2 Agriculture and sustainable development in the Netherlands

2.1 Agriculture in the Netherlands

The Netherlands is a small country (41.528 km², including 7.750 km² of open water) with an average population density of over 400 persons per km². Its geographic position, along the North Sea in the delta of a number of important European rivers, has always been a stimulus for transport and trade to and from the European hinterland. The prevailing natural conditions -a temperate climate with a fair rainfall distribution (total annual average 750 mm/yr), relatively fertile soils in a flat landscape- favour a varied and productive agriculture.

The combination of these two factors, together with a governmental policy that strongly supports a competitive agricultural sector, good entrepreneurial skills, support from a state-of-the-art agricultural research and education system, innovative supply and processing industries, the availability of inexpensive natural gas supporting greenhouse horticulture and floriculture as well as the production of cheap fertilizers, -and since the nineteen fifties- the emergence of the European Union and the associated market enlargement has resulted in a very strong agricultural sector in the Netherlands.

Yields of the main crops (potatoes, sugar beet, vegetables, cereals and flowers) and from dairy production are among the highest in the world. In monetary terms, the Netherlands ranks second, behind the United States, as net exporter of agricultural products. In 2007 total agricultural exports (mainly dairy products, pig- and poultry meat, vegetables, flowers and ornamental plants) amounted to about € 58 billion per year -or some 17 % of the total Netherlands' export of goods and services. Some 10 % of the GDP is earned by the agro-sector, including processing, trade and services, and the sector employs a similar 10 % the total working population of the Netherlands.

In small, densely-populated and highly-industrialised countries with a high per capita income like the Netherlands, agricultural production chains can still be very important and successful as an economic factor.

Agricultural imports amount to some € 34 billion per year (2007) and include cereals, oilseeds, vegetable proteins and fats (soy for instance) mostly as animal feed stuff. These imports originate mainly from countries outside the European Union, the United States, Brazil and Thailand in particular. For many of the imported products the Netherlands has a prime role as processor and distributor to other countries in the European Union.

More key data on the organization and performance of the Netherlands' agricultural sector are available from www.lei.wur.nl/UK/statistics/Binternet/. A brief overview of the development of agriculture in the Netherlands is presented in Annex 1.

2.2 Environmental and social concerns

The high productivity of the Netherlands' agricultural sector came along with levels of external inputs including mineral fertilizer, manure, pesticides and energy, which rank among the highest in the world. The use of these inputs increased (per farm as well as per hectare) mainly in the period 1950-1980. Starting from around 1980, public and political awareness emerged on the environmental and social impacts of these high-input farming systems. Henceforth, agricultural and horticultural development in the Netherlands has been placed under social and environmental conditions and restrictions that aim to promote environment-friendly agricultural production. Even with these conditions and restrictions in place, an intensive, dynamic and internationally-oriented agricultural sector has shown to be economically viable.

In the Netherlands, main environmental impacts from agriculture are caused by emissions of:

- *Nutrients (nitrogen, phosphorus, etc.)* in areas with high concentrations of pig- and poultry farms and dairy farms with high stocking-densities. Here, the production of manure is higher than required to maintain inherent soil fertility levels. The oversupply of nutrients endangers soils as well as ground- and surface waters. In the Netherlands, quite commonly, ground water is being extracted for domestic use, after purification. (See Case 1).
- *Ammonia* especially from animal manure is affecting the quality of forests (acid deposition) or, for that matter, the natural environment at large. High emissions of ammonia into the atmosphere occur in the same areas as enrichment of the environment with nutrients.
- *Other gasses*, including CO_2, CH_4 and N_2O, that are being emitted from, in particular, greenhouses and livestock farms, endanger the earth in the long run mainly through their effects on climate (See Cases 3 and 4).
- *Pesticides and other agro-chemicals* as used in plant and animal protection, imply not only the risks of water- and air pollution but also the risks of unsafe food and of the health of farm workers. (see Case 2).

