will be identified in that way. Production, consumption and trade patterns of pigs and pork products among the countries in the EC are also being examined in order to support the identification of concentration areas of pig production and to identify their main markets (section 2.4). Some concluding remarks on the size and distribution of livestock population among countries and regions are summarized in section 2.5.

2.2 Livestock population at the national level

The main categories of livestock population include cattle and other grazing animals, pigs and poultry. Table 2.1 first shows the distribution of livestock population in 1987 for all member countries of the EC. The total size of livestock population is presented in livestock-units (LU). It is a unit

representing the nutrient (energy) value of feed. This way enables a summation of the animal types according to their feed requirements 1).

The four countries with largest size of livestock population in 1987 (measured in livestock units) in successive order are France, Germany, the United Kingdom, and Spain. The share of these countries in total livestock population of the EC amounts to some 64%. France for example already accounts for over twenty percent of the total livestock population in EC-12. The total size of cattle in the EC is over 82 million animals. There are more than one hundred million other grazing animals, with some ninety percent of it being sheep. The total number of pigs in EC-12 amounts to almost one hundred million animals and the poultry population is around nine hundred million animals.

France, Germany, the United Kingdom and Italy successively are the four countries with the largest share in the EC-12 total of cattle livestock. These four countries include approximately seventy percent of the EC-12 total of cattle livestock. Large shares of other grazing animals are noticed in the United Kingdom, Spain, Greece and France, and these four countries in total account for around eighty percent of the EC-12 total of this animal category. The United Kingdom and Spain together already account for about sixty percent of the EC-12 total of other grazing animals.

Germany, the Netherlands, Spain and France successively are the four countries with largest level of pig population. These four countries in total cover almost two third of the EC-12 total of pig population. France, Italy, the United Kingdom and Spain are the successive countries with largest population of poultry and they account for almost seventy percent of the EC-12 total of poultry population.

Animal density (i.e., number of livestock units per hectare of utilized agricultural area) shows a wide differentiation among the countries of the European Community (see also table 2.1). It is an important phenomenon from an environmental point of view since it is a rough indicator concerning the amount of manure from organic sources which could be spread on the field, compared to the supply of organic minerals from livestock. High levels of animal density may indicate that more manure be supplied from

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1) Each of the four animal categories includes a set of animal types. This subdivision is specified below, with number of livestock units per animal between brackets. The coefficients enable conversion of livestock species or classes to a common unit, i.e. livestock unit. The coefficients are also used by the Farm Accountancy Data Network (FADN) (CEC, 1989). Cattle includes bovine animals less than 1 year (0.4), bovine animals, 1-2 years (0.6), male bovine animals over 2 years (1.0), heifers over 2 years (0.8), dairy cows over 2 years (1.0), other cows over 2 years (0.8). Other grazing animals include sheep (0.1), goats (0.1) and one-hoofed animals (0.6). Pigs consist of piglets (0.027), breeding sows (0.5) and other pigs (0.3). Poultry includes broilers (0.007), laying hens (0.014) and other poultry (0.03).

animals than could be applied on the field according to the mineral requirements to grow crops (see also chapter 4).

Table 2.1 Livestock population, utilized agricultural area (UAA) and animal density in EC-12 in 1987 a)

Country	Cattle	Other graz. animals b)	Pigs	Poultry	Total livestock (1000 LU)	UAA (1000 ha)	Animal density (LU/ha)
	(1000 animals)						
Germany, F.R.	15231	1329	23989	68696	17552	11843	1.5
France	21856	11650	11777	224908	23204	28058	0.8
Italy	8907	9437	8795	144350	11300	15545	0.7
Belgium	3071	218	5844	23243	3915	1370	2.9
Luxembourg	217	8	75	99	175	127	1.4
Netherlands	4895	1083	14349	98669	8016	2024	4.0
Denmark	2351	134	9266	15540	3967	2798	1.4
Ireland	6765	5033	911	7844	5773	4915	1.2
United Kingdom	12087	38529	7899	138918	15830	16750	0.9
Greece	678	12730	909	29752	2416	3842	0.6
Spain	5358	23191	12744	125338	11406	24797	0.5
Portugal	1387	3260	2362	31499	2301	3331	0.7
EC-12	82801	106602	98921	908856	105855	115399	0.9

a) Total livestock population in livestock units (LU); b) Other grazing animals mainly include sheep and goats.
(Source: FSS, 1987/LEI-DLO).

Animal density is largest in the Netherlands, with an average of four livestock units per hectare of utilized agricultural land. Animal density in Belgium is almost three livestock units per hectare. The relatively large countries in the EC, including France, Spain, the United Kingdom and Italy, do have a rather small level of animal density, being less than one livestock unit per hectare of utilized agricultural land. Germany however is an exception to this, as it is one of the countries with large areas of UAA and animal density of 1.5 livestock units per hectare, which is considerably higher than the EC-12 average of 0.9 LU/ha. It needs to be emphasized that animal density is based on national averages. There is however a wide range of values in case animal density is identified among the various farming types and individual farms (see also chapter 3).

Cattle is the dominant animal category within the EC, as based on livestock units, to be followed by pigs (table 2.2). Differences among countries however are large.

The share of cattle in national livestock population is ranging from twenty percent in Greece up to over eighty percent in Ireland and Luxembourg, with an EC average of 55 percent. Cattle is the largest animal category in all countries with the exception of Denmark and Greece. In Denmark, the contribution of pigs in national livestock is over fifty percent, and well over half of the livestock population in Greece belong to the category of other grazing animals.

The share of pig population in national livestock composition also shows a wide range among the countries, varying from less than ten percent in Luxembourg, Ireland and Greece up to at least thirty percent in Germany, Belgium, the Netherlands, Denmark and Spain. It is even more than forty percent in Denmark and the Netherlands. The share of poultry in national livestock population is above the average level of the EC-countries in the Netherlands and the EC countries bordering the Mediterranean sea. Other grazing animals cover more than twenty percent of national livestock population in the United Kingdom, Greece and Spain. This animal category only includes more than half of total national livestock population in one member state (Greece).

Table 2.2 Share of animal categories in the national livestock population in EC-12 in 1987 (percentages)

Country	Cattle	Other grazing animals	Pigs	Poultry
Germany, F.R.	60	1	34	5
France	68	6	13	14
Italy	54	9	21	16
Belgium	56	1	37	6
Luxembourg	89	1	9	1
Netherlands	44	2	41	14
Denmark	40	1	55	4
Ireland	85	9	4	2
United Kingdom	53	24	12	10
Greece	20	58	8	14
Spain	36	22	30	12
Portugal	43	17	24	15
EC-12	55	11	23	11

(Composition of animal categories is based on livestock units.)
(Source: FSS 1987/LEI-DLO).

2.3 Livestock population at the regional level

Livestock population generally is concentrated in the larger countries in those parts where economic cost advantages could be achieved in that way. Cost advantages for example, might be achieved in areas close to harbours and urban centres. It is therefore more appropriate, both from an economic and environmental point of view, to examine animal density at the regional level. Regions which are rather similar to countries like the Netherlands and Belgium, in terms of concentration of livestock population and animal density, might be identified in this way.

The information on size, composition and density of the livestock population, which was presented before at the national level, therefore will also be presented in the following at the regional level. First of all, some regions will be identified with high levels of animal density. We will also examine composition of animal density at the regional level, according to the main animal categories.

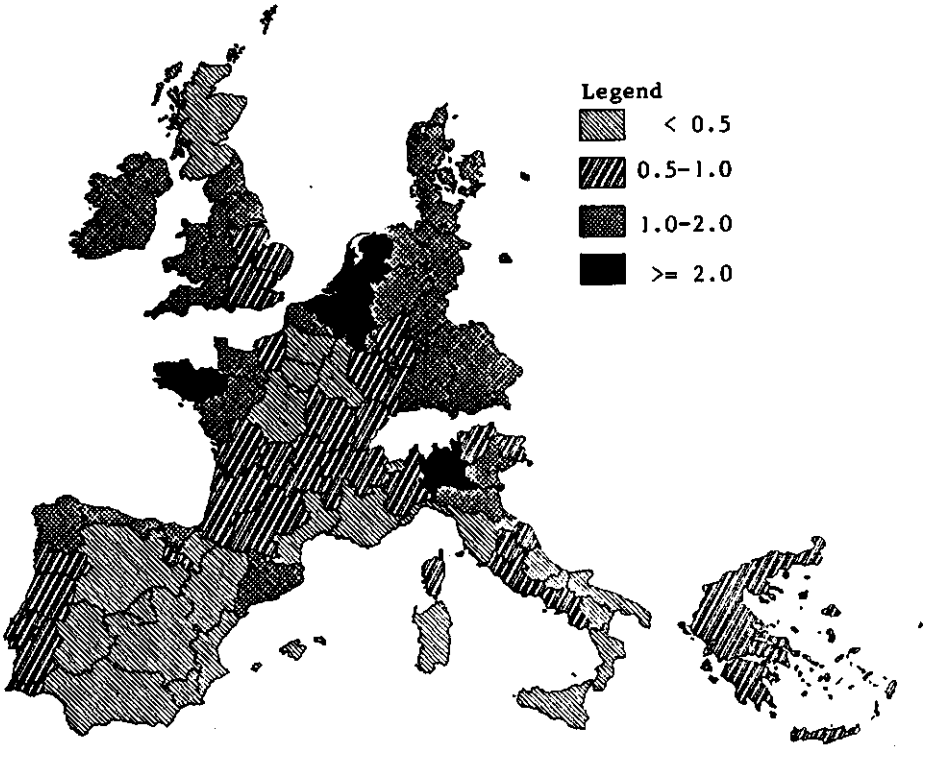

Figure 2.1 Animal density in EC-12 in 1987 (number of livestock units per hectare of utilized agricultural area)

Figure 2.1 shows animal density per hectare of utilized agricultural area in the EC at the regional level. Animal density is over 2 LU/ha in the Netherlands, Belgium, Bretagne (France) and Lombardia (Italy) (see also table 2.3).

Table 2.3 shows the size of livestock population in 1987 for a selected number of regions. Regions selected do have at least two million pigs and their contribution to the total pig population of the EC therefore is at least 2%. Luxembourg, Ireland, the United Kingdom and Greece are not included because of the constraint on the size of pig population. The thirteen regions which are included in the table in total cover approximately 25% of the EC-12 total of utilized agricultural land and over 40% of the EC-12 total of livestock population, if measured in terms of livestock units. These 13 regions however even include about 70% of total pig population in the EC-12.

In the larger countries, animal density generally is considerably higher in the regions considered than their national averages. In France for ex-

Table 2.3 Livestock population, utilized agricultural area (UAA) and animal density by region in EC-12 in 1987

Country/region *)	Cattle	Other graz. animals	Pigs	Poultry	Total (1000 LU)	UAA (1000 ha)	Animal density (LU/ha)
	(1000 animals)						
GERMANY, F.R.							
Niedersachsen	3310	207	7569	30180	4616	2713	1.7
Nordrhein-Westfalen	1971	159	6271	11383	3074	1580	1.9
Baden-Württemberg	1774	267	2319	5916	1889	1475	1.3
Bayern	5112	283	4136	11581	4800	3399	1.4
FRANCE							
Bretagne	2751	187	5712	85698	4574	1774	2.6
ITALY							
Lombardia	2196	156	2946	45759	2896	1142	2.5
Emilia-Romagna	941	118	2092	5047	1313	1257	1.0
BELGIUM	3071	218	5844	23243	3915	1370	2.9
NETHERLANDS	4895	1083	14349	98669	8016	2024	4.0
DENMARK	2351	134	9266	15540	3967	2798	1.4
SPAIN							
Cataluna	536	691	3667	32641	1810	1129	1.6
Castilla-Leon	1197	5235	2366	12052	2232	5336	0.4
PORTUGAL	1387	3260	2362	31499	2301	3331	0.7

**) The regions selected do have at least two million pigs.*
(Source: FSS 1987/LEI-DLO).

ample, it only is 0.8 livestock units per hectare of utilized agricultural land, whereas animal density in Bretagne is around three times higher than the national average. The exception to this is the case of Germany, which has a relatively high density of animal population. Pigs and poultry account for over half of the total livestock population in Bretagne. In Lombardia and Cataluna, animal density also is around three times higher than their national averages. In these regions, animal density successively is about 2.5 and 1.6 livestock units per hectare of utilized agricultural land, whereas national averages are even less than the average of EC-12.

The composition of each animal category in total livestock population of the regions mentioned above is presented in table 2.4. The share of cattle in the regional livestock population is in the range between 20% (Cataluna) and 75% (Bayern). The share of pig population in the regional total of livestock population is in the range between around twenty percent in Bayern and over fifty percent in Nordrhein-Westfalen, Denmark and Cataluna. The share of poultry in regional livestock population is in the range between three percent in Bayern and 24 percent in Bretagne. The

Table 2.4 Share of animal categories in the regional livestock population in EC-12 in 1987 (percentages)

Country/region *)	Cattle	Other graz. animals	Pigs	Poultry
GERMANY, F.R.				
Niedersachsen	49	1	42	8
Nordrhein-Westfalen	43	1	51	5
Baden-Württemberg	65	2	28	4
Bayern	75	1	21	3
FRANCE				
Bretagne	45	1	31	24
ITALY				
Lombardia	51	1	27	21
Emilia-Romagna	51	1	42	6
BELGIUM	56	1	37	6
NETHERLANDS	44	2	41	14
DENMARK	40	1	55	4
SPAIN				
Cataluna	20	4	56	19
Castilla-Leon	40	25	29	6
PORTUGAL	43	17	24	15

**) Regions selected have at least two million pigs.*
(Source: FSS 1987/LEI-DLO).

The share of poultry in regional total of livestock population is more than ten percent in Bretagne, Lombardia, the Netherlands, Cataluna and Portugal, and it is less than five percent in Bayern, Baden-Württemberg and Denmark. The share of other grazing animals is negligible in all regions, except in Castilla-Leon (Spain) and Portugal.

2.4 Production, consumption and trade of pigs and pork products

2.4.1 Introduction

The information provided in sections 2.2 and 2.3 did summarize the size and composition of livestock population in the EC countries, successively at the national and regional level. Pig population in five areas (Niedersachsen, Bretagne, Belgium, the Netherlands and Denmark) already account for over 40% of the pig population of the EC-12. These areas in total cover only 9% of the utilized agricultural land in the EC. Trade flows of pigs and pork products among others result from this concentration of production, but in fact depend on self-sufficiency rates and competitiveness of pig production in an international perspective. Production, consumption and trade patterns of pigs are further examined in this section. This will enable answering the question whether such concentration regions produce pigs for national markets or whether part of production is being exported to elsewhere. Such trade flows may also change in the future in case cost structure changes in response to alterations in environmental policies or any other changes that affect cost structure of pig production.

2.4.2 Production and consumption

Germany, France, the Netherlands and Spain have the largest share of final pig production in the EC in 1987 (table 2.5). The contribution of the four countries in the pig production of the EC-12 amounts to over 60 percent. The share of pig production in the member countries to the EC-12 total only slightly changed in the period between 1980 and 1987. A decrease was noticed in Germany and an increase in Spain. In Germany, it decreased from 28 percent in 1980 to some 24 percent in 1987. In Spain however, it increased from nine percent in 1980 to some 13 percent in 1987. Relative changes in the other countries have been even smaller.

Concentration of pig production increased between 1982 and 1987 in parts of Germany (Niedersachsen), France (Bretagne) and Italy (Lombardia) (table 2.6).

Table 2.5 Final pig production during the period 1980-1987. (Share of national final pig production in EC-12; total of EC-12 and of the member states by country, in million ECU.)

Country	1980	1982	1984	1986	1987	1987
			(%)			(mln. ECU)
Germany, F.R.	28	28	27	25	24	4329
France	14	13	13	13	13	2356
Italy	10	10	11	11	10	1869
Belgium	6	6	6	6	6	1054
Luxembourg	0	0	0	0	0	13
Netherlands	11	12	12	13	13	2244
Denmark	9	8	9	9	9	1682
Ireland	1	1	1	1	1	183
United Kingdom	9	9	8	7	7	1311
Greece	2	2	2	2	1	249
Spain	9	10	10	12	13	2235
Portugal	2	2	2	2	2	357
EC-12 (mln. ECU)	15228	19612	20107	19863	17881	17881

(Source: REGIO).

