Plan of Action against Plant Nutrient Losses from Agriculture

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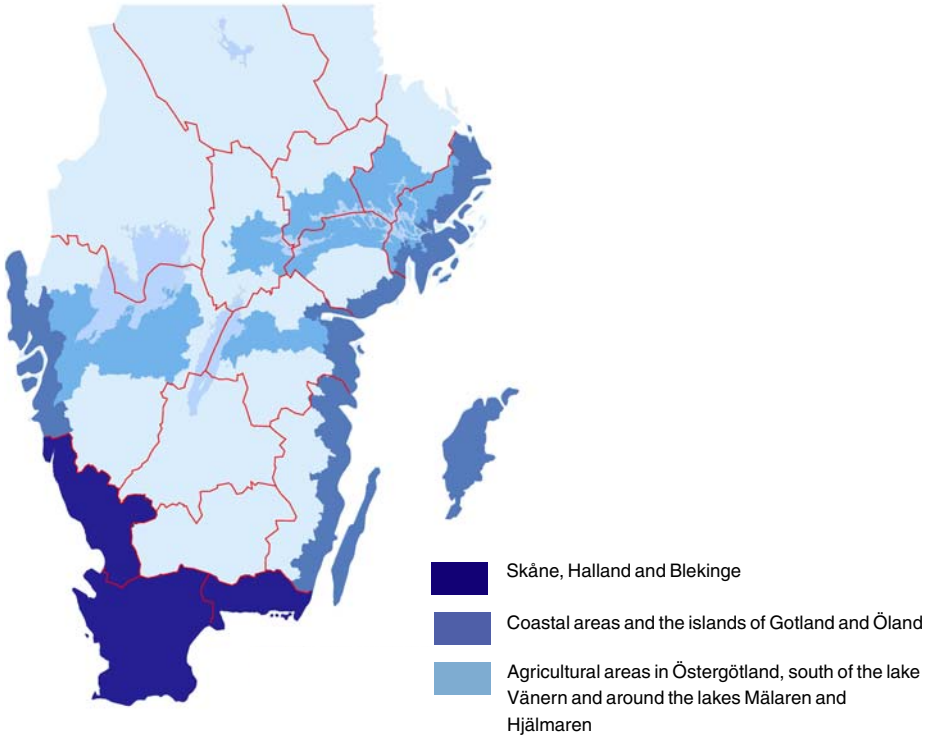
The plan of action

Sweden's plan of action

The first Swedish plan of action for reduced nitrogen leaching was produced as early as towards the end of the 1980s, when the eutrophication issue came to attention. Since then, the plan of action has expanded to also include measures for reducing losses of phosphorus and ammonia from agriculture. The work is based on international commitments and the environmental objectives adopted by Sweden. The most far-reaching or extensive measures are taken in areas appointed as particularly vulnerable to nitrate pollution (see map).



The measures of the plan are carried out via

- legislation
- financial instruments (environmental support, taxes)
- extension services and information
- research and development

International commitments

Efforts to limit and reduce losses to air and water have been going on for quite some time. Several international agreements have been adopted in recent decades, with the aim of limiting the emission of substances harmful to the environment.

Conventions of importance regarding nutrient losses from agriculture are for instance the Helsinki Convention in HELCOM (the Helsinki Commission) and the Oslo-Paris Convention (OSPAR). Both aim to reduce the emission of pollutants into the seas.

The goal of HELCOM is to protect the Baltic Sea from all kinds of pollution from land, shipping, and aviation. Among other things, the Convention aims to reduce nitrogen emissions caused by human activities by half from the level of 1985. The goal of OSPAR is to protect and preserve the marine ecosystems of the North Sea and the North-Eastern Atlantic Ocean.

Within the EU, there is common legislation since 1991, often referred to as the Nitrates Directive (91/676/EEC), which states minimum requirements for reducing nitrogen losses (nitrate losses) from agriculture to both surface and ground water as to coastal and sea water. According to the Directive, each Member State shall identify areas vulnerable to nitrate pollution, and establish a plan of action with the aim of reducing nutrient leaching from agriculture.