In addition to the environmental issues listed above, societal concern in the Netherlands is growing on:

- *Animal welfare*, especially in the intensive livestock production sector, where animals often have restricted space only to live-in and roam around. Also, many live-animals (pigs, piglets, calves) are being transported over long distances within Europe.
- *Animal diseases.* Given the intensifying international contacts and high animal densities, the Netherlands' livestock sector is under increasing risk of outbreaks of contagious diseases including Foot and Mouth Disease, Swine Fever and Avian Influenza. Such outbreaks have enormous consequences for individual farmers and their animals, as well as for the sector as a whole, including cross-border impacts.
- *Food safety.* Netherlands' authorities are well-aware of the health risks of specific ingredients, dioxins or antibiotics for instance, in food for humans. Such risks are large, and difficult to manage, in particular given the complexity of the current food production-chains as they encompass a continuum from farm inputs, farm production, (value-adding) processing, trade and transport and retail trade through to consumption.
- *Landscape and biodiversity*. The numerical and acreage growth of intensive agricultural production systems affects the quality of landscapes in the Netherlands -which become less varied- as well as the diversity of floral and faunal habitats in rural areas. Also, there is growing public demand for recreational space (see Sections 2.3 and 3.4).
- *Labour.* The Netherlands' agricultural sector -horticulture in particular- is facing difficulties with respect to availability of labour, especially during harvesting periods. Labour shortages draw many workers -mainly from new EU member states like Poland- to the Netherlands. The conditions of their work and accommodation are subject of discussion.
- *Energy.* Greenhouse cultivation in the Netherlands -in total some 5,000 holdings of about 2 hectares each- accounts for more than 80 % of the total energy consumption by the agricultural sector. Based on new physiological insights in conjunction with state-of-the art technology, transitions are now being made from energy-consuming to energy-producing systems (see Case 4).
- *Organic farming.* Consumers in the Netherlands -as elsewhere- increasingly demand food products from organic origin, both for reasons of health as for reasons of environmental concern and animal welfare. Rather than supporting the sector by subsidies, the Netherlands' government policy on organic agriculture focuses on market development, knowledge generation and multiple-stakeholder approaches (see Cases 5 and 6).

2.3 Changing functions of agriculture

Over the past three decades, the ever-wealthier Netherlands' society has become more and more critical of the impact of the increasingly-intensified agriculture and horticulture on landscapes, natural habitats and biodiversity. Generally-speaking the Dutch do not only expect the agricultural sector to produce sufficient and healthy food at acceptable prices, but they also expect this to be done in an attractively-looking rural area fit to recreate, enjoy leisure and value nature.

In this respect, farmers tend to cater for these new societal needs but they need incentives to provide balanced combinations of producing farm products and other profitable activities. Markets for these 'non-farm' products and services are rapidly developing and their growth, both in terms of numbers of farms and customers, as well as in terms of financial volume, is expected to continue in the years to come. Examples of such new services are landscape management and nature conservation, recreation, education, health-care and processing and on-farm sales of (organic) farm products. Such multi-functional farms try to re-establish the connection with society: connections between farmer and citizens, food and health, (animal) welfare and well-being, agriculture and the city.

Multi-functional land use is being elaborated in more detail in Chapter 3.4 of this report.

2.4 Policy measures

For the Netherlands, as a member of the European Union, EU policies on agriculture and rural development are leading at national level. As from the nineteen sixties, the EU Common Agriculture Policy (CAP) has been applied in order facilitate a viable agricultural sector. Among other things, this was done through production subsidies and mechanisms for guaranteed prices for agricultural commodities. Ever since, strict rural and environmental policies have become additional major elements of the CAP and for the Netherlands they apply to the following areas in particular:

- *Minerals and manure.* In 1984, the government introduced a temporary ban on the further expansion of intensive livestock farming (i.e. pigs and poultry rearing). This was done in order to reduce emission of minerals and ammonia. Later-on, this ban was replaced by a system of fixed maximum deposition levels of minerals per hectare in combination with tradable production rights ('mineral quota'). Manure production on cattle farms was restricted through the introduction –in 1984- of a dairy quota system at the level of the EU. As from 2006, the Netherlands has introduced new and stricter regulations on manure which correspond with the EU 'Nitrates Directive'.
- *Energy use in greenhouses.* In the early nineteen nineties a long-term agreement was reached between the national government and the horticultural sector (including vegetables, flowers bulbs and mushrooms) to improve efficiency of energy use by 50 % in 2000. Under this agreement growers were stimulated to invest in energy-saving technologies.
- *Pesticide use.* As in the case of energy use, a multi-year agreement stipulates a 50 % reduction of pesticide use by the sector. This was achieved by changing crop rotations, by introduction of pest and disease-resistant crop varieties and by bans on the use of specific pesticides. 'Closed' and 'Circulation' greenhouse systems were introduced to prevent emissions of pesticides and minerals to the open air and to ground and surface waters.

Besides the 'Nitrates Directive' of the European Union, as described above, agriculture in the Netherlands is further being regulated by the 'EU Water Framework Directive' which encompasses both, water quality and water quantity, and by the 'EU Soil Strategy'. In addition, the 'Air Framework Directive', the 'National Emission Ceiling Directive', the 'Integrated Pollution and Prevention Control Directive' and the 'Regulation on Energy' aim at reducing emissions of CO_2, NH_3, N_2O, etc. into the atmosphere, as well as at improving the sustainability of energy use. In this respect the agro-sector is actively involved in the production of bio-energy, not only from crops (cereals, oilseeds, etc.), but

also from manure. Further linkages between agricultural production and sustainability are being enforced by the so-called 'Cross Compliance Principle' of the CAP, since 2003. Under this principle farmers receive payments in compensation for the decreased prices of a number of commodities, including cereals, milk, sugar and beef, conditional to meeting specified standards on environmental quality, animal welfare, veterinary restrictions, etc.

2.5 Changing policies and the private sector

At the turn of the century, the growing societal concern about the environmental impact of agricultural production systems caused the government to reconsider its policy with respect to sustainable agriculture. Hence, in 2001, the 4th National Environmental Policy Plan (NEP-4) was issued, stipulating that system innovations were required to solve the existing -and considerable- environmental problems that had emerged. NEP-4 described the need for a societal transformation process toward sustainable agriculture. It implied interacting and mutually-reinforcing technological, economical, socio-cultural and institutional changes. The process became known as the transition toward sustainable energy balances and sustainable use of the natural resource base and -ultimately- toward a sustainable agriculture sector. The roadmap that was published subsequently ('*Transition Sustainable Agriculture 2003-2006')* defines sustainable agriculture as "a societal-accepted agriculture which meets the ecological, cultural, economic and international standards as required by the community".

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In 2005, the Ministry of Agriculture, Nature and Food Quality published its vision on the future of the agricultural sector in the report *'Going for Agriculture'*. This report, which was compiled on the basis of intensive interaction between policy makers, researchers and –in particular- private sector representatives including farmer organizations, is clearly positive in its assessment of the future potential of the sector. Major problems, however, including a growing international competition, decreasing governmental support and the need for higher investments in environmental safety measures, remain to be tackled. Bottom line of the report is that the sector is responsible for its own future. Governments' role, and that of the Ministry of Agriculture in particular, was to facilitate the change process from *"taking care of ...."* toward *"taking care to ...."*. Examples of this facilitating role of the government are given in Cases 5 and 6 below.

The multitude of complex and restrictive regulations that has been imposed by the government remains a challenge in the transition process. A level playing-field, implying a strict control of the application of these measures, is essential, both at the national and at the international level. The latter in particular in order to prevent that, by applying high and costly sustainability standards in the Netherlands, the sector can no longer compete in the international market, while pushing unsustainable production methods across the national boundaries.