Self-sufficiency rates of pork depend on production and consumption patterns. Trade flows of pigs and pork products may result in case countries do have self-sufficiency rates which are well over or well below 100%. Table 2.7 shows trends on self-sufficiency rates of pork in EC-12 between 1983 and 1988. For the EC as a whole it is only slightly higher than 100 percent, and it is over 250 percent in the Netherlands and Denmark. The contribution of these two countries in trade flows of pigs and pork products among the EC-12 countries is high. This will be further examined in the following subsection. There is a wide difference among the countries in consumption of pork. Consumption is highest in Denmark (some 66 kg per head of population), closely to be followed by Germany. It is lowest in the Mediterranean countries and the United Kingdom (around 25 kg per head of population). The consumption of pork did increase between 1983 and 1988 in most countries, with largest rates of increase in Spain, Portugal and Denmark.

Table 2.6 Share of regional final pig production in national total between 1982 and 1987 (percentages). Final pig production in million ECU in 1987

Country/region	Regional share in national final pig production (%)						Final 1987
	1982	1983	1984	1985	1986	1987	
GERMANY, F.R.							
Niedersachsen	30	31	31	30	31	33	1409
Nordrhein-Westfalen	25	26	26	26	26	26	1147
Baden-Württemberg	11	10	10	10	10	10	422
Bayern	18	18	17	18	18	17	748
FRANCE							
Bretagne	44	45	45	46	48	49	1147
ITALY							
Lombardia	22	23	31	31	31	31	587
Emilia-Romagna	25	25	25	25	24	25	462
SPAIN							
Cataluna	33	31	31	26	28	29	658

(Source: REGIO).

Table 2.7 Self-sufficiency rates of pork in EC-12 between 1983 and 1988 and consumption of pork in 1983 and 1988. Between brackets are given the percentage rates of increase in consumption per head of population between 1983 and 1988

Country	Self-sufficiency rate (%)				Consumption (kg per head)	
	1983	1986	1987	1988	1983	1988
Germany, F.R.	87	88	87	85	59	62 (+6%)
France	81	81	81	84	35	38 (+7%)
Italy	75	66	67	67	26	30 (+14%)
BLEU *)	148	145	162	167	44	47 (+6%)
Netherlands	252	278	288	278	41	47 (+14%)
Denmark	401	353	338	346	51	66 (+29%)
Ireland	123	114	118	114	34	34 (0)
United Kingdom	71	72	71	72	26	25 (-2%)
Greece	71	69	67	74	21	25 (+16%)
Spain	99	93	96	98	30	45 (+50%)
Portugal	98	97	100	90	17	24 (+43%)
EC-12	102	102	103	104	36	40 (+9%)

*) *Economic Union of Belgium and Luxembourg.*
(Source: Eurostat, 1991).

2.4.3 Trade patterns

The three countries with high self-sufficiency rates (Denmark, the Netherlands and Belgium) also are the most important countries of origin of the import of pigs and pork products in any of the member states. Table 2.8 provides information on the origin of the import patterns of pigs and pork products in the EC countries. The Netherlands is by far the most important country in this respect. Its contribution to the import value of pigs and pork products in any of the EC-12 countries is approximately forty percent. Denmark is the second country, with a share of some twenty percent, and Belgium is almost similarly important in this respect as Denmark is. The import of pigs and pork products from non-EC countries to the European Community is negligible and is only some two percent of total import value to the EC-12 countries. It amounts to some 120 million ECU in 1990.

*Table 2.8 Origin of the import of pigs and pork products in the EC-12 *) (Values in million ECU)*

Origin	1986	1987	1988	1989	1990
Netherlands	2028	1979	1977	2444	2435
Denmark	1019	944	970	1177	1300
BLEU	800	806	814	1035	945
Germany, F.R.	348	327	312	385	394
France	168	185	206	307	336
Italy	109	125	133	144	154
United Kingdom	111	86	99	132	123
World	4834	4623	4696	5913	5942
Total EC	4657	4522	4584	5724	5821
Totaal non-EC	177	101	112	188	119

**) Including intra trade patterns between the member countries. Only those countries are included which did have a share of at least 2% of total import in the EC during any year between 1986 and 1990.*
(Source: Eurostat).

After having identified the major countries of origin on the import of pigs and pork products we will now examine the destination of export flows from any of the member states (table 2.9). The total export value of pigs and pork products in 1990 to Germany, Italy, the United Kingdom and France, amounts to almost five billion ECU. This already includes

over eighty percent of the intra-trade of pigs and pork products in EC-12. These four EC-countries do have a large population size, a considerable consumption per head of population, and a self-sufficiency level of pork being well below 100%. This implies that considerable amounts of pork are required from abroad in order to meet such consumption levels. The share of the export to outside the EC in total EC-12 export of pigs and pork products is around 17% and some 60% of it is going to Japan and the USA.

Table 2.9 Destination of the export of pigs and pork products between 1986 and 1990 of the EC-12 (In million ECU)

Destination	1986	1987	1988	1989	1990
Germany, F.R.	1056	1068	1178	1371	1457
Italy	1142	1088	1030	1302	1344
United Kingdom	820	807	918	1159	1146
France	956	902	838	982	949
Japan	375	412	515	552	421
USA	368	323	280	235	287
BLEU	231	207	198	249	298
Greece	148	142	158	173	158
Spain	155	109	73	188	184
World	5539	5388	5680	6799	6949
Total EC	4629	4450	4585	5687	5776
Total non-EC	909	937	1093	1109	1169

(Source: Eurostat) Only those countries are included which did have a share of at least 2% of total export value of EC-12 during any year between 1986 and 1990.

Table 2.10 shows information at the country level on the export of pigs and pork products from any of the EC-12 countries in 1990. The table is limited to the most important exporting countries. The information from table 2.9 about the EC-12 export in 1990 has been subdivided by member state 1).

1) The export value of pigs and pork products to any of the EC countries is not equal to the total value of the import of pigs and pork products which originates from that country. The reason for this difference is among others that export is measured free on board (f.o.b.) and import is measured cost, insurance and freight (c.i.f.). Import is being registered in the country of destination and export is being registered in the country of origin.

Table 2.10 Destination of the export of pigs and pork products from the five most important exporting countries and the EC-12 in 1990 (Values in million ECU)

Destination	Exporting countries					
	France	BLEU	NL	Germany	Denmark	EC-12
Germany, F.R.	55	291	681	-	287	1457
Italy	171	233	639	127	161	1344
United Kingdom	36	40	398	43	551	1146
France	-	279	295	59	214	949
Japan	0	0	0	0	409	421
BLEU	35	-	167	72	5	298
USA	1	11	18	0	252	287
Spain	20	18	119	15	5	184
Greece	3	11	89	23	30	158
World	389	969	2505	520	2058	6949
Total EC	330	946	2426	389	1274	5776
Total non-EC	58	23	79	131	784	1169

(Source: Eurostat) Only those countries of destination are included which did have a share of at least 2% of the total export value of EC-12 in 1990.

Total export of pigs and pork products from the EC countries amount to some 7 billion ECU. More than eighty percent is being exported to the other member countries. Approximately 1.2 billion ECU is being exported to outside the EC, mainly to Japan and the USA. Over ninety percent of the export of pigs and pork from EC countries to Japan and the USA is originating from Denmark. Almost fifty percent of the export from any of the EC countries to Germany and Italy is coming from the Netherlands. This amounts to well over half of the export of pigs and pork products from the Netherlands.

2.5 Concluding remarks

(1) Cattle includes a large share (about 55%, if identified in livestock units) of total livestock population of the European Community. Its share is below average in the Netherlands and Denmark (due to the relatively large share of pigs in these countries), the United Kingdom and Greece (because of the considerable share of other grazing animals, mainly sheep), as well as Italy, Spain and Portugal. It is above

average in Belgium (56% of total livestock population), Germany (60%), France (68%), Ireland (85%) and Luxembourg (89%).

(2) The Netherlands, Denmark and Belgium are the three relatively small countries with in total a contribution of some 28% of the EC-12 total of final pig production and only 5% of utilized agricultural area. Self-sufficiency rates for pork products are high in these countries. These three countries in total already cover almost 80% of the import value of pigs and pork products in any of the EC-12 member states, and they have a strong position in this respect with competitive (cost) advantages. The export of pigs and pork products from these countries is an important resource to the national economies. Export levels of pigs and pork products increased during the 1980s in Denmark and even more so in the Netherlands.

(3) In addition to the three countries mentioned in item (2), several concentration areas in the large member countries also have a considerable share in total pig production of the EC. Niedersachsen (Germany), Bretagne (France), Lombardia (Italy), Yorkshire/Humberside (United Kingdom) and Cataluna (Spain) are the regions in different countries with largest share of national pig production. In the following chapters we will limit ourselves primarily to the five areas in different countries with largest share in the pig production in the EC. Regions and countries chosen for consideration (and between brackets is given their share in final pig production of EC-12 in 1987) therefore are in successive order the Netherlands (13%), Denmark (9%), Niedersachsen (8%), Bretagne and Belgium (both 6%). Areas in other countries which do also have a relatively large share in national total pig production are Cataluna, Lombardia and Yorkshire/Humberside. These regions will not be further examined because their share in the EC-total of final pig production in 1987 is rather small compared to the other concentration areas of pig production (less than 4%).

(4) The total contribution of the five areas in different countries with largest share in the EC-12 pig production (in successive order the Netherlands, Denmark, Niedersachsen, Bretagne and Belgium) is 42%. These five areas in total cover 9% of the utilized agricultural area and 24% of the total livestock population in the European Community.

(5) Animal density in 1987 (in terms of number of livestock units per hectare of utilized agricultural area) in the five areas selected is in the range between 1.4 (Denmark) and 4.0 (the Netherlands). In the other regions animal density is 1.7 (Niedersachsen), 2.6 (Bretagne) and 2.9 (Belgium). The average of EC-12 is 0.9, which is much smaller than animal density in the concentration areas of pig production. The number of livestock units of pigs per hectare of utilized agricultural land in

these areas is 1.6 (the Netherlands), 0.8 (Denmark), 0.7 (Niedersachsen), 0.8 (Bretagne) and 1.1 (Belgium). The average of EC-12 is only 0.2 livestock units from pigs per hectare of utilized agricultural area.

(6) Changes in the share of pig production from the member countries in the EC-total have been small during the 1980s. Concentration of pig production however further increased in some countries, mainly in Bretagne (France), Lombardia (Italy) and Niedersachsen (Germany). In Bretagne for example, its share in national total of final pig production increased from 44% in 1982 until 49% in 1987. The share of final pig production of France in total of the EC remained stable during that period.

(7) The consumption of pork products shows largest increases in southern Europe, but is still below the average level in the northern part of the EC. The production of pigs and pork products in Spain is mainly to support consumption of that country and the production of that country is around the self-sufficiency level. There is likely to be still room for either production increases in southern Europe, or for an increase in the export to the Mediterranean countries from elsewhere. This however assumes that consumption would further increase in that part of Europe.

(8) The import of pigs and pork products in the EC-12 countries in 1990 amounts to almost 6 billion ECU, of which 98% being intra-trade. Some 40% of that is originating from the Netherlands, 20% is coming from Denmark and some 15% from Belgium.
The EC-12 export of pigs and pork products in 1990 was nearly 7 billion ECU, of which 83% was intra-trade. The main countries of destination of the EC-12 export to third countries are Japan and the USA. Denmark is having a strong position in this respect because that country is able to meet the high veterinary requirements to Japan. The EC-export of pigs and pork products to these two countries amounts to around 0.7 billion ECU, with almost all coming from Denmark. The export to Germany and Italy which originates from the Netherlands amounts to about 1.3 billion ECU and covers more than 50% of the export value of these products from the Netherlands.

3. STRUCTURE OF PIG FARMING

3.1 Introduction

Structural characteristics of farms with pigs are important in the framework of this report since they may indicate any differences in the way how these farms might respond to changes in environmental policies. They are therefore critical in any assessment on changes of competitiveness of pig production in the EC. Farmers with a large coverage of utilized agricultural area for example, may adapt relatively easily to measures which state that less minerals are allowed to be applied. Such farmers might for example reduce the application of inorganic fertilizers and apply minerals from animal manure in a more effective and efficient manner. They might also apply minerals during the period of the year that they contribute most to plant growth. Important structural characteristics in this respect are the size of farms with pigs and animal density at these farms. This kind of information is given in this chapter by region and farming type.

The objective of this chapter is to identify some major characteristics of the structure of pig farming in concentration regions of pig production. We will focus on characteristics regarding farm size (section 3.2) and farming types (section 3.3). With respect to farm size we will focus on (i) the number of farms with pigs, (ii) the number of pigs per farm on farms with pigs and (iii) the number of pigs per hectare of utilized agricultural area on farms with pigs. Similar characteristics are also being discussed for a limited number of farming types (section 3.3). The five areas considered in the subsequent part of the report include Niedersachsen, Bretagne, Belgium, the Netherlands and Denmark. These are the five regions in different countries and some of the relatively small countries in the EC with largest share in the pig production of the EC. As was mentioned in the previous chapter, these regions in total cover over forty percent of total pig population in the EC in 1987.

3.2 Farm size

Differences among regions regarding the size of farms with pigs are presented in this section. The largest share of total pig population is at farms with more than 400 pigs. It is in the range between 43% in Niedersachsen and slightly over 75% in Bretagne and the Netherlands. All regions, with the exception of Niedersachsen, do have at least 65% of total pig population at farms with more than 400 pigs (table 3.1).

Table 3.1 Pig population in 1987 on farms with pigs by region and by number of pigs per farm (x 1000 animals)

Region	Number of pigs per farm					Total
	1-9	10-99	100-199	200-399	>400	
Niedersachsen	56	1238	1296	1704	3275	7569
Bretagne	27	217	306	763	4399	5712
Belgium	20	388	538	1011	3888	5844
Netherlands	7	445	969	1972	10956	14349
Denmark	16	696	833	1566	6155	9266

(Source: FSS, 1987/LEI-DLO).

The average farm with pigs in Niedersachsen has less pigs than elsewhere. In this region, some 44 thousand farms with pigs have less than 100 pigs, i.e. almost seventy percent of the total number of farms with pigs in that region (table 3.2). Farms of that size however include less than twenty percent of the total pig population in Niedersachsen. This share is even less in the other areas. In Denmark, around half of the farms with pigs do have less than 100 pigs, with in total only eight percent of the total number of pigs. A considerable share (i.e. over 20%) of the total number of farms with pigs in Niedersachsen, Bretagne and Belgium do have less than ten pigs. This is less than 10% in the Netherlands and Denmark. In all regions however, less than one percent of total pig population is on farms at that size. Specialization and concentration caused a rapid decrease in the number of farms with only a few pigs, especially in the Netherlands and Denmark. Meanwhile also the number of pigs per farm increased, as well as the number of larger farms. In Denmark for example, the number of farms with more than 500 pigs increased from only 700 in 1970 until almost 6000 in 1989 (Brouwer et al., 1992a).

Table 3.2 Number of farms with pigs (x 1000) in 1987 by region and number of pigs per farm

Region	Number of pigs per farm					Total
	1-9	10-99	100-199	200-399	>400	
Niedersachsen	15	29	9	6	5	63924
Bretagne	12	5	2	3	5	27180
Belgium	6	9	4	4	4	26345
Netherlands	2	8	7	7	11	35352
Denmark	3	16	6	5	7	37690

(Source: FSS, 1987/LEI-DLO).

The average number of pigs per farm on farms with pigs in the regions considered is around 225. It is below average in Niedersachsen (118) and above average in the Netherlands (406) (table 3.3). The average is between 210 and almost 250 in the three other regions. Differences among regions regarding the average number of pigs per farm are mainly due to pig population on the larger farms with pigs and to the relative importance of the larger farms in total pig population. On the one hand, in the Netherlands, some 54% of total pig population in 1988 is on farms with more than 800 pigs. These farms on average have more than 1400 animals. On the other hand, in Niedersachsen only some 30% of pig population in 1989 is on farms with more than 600 pigs (Brouwer et al., 1992a).

Table 3.3 Average number of pigs per farm on farms with pigs in 1987 by region and number of pigs per farm

Region	Number of pigs per farm					Average for all farms with pigs
	1-9	10-99	100-199	200-399	>400	
Niedersachsen	4	43	140	285	686	118
Bretagne	2	42	148	290	854	210
Belgium	3	44	142	284	912	222
Netherlands	4	53	144	286	960	406
Denmark	5	44	143	287	857	246

Source: FSS, 1987/LEI-DLO).