The aim for another EU Directive, the so called IPPC Directive (96/61/EEC) is, by coordinated efforts, to prevent and reduce pollution from a number of activities, including large installations holding pigs or poultry which can cause large losses in the form of nitrate and ammonia.

Towards the end of 1999, Sweden and countries in Europe and North America signed a protocol within the UN body UNECE's Convention on Long Range Transboundary Air Pollution. This protocol concerns measures against the discharge of several air pollutants, including ammonia.

National environmental objectives

In 1999, the Swedish Parliament adopted 15 Environmental Quality Objectives. With these new objectives, a holistic approach was taken as regards the efforts to reduce society's negative effects on the environment. One of the Objectives, *Zero Eutrophication*, attacks the problem of losses of nutrients to land and water. In order to make the environmental efforts more precise, the Parliament has also established interim targets to be met on the road towards fulfilling the objectives. The following targets as regards *Zero Eutrophication* concern agriculture:

- By 2010, Swedish waterborne discharges of phosphorus compounds from human activities to lakes, watercourses and coastal waters are to have declined by at least 20 per cent from the 1995 level.
- No later than by 2010, Swedish waterborne nitrogen discharges from human activities to the seas south of the Åland Sea are to have declined by at least 30 per cent from the 1995 level.
- No later than by 2010, Swedish discharges of ammonia are to have declined by at least 15 per cent from the 1995 level.

The measures aimed at reducing plant nutrient losses from agriculture are primarily based on this Environmental Objective and its targets.

Photo: Urban Wigert

Instruments for carrying out the measures

Legislation

Some of the measures in the plan of action are carried out via legislation. Regulations regarding the environment are gathered in the Environmental Code, and in its ordinances and regulations.

Many activities in agriculture and forestry risk harming or disturbing the environment, so particular consideration is necessary in such activities. For certain activities and measures, there are clear rules in the legislation, and for others the rules are of a more general nature. Whether or not there is detailed legislation concerning a certain measure, the Environmental Code's general rules about consideration always apply. Briefly put, they state that every person who carries out, or intends to carry out, activities must obtain the knowledge and take the measures necessary for protecting human health and the environment against damage or inconvenience.

More detailed rules about the handling of plant nutrients are available in the Ordinance on environmental concern in agriculture, and in the Swedish Regulation on environmental concern in agriculture.

The Ordinance on environmental concern in agriculture includes rules on manure storage capacity, covering of slurry stores and filling of stores under a cover. It also includes minimum shares of land under vegetative cover during autumn or winter (so called green land).

The Swedish Regulation on Environmental Considerations in Agriculture includes rules on spreading area and other aspects of spreading, as well as detailed rules on green land.

Storage of manure

If manure is to be spread at times that are suitable from an environmental point of view, it must be possible to store it properly. Manure shall be stored in a way that minimises the risk of contamination of surface and ground water. This means that the storage must be designed in a way that prevents runoff or leaching to surrounding areas. Rainwater that runs off from manure facilities counts as manure or as contaminated water, and must be collected and stored.

For all agricultural enterprises with more than ten livestock units, there are requirements regarding manure storage capacity. In the areas identified as vulnerable, storage capacity requirements apply to all enterprises with more than two livestock units. An enterprise shall be able to store manure for at least six to ten months before spreading, depending on which part of the country is concerned and what species the manure comes from.

Covering and filling of slurry stores

There may be large losses of ammonia when manure is stored. Such losses can be sharply reduced if the air directly above the slurry store is prevented from circulating. A method that efficiently reduces ammonia losses is to cover the slurry stores with, for instance, a roof, a floating plastic cover or a stable natural crust. If the slurry store is filled underneath the cover, this can be kept intact even during filling, which reduces the risk of ammonia emission. In the south of Sweden, and in parts of the plains in central Sweden, special requirements regarding the filling and covering of slurry stores apply to agricultural enterprises that keep livestock.