2.6 Corporate social responsibility

Next to applying governmental rules and regulations, the private sector has a responsibility of its own in terms of sustainable development. This 'Corporate Social Responsibility (CSR)' is about the role of companies and enterprises in making our lives and planet more sustainable and can be described as 'a concept whereby companies integrate social and environmental concerns in a

Corporate Social Responsibility including good environmental stewardship is a must for enterprises in the agricultural sector.

transparent way in their business operations and in the interaction with their stakeholders on a voluntary basis'. As for enterprises in the agricultural sector, next to social considerations, good environmental stewardship is -of course- a specific requirement in terms of sustainable development: natural resources, if not well-managed are finite.

In 2001 the Netherlands' government released the policy brief 'CSR, the perspective from the government', in which the ambition is formulated that all companies should be involved pro-actively in corporate social responsibility: the initiative should come from the businesses. The government, however, has a stimulating and facilitating role which includes, for example, the establishment of a national Knowledge and Information Centre ('MVO Nederland'). Also, in 2004, during the statutory Netherlands' chairmanship of the European Union, a pan-European conference on CSR was organized.

In the current 'Cabinet Vision on CSR, 2008-2011' the words *Inspire*, *Innovate* and *Integrate* are central. *Inspire* implies putting spotlights on outstanding CSR companies. It also implies the provision of good examples by the government itself, for instance in its procurement policy. *Innovate* relates to the crucial role of innovation by companies and *Integrate* means that CSR should be fully incorporated in all processes and activities of companies and be part of its core business.

At present, most of the larger companies in the Netherlands have a CSR policy or are otherwise involved in CSR activities (see Box 2). In 2006, a study carried out among the world's largest companies showed that the 24 Dutch companies that are part of the Amsterdam Stock Index (AEX) performed best. Four of these companies are sector leader in the Dow Jones Sustainability Index.

The Netherlands´ Ministry of Agriculture facilitated the development of a ´Sustainability Scorecard´ for companies involved in agribusiness. With the Scorecard, which is publicly accessible on the internet (www.duurzaamheidscan.nl) companies can mirror their sustainability performance and this may motivate them to improve their sustainability strategy.

2.7 Knowledge generation, transfer and innovation

Agricultural research is one of the driving forces behind the development of the agricultural sector, in the Netherlands as elsewhere. The effectiveness of agricultural research depends to a large extent on the ways in which the knowledge generated is being transferred to practitioners, farmers and other agricultural entrepreneurs including processors and traders alike. Moreover, outcomes of agricultural research may also be applied to support development of government policies related to sustainable agricultural development, the management of natural resources and international trade close linkages between entrepreneurs, researchers, extension agents, policy makers and partners in agricultural production and in supply and market chains. These have pushed the Netherlands' agricultural sector into a world top position.

Box 2
CSR: Sustainable soy for healthier milk

In 2007, the international cooperative dairy company Campina introduced `a new kind of milk´ that is healthier (it has more-balanced fatty acid contents) and from cows that spend a daily minimum number of hours on our grasslands and that are fed with sustainably-produced soy, mainly from South America. Soy production in South America is putting pressure on tropical rainforests, which are increasingly being converted into farm land. Campina, jointly with a number of NGO´s including Solidaridad, Natuur en Milieu and the World Wildlife Fund, developed 'Guidelines for Sustainable Soy Production' and the certified soy so produced is being fed to the cows that deliver the new milk. In 2006, some 10.000 tons of sustainable soy were produced and production is planned to grow to approximately 150.000 tons by 2011 when all Campina farmers in the Netherlands, Germany and Belgium should be feeding their cows sustainable soy.