So far, the size of farms has been classified according to the number of pigs per farm. In the following, we will distinguish farm size on farms with pigs, according to the number of pigs per hectare of utilized agricultural area. In the five areas considered, the average number of pigs per hectare of utilized agricultural area is in the range between around 3 in Niedersachsen, Bretagne and Denmark and slightly over 7 in the Netherlands (see also table 2.3). The average of Belgium is around 4. Animal density on farms with pigs, in terms of the average number of pigs per hectare of utilized agricultural area, is much higher and also shows a wider range of values among the concentration areas than the average among all farms in a region (table 3.4). Animal density on farms with pigs shows a considerable difference among the size classes. The number of pigs per hectare of utilized agricultural area on farms with more than 400 pigs, for example, is in the range between around 15 (Niedersachsen and Denmark) to well over 90 in the Netherlands. On average, animal density on farms with pigs is between 5 pigs (Niedersachsen) and 37 pigs per hectare of utilized agricultural area (the Netherlands). The number of pigs per ha of utilized agricultural land therefore is higher with increasing size classes. The large difference of animal density between Niedersachsen and the Netherlands could be explained by differences on the number of pigs per farm, as mentioned before, and the utilized agricultural area per farm. The average farm size (in terms of the number of pigs per farm) in the Netherlands is much higher than in Niedersachsen and the reverse holds regarding the average of utilized agricultural area per farm. About 80% of the total pig population in Niedersachsen in 1989 is located at farms with with at least 20 ha of land (Brouwer et al., 1992a). About 60% of the pig

Table 3.4 Animal density in 1987 on farms with pigs (number of pigs per hectare of utilized agricultural area) by region and number of pigs per farm and the average for all farms with pigs

Region	Number of pigs per farm					Average for all farms with pigs
	1-9	10-99	100-199	200-399	>400	
Niedersachsen	1	2	4	7	14	5
Bretagne	1	2	6	10	28	9
Belgium	1	2	8	19	74	14
Netherlands	1	5	12	23	95	37
Denmark	1	2	5	8	15	8

(Source: FSS, 1987/LEI-DLO).

population in the Netherlands is located at farms with on average only 3 hectare of land.

In the following, we will examine the size of utilized agricultural area on farms with pigs. The number of farms with pigs is classified according to the number of pigs per farm and the size of utilized agricultural area

Table 3.5 Share of classes of farms by number of pigs per farm in total number of farms with pigs and number of farms with pigs in 1987 by region and utilized agricultural area

Region/UAA	Number of pigs per farm					Total number of farms
	1-9	10-99	100-199	200-399	>400	
Niedersachsen						
<10 ha	38	56	5	1	0	21013
10 - 30 ha	20	47	19	10	5	22630
>30 ha	13	32	20	17	18	20281
Total	23	45	15	9	7	63924
Bretagne						
<10 ha	73	11	3	3	11	4617
10 - 30 ha	44	23	9	9	15	15255
>30 ha	29	16	9	15	32	7308
Total	45	19	8	10	19	27180
Belgium						
<10 ha	27	30	11	13	20	10783
10 - 30 ha	16	36	18	15	15	12079
>30 ha	29	39	13	10	8	3483
Total	22	34	14	14	16	26345
Netherlands						
<10 ha	6	24	17	17	36	19045
10 - 30 ha	5	23	21	23	28	14602
>30 ha	7	21	19	22	31	1705
Total	5	24	19	20	32	35352
Denmark						
<10 ha	21	64	9	4	3	4750
10 - 30 ha	9	51	17	13	10	17650
>30 ha	5	25	15	19	35	15300
Total	9	42	15	14	19	37690

(Source: FSS, 1987/LEI-DLO).

per farm (table 3.5). On average, the share of farms with less than 100 pigs in the total number of farms with pigs is between 29% (the Netherlands) and 68% (Niedersachsen). Approximately 45% of the farms with less than 100 pigs in Niedersachsen do also have less than 10 ha of land. This region has 21 thousand farms with pigs which have less than 10 hectare of utilized agricultural area. A large share of these farms (56%) do have between 10 and 100 pigs. The number of farms in Niedersachsen with less than 10 ha and more than 400 pigs is negligible. The share of the number of farms with more than 400 pigs and less than 10 ha of utilized agricultural area in total number of farms is considerable in the Netherlands (20%) and Belgium (8%). In all regions considered, with the exception of Belgium and the Netherlands, a considerable share of the farms with pigs do have more than 30 ha of utilized agricultural land. In the Netherlands, some 32% of the farms with pigs do have more than 400 pigs. More than half of the number of farms with pigs in that country do have less than ten ha of utilized agricultural land.

3.3 Farming types

The distribution of pig population among farming types is being presented in this section. Table 3.6 shows the composition of pig population according to five major farming types 1). The farming types distinguished are those with largest shares in regional pig population. The five farming types which have been considered cover between 78% (Niedersachsen) and 99% (Bretagne) of the total pig population in the regions considered. Specialist granivores include over 50% of pig population in Bretagne, Belgium and the Netherlands. Niedersachsen is the only region where this farming type does not have the largest share in regional pig population. The share of pig population on farming type 82 (farms with various crops and livestock combined) is large in Niedersachsen and Denmark. Almost 80% of the pig population in Denmark is either located on farming type 50 or on farming type 82. The share of pig population on farms with pigs and other livestock, is small in Denmark. The total of the farming types 41, 71 and 72 (i.e. mixed livestock farms and specialist dairying) only account for 10% of Danish pig population. In the other areas, this is between

1) Principal farming type 41, according to the Community typology for agricultural holdings, includes specialist dairying; type 50 are specialist granivores (intensive livestock farms); type 71 are mixed livestock, mainly grazing livestock; type 72 includes mixed livestock, mainly granivores, and type 82 includes various crops and livestock combined. Further subdivisions into particular type of farming of the principal farming types could be made.

around 30 and 37%. In the Netherlands some 12% of total pig population is located on specialist dairying. The share of pig population at mixed livestock farms (farming types 71 and 72) and at various crops and livestock combined is rather small in that country.

Table 3.6 Share of pig population of five major farming types in the regional pig population (%) and pig population (x 1000 animals) in 1987 by region

Region	Farming type					Pig population (x 1000)
	41	50	71	72	82	
Niedersachsen	7	14	13	17	27	7569
Bretagne	3	54	5	28	9	5712
Belgium	4	51	5	20	9	5844
Netherlands	12	62	1	17	4	14349
Denmark	2	40	4	4	39	9266

(Source: FSS, 1987/LEI-DLO).

The number of pigs per farm is presented for five farming types in table 3.7. A distinction has been made into piglets, breeding sows and other pigs (including fattening pigs). Specialist granivores on average do have more than 700 pigs with the exception of Niedersachsen. In Niedersachsen it is around 200 pigs per farm. The number of pigs per farm generally is much less in this area than in the other areas considered. The number of pigs per farm generally is highest in the Netherlands. In Niedersachsen, the number of pigs per farm is of about the same size on the three farming types with largest share of pig population, i.e. farming type 50 (specialist granivores), 72 (mixed livestock, mainly granivores) and 82 (various crops and livestock combined). In the other areas, the number of pigs per farm on farming type 50 is about twice as much compared to farming type 72.

The Netherlands has a large share of breeding sows and piglets in total pig population (49%), and is a net exporter of piglets and fattening pigs to other member states (Brouwer et al., 1992a). In the successive areas, the share of piglets in total pig population is 24% (Niedersachsen), 28% (Bretagne and Belgium), 36% (the Netherlands) and 32% (Denmark) (table 3.8). Niedersachsen, Bretagne and Belgium are net importers of piglets in order to compensate for the relatively high production levels of fattening pigs. The import of piglets in Belgium for example, was around 1.3 million animals in 1990.

Table 3.7 Number of pigs per farm with pigs by farming type and average number of all farms with pigs in 1987 by region and type of pig

Region	Farming type					Average of all farms with pigs
	41	50	71	72	82	
Niedersachsen						
Piglets	13	65	29	56	50	28
Breeding sows	6	30	13	28	24	13
Other pigs	23	107	75	157	147	77
All pigs	42	202	118	242	222	118
Bretagne						
Piglets	5	241	26	96	73	58
Breeding sows	3	84	11	37	26	21
Other pigs	11	505	47	270	170	131
All pigs	19	830	84	403	268	210
Belgium						
Piglets	23	143	50	105	111	62
Breeding sows	10	59	22	44	45	26
Other pigs	26	509	37	212	181	134
All pigs	59	711	109	361	337	222
Netherlands						
Piglets	38	314	34	145	119	147
Breeding sows	14	110	13	50	44	52
Other pigs	107	359	94	210	226	207
All pigs	159	783	142	406	389	406
Denmark						
Piglets	10	312	26	117	99	78
Breeding sows	3	114	9	44	34	28
Other pigs	32	372	82	189	204	
All pigs	45	797	117	350	337	246

(Source: FSS, 1987/LEI-DLO).

Table 3.8 Composition of pig population by farming type and of all farms with pigs in 1987 (x 1000 animals), by region and type of pig

	Farming type					Total
	41	50	71	72	82	
Niedersachsen						
Piglets	171	348	238	300	465	1814
Breeding sows	78	164	112	150	227	854
Other pigs	302	573	628	838	1363	4901
Total	550	1084	978	1287	2055	7569
Bretagne						
Piglets	52	902	80	382	133	1572
Breeding sows	26	312	34	147	48	576
Other pigs	115	1884	148	1067	311	3564
Total	193	3098	262	1596	492	5712
Belgium						
Piglets	101	602	132	342	164	1623
Breeding sows	44	247	57	144	67	682
Other pigs	116	2137	98	692	268	3539
Total	262	2987	287	1178	499	5844
Netherlands						
Piglets	426	3572	22	889	192	5200
Breeding sows	161	1254	9	310	70	1848
Other pigs	1189	4090	62	1290	364	7301
Total	1776	8916	93	2489	627	14349
Denmark						
Piglets	42	1443	88	129	1053	2958
Breeding sows	13	529	31	48	362	1046
Other pigs	137	1721	281	208	2179	5262
Total	192	3692	400	385	3594	9266

(Source: FSS, 1987/LEI-DLO).

*Table 3.9 Utilized agricultural area (UAA) per farm by farming type and average of all farms (hectare) in 1987 by region and type of utilized agricultural area *)*

	Farming type					Average for all farms
	41	50	71	72	82	
Niedersachsen						
Permanent pasture and meadow	22	1	11	6	2	9
Forage crops	4	1	4	4	1	2
Cereals	4	4	10	8	14	10
Other arable crops	1	0	1	1	3	3
Total UAA	30	6	27	20	20	25
Bretagne						
Permanent pasture and meadow	5	1	3	3	1	3
Forage crops	15	3	7	16	1	9
Cereals	4	10	4	7	10	5
Other arable crops	1	1	1	2	4	2
Total UAA	25	16	15	28	16	19
Belgium						
Permanent pasture and meadow	14	1	7	6	2	7
Forage crops	4	1	3	3	1	2
Cereals	2	1	3	1	3	4
Other arable crops	1	0	2	2	4	2
Total UAA	20	3	15	12	10	15
Netherlands						
Permanent pasture and meadow	20	1	8	7	3	8
Forage crops	3	2	4	2	3	2
Cereals	0	0	1	0	1	1
Other arable crops	0	1	2	1	5	4
Total UAA	23	4	15	10	12	15
Denmark						
Permanent pasture and meadow	5	1	4	4	1	2
Forage crops	13	0	7	5	0	4
Cereals	10	20	15	15	24	17
Other arable crops	7	8	6	6	10	9
Total UAA	35	29	33	30	35	32

**) It needs to be mentioned that this table provides average values for each farming type. The information is therefore not limited to farms with pigs.*
(Source: FSS, 1987/LEI-DLO).

Table 3.9 shows the average size of utilized agricultural area per farm 1). The average size of utilized agricultural area is small at the specialist granivores in Belgium, the Netherlands and Niedersachsen. This farming type includes more than half of the pig population in Belgium and the Netherlands, while such farms in these two countries on average have more than 700 pigs. This farming type only includes 14% of the pig

Table 3.10 Utilized agricultural area (UAA) by farming type and of all farms (x 1000 ha) in 1987 by region and type of UAA

Region	Farming type					All farms
	41	50	71	72	82	
Niedersachsen						
Permanent pasture and meadow	589	6	96	35	16	1025
Forage crops	102	4	32	23	9	235
Cereals	98	23	88	44	133	1063
Other arable crops	14	2	11	4	31	371
Bretagne						
Permanent pasture and meadow	169	8	19	16	4	316
Forage crops	544	20	43	79	2	854
Cereals	138	64	23	36	29	423
Other arable crops	44	8	7	9	10	173
Belgium						
Permanent pasture and meadow	254	7	22	20	5	622
Forage crops	63	5	8	10	3	160
Cereals	27	4	10	5	8	350
Other arable crops	9	2	7	5	9	223
Netherlands						
Permanent pasture and meadow	820	18	7	48	7	1099
Forage crops	109	21	3	16	7	236
Cereals	3	2	1	1	3	176
Other arable crops	13	8	2	4	12	483
Denmark						
Permanent pasture and meadow	73	4	14	4	11	210
Forage crops	197	2	26	5	4	327
Cereals	157	94	52	17	254	1499
Other arable crops	107	37	21	7	110	751

(Source: FSS, 1987/LEI-DLO).

1) Utilized agricultural land is subdivided into permanent pasture and meadow, forage crops (temporary grassland and other forage crops), cereals and other arable crops (i.e. total of arable crops with the exception of forage crops and cereals).

pig population in Niedersachsen. The average farm with pigs at specialist granivores in that region only has around 200 pigs. Animal density at specialist granivores therefore is much higher in Belgium and the Netherlands than in Niedersachsen. The share of cereals in total utilized agricultural area on specialist granivores is high in Niedersachsen, Bretagne and Denmark. Total size of utilized agricultural area is presented by farming type for all regions in table 3.10. Total size of utilized

*Table 3.11 Some structure characteristics of specialist granivores in 1987, i.e. (i) number of farms, (ii) average size of farms (in hectare), (iii) economic size per holding *) (ESU)*

	Farming type				
	50	501	5011	5012	5013
Niedersachsen					
Number of farms	5701	5202	2809	649	1744
Average size (ha)	6	6	3	6	11
Economic size by holding (ESU)	14	12	7	15	19
Bretagne					
Number of farms	6124	3227	349	248	2630
Average size (ha)	16	21	9	11	24
Economic size by holding (ESU)	56	60	24	47	67
Belgium					
Number of farms	5194	3953	827	1611	1515
Average size (ha)	3	4	3	3	6
Economic size by holding (ESU)	31	35	20	36	42
Netherlands					
Number of farms	13530	10616	4238	4163	2215
Average size (ha)	4	4	4	2	6
Economic size by holding (ESU)	42	41	47	24	63
Denmark					
Number of farms	4750	4590	850	280	3450
Average size (ha)	29	29	22	21	32
Economic size by holding (ESU)	76	77	77	49	79

**) The economic size of a holding takes account of the size of utilized agricultural land and the animals which belong to a holding, and is expressed in European size units (ESU). One ESU equals 1100 ECU of standard gross margins.*
(Source: FSS, 1987/LEI-DLO).

agricultural area is between 1.4 million hectare (Belgium) and 2.8 million hectare (Denmark) (see also table 2.3 where total size of utilized agricultural area is given by region).

Table 3.11 finally provides information on some structure characteristics of specialist granivores. As was mentioned before, this farming type includes more than half of the pig population in Bretagne, Belgium and the Netherlands, and some 40% of the pig population in Denmark. A subdivision of specialist granivores (principal farming type 50) has first been made into specialist pigs (particular farming type 501). This type has also been further distinguished into specialist pig rearing (farming type 5011), specialist pig fattening (farming type 5012) and pig rearing and fattening combined (farming type 5013).

Most specialist granivores are specialist pigs (farming type 501). The share of specialist pigs in the number of specialist granivores is in the range between 53% (Bretagne) and 97% (Denmark).

The economic size (depicted in ESU) of specialist pigs (farming type 501) is highest in Denmark. It is only slightly smaller in Bretagne, while it is very low in Niedersachsen. A medium position is taken by the Netherlands and Belgium. The economic size of farms with pig rearing and fattening combined on average is higher than the size of the other specialist pig farms. The economic size of specialist granivores is small in Niedersachsen compared to the other regions. This is due to the fact, which was already mentioned before, that farms with pigs in Niedersachsen on average have less pigs than elsewhere.