Foto: Henrik Nätterlund

Restrictions on applied quantities of manure and fertiliser

For environmental reasons, there are restrictions on how much manure and fertiliser may be applied per hectare land. The requirement regarding land available for spreading manure is there in order to avoid plant nutrient losses to lakes, watercourses and the sea from excessive spreading. From 1 January 2006, the supply of phosphorus from manure and organic fertilisers may not exceed 22 kg per hectare available land (with certain exceptions), counted as a five-year average.

Within areas identified as vulnerable, the supply of nitrogen via manure and fertilisers may not exceed the quantities considered necessary for the crop in the site in question.

Spreading of fertilisers

The rules on precautionary measures when spreading fertilisers are not the same in all parts of Sweden. In the areas identified as vulnerable, the rules are more far-reaching than in the rest of the country. In all of Sweden, manure and other organic fertilisers that are spread during the period 1 December – 28 February, shall be worked into the soil on the same day. In the counties of Halland, Skåne and Blekinge, however, the corresponding time limit is four hours, if the manure is spread on bare soil. This applies during the entire year.

Mineral fertilisers based on urea that is spread on bare soil shall always be worked into the soil within four hours of the spreading. The purpose of this rule is to minimise ammonia losses during spreading, and applies in all of Sweden.

As regards the areas identified as vulnerable, the following precautionary measures apply:

- Fertilisers may not be spread on water-saturated or flooded ground.
- Fertilisers may not be spread on frozen or snow-covered ground.
- Manure and other organic fertilisers may not be spread during the period 1 January – 15 February.

Photo: Mats Pettersson

- Mineral fertiliser nitrogen may not be spread during the period 1 November – 15 February.
- During the period 1 August – 30 November, manure and other organic fertilisers may only be spread on growing crops or before autumn sowing. This applies to the counties of Blekinge, Skåne, Halland and Gotland, as well as to the vulnerable coastal areas.
- Solid manure (except from poultry) may however be spread on bare soil during the period 20 October – 30 November, even if the land is not about to be sown, provided that the manure is worked into the soil within four hours. This applies to the counties of Blekinge, Skåne and Halland. On the islands of Gotland and Öland, the same rule applies, except that the time frame is 10 October – 30 November. In other vulnerable coastal areas, this latter time period applies if the manure is worked into the ground on the same day as it is applied.

Spreading liquid manure in growing crops

The largest part of ammonia losses due to the spreading of manure takes place in the first hours after spreading. This means that if the manure is quickly worked into the soil or placed directly into the ground, the losses are efficiently reduced. However, when spreading takes place in growing crops, it is not always possible to work the manure into the soil.

In the counties of Halland, Skåne and Blekinge, the spreading of liquid manure in growing crops shall be carried out using a technology that efficiently reduces ammonia losses.

Spreading in growing crops shall be carried out using one of the following options:

- A method that places the manure directly on the ground underneath the green cover, for instance band spreading.
- Liquid manure drill or a similar method that places the manure directly into the ground.
- Any method that dilutes the manure with water before spreading (1 part manure and at least $^1/_2$ part water).
- Spreading followed by irrigation supplying at least 10 mm of water. The supply of water shall begin no later than four hours, and be completed within 12 hours, after the spreading began. Rain counts towards fulfilment of the 10 mm requirement.

Rules concerning land under vegetative cover in the autumn and winter

An efficient way of reducing plant nutrient losses from arable land during the autumn and winter is to keep the land under vegetative cover (green land) during this period, particularly in areas with light soils and gentle climate. In Halland, Skåne and Blekinge, the rules state that 60 per cent of arable land shall be under vegetative cover during the autumn and winter. In the rest of southern

Sweden, the requirement is 50 per cent. There are rules about when certain crops must be sown and ploughed up in order for the area to be considered as being under vegetative cover during the autumn and winter.

Financial instruments

Since 1984, Sweden has used environmental fees to reduce the use of fertilisers. At the moment, there are special taxes on nitrogen and cadmium content in fertilisers. In January 2006, the nitrogen tax was SEK 1.80 per kg nitrogen. The tax on cadmium in fertilisers containing phosphorus was at the same time SEK 30 per g cadmium that exceeds 5 g cadmium per tonne phosphorus.