The Netherlands' Ministry of Agriculture has always supported strong and effective instruments for the generation and transfer of knowledge in close combination with an equally-strong multi-level agricultural education system. This so-called '*OVO Drieluik'* (the 'REE Triptych': Research-Extension-Education) implied

Along with the increasing specialisation of the agricultural enterprises and the privatization -in the early nineteen nineties- of both the Netherlands' agricultural extension services and the agricultural research institutes, new mechanisms for research-producer interaction ('innovation') emerged (See Case 6). Such new mechanisms were also required in order to make-up for the decreasing number of students at -mainly- vocational training levels. The latter resulted in lower numbers of skilled young farmers as well as in lower numbers of well-trained teachers. Currently, therefore, new mechanisms are being developed linking knowledge circulation and practical experience in interactive education-research-farm linkages and apprenticeships.

2.8 Lessons learned from practice

The Netherlands has a highly productive and competitive agro-sector. This is the result of a number of favourable geographical and bio-physical conditions, and of a pro-active and stimulating governmental policy in the past. This policy was developed and implemented over the years in good dialogue between the government and farmers organizations. Initially the aim was to strengthen the economic position of farmers by increasing farm productivity levels. More recently, under much societal pressure, this policy had to change in order to counter the negative environmental impacts of the highly intensive production systems. The introduction of new measures and regulations was difficult, however, as farmers were opposed -the costs of implementation being too high- and many changes were made during the implementation process. On hindsight, and given the actual level of know-how available in the Netherlands in dealing with the impacts concerned, it would have been much better if environmental guidelines had been incorporated in the farm policy at a much earlier stage.

Environmental guidelines have to be incorporated in farm policies and operations at a very early stage.

Below a number of practical cases is being described, providing examples of how in the Netherlands we dealt with some of the policy changes and shifting interests of societal stakeholders with respect to agriculture. The cases concerned include: Mineral balances, Sustainable management of pesticides, Greenhouse-gas emissions, Innovative use of energy in greenhouses, Organic livestock farming, and Transition processes.

Case 1: Mineral balances and regulations

The downside of high-input agriculture became visible: accumulation of heavy metals, nitrate leaching into ground water, eutrophication of surface water and soil acidification.

First signals that the rapid intensification of the agricultural sector was not environmentally sustainable date from the end of the 1960's. The public view of the country-side being natural and healthy -as compared to industrialized and urban areas- changed slowly when an increasing number of reports was published about nitrates leaching into the ground water, copper accumulating in soils treated with pig-slurry, phosphorus saturation of soils, eutrophication of surface waters by nitrogen and phosphates and soil acidification and suggested forest dieback due to ammonia from manure. These reports made environmental action groups to put pressure on the government to change its agricultural policy away from promoting productivity toward environmental stewardship and nature conservation.

Mineral balances have played a key role in understanding the effects of agricultural intensification on the environment. For example, livestock production systems in the Netherlands rely heavily on imported animal feed. The manure produced in the process, along with the nutrients in it, was largely dumped on relatively small areas of arable land. This led to harmful surpluses of nitrogen, phosphorus, potassium, copper and zinc in the soil and in ground water.

The Netherlands' manure policy, which aims to decrease losses of nitrogen and phosphorus to the environment is being constrained by possible impacts on socio-economic strength and viability of the agricultural sector. Measures taken so far include: (i) Limiting nitrogen and phosphorus production at the farm; (ii) Restricting losses at farm level by setting limits on mineral balances based on crop- and soil-type; (iii) Trading manure between farms, e.g. from intensive livestock farms to stockless arable farms; (iv) Gradual lowering the limits of manure use per unit acreage of land; (v) Improving fertilizer and manure use-efficiency and (vi) Stimulating technological solutions such as the drying and export of manure.

The costs of enforcement and monitoring of this manure policy have been high. Partly, this resulted from the exploitation, by farmers, of loopholes in the system, from fraud and from legal counter procedures. In addition, many of the regulations were changed in the course of the process and there was insufficient time for proper implementation and fine-tuning in practice.

Improvement was stepwise, to allow for gradual adaptation by the farmers.