3.4 Concluding remarks

(1) Structural characteristics of pig farming in Niedersachsen differ considerably from elsewhere. The share of pig population on farms with more than 400 pigs in total pig population is in the range between 43% in Niedersachsen and over 75% in Bretagne and the Netherlands. In all regions except Niedersachsen, more than 65% of regional pig population is located on farms with over 400 pigs. In the Netherlands even half of the total pig population is located on farms with more than 800 pigs.

(2) Farms with pigs in Niedersachsen on average have less pigs than those elsewhere. There are many farms with only a few pigs. About thirty percent of the number of farms with pigs have less than 10 pigs (Windhorst, 1990). These farms account for about one percent of the pig population in Niedersachsen. The average number of pigs per farm on farms with pigs is in the range between 118 in Niedersachsen and 406 in the Netherlands. These differences are mainly due to (i)

differences in pig population on the relatively large farms, i.e. on farms with over 400 pigs, and (ii) the relative importance of the larger farms in total pig population. The process of increasing specialization and concentration of pig production due to economies of scale is staying behind in Niedersachsen, at least compared to what has taken place elsewhere.

(3) Animal density of pig population differs among the regions. The average number of pigs per hectare of utilized agricultural area is between 3 in Niedersachsen, Bretagne and Denmark and 7 in the Netherlands. The average of Belgium is around four. The range is even wider on farms with pigs, because of the structural differences of these farms. On average, the number of pigs per hectare of utilized agricultural area on these farms is between 5 in Niedersachsen and 37 in the Netherlands. The averages for Denmark and Bretagne are only slightly higher than Niedersachsen. The number of pigs per ha of utilized agricultural land on average is higher with increasing size classes of the number of pigs per farm. At farms with more than 400 pigs, it is in the range between 14 in Niedersachsen and 95 in the Netherlands. Such large differences are due to differences among regions regarding the average number of pigs per farm and the size of utilized agricultural area per farm.

(4) More than half of total pig population in Bretagne, Belgium and the Netherlands and 40% of the Danish pigs are located on specialist granivores. In Niedersachsen and Denmark, considerable shares of pig population also are on farms with various crops and livestock combined. The share of the total pig population in Denmark on farms with mixed livestock is small in Denmark (10%) and much larger in the other regions. It is up to a level of around 40% in Niedersachsen and Bretagne.

(5) The number of pigs per farm generally is largest on specialist granivores. Differences among regions however remain large. On this farming type, it is in the range between 200 in Niedersachsen and over 700 in the other regions.

(6) The average per farm of utilized agricultural area on specialist granivores is large in Denmark (29 ha) and small in Belgium and the Netherlands (successively 3 and 4 ha). It needs to be mentioned that cereals are grown on more than half of the utilized agricultural area in Denmark. This also holds on farming types 50 and 82; these two types in total include about 80% of total pig population in Denmark.

(7) The share of farms with pig rearing and fattening combined in the total number of specialist granivores is high in Bretagne and Denmark, closely to be followed by the Netherlands. It is highest in Den-

mark. The economic size of these farms on average is higher than the other specialist granivores in these regions.

(8) The economic size of specialist granivores is relatively small in Niedersachsen. The economic size of specialist pig fattening on average is much smaller in the Netherlands than in Bretagne, Belgium and Denmark, and only slightly higher in that country than in Niedersachsen.

4. ENVIRONMENTAL POLICY AND PIG FARMING

4.1 Introduction

Policies which aim to reduce losses of minerals to the environment are discussed in the present chapter. We will focus on policies in Germany (especially Niedersachsen), France (especially Bretagne), Belgium (mainly Flanders), the Netherlands and Denmark. The regions selected in countries are those with a large share of national pig population. Based on the situation of 1988 the share of regional pig population in national total successively is 32% (Niedersachsen), 50% (Bretagne) and 95% (Flanders) (Brouwer et al., 1992a). A subsequent reason to focus at the regional, rather than the national, level was that the regions selected in Germany and France may have specific standards that are stricter than the national policies. In some countries (Germany and Belgium) at least part of the environmental standards are agreed upon at the state level, because of the federal nature of the country. The provincial government in Bretagne also allows for environmental standards that differ from national ones. State government of Flanders is responsible to environmental policies for that part of the country. The responsibility of state government in Flanders also includes manure policy. The investments required in these regions might therefore be higher than in case only national policies were taken into account.

The areas selected do have a high level of animal density, as was already mentioned in chapter 2, and a subsequent high excretion level of nitrogen by animals (table 4.1). The total supply of nitrogen from organic manure in Flanders is of about the same level as in the Netherlands. It increased during the period between 1985 and 1989 from 245 until 265 kg N/ha (Lauwers, 1991).

The contribution of pigs in total supply of nitrogen from organic manure in the five regions considered, is in the range between 22% (Bretagne)

*Table 4.1 Excretion of nitrogen by animals per hectare of utilized agricultural area (kg N/ha) and total (kton N) and contribution of animal types by country and region in 1987 *)*

Country/region	Average (kg N/ha)	Total (kton N)	Cattle	Sheep	Pigs	Poultry
			(%)			
Germany, F.R.	105	1243	74	1	21	3
Niedersachsen	111	300	65	0	29	5
France	60	1670	79	5	8	7
Bretagne	163	290	63	0	22	14
Belgium	189	258	70	1	25	4
Netherlands	257	520	61	2	28	9
Denmark	87	245	56	0	40	3
EC-12	64	7441	67	11	15	6

**) Danish coefficients have been used to assess the excretion by animals for cattle, sheep, pigs and poultry (N). Information on the coefficients has been provided by the Statistical Office of Denmark (see also table 4.3).*
(Source: LEI-DLO).

and 40% (Denmark) 1). There is also a wide spreading among areas within the regions considered. The spreading among regions regarding the supply of nitrogen from organic sources in the Netherlands for example, is in the range between 30 and 800 kg N/ha, in case the country is subdivided in 31 subregions. The other concentration areas of pig production also have a wide range on the supply of nitrogen per hectare. On average it is highest in areas with a high level of pig density, with the exception of Denmark. In that country animal density is highest in areas with large cattle population, although livestock population is distributed more evenly than in the other concentration areas of pig production (Brouwer et al., 1992a).

Figure 4.1 also shows an assessment on the excretion of nitrogen from animals in the EC at the regional level.

Policies discussed in this chapter are aimed to reduce deteriorating effects to the environment from high application rates of minerals on agricultural land and subsequent losses to soils, water and air. We will first

1) The share of nitrogen from manure of pigs in total supply of nitrogen from organic sources in this case is smaller than the assessments based on livestock units and given in chapter 2 of the report. This difference is due to the fact that the nitrogen content of manure from pigs is smaller than the nitrogen content of manure from cattle.

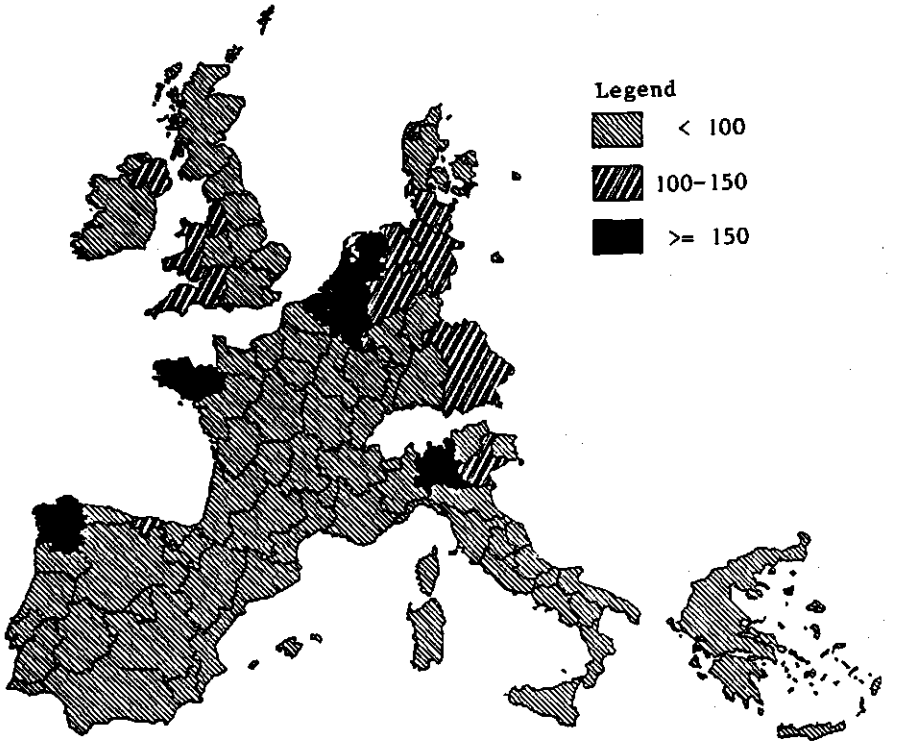

Figure 4.1 Excretion of nitrogen from animals (in kg N per hectare of utilized agricultural area)

limit ourselves to those policies that affect livestock production in general. Policies which aim to reduce deterioration effects of pesticides are therefore not considered. We will focus on linkages with pig production if appropriate. A short summary of environmental issues of societal concern is therefore first presented in this chapter (section 4.2). A summary of major policies is presented in section 4.3. A distinction has been made between (i) standards on the application of minerals from organic manure, (ii) rules regarding the period of the year that spreading of manure is not allowed and rules regarding the way of spreading animal manure, (iii) policies to reduce the emissions of ammonia and (iv) policies regarding soils saturated with phosphate. Finally we will summarize the major policy decisions (mainly administrative matters, such as the permission to increase size of farms only under special constraints). Such policies may affect any of the above-mentioned environmental concerns in an indirect way.

4.2 Environmental issues of concern

4.2.1 Introduction

Mineral surpluses 1) and subsequent losses to the environment are high in the regions considered. Nitrogen surplus for example, is over 100 kg N per ha in the five concentration regions for pig production, with the exception of Niedersachsen where it has an average of 85 kg N per ha. In the other regions it has been assessed to be 310 kg N/ha (the Netherlands), 251 kg N/ha (Flanders) and 117 kg N/ha (both in Bretagne and Denmark). The average level of nitrogen surplus in the EC is assessed to be 37 kg N per ha (Becker, 1991).

4.2.2 Water quality and nitrate

The poor *quality of water* is one of the most important environmental issues of concern in the regions considered, whether it is the quality of drinking water (Bretagne, Flanders, the Netherlands and Niedersachsen) or of coastal waters from the point of view of tourism or fisheries (Bretagne and Denmark) (Brouwer et al., 1992b). In this respect, leaching losses of nitrate are an important issue for the agricultural sector. Agriculture is a leading non-point source of water pollution from nitrate. In Denmark for example, the share of this sector in water pollution from nitrate is up to around 90%. The remaining part is originating from municipal waste water and industry (Dubgaard, 1991). Within the EC, high levels of nitrate are observed in several member countries, especially in six northern European countries with intensive agricultural practice, including Belgium (mainly the western part of Flanders), Denmark (coastal areas in the western part of the country), France (coastal zone of Bretagne), Germany (among others in areas of Niedersachsen with relatively poor soil conditions and a high leaching potential) and the Netherlands (especially on sandy soils with a high leaching potential in the eastern and southern part of the country). Leaching losses of nitrate in southern Europe are high in the region Lombardia (the Po river area) and Galicia (the northwestern part of Spain). These areas also have a high supply of nitrogen in organic manure.

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1) Mineral surpluses are part of a mineral balance. At the regional level, mineral surplus is defined as the difference between the total application of minerals from external sources (mainly feed concentrates, inorganic fertilizers and deposition of nitrogen components), and the marketable products produced (livestock products, arable and horticulture products).

The Commission of the European Communities did publish a council directive (91/676/EEC) in 1991 concerning the protection of fresh water, coastal water and sea water from nitrate that is originating from non-point sources. According to that directive, the application of nitrogen from animal manure on the farm level may not exceed 170 kg/ha in those regions which are identified by national governments to have a high leaching potential of nitrate. In various regions of Europe, the average supply of nitrogen from organic manure is even higher than 170 kg/ha, if considered at the regional level. Belgium and the Netherlands are the two countries with a total supply of nitrogen from organic sources that exceeds 170 kg/ha. Regional averages of Bretagne, Lombardia and Galicia are only slightly below this level, according to the assessment in table 4.1 (see figure 4.1). This implies that mineral surpluses are most likely also to be high in that region, if measured at the farm level. Leaching levels of nitrate do not only depend on animal manure applications. The risks are highest when (i) rainfall is high, (ii) evaporation is low and (iii) crop demands are low (Hanley, 1990). This implies that the vulnerability to leaching is highest in the autumn and winter period. National policies have to be formulated within the next couple of years in order to compensate for the standards from the nitrate directive. Member countries are obliged to include those policies that they are able to offset the standards on nitrate by the year 2004 at the latest. The standards might be a maximum on the application of nitrogen from organic sources, or other measures that farmers are able to offset the standards of the nitrate directive. A considerable part of the available groundwater resources in Europe however, is presently still above this standard, particularly in areas with a high concentration of intensive livestock production. During the mid 1980s the nitrate levels of some six percent of the available groundwater resources in Germany were over 50 mg per liter, whereas some 21% was in the range between 25 and 50 mg per liter (Pfaffenberger and Scheele, 1990).

4.2.3 Emissions of ammonia

A reduction of *emissions of ammonia* in order to reduce acidification of soils and water is receiving less attention in the regions considered than the issue of nitrate in water. An exception to this might be the situation in the Netherlands and Flanders where policy objectives are already formulated to reduce these emissions. The contribution of nitrogen from ammonia to acid loads is significant in countries with intensive livestock production (i.e., Belgium and the Netherlands). About a third of total acidification in the Netherlands is considered to originate from livestock production in that country (RIVM, 1991). The largest share of the emissions of ammonia is from cattle (63%), to be followed by pigs (23%). A re-

duction of at least 50% has to be achieved in the Netherlands by the year 2000 compared to the situation in 1980. Government of that country is however aiming to achieve a reduction of 70% during that time period (LNV, 1991). The environmental policy plan and nature development plan for Flanders aims for a 20 percent reduction of the emissions of ammonia by the year 2000, compared to the level of 1980. A 60 percent reduction level needs to be achieved by the year 2010 (Kelchtermans, 1990). No reduction goals have been formulated in the other countries, although adjustments have to be made by farmers with pigs in Germany in order to compensate for the standards of a nuisance act. Federal Government of Flanders is also considering to formulate policies on how to reduce emissions of ammonia. Germany, Belgium, the Netherlands and Denmark for example, do already have or will soon introduce rules on the way of how to apply manure on the field. These policies are aimed to diminish the emissions of ammonia at the stage of spreading of manure. The spreading of manure on frozen soils is forbidden in several countries in order to reduce leaching losses of minerals.

4.2.4 Accumulation of phosphate

Saturation of soils with phosphate results from the accumulation of this mineral in soils until a threshold for storing them is reached. This issue is primarily receiving attention in the Netherlands, and to a smaller extent in Belgium. The Netherlands also is the only country that is already considering special standards on the application of manure in regions with soils saturated with phosphate. This special concern on soils saturated with phosphate might be explained by the fact that groundwater level is relatively high in that country. Groundwater level in the Netherlands on average is less than one meter below surface level. On the other hand, the groundwater level of Bretagne for example, is on average some 10-20 meters below surface level. This means that the saturation of soils with phosphate and the subsequent leaching losses to groundwater are likely to be less serious in Bretagne than in those areas of the Netherlands with high water tables. It however needs to be mentioned that about half of phosphor in surface water of Bretagne is from agriculture, and originates from erosion and surface runoff. Approximately 300,000 ha of land, or about half of the coverage of cultivated land in the sandy soils of the Netherlands, is assessed to be saturated with phosphate (Breeuwsma et al., 1990). Leaching losses might start by the time that this chemical gets released since the buffering capacity of soils for storing them is about reached.