Since 1996, there are also various forms of financial support for reducing plant nutrient losses from agriculture. They are partly financed by the EU, and at present they concern:

- buffer strips
- reduced nitrogen leaching (catch crops and spring tillage), and
- wetlands and ponds.

The purpose of buffer strips is to reduce the erosion of plant nutrients, primarily phosphorus, from arable land to water. The buffer strip shall be sown with grass and be at least six meters wide counted from the watercourse. In 2005 there were 9 000 hectare buffer strips. The target of the support is 5 500 hectare.

In order to reduce nitrogen leaching during the period from October to March, support is granted for the sowing of catch crops, and for spring tillage. A catch crop has its main growing period between two main crops, and is grown so that it can take up the plant nutrients left in the soil after harvest, that may otherwise be lost by leaching. Farmers can also receive support if they chose to till their fields in the spring, when the risk of nutrient leaching is lower than in the autumn. Participation has been very high in these two measures, and in 2005, 180 000 hectare are sown to catch crops, and 91 000 hectare are subject to spring tillage. On some 73 000 hectare, both practices are applied. The target for this form of support was that 50 000 hectare should become part of the scheme.

Photo: Mona Strandmark

Wetlands and ponds may act as nitrogen and phosphorus traps, and are important for the reduction of the negative effects associated with plant nutrient leaching. They may also be significant for biodiversity in the landscape. The target for this support is 6 000 hectare wetlands and in the end of 2005 3 300 hectare wetlands had been constructed.

Foto: Henrik Nätterlund

Extension services and information

Extension services

Since 1995, extension services and information are part of the Swedish Environment and Rural Development Plan. This plan was drawn up to fit both the Swedish Environmental Objectives for agriculture as well as EU legislation. Each country administrative board annually draws up a plan for its county, together with various regional organisations. This plan includes regional targets for the activities.

The county plans offer training, both to individuals and to whole groups together. Individual discussions may give the farmer knowledge about environment friendly solutions for the handling of manure and other plant nutrients, based on the enterprise's situation and needs. When whole groups are gathered, county administrative boards and other operators may provide information and demonstrations about the best use of manure and mineral fertilisers in order to reduce the risk of plant nutrient losses. Gatherings like this are also good opportunities for exchanging valuable experiences.

In areas identified as particularly vulnerable to plant nutrient losses, a project called "Greppa Näringen" (Focus on Nutrients) has been introduced within the county plans. This project provides knowledge and tools to farmers, helping them to reduce i.e. losses of nitrogen and phosphorus in a cost-efficient manner. For instance, extension services advocate farmers to reduce the rate of fertilisers when too much fertilisers are used, to move the spreading of manure to times when plant nutrient losses are minimal, and to adapt animal feeding better to need. In addition, Greppa Näringen aims for encouraging the introduction of other environmental measures, for instance the growing of catch crops and the establishment of wetlands.

The first individual extension service visit includes a presentation of the environmental objectives, and the farmer's environmental accounts are studied. During this first visit, the farmer and the advisor together draw up a plan for the extension services that may be relevant for that particular farm in the next three

years. The idea is that the advisor from Greppa Näringen also will return to the farms to follow up on changes. During the second visit, a plant nutrient balance is drawn up for the farm. Such plant nutrient balance is then repeated, in order to further improve nutrient handling and to monitor developments. Data from the plant nutrient balances are stored in a database, so that they can be used for the follow-up of the individual farm, but also for evaluating the project as a whole.

The project began in yr 2001 in the counties of Skåne, Halland and Blekinge. Since then, Greppa Näringen has expanded, and now comprises special extension services and information in twelve counties. At the moment, more than 6 100 farmers participate in the project.

Regional activities at the Board of Agriculture

The Board of Agriculture employs plant nutrient advisors at four sites outside the main office. These advisors' work span several counties. Their task is to make sure that the plan of action for reducing plant nutrient losses is carried out efficiently. This means that regional activities in the area of plant nutrients shall be run in a way that:

- adapts the use of plant nutrients to need, as regards cultivation,
- adapts feeding to needs,
- ensures that mineral fertilisers and manure are spread in a way that makes optimal use of the plant nutrients and avoids negative effects on the environment,
- stimulates the use of cropping systems and cropping techniques that combine financial profitability with minimal environmental effects,
- minimises ammonia losses from agriculture, and thereby also eutrophication and acidification.

