Ecosystem Health and Sustainable Agriculture

Sustainable Agriculture

Editor: Christine Jakobsson
Introduction

The advisory and information project Focus on Nutrients (in Swedish Greppa Näringen) was introduced in 2001 by the Swedish Board of Agriculture in collaboration with the Federation of Swedish Farmers (LRF), county authorities and agricultural advisory organisations. It offers free environmental advice to farms of more than 50 hectares and/or more than 25 animal units*. The aims are to reduce emissions of greenhouse gases from agriculture, to reduce nitrogen and phosphorus losses from agriculture in a cost-effective way and to promote the safe handling of crop protection products. Focus on Nutrients is funded by the Swedish Government, the EU and re-invested environmental taxes. In recent years around 2.9 million Euros have been spent annually, of which three-quarters went to the individual advice sessions that are provided free of charge to farmers.

The project takes the form of a campaign to provide training and advice and aims to encompass the entire flow of nutrients on the farm. The background to the project is the Swedish national environmental quality objectives (EQO). Farmers are expected to voluntarily implement measures to reach the goals as a result of the advisory service. They can choose between approximately 20 different advisory modules suitable for the different production specialisations on farms and, together with the advisor, develop concrete solutions that benefit both the environment and farm profits.

<table>
<thead>
<tr>
<th>Swedish EQO</th>
<th>Area covered by Focus on Nutrients</th>
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</thead>
<tbody>
<tr>
<td>Zero Eutrophication</td>
<td>Phosphorus losses, nitrogen leaching, ammonia volatilisation</td>
</tr>
<tr>
<td>Natural Acidification Only</td>
<td>Ammonia volatilisation</td>
</tr>
<tr>
<td>Good-Quality Groundwater</td>
<td>Nitrogen leaching</td>
</tr>
<tr>
<td>Reduced Climate Impact</td>
<td>Nitrous oxide emissions (nitrogen leaching)</td>
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<tr>
<td>A Non Toxic Environment</td>
<td>Handling of plant protection chemicals</td>
</tr>
</tbody>
</table>

* animal unit: 1 cow, 1 horse, 3 sows, 10 slaughter pigs, 100 poultry
Resources Directed to Where the Need is Greatest

Focus on Nutrients started in Southern Sweden, where agriculture is more intensive, the environmental impact is larger and environmental protection measures have the greatest effect. Advisory work was extended in stages to include all the plains of Götaland and Svealand (Central Sweden), a region identified as being nitrate-sensitive according to the EU Nitrate Directive (Figure 61.1) as well as since 2010 to several bordering counties (Jönköping, Kronoberg, Dalarna, Värmland and Gävleborg). The reasons for this are that advisory service on climate change is recently offered and some of the waterbodies in these counties are not classified as good ecological status according to the EU Water directive. Northern Sweden is still not included, mainly due to its very extensive agriculture leading to a smaller impact on the environment. The county authorities procure advisory services from advisory firms or organisations.

There are many different ways to reduce nutrient leaching, some of which are more important than others. The most critical are:

- Adapt animal feeding strategies to the animals needs of nitrogen and phosphorus (do not overfeed with protein).
- Decreasing nitrogen emissions from animal houses to a minimum.
- Decreasing nutrient losses from manure storage and during spreading to a minimum.
- Spreading farmyard manure when there is little risk of nutrient losses.
- Having fewer occasions when more than the optimal amount of nutrients is applied to crops.
- Decreasing fertilisation for a high protein content in crops.
- Carrying out as much soil tillage as possible in spring or late autumn.
- Increased cultivation of catch crops.
- A larger area of wetlands.

Sequence of Advisory Modules

The advisor applies the EQO at the level of the individual farm and goes through all the possible ways of decreasing nutrient losses to the atmosphere and water. The need for advice varies from farm to farm and is tailored accordingly. The advice offered is divided into different modules, some of which apply to all farms, e.g. nutrient balance. Each farm is unique and many farms have already drawn up a nutrient balance. After that, the advice required is tailored according to the specialisation and type of livestock on the farm. Advice is provided by different local advisors and it is up to the farmer to choose. The service starts with a single farm visit and relies on the advisor returning to monitor the outcome of the advice given. To help in this process, different key environmental indicators are calculated. These are documented so that the progress in improvements can be traced. Below the modules in Focus on Nutrients are listed. A later addition is the module on climate change and it should also be mentioned that all modules are climate secured.