4.2.5 Manure surplus

Manure surpluses are identified in all regions considered, mainly at farms with pigs. Manure surplus is defined as the amount of animal manure which cannot be applied at the farm according to the standards for its application. The standards are likely to differ among countries (see section 4.3.2), which also affects the amount of manure surplus. The issue of manure surpluses as such is only causing environmental concern in an indirect way, i.e. through high application levels of minerals from animal manure. There are however major differences among regions on the size of these surpluses and the options that farmers do have to get rid of them. Structural characteristics of the farms with manure surpluses are critical to the way they treat them. In Denmark for example, about a third of the total amount of manure from specialized pig farms can not be spread on the field of these farms, according to present standards. Roughly 70% of the pig population at specialist granivores is on farms with a manure surplus. About half of the manure from these farms needs to be applied elsewhere (Brouwer et al., 1992a). Sufficient possibilities for the application of animal manure are however available in that country at farms in the neighbourhood. This implies that no transport of animal manure presently takes place in Denmark over distances of more than five kilometers. The same more or less happens to be the case in Bretagne. Transport of manure at distances of more than 15 kilometer is limited in that area. The situation is completely different in Belgium and the Netherlands. Between 60 and 70% of manure from pigs could not be spread at the own farm in Flanders and the Netherlands. In Flanders, some 75% of manure from fattening pigs is accounted for as surplus, while it is some 31% of manure from sows (Lauwers, 1991). The possibilities are limited to spread manure at short distance of farms with a surplus, and transport is therefore required over longer distances than elsewhere. One of the options that farmers have to limit cost increases of the transport of manure, is to increase the dry-matter content of manure. In the Netherlands, a quality premium is provided to the transport by a manure bank of manure with a sufficiently high dry-matter content.

It is also considered that surpluses may further increase in the future in the Netherlands and Flanders, if in the future standards on the application of minerals from animal manure will go down. The share of cattle in manure surplus is likely to increase during the next couple of years in the Netherlands and Belgium. The share of cattle in manure surplus of the Netherlands is presently around 5%, but will increase largely as soon as standards will be introduced to regulate the application of nitrogen from organic sources. This will most likely also result in a cost increase of pig farmers to get rid of their manure, because the more expensive options

need to be chosen by them to get rid of the manure. Transport may be required over longer distances or other options have to be considered that result into cost increases. An increase of transport costs to get rid of manure has been an important driving force in the Netherlands to the rationalization of water consumption and the focus to increase the dry-matter content of manure.

4.3 Policy responses

4.3.1 Introduction

Policy responses to the issues mentioned in the previous section are likely to differ, primarily because the issues also show major differences among the countries. The policy process itself regarding the response to agricultural pollution also differs largely among the countries (Baldock and Bennett, 1992). The role of economic and political factors in the process of environmental policies is however not considered in the framework of the report. Numerous policies have been formulated in the regions considered in order to limit or prevent deterioration effects on the environment of excess application levels of minerals. Policies differ for several reasons, either because of differences in the severity of the issues of concern or because of differences in structural characteristics of farming. We will first summarize some of the critical items in the policies to reduce deterioration effects of manure.

Land-related production of pigs and other types of livestock is considered to be critical in *Niedersachsen* in order to reduce manure surpluses. Approximately 80% of the pig population presently is located at farms with more than 20 hectare of land. Tax policy in Germany is a major determinant of the fact that the number of pigs per farm on average is rather small compared to the other concentration areas of pig production in the EC. Farms that are identified as 'landwirtschaftliche Betriebe' will have to pay smaller tax rates than the so-called 'gewerbliche Betriebe', which are treated as industrial firms. The difference between the two depends on farm size (in utilized agricultural area) and animal density per hectare. Another phenomenon is the fact that product quality is considered to be important by consumers in Germany. Consumers in that country for example, rather prefer agricultural products produced at small-scaled farms than at merely industrialized farming types. Policy aims to increase land-dependence of pig production whenever possible. The number of pigs at farms with pigs in Niedersachsen on average is either small or large. Medium-sized farms are rare in this region due to tax policy and some preference by consumers for small-scaled production.

Manure surpluses might be applied at the local level, either through contracts with other farmers that have agreed to accept manure, or through manure markets. Transport of manure over longer distances will not be stimulated through national or state policy because an increase of pig population may then result. Processing of manure in factories is considered to be limited to a relatively small area within Niedersachsen, i.e. the Haverbeck region. This area is of major importance for nature development and standards on the application of manure in that area therefore are stricter than elsewhere. The experimental station in Haverbeck is receiving financial support from national and state government.

An increase of the dry-matter content of animal manure is considered to be important in *Bretagne* in order to limit cost increases when standards might change and the amount of manure surplus will increase. Manure surplus might also increase in case pig production in this area will further rise. Manure is presently applied at short distance (some 15 kilometers at the maximum) of the farms with surpluses. The dry-matter content of manure from fattening pigs is on average less than 5%. On the other hand, the dry-matter content of manure from fattening pigs may reach a level of around 10 to 12 percent in the Netherlands. Such a high dry-matter content is reached for manure transported over long distances, due to the large transportation costs (Brouwer et al., 1992a). An increase of the content of dry-matter would already be achieved in Bretagne through a more efficient use of water to feed pigs. The increase of transport costs might be limited in case standards on the application of manure would get stricter, and the dry-matter content of animal manure would also increase. Enlightenment schemes and limited subsidies to stimulate the introduction of equipment which prevent wasting of water are important instruments to achieve this goal.

Technical solutions are considered to be important in *Flanders* because the structural characteristics of pig farming do not allow for other options. Technological adjustments focus on the stimulation of mineral efficiency of feed concentrates and of manure transport over relatively long distances. It was already mentioned in the previous chapter that a large share of pig production takes place on farms with a small size of utilized agricultural area. The option of processing of manure in factories will be kept open for the moment, but no decisions have been made in the manure law of 1991 (Mestdecreet). Both the Netherlands and Flanders leave the option open to reduce the size of livestock population in case the technical solutions are insufficient to meet the environmental standards.

Technical solutions also are of major importance to the reduction of the deterioration effects in *the Netherlands*. Three options are considered to deliver a major contribution to the way how manure surpluses should be treated with changing standards. The options include (i) increasing trans-

port of manure to regions without surpluses, (ii) improving mineral efficiency of feed by animals, and (iii) processing of manure in factories. They should enable to meet the standards on the application of animal manure that will get stricter in the coming years. Manure policy presently is mainly based on phosphate in animal manure. Government is however considering options to offset the targets of the EC-directive on nitrate and the Rhine Action Plan.

Environmental policies in *Denmark* were aimed to achieve a reduction in 1992 of some 50% in the leaching of nitrogen and 80% in the leaching of phosphate and pesticides. Extending storage capacity of animal manure at the farm is considered to be an important issue in order to meet the standards that get stricter on the spreading of animal manure. The capacity to store manure also needs to be increased because the period of the year will be further reduced that spreading of manure is allowed. Animal density is relatively small in the country, at least compared to the other concentration areas. It was already mentioned that transport of manure surpluses is limited to a few kilometers. Farms with more than 10 ha of land need a crop rotation plan and a fertilizer application plan. The plan on the application of fertilizers will require information about quantity and period of spreading of organic manure and the use of chemical fertilizers. The two plans aim to stimulate a more efficient use of minerals.

4.3.2 Standards on the application of manure

Standards on the application of nitrogen exist in all regions, with the exception of the Netherlands (figure 4.2). Standards in Bretagne and Flanders are based on the total application of nitrogen from organic and inorganic sources. The application of phosphate is limited in the Netherlands and Flanders. This means that Flanders has standards on both the application of nitrogen and on phosphate. The standards on phosphate in Flanders are however more of a critical factor to pig production than nitrogen is, first of all because the share of phosphate in manure from pigs and poultry is much higher than in manure from cattle. Also, gradual changes are only expected on the application of phosphate. Standards in the Netherlands will alter in 1995. They might be based on the total of phosphate from organic and inorganic sources as of that year. Manure surpluses are considered to increase at the farm level at that time and costs will increase for farmers to get rid of these surpluses.

The standards of Niedersachsen and Denmark are based on the number of animal units per hectare. In Niedersachsen, the basis is a manure unit which is considered to correspond to 80 kg of nitrogen. The basis for

the application of manure in Denmark is a maximum on animal units which corresponds to 108 kg of nitrogen per animal unit 1).

Region	Nitrogen (N)	Phosphate (P_2O_5)
Niedersachsen (as of 31 december 1992)	2.5 ME/ha (200 kg N/ha), or the equivalent of: - 2.5 dairy cows - 7.5 breeding sows - 15.0 fattening pigs - 250 laying hens - 750 broilers	
Bretagne	- Pasture: 350 kg N/ha - Pulses: 0 kg N/ha - Other arable crops: 200 kg N/ha	
Flanders	- 400 kg N/ha (all crops)	Fodder maize: 200 kg P_2O_5/ha Arable crops: 150 kg P_2O_5/ha Grass: 175 kg P_2O_5/ha
Netherlands		Grass: 200 kg P_2O_5/ha Fodder maize: 250 kg P_2O_5/ha Other arable crops: 125 kg P_2O_5/ha
Denmark	Farms with cattle: 2.3 DE/ha Farms with pigs: 1.7 DE/ha Other farms with animals: 2.0 DE/ha Farms without animals: 1.7 DE/ha	

Figure 4.2 Standards on the application of minerals from inorganic and/or organic sources for the year 1992 (kg/ha utilized agricultural area)

1) Dairy cows are the basis of the accounting systems in Denmark and Niedersachsen. One dairy cow is equivalent to one Danish animal unit (DE) and one manure unit (ME) in Niedersachsen. The system in Denmark is based on the assessed amount of nitrogen in animal manure, and in Niedersachsen on the feed requirements of animals. A dairy cow is equivalent to a manure unit, both in Denmark and Niedersachsen. The units of measurement used in these two countries correspond to different levels of nitrogen. This indicates that the starting points regarding the mineral content of animal manure differ among countries. A manure unit in Niedersachsen is considered to be equivalent to 80 kg N, whereas an animal unit in Denmark is considered to be equivalent to be equivalent to 108 kg of nitrogen.

Not only the environmental standards themselves need to be considered, but also the starting point and basic considerations of the policies, especially the excretion of minerals by animals. A comparison among regions is required to be based on an evaluation of both the standards for the application of animal manure as well as the excretion of minerals by animals. The standards on the application of manure differ among regions. In addition to that, the regions also show major differences on the amount of nitrogen and phosphate that is assessed to be in animal manure (table 4.2).

Table 4.2 Excretion of minerals by animals (kg N and kg P_2O_5 per animal per year)

Region	Animal type	Nitrogen	Phosphate
Niedersachsen	Dairy cows	72.0	35.0
	Breeding sows	25.0	18.0
	Fattening pigs	9.5	6.5
	Laying hens	0.68	0.50
	Broilers	0.25	0.20
Bretagne	Dairy cows	73.0	36.0
	Breeding sows	17.5	15.0
	Fattening pigs	8.8	7.5
	Laying hens	0.50	0.70
	Broilers	0.22	0.22
Flanders	Dairy cows	87.2	34.5
	Breeding sows	26.9	15.0
	Fattening pigs	9.9	5.0
	Laying hens	0.56	0.51
	Broilers	0.23	0.19
Netherlands	Dairy cows	131.0	41.0
	Breeding sows	34.7	20.3
	Fattening pigs	16.2	7.4
	Laying hens	0.72	0.50
	Broilers	0.52	0.24
Denmark	Dairy cows	108.0	32.7
	Breeding sows	36.0	26.3
	Fattening pigs	13.5	8.2
	Laying hens	0.78	0.57
	Broilers	0.43	0.29

Source: Brouwer et al., 1992a.

The excretion of minerals from animals shows a wide range among the regions. The assessed mineral content of animal manure in the Netherlands and Denmark for example, is higher than what has been assessed elsewhere. The phosphate content of manure, as it has been assessed in the 1991 manure law of Flanders, is almost 25% below the situation in the Netherlands. The difference between Denmark and Bretagne regarding nitrogen is around 35%. In case standards on the application of nutrients would be fixed in all five countries at the same level, less manure would be allowed to be spread in the Netherlands and Denmark than in the other regions. The order of magnitude of differences is shown in table 4.3. In this table, the production (excretion) of minerals from animals (in kg per animal per year) is assessed for livestock population in the Netherlands, based on the assessed excretion of minerals as given in table 4.3. Total livestock population in the Netherlands in 1990 was 1.9 million dairy cows, 1.7 million breeding sows, 7.0 million fattening pigs, 44.3 million laying hens and 41.2 million table fowls. No other animal types are considered in the assessment of table 4.3.

Table 4.3 Excretion level of minerals from animals in the regions identified and size of livestock population in the Netherlands in 1990 (the Netherlands = 100)

Basis	Nitrogen (kton N)	Phosphate (kton P_2O_5)
Niedersachsen	60	86
Bretagne	55	93
Flanders	66	78
Netherlands	100	100
Denmark	87	100

Farmers presently have to adjust their practice according to the standards that in most cases were only introduced recently. They however also have to consider further changes in manure policies within the next couple of years. Standards on the application of manure will further change in Niedersachsen, Flanders and the Netherlands.

National government of Germany for example, is presently considering to adjust the standards on the application of animal manure such that they meet the standards of the nitrate directive of the EC. Standards on the application of nitrogen from organic sources might become 170 kg N per ha (arable land), 240 kg/ha (intensively used grassland) and 210 kg/ha (other grassland). Standards on phosphate might become 120 kg/ha. Also

standards on the application of potassium are considered in the so-called Düngemittel-Anwendungsverordnung.

Standards on the application of manure will change in the Netherlands within the next couple of years. By the year 1995, standards on the application of phosphate become 175 kg/ha (grassland) and 125 kg/ha (maize and other arable land). Standards will further change after that year and they should reach extraction rates by the year 2000 at the latest. The extraction rates of phosphate by crops are not precisely defined yet, but they might be around 70 kg/ha (arable crops), 110 kg/ha (grass) and 75 kg/ha (fodder maize).

The standards on the application of phosphate from organic and inorganic sources will stepwise change in Flanders until the year 2001. Standards on phosphate should by that time reach a level of 125 kg of phosphate per ha, as mentioned in the environment policy plan of 1990 (Kelchtermans, 1990). Environmental policy in Flanders may also distinguish between soil type, type of crop or ecological vulnerability of regions (such as soils saturated with phosphate). Such refinements of manure policy are however not defined yet. No changes are presently considered regarding standards to apply nitrogen. These are based on the groundwater act of 1985.

Adjustments on the actual standards to apply minerals from organic manure are not considered yet in Bretagne and Denmark.

4.3.3 Rules on the spreading of manure

Rules regarding the period of the year that spreading of manure is not allowed are primarily aimed to limit leaching losses of minerals to surface water and groundwater. The rules are such that minerals should be applied during the period of the year that they contribute most to plant growth. Spreading of manure for that reason is preferred to take place in spring rather than in the autumn period after harvest of crops. There might be also rules on the way how manure should be applied on the field, such as the obligation to work manure under the ground within say 12 hours after spreading, or to apply low emission equipment while applying manure. These rules aim to reduce the emissions of ammonia at the stage of spreading (figure 4.3).

Special rules on the way to apply manure are considered in Flanders, the Netherlands and Denmark (figure 4.3). They aim to limit the emissions of ammonia at the stage of spreading of manure. More minerals then become available for plant growth. A negative side-effect of it might be the increasing risk of nitrate leaching in case the total application level (also including minerals from inorganic sources) remains unchanged. Bretagne is just for that reason not considering to introduce such policies, because

Region	Period of the year that spreading of manure is not allowed and rules on the way of spreading
Niedersachsen	October 15 - February 1 (grassland); between harvest and February 1 (arable land)
Bretagne	November 15 - January 31; during the weekend in July and August; slope over 7%; frozen soils and land covered with snow; at short distance of houses and water protection areas.
Flanders	November 2 - February 15; frozen soils and land covered with snow; Sundays and national holidays; Saturdays (except between February 15 and May 16). There is an obligation to work manure under the ground within 24 hours after spreading.
Netherlands	Grassland: October 1 - January 31/December 31, depending on the fact whether soils are sensitive to leaching of nitrate *); Arable land and maize: September 1 - January 31 on soils sensitive for leaching of nitrate, and no special restrictions to spread manure on arable land for the other soil types; frozen soils. There is an obligation to use emission-reduced means to apply manure on arable land and maize land (during the whole year) and on grassland (until June 15).
Denmark	After harvest until November 1; land not cultivated; land covered with snow or frozen soils. Farmers are obliged to work manure under the ground within 12 hours after spreading. As of 1995, spreading of manure might be forbidden after harvest until March 1.