In summary, the Netherlands' manure policy is complicated as it addresses a complex and unruly problem. It has a history of 20 years of changes, successes and failures. The farm-level nitrogen- and phosphorus-accounting system 'MINAS', which was implemented in 1998, has been the core instrument of the policy. It marks the shift from regulation- and measure-oriented policies toward target-oriented policies. MINAS included stimulation mechanisms in terms of economic incentives for the farmers involved, but it was abolished in 2006 under pressure of the European Commission. The current system of soil- and crop-specific application limits for nitrogen and phosphorus is again a measure-oriented policy. As yet it is too early to conclude whether this system will lead to the desired sustainable levels of nutrient use efficiency and nutrient losses.

Case 2: Sustainable management of pesticides

The Netherlands is a main exporting country for high value crops such as vegetables, flowers, seeds and intensive arable crops. The high quality demands for these crops, together with high prices for labour and land, have led to capital-intensive production systems that are highly mechanised and have high inputs in terms of energy, nutrients and

Reducing the impacts of pesticide emissions to the environment was successfully achieved through an innovative combination of policy, research and knowledge circulation in a joint effort of all stakeholders involved.

pesticides. Pollution of water, air and soils with the pesticides (and the fertilizers) applied were among the negative consequences of these high-input systems.

In concerted effort, the Netherlands' government, research institutions, private sector (pesticide producers), extension services and farmer organizations have developed effective measures to minimize these detrimental impacts. Among the measures taken were: (i) Legislation –and the gradual adaptation thereof- to limit pesticide use, including bans on specific highly-polluting compounds; (ii) Development, by means of strategic and applied research, of acceptable and manageable strategies for low-impact pesticide applications and (iii) Optimization and dissemination of these strategies in close collaboration with practitioners (i.e. the farmers, the chemical industry and contract workers).

A covenant made-up between the stakeholders strongly enhanced the adoption of sustainable techniques in the daily agricultural practice. So far these efforts resulted in a reduction of the negative impacts of pesticide use of over 85 % (1997-2005), and gains are still being made.

Case 3: Greenhouse gas emissions, climate change and bio-energy.

Plants play a central role in the carbon cycle, in the energy balance as well as in the generation of greenhouse gasses. The use of plant biomass for energy production, the plant's role in soil organic-matter cycles and in reducing emissions of methane and nitrous gasses from agriculture are all topical issues in the global policy debate and in the international research arena.

As climate change processes do not stop at national borders, the issues listed above have a strong international dimension. Moreover, and increasingly, the biomass used for energy production -and consumption- in (rich) countries in the North, is being produced in (developing) countries in the South. This incites discussions on the desirability to produce fuel rather than food in poor countries that have vulnerable food security situations. Moreover, the growing demand for biomass is causing food prices to rise, the world over. This may be a short-term asset for farmers, but it is a threat for governments and consumers, in particular the poor in developing countries. Quite recently protests on food prices emerged in countries like Mexico, Côte d'Ivoire, Indonesia, Haiti, and others.

Lesson learned of the case: Strategies designed and solutions obtained can be examples for other countries. The case has strong international aspects.

Bio-energy policy of the Netherlands is still being developed including the development and international acceptance of sustainability criteria (see also Section 5.A). Research activities focus on second-generation bio-energy mainly (i.e. energy produced from organic residues from farms and food chains). In the international context much research attention is on energy crops such as *Jatropha curcas* that would thrive on marginal lands.

In attempts to mitigate climate change, new farming strategies are being developed in the Netherlands, which minimize emission of greenhouse gasses, that counteract the reduction of soil organic matter or that reduce methane production from peat soils. High levels of soil organic matter are helpful as well in adaptation to climate change by bringing about higher resilience to extreme weather conditions. In protected cultivation systems ('greenhouses') pilots are being initiated changing energy-consuming into energy- producing systems (see Case 4, below).