- Start – planning advisory needs
- Basic nutrient balance
- Repeat nutrient balance
- Nitrogen strategy
- Phosphorus strategy
- Soil compaction
- Handling of plant protection chemicals
Farm Level Economics and How to Change Behaviour

- Planning wetlands
- Grass crop strategy
- Animal housing environment
- Planning of buildings
- Inspection of feeding plan for dairy cows
- Inspection of feeding plan for beef cattle
- Grazing strategy
- Feed consumption recording for piglets
- Feed consumption recording for fattening pigs
- Climate change strategy

More Information Pathways Used
Towards the end of this ten-year period, 7,250 farmers are receiving recurrent advisory services. Some 700 have received advisory services but are no longer farmers. 1,350 have received advice about wetlands or water protection and some 750 have signed up to use calculation services on the website. This corresponds to a total participation of 10,050 farmers. The advisory services have had the greatest uptake in the county of Skåne, in the south of Sweden, where more than 60% of the arable land belongs to farms within Focus on Nutrients. All members receive a membership letter twice a year. The project website www.greppa.nu is an information channel directed at both farmers and advisors. Environmental news, assessment of manure and calculation of nutrient balances are examples of functions used by farmers visiting the website. Advisors obtain material for their advisory work via a special link. Training courses are provided for advisors.

Benefits of the Project
Information is collected from the first visit and is stored in a database. This provides a description of cropping practices and plant nutrient balances and how they have changed after the advisory service. Other evaluation methods include postal questionnaires on environmental attitudes, protection measures and opinions on the project.

Nutrient Leaching
A plant nutrient budget for nitrogen, phosphorus and potassium is calculated on many farms. The inflow of nitrogen to the farm occurs through purchased products, i.e. feed and fertilisers, deposition and nitrogen fixation. The outflow of nitrogen takes place through products, e.g. crops and livestock (meat and milk). What remains is called surplus, of which a small fraction is transformed to increase the soil humus content, but the majority is lost as ammonia emissions, leaching and denitrification. On a Swedish arable farm, the nitrogen use efficiency is often around 70%, which means that 30% of the nitrogen supplied is lost. The surplus is often between 30 to 50 kg per hectare. Nitrogen use efficiency on livestock farms varies between 25 and 70% depending on animal species and number of animals per hectare. On an intensive dairy farm, the nitrogen surplus is often around 150 kg per hectare in southern Sweden. The conversion of plant products to animal products leads to unavoidable losses (Figure 61.2). On 35

![NITROGEN SURPLUS ON 575 DAIRY FARMS](image1)

Figure 61.2. The nitrogen surplus is explained by ammonia emissions, nitrogen leaching, nitrogen gas emissions and some storage in the soil. The surplus increases with increasing the surplus on many farms. Data from Focus on Nutrient farms (SLU).

![NITROGEN SURPLUS ON 35 DAIRY](image2)

Figure 61.3. These farms form part of the Skåne creameries environmental bonus programme and have continuous balances from 1997 with the exception of the year 2000. Milk production has remained fairly constant (~ 6,000 kg milk/hectare) but the nitrogen surplus has decreased over time (SLU).
milk-producing ‘environmental bonus farms’ that were monitored over a long period, the nitrogen surplus decreased by over 45 kg per hectare from 1997, with a 7 kg decrease in the period 2001-2004 (Figure 61.3), showing that it is possible to decrease surpluses and that long-term work produces rewards. The decrease in nitrogen leaching from Swedish fields is mainly explained by farmers growing considerably more catch crops, nitrogen use efficiency being improved, a decrease in the area of arable land and delayed soil tillage (Figure 61.4). The decrease in leaching depends to a lesser extent on changes in livestock numbers and in the time of manure spreading.

Concrete Measures
Changes in cropping practices such as reducing manure spreading in early autumn and performing soil tillage, especially ploughing of ley, to a larger extent in the spring can lead to decreased nitrogen leaching. Agriculture is dependent on the weather and therefore there have to be certain margins in cropping, as variations between years remain. In very dry or wet years it is difficult to get high yields, which leads to poorer returns on nitrogen and greater losses. One way to decrease the flow of nitrogen that continues to leach out despite preventive measures is the establishment of wetlands. Conversion of nitrate nitrogen to nitrogen gas and increased biological diversity are both benefits created by wetlands. Almost 3,700 hectares of new wetlands were established in Sweden in the period 2000-2005.

Better Manure Handling Decreases Ammonia Emissions
Ammonia losses have decreased on many farms, partly due to increased precision in manure spreading, such as more incorporation of manure (Figure 61.5). A positive development is that many farmers are converting from a solid manure system to slurry, but if the manure is not quickly incorporated into the soil the entire nutrient gains can be lost. On livestock farms in particular, there are many ways to reduce emissions. Ammonia emissions represent 25% of the nitrogen surplus on dairy farms and nitrogen gas emissions 20%. Nitrogen gas emissions are a loss for the farmer but are not an environmental problem, although small amounts of the greenhouse gas nitrous oxide are emitted. The most critical deciding factors in decreasing ammonia emissions are appropriate storage and spreading of manure. Losses during storage can be avoided through good
covering and thus decreased air exchange, which is easiest for slurry. Spreading of manure on open soil is decreasing and spreading in ley and other growing crops is increasing. The project has shown so far that farmers nowadays seldom spread manure during unsuitable weather conditions such as warm and windy weather, while increasing numbers are incorporating manure more promptly.

Animal Diet and Housing Important for Ammonia Emissions
Another important measure to reduce the nitrogen content in urine and faeces produced by livestock is to supply the correct diet and not overfeed animals with protein. On 575 dairy participating farms, a 4-6% reduction in the inflow of protein-rich concentrate has been observed in recent years but milk production has still increased due to more efficient forage production and feeding strategies.