Figure 4.3 Period of the year that spreading of animal manure on the field is not allowed and rules regarding the application of animal manure by region

**) Sandy and loess soils are considered to be sensitive for leaching losses of nitrate. Clay and peat soils are considered not to be sensitive for leaching losses.*

of the major concern in that region on the leaching of nitrate. Farms will need sufficient capacity to store their manure during the period of the year that spreading is not allowed. The required capacity is in the range between six months and one year (figure 4.4). This first depends on the period that spreading is not allowed. Some margin is also incorporated

because spreading may not be possible for farmers due to weather conditions by the time that spreading is again allowed. There are no specific rules regarding the required capacity to store animal manure in the Netherlands. In that country however, farmers need sufficient capacity to store their animal manure in order to meet the rules for spreading. Farmers are recommended to have sufficient capacity to store their manure for at least six months.

Niedersachsen	Six months
Bretagne	Six months
Flanders	Storage capacity has to be build in the case of old stables in order to avoid problems with spreading restrictions
Netherlands	No specific rules
Denmark	Nine months at farms larger than 31 animal units; farms smaller than 31 animal units need to have sufficient capacity to meet the limitations for the application of animal manure

Figure 4.4 Rules regarding the required capacity to store animal manure at the farm

4.3.4 Reduction of the emissions of ammonia

Standards on the emissions of ammonia are introduced in order to contribute to a reduction of the acidification of soils and water. Both in the Netherlands and Germany farms with pigs have to meet standards that are part of a Nuisance Act. Reduction schemes are only agreed upon in Flanders and the Netherlands.

Government of the Netherlands aims to reduce the emissions of ammonia with at least 50% by the year 2000 at the latest compared to the situation in 1980. Objectives aim to achieve a reduction of 70%. A reduction of 50% is considered to be technically and economically feasible.

Government in Flanders aims to reduce the emissions of ammonia by 20% in 2000 and by 60% in 2010 compared to the situation in 1980.

In Germany, the Bundes-immissionsschutsgesetz aims to reduce emissions of ammonia. Limit values and standards concerning ventilation of stables and storage of manure are arranged by the TA-Luft, the so-called Technische Anleitung zur Reinhaltung der Luft. Farms with more than 700 fattening pigs or 200 sows need an allowance for production.

4.3.5 Policies on soils saturated with phosphate

It was already mentioned before that the notion of soils saturated with phosphate is mainly concerning regions with high groundwater levels, mainly the Netherlands and parts of Belgium as well. Standards on the application of phosphate from animal manure might be changed more rapidly in the Netherlands in areas with soils that are saturated with phosphate.

4.3.6 Remaining policies

Most of the national or provincial governments have rules that farmers have to meet in order to get permission to increase the size of their farm.

Farmers with pigs in Bretagne need to have a so-called Plan d'Epandage, which states the way how they get rid of their manure. This Plan d'Epandage is critical to get the permission to increase livestock population or establish new farms.

The provincial board of Western Flanders, the area with highest concentration of pig production in Belgium, is considering to change rules for farmers that have to renew their licence. This will become part of a directive on an environmental allowance. Farms with more than 1500 places with fattening pigs in that case would have to cut the number of places with 30%. Fourteen percent of the number of fattening pigs might however be changed to sows. This policy is mainly due to the high shortage of piglets in Flanders and the subsequent high import level of piglets, about 1.3 million animals, from elsewhere. The import of piglets in Flanders mainly originate from the Netherlands.

4.4 Concluding remarks

(1) The poor quality of water is one of the most important environmental issues of concern in the regions considered, whether it is the quality of drinking water (Bretagne, Flanders, the Netherlands and Niedersachsen) or of coastal water from the point of view of tourism or fisheries (Bretagne and Denmark). Leaching levels of nitrate of 50 mg/l (EC drinking water standard) and more occurs in about 25% of the agricultural soils in the EC.
Policy responses include standards on the application of manure, rules on the way of spreading of animal manure, as well as a period of the year that spreading of manure is forbidden.

(2) Standards to apply manure are rather severe in Denmark and to a smaller extent in the Netherlands and Niedersachsen. The standards

themselves are important in this respect, but also the starting points on the excretion of minerals from animals. These also differ among the regions. The starting point in Niedersachsen for example differs from elsewhere, since the assessed mineral content of manure is lower than in Denmark and the Netherlands. This implies that in case standards in Niedersachsen are the same as in the Netherlands, less manure is allowed to be applied in the Netherlands and Denmark than in Niedersachsen.

(3) Manure surpluses exist at the farm level in all regions considered. There is a wide range among regions regarding the share of manure surplus from farms with pigs in total manure supply from these farms. It is accounted to be in the range between around 30% in Denmark and 60% in the Netherlands. The case of Niedersachsen is rather similar to Denmark and the situation in Flanders is rather similar to the Netherlands. Bretagne is taking a medium position in this respect.

(4) Differences among regions are considerable regarding the way farmers get rid of their manure surpluses. Pig farmers in Bretagne and Denmark for example, still have sufficient possibilities to apply manure surplus at short distance of the farm. It is not likely that this will largely change in the near future in Denmark. In Bretagne however this may change, especially along the coastal areas of the Côtes d'Armor and the Finistère, where pig production is concentrated. There remains to be still room for a considerable reduction in dry-matter content of animal manure in Bretagne. An increase in dry-matter content is likely to be required in that region in case transport of manure becomes more important. That might be the case with changes in environmental standards or in case pig population continues to increase during the years to come. In Niedersachsen, the problem of getting rid of manure surpluses is concentrated in small areas, mainly in the Vechta region within the Landkreis Weser-Ems. Transport of manure, at distances that are much larger than in the other areas, is becoming more and more necessary in Flanders and the Netherlands.

(5) Standards on the application of animal manure will change in the near future in Niedersachsen, Flanders and the Netherlands. Standards on the application of nitrogen, phosphate and potassium are considered in Germany, in order to meet the nitrate directive from the EC (Düngemittel-Anwendungsverordnung). In Flanders, standards on the application of phosphate will change towards a level of 125 kg/ha by the year 2001 at the latest. Standards on the application of phosphate will change in the Netherlands in the years to come and have to reach extraction rates from plants by the year 2000. No further changes are known so far regarding the application of animal manure in Bretagne and Denmark.

(6) The period of the year that spreading of manure is not allowed may get longer in Denmark. The required capacity to store manure will therefore increase up to nine months as of 1993.
(7) Reduction schemes on the emissions of ammonia have only been agreed upon in Flanders and the Netherlands. The larger farms in Germany have to meet specific quality standards regarding the emissions from stables and storage of manure.

5. FINANCIAL SITUATION OF PIG FARMING

5.1 Introduction

Structural characteristics of farms with pigs are critical to the adjustment processes that might be required in response to changes in environmental policy. Such policies will affect cost structure of pig farming because investments are required or other adjustments need to be made by the farmers in order to meet the adjusted standards. Differences between regions regarding structural characteristics of pig farming as well as differences on environmental policies are likely to affect cost structure in a different way. The financial position of pig farming is important in the assessment of whether farmers are able to meet cost increases and whether competitive advantages might change. The competitive advantages of pig farming in the concentration areas will be negatively affected in case farmers in these countries meet relatively high costs for investments and their financial position is insufficient to meet such costs in the long run. On the other hand, competitiveness of pig farming may remain to be sufficiently strong in case the costs for investments are high compared to elsewhere, but the financial position and operational results of farmers are sufficiently strong to meet them.

The objective of the present chapter is to examine the financial situation of pig farming in the areas considered. This enables to assess the economic possibilities of farmers with pigs in these regions to compensate for the standards through investments or other adjustments in agricultural practice, and the subsequent cost increase. An assessment of competitiveness of pig production will be made from the structural characteristics of pig farming and environmental standards that farmers need to meet, together with trends over the past couple of years on the operational results and financial position of pig farming. The findings on that assessment are presented in chapter 6 of the report.

Information on operational results and the financial position of pig farming is based on the Farm Accountancy Data Network (FADN) of the Commission of the European Communities. Some general characteristics of the farms represented in the FADN are first presented in section 5.2.

This provides some details on the structural characteristics of the farms represented by the farm accountancy network. Development over time of some indicators on the operational result of pig farming is given in section 5.3. Some characteristics on the financial position of farms with pigs are discussed in section 5.4. The farming types selected from FADN are those with largest share in regional pig population. Some concluding remarks on the operational results and financial position of pig farming are summarized in section 5.5. The information in the present chapter is based on averages of the accounting years 1984/85-1989/90 unless otherwise stated.

5.2 General characteristics of farms represented by FADN

A limited number of farming types has been selected from the FADN. These types in total cover a considerable share of the pig population in the regions. The farming types selected cover almost 60% of the pig population in Belgium and around 75% in the Netherlands and Denmark. The farming types that have been selected in Niedersachsen and Bretagne cover around 70% of the pig population according to the FADN census data (table 5.1).

The share of pigs on specialist granivores in regional total pig population was gaining importance during the period considered. Increases of pig population were large on farms with pig rearing and fattening combined. The total pig population on that farming type increased with around 50% in all regions. It even more than doubled in Bretagne, where pig population at farming type 5013 increased from around 380 thousand LU in 1984 until some 850 thousand LU in 1989 1). It is the farming type with largest share of pig population in Bretagne and Belgium (over the period considered). Pig population on this farming type steadily increased also in the Netherlands and became the category with largest share in 1989/90.

Pig population did decrease during the six years' period at farms with mixed livestock and field crops and granivores combined. Pig population in Niedersachsen for example, decreased at farms with mixed livestock. In the Netherlands it decreased at the specialist dairying and in Denmark at the farms with various field crops combined. The decrease of pig population at farms with mixed livestock is first due to the high profitability of specialization in farming. Investments in pig farming increased in re-

1) The sample of farms in Bretagne has changed in 1988/89 compared to previous years. The large increase of pig population during that year partly results from the revised sample.

Table 5.1 Size and development of the regional pig population on selected farming types in the period 1984/85-1989/90 and the share of these farming types in the regional pig population, by region and by farming type

Region/ Farming type a)	Pig population in the period 1984/85-1989/90							Share in regional population(%)
	average (1000 LU)	development (average 1984/85-1989/90=100)						
		84/85	85/86	86/87	87/88	88/89	89/90	
Niedersachsen								
Type 50 b)	197	104	86	111	97	.	.	12
Type 821	469	91	94	94	99	109	108	27
Type 723	235	112	116	98	75	76	90	14
Type 711	213	93	106	95	105	109	88	12
Total selected	1114	98	100	98	95	83	81	65
Bretagne								
Type 5013	537	71	66	82	89	148	159	42
Type 721	224	115	93	141	53	91	110	18
Type 723	151	78	132	26	114	147	130	12
Total selected	912	83	84	87	84	134	142	72
Belgium								
Type 5013	392	83	71	103	107	118	119	34
Type 821	131	66	59	109	100	140	139	12
Type 721	139	105	89	90	98	100	106	12
Total selected	662	84	72	101	104	118	120	58
Netherlands								
Type 5011	545	88	91	104	115	106	97	21
Type 5012	361	106	104	79	98	106	102	14
Type 5013	442	92	73	78	104	125	134	17
Type 721	385	99	87	102	113	95	105	14
Type 411	245	117	112	107	92	100	73	9
Total selected	1979	98	91	93	106	107	105	75
Denmark								
Type 5013	614	77	77	87	125	114	121	26
Type 821	913	99	99	101	98	102	100	39
Type 1244	242	115	106	107	96	87	79	11
Total selected	1769	94	92	97	107	104	104	76

a)Type 5011: Specialist pig rearing; Type 5012: Specialist pig fattening; Type 5013: Pig rearing and fattening combined; Type 50: Specialist granivores (intensive livestock farms); Type 821:Field crops and granivores combined; Type 721: Mixed livestock; granivores and dairying combined; Type 723: Mixed livestock; granivores with various livestock; Type 711: Mixed livestock; mainly dairying; Type 1244: Various field crops combined; Type 411: Specialist milk production; b) Period 1984/85-1987/88.
Source: FADN/LEI-DLO.

sponse to the milk quota. A second reason that the farms with mixed livestock decreased was the decrease of cattle population due to the milk quota.

Some general characteristics of the farms with pigs are given below. We will focus on farm size and animal density (table 5.2) as well as on output and costs for feedingstuff to feed pigs and poultry (table 5.3). Specialist granivores on average are larger than the other farming types considered, if measured in European Size Units (ESU) per farm 1). The only exception

Table 5.2 Size, animal density and the composition of the pig population on the farms selected from FADN by region and by farming type

Region/ Farming type a)	Size (ESU)	Animal density (LU/ha UAA)	LU pigs	
			average (LU)	of which fattening pigs (%) c)
Niedersachsen				
Type 50 b)	43	5	105	56
Type 821	38	3	83	69
Type 723	42	4	115	82
Type 711	35	2	33	66
Bretagne				
Type 5013	57	9	169	71
Type 721	44	5	73	72
Type 723	41	4	73	68
Belgium				
Type 5013	57	29	215	69
Type 821	46	5	87	52
Type 721	45	8	78	55
Netherlands				
Type 5011	64	28	132	15
Type 5013	69	35	233	68
Type 721	64	11	106	63
Type 411	62	3	7	90
Denmark				
Type 5013	85	7	211	68
Type 821	47	2	83	78
Type 1244	32	0	14	90

a) See table 5.1; b) Period 1984/85-1987/88; c) Period 1987/88-1989/90.
Source: FADN/LEI-DLO.

1) An ESU is based on the Standard Gross Margins.

are farms with pigs in Niedersachsen and the Netherlands. Differences among farming types on average farm size are rather small within these areas. Farms in Niedersachsen on average are relatively small, and the reverse situation happens to be the case in the Netherlands 1). Animal density is highest on specialist granivores. In Belgium and the Netherlands it is much higher than elsewhere.

Pig population per farm on average is high on farming type 5013. It also increased over the time period considered. In Belgium for example, it increased from 188 LU in 1984/85 to 239 LU in 1989/90. The average size per farm of pig population at farming type 5013 presently is about the same in Bretagne, Belgium, the Netherlands and Denmark. Also important in this respect is that the number of farms with pig rearing and fattening combined, represented in FADN, increased in these four regions.

Costs of feedingstuff, to feed pigs and poultry, are high on farms with pigs (table 5.3). Farmers however may produce a considerable share of their feed requirements at the own farm. The share of home-grown feed shows major differences among the regions considered. Structural characteristics of the farms with pigs are important in this respect. In Denmark for example, around 40% of the feed requirements are home-grown at farms with various field crops combined. In that country, even 14% of feed requirements is home-grown at farms with pig rearing and fattening combined. These farms on average have around 30 ha of land.

The share of output from pigs in total output is over 90% on specialist granivores in the Netherlands and Belgium. It is only slightly less in Bretagne and Denmark. Total output on farms with pigs however shows a wide variation over the years. Prices of pigs and pork products respond to supply and demand. The output roughly is above average during the accounting years 1984/85, 1988/89 and 1989/90. The accounting year 1989/90 shows output levels that are substantially higher than the average of the six years' period considered, and the accounting years 1986/87

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1) According to FADN, the average farm size of farming type 5012 in the Netherlands is 51 ESU. It was 53 ESU during the accounting year 1987/88. This is much higher than what was mentioned in table 3.11. The average size of the farms in farming type 5012 only is 24 ESU in 1987, if based on the Farm Structure Survey of the year 1987. The large difference between the two data sources is due to small sample size and the number of farms that are represented by the FADN, as well as to the size of the farms which are represented in the FADN. Farming type 5012 represents 1130 farms in the Netherlands during the year 1987/88, which is much less than the 4163 farms that are in the Farm Structure Survey. The FADN therefore a limited number of farms of farming type 5012 (about a fourth). The farms represented however are on average much larger than the remaining farms that belong to this type.
Altogether it was decided that the financial situation of specialist pig fattening would not be assessed, primarily due to the small sample size of this farming type.

and 1987/88 are well below the average of the time period which was considered. Operational results and the financial position of pig farming for that reason need to be examined over a longer period of time in order to arrive at a balanced judgment on the financial situation and the ability to meet cost increase.