Case 4: Energy-producing greenhouses with lower carbon footprints

Greenhouses are like solar panels, but growers presently do not use all the energy collected in their production systems. If only all the capacity of such panels could be used, greenhouse production would make a big step forward toward a lower carbon foot print. In the 'Greenport Greenhouse' a Dutch tomato grower and the Greenhouse Horticulture Institute of Wageningen UR have realized a pilot in which the greenhouse supplies heat to a nearby school for disabled children, a house for elderly people and a swimming pool. In this pilot, rather than optimizing current systems, the concept of semi-closed greenhouses was developed in which growing conditions can be controlled easier and losses of energy and CO_2 are less. The concept combines technical, environmental and social sustainability issues in greenhouse production.

Thinking out of the box: Producing energy in greenhouses.

In traditional greenhouses, heat from solar radiation or from a generator can be used only momentarily. New technical solutions now enable the harvesting of heat, in the form of hot water. Already, growers can store heat in tanks, for daily use. It is now possible, however, to store the heat in aquifers for periods of up to several months. This reduces the waste of energy and it allows growers to use summer-heat in winter conditions. Moreover, heat surpluses may be sold to external partners -as is done in the pilot- and, eventually, to formal energy companies. In this transition greenhouses are no longer (huge) energy consumers but they become energy suppliers.

The Greenport Greenhouse is a CO_2-efficient growing system allowing for higher primary production than in 'open' greenhouses. Also, the storage of low value heat in aquifers reduced gas consumption in the greenhouse by some 35 %. Besides, the energy partners in the pilot no longer use gas for their heating, and now keep higher budgets for their primary tasks: caring for their clients. The whole system has a much lower carbon foot print than conventional ways of heating.

Case 5: Organic livestock production

Organic agriculture aims at production processes that are marked by the sustainable use of natural resources (soil, water, feed and animals). This implies not using chemical fertilizers and pesticides, limited use of chemical medicines and due respect for the integrity of the animals. In this way, organic agriculture has positive effects on the environment. As a result, the sector is pioneering in the fields of preventive measures, sensible use of natural resources and animal welfare. The latter is high on the political and public agenda in the Netherlands.

The Netherlands' government regards organic agriculture as a good example of sustainable production and it is actively stimulating the growth of a professional organic agriculture sector. Currently, some 10 % of the budget for research and knowledge circulation of the Ministry of Agriculture is earmarked for this area. Besides, a covenant has been made-up between the Ministry, the private sector and a number of civil society organizations to promote organic agriculture. Under the covenant financial support is provided to a task force on 'Market Development Organic Agriculture'. The objective is to increase consumer demand for organic products, in combination with increased production. Other instruments used by the government are (funds for) knowledge generation and innovation aimed at organic entrepreneurs, payment of certification costs and support to regional initiatives.

The legal framework for organic livestock production sustains systems that allow animals to behave more-naturally and socially and at higher comfort levels than in regular livestock systems. Next to behaviour and comfort, health and feeding are elements that affect animal welfare as well. With regard to the latter two, the organic sector does not yet distinguish itself from practices in the regular sector and a number of bottlenecks need to be addressed. As the sector is setting high standards, new dilemmas are encountered

which need societal debate. Amongst these are the delicate balance between animal welfare and environmental impact, and the related issue of consumer prices. In outdoor runs, for example, where animals roam freely, manure cannot be effectively controlled. Also, more roaming space per animal implies higher costs per unit.

As, until very recently, mainstream research in the Netherlands has not paid much attention to the specific research questions from organic agriculture, research so far has been mainly bottom-up in nature. In doing so, the sector itself has accumulated more knowledge and experience than regular research institutions. By joining competences and knowledge the sector and the institutes are currently strengthening their collaboration.

Case 6: Netherlands' agriculture in transition: Developing knowledge and innovation

Over the past few decades, societal demand has grown in the Netherlands for agricultural products that carry fewer risks for human health and natural pollution. A new demand that is being articulated is 'sustainability', aiming for agri-businesses being more environmental-friendly, economically viable and socially acceptable. Many practitioners have argued that understanding sustainability requires new and innovative ways of knowledge production that are socially spread, application oriented, trans-disciplinary and accountable to multiple audiences and stakeholders.