Additional measures to prevent ammonia emissions often involve high costs, for example conversion of livestock housing and manure containers, and can often only be implemented in new buildings or if the investment is heavily subsidised. Such measures include cooling manure in manure tanks, installing efficient urine separation, decreasing the manure area in houses and building roofs over manure containers.

Increasing Efforts for Phosphorus
Efforts are now being increased to obtain knowledge and produce new advice regarding phosphorus. The improved Greppa Näringen prevention programme for phosphorus losses involves:

- Decreasing the amount of phosphorus that can be lost
- Decreasing the risk of phosphorus leaving the field
- Capturing the phosphorus lost from fields.

Both dairy and pig production farms have similar surplus in their plant nutrient balance and in the case of phosphorus this is mainly a question of avoiding overfeeding the animals, as a large proportion of the phosphorus supplied to animals via the diet ends up in the manure. It is also important for farmers to have an up-to-date soil map of their fields so that they can refine their fertilisation strategy. Phosphorus fertilisation can often be decreased on many farms with potato crops. Focus on Nutrients has found that on most farms phosphorus fertilisation is well adjusted to crop requirements but on livestock farms there are still gains to be made by applying manure to all fields on the farm and not only in the vicinity of the animal housing (Table 61.2).

<table>
<thead>
<tr>
<th>Difference per hectare between inflow and outflow of phosphorus with:</th>
<th>First balance year 2002</th>
<th>Balance year 2004</th>
<th>Difference between balances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed</td>
<td>27.1</td>
<td>25.2</td>
<td>-1.9</td>
</tr>
<tr>
<td>Fertiliser, bedding</td>
<td>0.6</td>
<td>0.6</td>
<td>0.0</td>
</tr>
<tr>
<td>Animal products</td>
<td>-8.2</td>
<td>-9.7</td>
<td>-1.5</td>
</tr>
<tr>
<td>Vegetable products</td>
<td>-11.8</td>
<td>-13.5</td>
<td>-1.7</td>
</tr>
<tr>
<td>Surplus</td>
<td>7.7</td>
<td>2.6</td>
<td>-5.1</td>
</tr>
</tbody>
</table>

Appropriate Tillage and Barrier Zones Stop Field Losses
To decrease the risk of phosphorus leaving the field, it is necessary for the farmer to know their fields well, to know how water moves and where it collects in hollows and to prevent phosphorus dissolved on soil particles from reaching the water environment. Careful soil tillage gives rapid infiltration, which decreases the risk of phosphorus being lost in surface runoff. Environmental subsidies are available for the creation of riparian zones along watercourses and lakes and for establishing wetlands on suitable sites in the agricultural landscape. Wetlands do not decrease the amount of phosphorus, but prevent it from leaching out into sensitive watercourses. They can be seen as a filter and the material they capture is collected in the bottom sediment and must be removed on occasion. Barrier zones are frequently implemented. In one of the latest environmental target reviews, 88% of farmers reported that they had established such zones along watercourses. In addition, 63% are now growing grass on land prone to flooding and many of those who have surface water wells in arable fields have ensured that there is grass growing around them.

Safer Handling of Crop Protection Products
Around 90% of farmers surveyed in Focus on Nutrients fill their crop sprayers on impermeable slabs or similar
and thus decrease the risk of crop protection chemicals leaking out into lakes and watercourses. The project motivates farmers to improve their handling of crop protection chemicals and over 1,000 advice sessions on safer crop protection have been provided. Apart from filling crop sprayers on an impervious surface where water is collected – or on a biobed – around 90% also test the function of their crop sprayers regularly nowadays. The use of glyphosate (Roundup) in conjunction with weed control on farm yards and other paved areas has decreased compared with previously.

The Vemmenhög Project led by Jenny Kreuger at SLU shows that it is possible to decrease the occurrence of pesticide residues in watercourses by 90%, despite almost no changes being made to the amounts of crop protection chemicals used (described in Chapter 24). This is achieved through safer handling of crop protection chemicals, a measure that has been promoted in advisory work in Swedish agriculture in recent years. In addition to the work on avoiding point sources of emissions, this is increasingly a question of choice of chemical.

Losses of glyphosate can be particularly large on clay soils, while other pesticides leach more readily from sandy soils. The intrinsic leaching properties of different crop protection chemicals and the timing of application have a great impact on the occurrence of chemical residues in watercourses. Fewer autumn sprayings are recommended, since these carry a greater leaching risk. The soil is often saturated with water at this time of the year, while crop uptake and evaporation are minimal. Therefore excess water in the soil goes towards filling the groundwater reserves or runs out via the drainage system and the risk of undesirable transport of chemical residues increases.
References


Chapter 61


Swedish Board of Agriculture, SBA. 2009. Focus on Nutrients - a project run jointly by the Swedish agricultural industry, the Swedish county administrative boards and the Swedish Board of Agriculture.