Table 5.3 Outputs and costs for feedingstuffs to feed pigs and poultry on the farms selected from FADN by region and by farming type

Region/ Farming type a)	Output			Costs of feedingstuffs for pigs and poultry	
	total	pigs	poultry	total (1000 ECU/ holding)	of which home-grown (%)
	(1000 ECU)				
Niedersachsen					
Type 50 b)	116	90	0	59	19
Type 821	111	68	1	49	27
Type 723	144	89	0	64	14
Type 711	89	27	1	19	32
Bretagne					
Type 5013	176	151	0	103	9
Type 721	121	63	4	49	5
Type 723	117	63	14	56	8
Belgium					
Type 5013	196	178	0	117	3
Type 821	108	73	0	48	9
Type 721	118	60	5	45	1
Netherlands					
Type 5011	158	147	3	84	0
Type 5013	227	204	9	140	0
Type 721	162	76	10	59	0
Type 411	132	5	1	5	1
Denmark					
Type 5013	241	207	0	120	14
Type 821	112	73	2	48	33
Type 1244	59	11	1	8	44

a) See Table 5.1; b) Period 1984/85-1987/88.
Source: FADN/LEI-DLO.

5.3 Operational results

The operational results of pig farming in the five regions considered are described in terms of four indicators (table 5.4):

Table 5.4 Operational results on the farms selected from FADN by region and by farming type

Region/Farming type a)	Net revenues pig farming (ECU/LU of pigs)	Family farm income per family work unit (ECU/holding)	Net value added from pig farming (ECU/holding)	
			total	per LU pigs
Niedersachsen				
Type 50 b)	304	6870	14445	137
Type 821	235	9397	12889	155
Type 723	222	13210	17241	150
Type 711	236	11449	6805	204
Bretagne				
Type 5013	290	12867	26265	155
Type 721	244	10953	13560	185
Type 723	254	9030	12050	164
Belgium				
Type 5013	292	31058	46776	218
Type 821	302	20653	22733	262
Type 721	217	20854	19576	250
Netherlands				
Type 5011	475	19583	33724	255
Type 5013	293	21092	39910	171
Type 721	221	20215	20373	192
Type 411	72	25915	1883	263
Denmark				
Type 5013	418	25603	57816	274
Type 821	316	9955	18933	227
Type 1244	173	-52	3040	221

a) See Table 5.1; b) Period 1984/85-1987/88.
Source: FADN/LEI-DLO.

- The margin from output over feed of pig farming (in ECU per livestock unit of pigs). This indicator is defined as the difference between total output from pigs and the costs to feed pigs and poultry, and divided by the number of livestock units of pigs. Other variable costs are not considered in this indicator. Costs for feedingstuffs however are the largest share of variable costs.
- Family farm income per family work unit.
- Net value added from pig farming 1); total per farm.
- Net value added from pig farming; average per livestock unit of pigs.

The margin from output over feed of pig farming (in ECU per livestock unit of pigs) are highest on specialist granivores. In the Netherlands, it is highest at specialist pig rearing. In Denmark it is higher than elsewhere at farming type 5013. It is above average in the years 1984, 1985 and 1989. It was low in the year 1987. Net revenues in the accounting year 1989/90 on average were at least some 50% higher than the average of the period 1984/85-1989/90. On average they are higher at specialist granivores than at other types of farms.

Family farm income per family work unit on average is highest at farms with pig rearing and fattening combined, except in the Netherlands where it is highest at specialist dairying. It however needs to be mentioned that on average per farm only some 4% of total output is from pigs at specialist dairying in the Netherlands. Family farm income mainly shows differences among regions rather than among farming types. It is highest in Belgium with an average level over 20000 ECU, and is only slightly smaller in the Netherlands. It is around 10000 ECU in Bretagne, and between 7000 and 13000 ECU in Niedersachsen. Differences in family farm income among farming types are large in Denmark. It is high at farms with pig rearing and fattening combined, but much smaller at farms with field crops and granivores combined. Family farm income in Denmark is even negative at farms with various field crops combined. The share of pig population in total pig population however shows a decreasing trend at this farming type.

Net value added from pigs is highest in Denmark at farms with pig rearing and fattening combined, which is due to various reasons. These farms on average are much larger than elsewhere (if measured in economic size units), and the net value added per livestock unit of pigs is also high compared with the situation elsewhere. The average size of

1) Net value added from pig farming is defined by net value added multiplied by the share of the output of pig farming in total output. The interpretation of this indicator is however difficult at farms that are less specialized in pig farming.

farming type 5013 was 57 ESU (Bretagne), 57 ESU (Belgium), 69 ESU (the Netherlands) and 85 ESU (Denmark).

5.4 Financial position

The state of operational results of pig farming is not sufficient in an assessment of the long-term perspective. Information on the financial position would also be required in order to provide a proper judgment of how competitiveness of pig farming might respond to changes in environmental policy. The financial position of pig farming will be further examined in this section. We will distinguish among a set of indicators that reflect the financial situation of the farm types considered:

(1) Family farm income;
(2) Solvability, i.e. the extent that a farm was financed by net worth and the subsequent possibility of a farmer to compensate for financial commitments in the long run. It is defined by the share of net worth in total worth;
(3) Ratio of total liabilities to family farm income. This indicator provides information on the ability that farmers would have to pay off debts from present income. The ratio shows the number of years required to pay off all debts from present income;
(4) Percentage of long and medium term loans in total liabilities, which gives an impression on the structure of liabilities and the financial commitments that farmers have to meet in the long run;
(5) Paid interest, as a percentage of liabilities. This provides an impression on regional differences regarding the rate of interest;
(6) Change in net worth (ECU), which is approximately equal to savings. Continuity of a farm may become difficult in case the change in net worth is strongly negative over a longer period of time;
(7) Change in net worth (percentage of total net worth);
(8) Cash-flow (change in net worth plus depreciation). This indicator provides insight in the possibility to meet costs of the available foreign assets and to attract new assets.

Information on the items (1) to (5) is given in table 5.5, and the remaining items are presented in table 5.6.

Solvability generally is rather low in Denmark and at specialist pig fattening in the Netherlands. It is high in Niedersachsen and Belgium (over 70%). Bretagne and the Netherlands take a medium position in this respect. Because of the large share of land owned by the farmers, one might expect that the small solvability of farms in Denmark would be due to the high value of land on the balance-sheet. This is likely not to be the case

Table 5.5 Financial structure on the farms selected from FADN by region and by farming type

Region/Farming type a)	Family farm income (ECU)	Solva-bility	Ratio of liabilities to family farm income	Liabilities	
				% long and medium term loans	interest paid (% of liabilities)
Niedersachsen					
Type 50 b)	10273	76	6	71	5
Type 821	12357	70	7	78	5
Type 723	18054	73	4	63	5
Type 711	16193	81	3	74	5
Bretagne					
Type 5013	19060	52	7	63	8
Type 721	19619	67	4	67	7
Type 723	14659	57	6	57	7
Belgium					
Type 5013	46778	70	1	100	6
Type 821	28473	73	1	100	6
Type 721	33752	74	1	100	6
Netherlands					
Type 5011	23939	61	5	93	8
Type 5013	29364	59	6	93	7
Type 721	29940	69	5	94	7
Type 411	38239	69	4	94	6
Denmark					
Type 5013	29027	41	10	75	9
Type 821	8902	46	17	74	10
Type 1244	251	46	20	69	10

a) See table 5.1; b) Period 1984/85-1987/88.
Source: FADN/LEI-DLO.

because the value of land on average per hectare in Denmark is much smaller than elsewhere. The value of land, excluding the part rented, over the period 1984-1989 on average was some 1650 ECU per hectare at farms with pig rearing and fattening combined. In the other regions the average value of land owned by farmers at type 5013 were some 3450 ECU/ha (Bretagne), 14800 ECU/ha (Belgium) and 18500 ECU/ha (the Nether-

lands). Although the total size of utilized agricultural area at type 5013 on average is larger then elsewhere, the total value of land on the balance-sheet remains to be relatively small. The investments in buildings in Denmark are considerably higher than elsewhere.

There is a wide difference among regions and farming types on the ratio between total liabilities and family farm income. In the case of Denmark, the whole family farm income of at least ten years would be required to pay the debts. There are two reasons for this indicator to be relatively small in Belgium. First, family farm income on average is higher in Belgium than in the other regions considered and second, the average amount of total liabilities is smaller than elsewhere. Total liabilities are relatively high in the Netherlands and Denmark. The situation in Denmark might be explained by the high interest paid (at a level of around 10% per year) which reduces family farm income, together with a relatively small level of solvability. The high costs of paid interest reduces family farm income in Denmark, although the change of net worth remained to be positive during the period of six years (table 5.6). The share of long and medium term loans in total liabilities are highest in Belgium and the Netherlands. The share of short-term loans in total liabilities is less than 10% in the Netherlands and is even negligible in Belgium.

The rate of interest is small in Niedersachsen and Belgium (successively 5 and 6%) and high in Denmark (up to 10%). Bretagne and the Netherlands are taking a medium position in this respect, with an interest rate of some 7-8%. Many farmers in Denmark did arrange for long-term loans by the early 1980s when interest levels were very high (up to 20%) (Ten Pas and Van der Ploeg, 1990).

The change of net worth over the period 1984 to 1989 is negative in Niedersachsen (table 5.6). Net worth however shows a considerable increase in Bretagne and Belgium. The annual increase of net worth in Bretagne and Belgium was around 5 to 7%. Although it was mentioned before that family farm income is relatively small in Denmark, the change of net worth remains to be positive at all farming types during the period considered. Net worth only shows an increase in the Netherlands at the farms with livestock combinations and at farms with pig rearing and fattening combined. The percentage change in net worth was negative in Niedersachsen over the six years' period. The annual decrease of net worth in that region was in the range between 3% and 8%. Net worth decreased in most of the countries during the accounting year 1987/88. The highest increase took place during the year 1989/90. The increase on average was at least 10% during that year at farms with pig rearing and fattening combined.

Table 5.6 Financial position on the farms selected from FADN by region and by farming type

Region/ Farming type a)	Change in net worth								Cash-flow (ECU)
	total 84/89 (ECU)	percentage change in net worth (%)							
		84/89	84/85	85/86	86/87	87/88	88/89	89/90	
Niedersachsen									
Type 50 b)	-8237	-4	0	-4	-7	-7	.	.	1786
Type 821	-6862	-4	0	-4	-5	-10	-5	3	4802
Type 723	-7340	-3	0	-4	-8	-6	-5	3	4031
Type 711	-14567	-8	-7	-10	-10	-9	-6	-4	-5081
Bretagne									
Type 5013	10059	7	14	3	7	5	-1	15	24344
Type 721	8513	6	8	7	9	5	3	4	18813
Type 723	3370	3	3	0	-1	2	-4	14	12799
Belgium									
Type 5013	11062	7	7	9	3	-4	11	16	20334
Type 821	5964	5	7	5	1	0	6	11	13117
Type 721	7717	5	-1	0	-2	7	12	11	14978
Netherlands									
Type 5011	-358	0	2	3	-5	-15	1	11	11611
Type 5013	2946	1	1	4	-2	-13	6	10	18299
Type 721	5644	2	-3	4	-1	-3	4	7	18517
Type 411	9522	3	1	1	1	3	5	4	21957
Denmark									
Type 5013	1130	1	8	-8	7	-17	-7	14	18431
Type 821	1246	1	6	-2	6	-8	-11	9	11012
Type 1244	1758	2	6	1	7	-5	-13	4	9540

a) See Table 5.1; b) Period 1984/85-1987/88.
Source: FADN/LEI-DLO.

The cash-flow per farm with pigs is very small in Niedersachsen and even negative at farms with mixed livestock; mainly dairying. The cash-flow at farms with pig rearing and fattening combined is around the same level (between 18000 and 24000 ECU) in Bretagne, Belgium, the Netherlands and Denmark.

5.5 Concluding remarks

Operational and financial results of farms are summarized in table 5.7, and is based on the codes explained in figure 5.1. The information provides a qualitative assessment of the competitive advantages that farmers do have compared to elsewhere.

Table 5.7 Summary on the results of the farms selected from FADN by region and by farming type c)

Region/ Farming type a)	A	B	C	D	E	F	G	H	I	J
Niedersachsen										
Type 50 b)	+	0	0	0	+	0	+	-	0	-
Type 821	0	0	0	0	0	0	+	-	0	-
Type 723	0	0	0	0	+	0	+	-	0	-
Type 711	0	+	0	0	+	+	+	-	-	-
Bretagne										
Type 5013	0	0	0	0	0	0	-	+	+	+
Type 721	0	0	0	0	0	0	0	+	+	+
Type 723	0	0	0	0	0	0	0	0	+	+
Belgium										
Type 5013	0	+	+	+	0	+	0	+	+	+
Type 821	+	+	+	+	+	+	0	+	+	+
Type 721	0	+	+	+	+	+	0	+	+	+
Netherlands										
Type 5011	+	+	+	+	0	0	-	0	+	+
Type 5013	0	0	+	+	0	0	0	0	+	+
Type 721	0	0	+	+	0	0	0	+	+	+
Type 411	-	+	+	+	0	0	0	+	+	+
Denmark										
Type 5013	+	+	+	+	0	0	-	0	+	+
Type 821	+	+	0	-	0	-	-	0	+	+
Type 1244	0	+	-	-	0	-	-	0	+	0

a) See table 5.1; b) Period 1984/85-1987/88; c) See figure 5.1 "Clarification of letters and signs". Source: FADN/LEI-DLO.

Code	Description	Code-signs		
		-	0	+
A	Margin from output over feed of pig farming (ECU/LU of pigs)	<100	100 - 300	>300
B	Net value added from pigs (ECU/LU of pigs)	<100	100 - 200	>200
C	Family farm income per family work unit (ECU x 1000)	<5	5 - 15	>15
D	Family farm income (ECU x 1000)	<10	10 - 20	>20
E	Solvability (%)	<40	40 - 70	>70
F	Family farm income (% of liabilities)	<10	10 - 30	>30
G	Interest paid (% of liabilities)	>8	6 - 8	4 - 6
H	Change in net worth (ECU x 1000)	<-5	-5 - 5	>5
I	Change in net worth (% of total net worth)	<-5	-5 - 0	>0
J	Cash-flow (ECU x 1000)	<5	5 - 10	>10

Figure 5.1 Clarification of code letters (A-J) and code signs

(1) Specialization of pig production increased in all regions during the time period considered. The increase of pig population at specialist granivores was largest at farming type 5013. Pig population at farms with pig rearing and fattening combined did increase by more than 50% in Belgium, the Netherlands and Denmark. It even more than doubled in Bretagne. This farming type presently has the largest share of pig population in Bretagne, Belgium and the Netherlands. The largest share of total pig population of Niedersachsen and Denmark presently is located at farming type 821. The average size of farms with pig rearing and fattening combined also increased during the 1980s. Family farm income per family work unit is also rather high at this farming type. Total pig population, located at farms with pigs and other livestock and/or crops, decreased in all regions between 1984 and 1989.

(2) Operational results and the financial position of farms with pigs in *Niedersachsen* are rather poor compared to the situation elsewhere. Family farm income is low, net worth shows a steadily decreasing trend and the cash-flow also is very low. The present state of solvability in this region is however sufficiently high to offset the costs of actual liabilities in the long-run. The financial position to meet any sub-

stantial cost increases on average are altogether considered to be very much limited in Niedersachsen compared to elsewhere.

(3) The financial position of pig farming in *Bretagne* on average is identified to be relatively strong, with a reasonable level of family farm income, a considerable increase of net worth in the 1980s and a high cash-flow level. The financial position of farms with pig rearing and fattening combined is better than on farms with livestock combinations. Change of net worth and of cash-flow has been large on this farming type. About 40% of the pig population presently is located on farming type 5013. The ability to offset cost increases on average are relatively good on all farming types considered. The financial position of farms at type 721 (i.e., mixed livestock; granivores and dairying combined) is slightly better than the financial position of farms at farming type 723 (mixed livestock; granivores with various livestock).

(4) Family farm income is very high in *Belgium* compared to elsewhere. The ratio between family farm income and the present level of total liabilities is also much higher than elsewhere. This implies that total family farm income of on average some two years would be required to pay off all liabilities. Total liabilities are higher in the other regions. Net worth shows a steady increase over time and the level of cash-flow also is at a reasonable level. The actual financial position of farms with pigs to meet higher costs on average is considered to be good. The financial position is highest on farms with pig rearing and fattening combined. This also is the farming type which presently has largest share of pig population in Belgium.

(5) Family farm income in *the Netherlands* is rather high at all farming types considered. Net worth decreased slightly at specialist pig rearing. The average increase of net worth was small at farms with pig rearing and fattening combined, compared to the situation in Bretagne and Belgium. The ability to meet a considerable increase of costs at farms with farming type 5013 is identified to be slightly worse than in Bretagne, Belgium and Denmark.