Additionally, in such new approaches there is better appreciation of the role of local knowledge, in particular if applied in agriculture or nature management. Concurrently, innovation is seen as a non-linear process in which many actors are involved and knowledge is related to specific socio-spatial environments, in order to arrive at sustainable solutions. New ideas can originate from practical experience, and the role of science in the innovation process is often limited.

The Netherlands' government has initiated a number of programmes that aim to enhance a new knowledge infrastructure. One example is 'TransForum', a platform in which entrepreneurs, non-governmental organizations, government officials and scientists meet to exchange knowledge and develop innovations for a sustainable agriculture (see Box 3). Another example is the Taskforce Multifunctional Agriculture which argues for more coordination in knowledge exchange between stakeholders in multifunctional agriculture.

Box 3:
TransForum: Linking stakeholders on pathways toward sustainable agriculture

TransForum links stakeholders in order to work on innovative practical projects that are based on 'learning by doing'. Practical problems drive the research and jointly with entrepreneurs TransForum finds new pathways to sustainable agriculture and vital rural areas. Not only is practical knowledge being produced but also the methods to generate that knowledge. Individual TransForum projects are part of one of three innovation strategies:

- *Vital clusters: New combinations of economic chains in spatially-concentrated clusters.*
- *Regional development: New combinations of activities for vital rural areas.*
- *International agro-food networks: New trans-boundary production and trade networks in which the Netherlands can excel.*

Innovation in organic farming

In 1997, on the initiative of the Netherlands' Ministry of Agriculture, a start was made to develop and apply new approaches to knowledge generation, in particular with respect to the potential of organic farming in modern agriculture. Organic farming starts with the inherent qualities of the soil: External growth factors, in particular those related to inputs,

play a minor role, if at all. Emphasis is on the internal growth factors within the specific local ecological conditions or that are otherwise locally available.

Research into organic agriculture considers farmers' knowledge as a valuable resource alongside scientific knowledge. One of the pioneering research institutes in this field is the Louis Bolk Institute in the Netherlands (www.louisbolk.org). The institute's research practice is based on 30 years of mutual learning with farmers in the field of organic animal farming. It argues that organic farming relies much more on management skills than on technical adaptations and that top-down innovations and standardization become less relevant. Development of organic farming therefore should rely on learning situations in which farmers can experience new ways of action. In doing so, organic farming in the Netherlands now forms a sector that has created an alternative to modern agriculture.

Innovation in nutrient management

The Netherlands' government also initiated several projects on nutrient management that aimed at developing sustainable farming practices according to the standards set by the European Commission. These so-called Nitrate Projects included innovative approaches to increase nutrient-use efficiency of manure and fertilizers. The projects were developed and implemented at national and regional level respectively, and involved national demonstration projects. At national level the projects performed research and developed new knowledge. Regional projects aimed to circulate information -in this case information on nutrient management- in the respective regions. The national demonstration projects focused on knowledge circulation throughout the country.

The projects applied a model on knowledge development based on 'diffusion of innovation', at three scale levels: Innovation development at experimental and pioneer farms (the 'early innovators') takes place at the top level. The next hierarchical level is that of the 'early adopters' at demonstration farms. The latter have an important role in the diffusion of knowledge towards the rest of the agricultural sector at the ground-level.. An example of such a national research and dissemination programmes is '*Koeien en Kansen' (1996-2006;* see text box).

'Cows and Opportunities' *(Koeien en Kansen) determined the effects of the national targets for ammonia emission and nitrate leaching at farm level. Extensive datasets of mineral balances at dairy farms in different parts of the country and on different soil types were recorded. While monitoring the fate of ammonia and nitrate the project also functioned as a demonstration and study project for the 16 dairy farmers involved. Nine farms focused on knowledge circulation in regional networks ('scaling-out').*