Regional advisors shall spread information about results from research and trials in the area of plant nutrients to the operators in the region, as well as other important information (like legislation). Furthermore, they shall support other advisors in their work, and take part in various regional projects and studies within their special fields.

Foto: Ingela Toth

Photo: Urban Wigert

Information material

On a regular basis, the Board of Agriculture produces brochures and other information material for farmers and advisors. Several reports are published that are used as a basis for extension services and for monitoring compliance with the environmental legislation (**www.sjv.se**).

The extension service project Greppa Näringen has its own website, **www.greppa.nu**. This site contains news about measures and environmental objectives, a fact database, and interactive services like plant nutrient balances and a tool for the valuation of manure.

Furthermore, in cooperation with LRF Konsult the Board of Agriculture has designed computer software as an aid for plant nutrient extension services focused on environmental issues. This software is called STANK in MIND, and can for instance be used for evaluating how various ways of handling manure affect the use of the plant nutrient content, or for calculating plant nutrient balances at the farm.

Further training for advisors

The Board of Agriculture offers further training for the plant nutrient advisors at the county administrative boards since several years. On these occasions, current plant nutrient issues are discussed, as well as new facts that have emerged from research and development projects in this field. New environmental legislation and control activities associated with this are also discussed at the meetings.

Research and development

When the plan of action was introduced, it was accompanied by research and development (R&D). These activities include both cropping and technical development within the fields of agriculture and horticulture. Some R&D projects includes measures to improve the handling of manure during spreading, the sowing of catch crops, and feeding strategies. Research and development form an important basis for the design and selection of measures and instruments.

Follow-up and environmental monitoring

Follow-up and evaluation

When the plan of action undergoes follow-up and evaluation, the data used includes i.e. cropped area, livestock numbers, fertiliser sales and participation rates in environmental schemes. Every other year, Statistics Sweden carries out a survey about the handling of fertilisers in agriculture. This study presents data on spreading and storing of manure, and the use of mineral fertilisers.

Every year there is a follow-up of the environmental objectives, and every four years a more thorough evaluation is made. As part of this, the effects of agriculture on the environmental objectives and effects of measures taken within agriculture are examined. In order to follow up on the environmental objective *Zero Eutrophication*, and to obtain data for reporting to for instance HELCOM, model calculations are made concerning total nitrogen and phosphorus load from all sources to the sea. In this context, calculations are also made regarding total nitrogen leaching and phosphorus losses from agriculture. Other calculations concern ammonia discharge from agriculture and other sectors.

The environmental effects of the EU's common agricultural policy are evaluated in a project jointly by the Board of Agriculture, the Environmental Protection Agency and the National Heritage Board. This project includes studies of specific questions about how policies affect plant nutrient losses from agriculture.

Monitoring the environment

The state of the environment and changes to it are monitored within national monitoring programmes. There are monitoring programmes for lakes, watercourses and seas. To a certain extent, these programmes can be used for obtaining information about the effects of measures taken within agriculture.

Within the environmental monitoring programme, there are special programmes called "typical areas" and "observation fields", which are directly aimed at monitoring agriculture's effect on water quality. Typical areas consist of small catchment areas dominated by agriculture, where samples are taken from run-off water and in groundwater close to the surface. Observation fields consist of arable land in the ordinary crop rotation of individual farmers. Samples are taken of drainage water and groundwater close to the surface.

The county administrative boards handle the sampling of typical areas, and the Swedish University of Agricultural Sciences is responsible for coordinating and presenting the results. The University also holds responsibility for the observation fields' programme.

Deposition of airborne nitrogen compounds is monitored within the national environmental monitoring programme. The national environmental monitoring programme is the responsibility of the Environmental Protection Agency. Assessments of air chemistry are made through monitoring stations that are part of the so-called Swedish Precipitation Chemistry Network, and through stations that are part of a European network. The Swedish Environmental Research Institute carries out the measurements.

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