(6) Family farm income in *Denmark* is high at farming type 5013, and low at farms with various field crops combined. It needs to be mentioned here that in Denmark the income generated from non-agricultural activities is also important (Ten Pas and Van der Ploeg, 1990). This amount is not included in the FADN and therefore not part of the level of family farm income identified in this chapter. Total increase of net worth was rather small between 1984 and 1989 and also less than the situation in the Netherlands. The average cash-flow at farming type 5013 was around 18000 ECU during the period between 1984 and 1989, which is of about the same level as it is in the other regions. The ability to offset additional cost increases in the future are relatively

good in that country. It is on average better at farms with pig rearing and fattening combined than at the other farming types considered. Family farm income and cash-flow on average are smaller at farming types 821 and 1244 than at farming type 5013. Solvability of the farms considered is relatively small compared to the situation in other regions. Also, the ratio between the total liabilities and family farm income is high, which implies that the total family farm income would be required for considerable number of years (at least some ten years according to present level of family farm income) in order to pay off total debts of the farmers. Investments made into environment-friendly equipment have been relatively high during the past couple of years.

6. COMPETITIVENESS OF PIG PRODUCTION

6.1 Introduction

The basic question of this study is to examine to what extent environmental policy in the various member states of the European Community may affect competitiveness of pig production in the near future. An answer to this question requires the incorporation of various considerations.

First of all, the structure of the agricultural sector is important for the options that farmers do have to compensate for any changes regarding the standards on the application of organic manure. A critical characteristic on the structure of farms in this respect is the amount of land that is available for spreading of animal manure. In Denmark for example, approximately a third of all manure from pigs cannot be applied at the own farm due to strict environmental standards. This surplus however can be applied at other farms since a farm has on average some 35 ha of land. Structural characteristics of farms with pigs therefore are likely not to raise major difficulties to them to get rid of manure surpluses. Transport costs of manure surpluses are relatively small because of the short distance to apply the surplus manure. This differs largely with the situation in the Netherlands and Belgium. Transport of manure from farms with surpluses to (arable) farms in regions without surpluses is important and is one of the basic solutions in Belgium and the Netherlands to offset stricter standards in the future.

Also important, of course, are the environmental standards themselves, as well as the assumptions made in these policies regarding the mineral content of animal manure. Investments might be required to reduce emissions, to store manure at the farm. Costs may also increase in order to get rid of manure surpluses. The environmental standards themselves are rather strict in Denmark compared to elsewhere, but major investments have been made over the past couple of years.

The perspective of the competitiveness of pig farming in the regions considered in response to changing environmental policies will be assessed upon three interrelated items:

- Structural characteristics of pig farming and the cost increases that might result in case standards on the application of animal manure do change. The actual state on the structure of pig farming is related to changes on the policies to apply animal manure. An important aspect is the extent to which the structural characteristics of farms with pigs will cause a relatively high cost increase in case standards to apply manure change. It is either good or poor, and marginal in case difficulties might arise with major changes in the standards to apply manure from organic sources. Animal density at farms with pigs is an important indicator in the assessment.
- Investments required in environment-friendly equipment or other cost increases that might result in order to compensate for the environmental standards over the next couple of years. Investments among others might be required in order to reach sufficient capacity to store manure. Investments are also required into equipment to reduce the emissions while spreading animal manure on the field or into stables with less emissions to the air. The need for investments to compensate for the new standards might be large, modest or small.
- Present situation on the financial position of farms with pigs and the ability to meet an increase in costs within the next couple of years. The financial position to meet any cost increases might be good or critical in case several criteria raise difficulties. It is considered to be sufficient in case only one of the criteria on the financial position are considered to be critical for pig farming.

6.2 Structural characteristics of farms and environmental policy

Differences among regions regarding structural characteristics of farms with pigs are large. This is reflected among others by animal density.

Animal density (in terms of the number of pigs per hectare of utilized agricultural area on farms with pigs) on average is smallest in *Denmark* and *Niedersachsen,* and highest in *the Netherlands* and *Belgium. Bretagne* is taking a medium position in this respect.

Farms with pigs in *Denmark* presently still have sufficient options for spreading of animal manure at a rather short distance of the farm with pigs, even if environmental standards to apply manure would further change in the future. This also holds for the farms with pig rearing and fattening combined. Such farms on average are relatively large in Denmark. They presently already have a considerable supply of manure which cannot be applied at the farm. It is presently not foreseen that major changes will take place on the standards to apply manure in Denmark. In *Bretagne,* manure surpluses from pig farms presently are applied at a dis-

tance of less than some fifteen kilometers from the farm. Animal density at farms with pig rearing and fattening combined are rather high in Bretagne. This implies that costs are likely to increase in case any changes in manure policy will take place or in case pig population continue to increase in the years to come. Further changes in the standards to apply manure are however not known so far. Within *Niedersachsen*, the standards to apply manure are presently primarily raising difficulties in the Landkreis of Weser-Ems, and more specifically in the Vechta region. Standards on the application of minerals from organic manure are considered to change in the years to come in order to meet the nitrate-directive from the EC. Structural characteristics of the farms are likely to meet the adjusted standards 1). Animal density at specialist granivores is rather high in the concentration areas of Niedersachsen, although the average level still remains to be less than in Denmark. This phenomenon may therefore raise difficulties with alterations in standards to apply animal manure, such as standards to offset the nitrate directive from the European Community. Standards to apply minerals from organic sources are likely to change considerably in *Belgium* and *the Netherlands*. Standards to apply phosphate will change gradually in the years to come, which implies that costs will increase to get rid of manure surpluses. The poor quality of the available drinking water resources due to leaching of nitrate, both in the Netherlands and Flanders, will likely also affect manure policy.

6.3 Investments required in response to environmental policy

The need for investments in response to changes in environmental policy is highest in the Netherlands and Flanders, mainly in equipment to reduce the emissions of ammonia (during the spreading of manure and in stables). The needs for investments in Denmark are primarily to increase the capacity to store manure at the farm. By the year 1993 all farms with at least 31 animal units need the capacity to store their manure for at least nine months. The needs for investments are considered to be relatively small compared to the situation in the other regions. In Bretagne, investments as well as major efforts on farm management at farms with pigs are likely to be required to increase the dry-matter content of animal manure, but they are considered to be modest. The same is likely to be the case in

1) It was already concluded before that structural characteristics of farms with pigs in Niedersachsen differ largely from those elsewhere. Specialist granivores in Niedersachsen do on average have less pigs than the farms in the other regions considered.

Niedersachsen, where the investments in environment-friendly equipment will mainly result from the standards (on emissions from stables and the application of animal manure) set by the Bundes-immissionsschutsgesetz.

6.4 Competitiveness in response to environmental policy

One of the important phenomena in the comparison of competitive (dis) advantages among countries is the efficiency in using inputs to produce one unit of output. Pig farming in the Netherlands and Belgium have competitive cost advantages regarding their efficiency level in using inputs. The volume of input per 100 kg of output from pigs in the countries considered is in the range between 0.89 (the Netherlands) and 1.10 (Germany) (Bureau and Butault, 1992). The index value of Belgium is also small (0.90) and it is 0.98 in Denmark and France. The competitive advantages of pig farming in the Netherlands mainly result from the relatively small costs to feed pigs (Wisman, 1991).

The ability of farms with pigs to meet an increase of costs, given their actual financial position, is summarized in section 5.5. Competitiveness of pig production results from the balance between on the one hand the cost increases that need to be considered in response to changes in environmental policy (standards to apply minerals on the field, investments to diminish deteriorating effects on the environment) and the ability to compensate for an increase of costs from the present financial position (figure 6.1).

The ability to meet an increase of costs is considered to be in the range between poor (if any cost increase might affect operational results very negatively) and good (if any increase of costs might be born relatively easily compared to similar farms with that farming type elsewhere). It is considered to be sufficient if only one essential indicator on the financial position of farms with pigs is noticed to be critical.

The extent to which the structure of farms with pigs may raise difficulties and cause an increase of costs in response to environmental policy is identified to be good (Niedersachsen and Bretagne with the exception of intensive livestock farms, and Denmark) and poor (Belgium and the Netherlands).

The investments required for environment-friendly equipment might be large (The Netherlands and Belgium), modest (Niedersachsen and Bretagne) and relatively small (Denmark). The investments required in Denmark are primarily limited to the increase of the capacity to store manure at the farm up to nine months. The need for investments in Niedersachsen are primarily to limit the emissions from stables and in

Region/ Farming type *)	Structure of farms	Investments required	Financial position	Perspective
Niedersachsen				
Type 50	Marginal	Modest	Poor	Critical
Type 821	Good	Modest	Poor	Critical
Type 723	Good	Modest	Poor	Critical
Type 711	Good	Modest	Poor	Critical
Bretagne				
Type 5013	Marginal	Modest	Good	Good
Type 721	Good	Modest	Good	Good
Type 723	Good	Modest	Sufficient	Good
Belgium				
Type 5013	Poor	Large	Good	Good
Type 821	Poor	Large	Good	Sufficient
Type 721	Poor	Large	Good	Sufficient
Netherlands				
Type 5011	Poor	Large	Sufficient	Critical
Type 5013	Poor	Large	Sufficient	Sufficient
Type 721	Poor	Large	Good	Sufficient
Type 411	Poor	Large	Good	Sufficient
Denmark				
Type 5013	Good	Small	Good	Good
Type 821	Good	Small	Sufficient	Good
Type 1244	Good	Small	Sufficient	Good

Figure 6.1 Structural characteristics and the options to spread manure at marginal cost increases, investments required to compensate for environmental standards, actual financial position and perspective to meet cost increases identified

**) See table 5.1.*

Bretagne to increase the dry-matter content of manure. Major investments are required in Belgium and the Netherlands in order to meet the standards on emissions (in stables and during the application of animal manure) and to get rid of manure surpluses.

A qualitative assessment has been made regarding the perspective of pig farming in the concentration areas. It is identified to be either good or critical. It is identified to be sufficient in case only one of the key indicators on the financial position is identified to be critical or in case the struc-

ture of pig farming might cause a considerable cost increase with a change on the standards to apply manure from organic sources.

The perspective of pig farming is identified to be good at the farming types considered in Bretagne and Denmark, as well as at farming type 5013 in Belgium. It is identified to be sufficient at the remaining farming types of Belgium, since the financial position of farms with pigs at these farming types are slightly worse than at farming type 5013.

The perspective of pig farming is identified to be critical in Niedersachsen because the financial position to meet major increases of costs are difficult. Net worth decreased at all farming types during the period between 1984 and 1989 and the cash-flow also was small compared to elsewhere. Although solvability of the farms with pigs on average is sufficiently high to offset the costs of actual liabilities, any additional increases of costs will most likely affect the perspective of pig farming in a negative way.

The perspective of pig farming in the Netherlands is identified to be critical at farming type 5011. The financial position is also identified to be critical at specialist pig rearing, both because net worth showed a slight decrease during the six years' period considered and because the need for investments and adjustments in farming practice are high. The perspective is assessed to be sufficient in the remaining farming types, either because the financial position is sufficient (farming type 5013) and good (farming types 721 and 411).

7. MAJOR FINDINGS

Competitiveness of pig farming has been examined in this report in five concentration regions of pig production within the EC. The regions identified were those that already achieved competitive advantages in the past. In the Netherlands for example, cost advantages were achieved in pig farming by means of the ability to produce feed concentrates at lower costs than elsewhere. Pig farmers in the concentration regions have also been able to improve their competitive advantages through innovation, rationalization of production processes and integration of chains in the production process. Also important has been that the pig farmers in the concentration regions perceived entirely new market opportunities that have been ignored before (Porter, 1990). Pig farmers in Denmark for example have been very sucessfull in opening new markets, like the export to Japan with its high veterinary requirements but relatively high product prices.

An increase of production costs might result in the EC in case the producers of pigs will meet similar cost increases due to changes of environmental standards and the actual structure characteristics of pig farming. An increase of product prices might then result, possibly in combination with a more or less substantial move of production to areas with smaller pressure on the environment. Such an increase of production costs might partly compensate for higher production costs. Differences on the structure of pig farming and the notion of environmental policy in the areas considered however are large, which implies that the perspective for an increase of product prices are likely to be limited.

The perspective for an increase of pig production is considered to be relatively good in Bretagne and Denmark, according to the rather strong financial situation of pig farmers in Bretagne and the modest need in Denmark for investments in environment-friendly equipment. The future perspective is however rather critical in Niedersachsen. The same conclusion holds for farms with specialist pig rearing in the Netherlands. In this respect it needs to be mentioned that the structure of farms with pigs in Niedersachsen on average is staying behind compared to the other concentration regions. This area for example has a considerable number of farms with only a few pigs. The future perspective of the large farms with

pigs might be much better than the perspective of the average farm with pigs. It was not possible to examine such differences according to individual farm accountancy data becaus the Farm Accountancy Data Network only provides averages of farming types.

Only qualitative assessments have been made regarding the future perspective of pig farming in response to changes in environmental policy. The impact of other policies on pig farming, such as the present changes on market-and price policy of the agricultural sector (i.e., the Mac Sharry reform) is not considered in this report (see for example Walter-Jorgensen et al., 1992). It is likely that such adjustments in agricultural policy will also affect the future perspective of pig farming. Some fifteen percent of cereal land has to be taken out of production by farmers with a cereal production of at least 92 ton. This decision is part of the Mac Sharry reform and implies that the option to spread manure from pigs will be reduced especially in Denmark.

The assessments made in this report on changes in environmental policy and the impact on cost structure and competitiveness of pig production in the EC are only based on the case of five concentration regions. Largest increase of pig consumption during the 1980s is observed in the Mediterranean countries. The consumption of pig meat is presently even going down in the United Kingdom, Germany and France. Production might further increase in the Mediterranean Countries in the years to come, either because of the environmental standards in the northwestern part of Europe, or the need to meet the increasing consumption levels and the relatively small self-sufficiency rates of pork products.

No adjustments are considered in the report on the structural characteristics of farms with pigs in order to meet the standards in environmental policy. The structure of pig farming in Niedersachsen for example, is identified to stay behind compared to the farms with pigs elsewhere. Rationalization and specialization of pig farming in Niedersachsen might change in the years to come, which might improve the future perspective of pig farming in this region.

Several indicators have been used to depict livestock population under the same denominator. This has been done in order to enable a comparison among regions regarding the impact of environmental policy on livestock farming. On the one hand we made use of livestock-units, with animal types represented in terms of feed requirements (input to animals). We also made use of coefficients with standards on the excretion from animals (output from animals). Animal units have been identified in Denmark and manure units in Niedersachsen. One dairy-cow is equivalent to the unit of value in both Niedersachsen and Denmark. They differ since the equivalent of one manure unit in Niedersachsen equals 80 kg N and some 110 kg N in Denmark.

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ANNEX

Annex A Representativeness of farms in the sample of FADN

Table A1 Number of farms in the sample of FADN and the number of farms represented by the sample of FADN

Region/ Farming type a)	Sample (average 1984-1989)	Number of farms represented by sample						
		84/89	84/85	85/86	86/87	87/88	88/89	89/90
Niedersachsen								
Type 50 b)	13	1872	1804	1799	1804	2080	.	.
Type 8210	81	5620	4756	5795	6380	5401	5492	5898
Type 7230	29	2052	2939	2930	2200	1370	1267	1603
Type 7110	74	6376	6936	6520	6192	5964	7407	5235
Bretagne								
Type 5013	50	3170	2924	2662	3242	2744	3665	3782
Type 7210	27	3059	3807	2867	4200	2064	2472	2942
Type 7230	19	2053	2165	2457	1096	2368	2092	2141
Belgium								
Type 5013	52	1826	1732	1521	2156	1713	1878	1958
Type 8210	40	1504	1136	1145	1765	1454	1752	1769
Type 7210	48	1777	2264	1893	1849	1524	1524	1608
Netherlands								
Type 5011	57	4127	3776	4073	4404	4427	4064	4015
Type 5012	13	1186	1373	1337	870	1130	1176	1230
Type 5013	29	1896	1761	1541	1659	1967	2234	2215
Type 7210	54	3633	3568	3639	3597	3725	3680	3591
Type 4110	423	34275	35526	36508	37282	33202	31930	31204
Denmark								
Type 5013	105	2911	2363	2307	2417	3555	3267	3557
Type 8210	329	10938	10831	11277	11246	10832	10750	10689
Type 1244	348	17572	15685	16205	16569	18993	18939	19038

a) See table 5.1; b) Period 1984/85-1987/88.
Source: FADN/LEI-DLO.