Best agricultural practices around the Baltic Sea
Optimising the use of nutrients is a cost-effective way to enhance farm productivity and brings other benefits to the farm, as well as improving the environment. For the farmer, it can sometimes be quite a challenge to choose the best way of using or handling nutrients on the farm. Advisory services are central to putting best agricultural practices into use.

Read more about good agricultural practices, measures and investments at balticdeal.eu/measures
Nitrogen (N) and phosphorus (P) are the glue of life. They are essential for all living organisms and are intrinsic to all ecosystems. They are used to build and repair tissues and regulate body processes and are converted to and used as energy. In agricultural ecosystems, well-planned, economical use and management of nutrients by farmers is essential for sustainable development. This is irrespective of whether the nutrients come from the soil substrate or are provided via external inputs of manure or fertiliser, and whether they are used for producing food, renewable energy or fibres for the local society or, as is the case in Europe today, for the global market. In sustainable agricultural systems, nutrients are wisely used resources.

Farmers in the forefront
Farmers in the Baltic Sea region are well aware that unwise handling and use of nutrients may lead to losses of an important resource from the farm. They are also highly conscious of the expectations of society regarding further reductions in farm losses of nutrients to surface waters and ground water, some of which may eventually find their way to the Baltic Sea. New knowledge, techniques and practices are continuously being introduced in the area of nutrient handling and use and are increasingly being disseminated among farmers, sometimes together with investment support.

Importance of knowledge
Advisory services are central to putting best agricultural practices into use. Around the Baltic Sea, skilled national advisors meet farmers individually or in groups on a daily basis. Armed with the latest knowledge, these advisors are working towards sustainable development in future agriculture.

Demonstrating best practices
Demonstration farms are another way to ensure effective dissemination of best agricultural practices. Positive farmers as role models, with the support of advisors, provide real world examples of best practices on these demonstration farms. This brochure presents examples of demonstration farms representing a mixed set of production systems, chosen from the countries represented in the Baltic Deal project. These real world examples represent an array of measures, practices and investments, concretely leading to reduced nutrient losses. In addition, the report lists the over 100 demonstration farms that constitute the Baltic Deal demonstration network at present. The number of actual practices, measures and investments represented on these farms is even greater.

We warmly welcome you to learn more about this!
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A downward trend
The eutrophication of the Baltic Sea can be observed through excessive algal blooms, changes in biodiversity, dead areas of sea bottom and decreased fish catch.

On a positive note, the latest official figures from the Intergovernmental Helsinki Commission (HELCOM) on nutrient loads indicate a clear downward trend since 1990. Computer simulations and practical research reveal that this trend started a decade earlier and that current levels are lower than those of 1960.

This is mainly due to considerable investments in wastewater treatment plants, elimination of various industrial hotspot point sources and improvements in agricultural practices.

Recent Swedish research also detected significant downward trends in nutrient loads and concentrations in Swedish agricultural catchments, clearly reflecting agri-environmental measures and advisory efforts.

In a sample of 65 small watercourses in southern and central Sweden that are predominantly agricultural, with minimal im-
pact from other human sources, significant downward trends can be seen in both the concentration and transport of nitrogen and phosphorus.

Assessments of phosphorus inputs to the waters of the Baltic Sea show that the internal loads from bottom sediments are currently larger than the influx from the drainage basin.

**Fewer predators – more algal blooms**
The nutrient load is highly influenced by the internal ecosystem functioning of the Baltic Sea. The role of fish stocks in the nutrient chain has recently been highlighted as being of particular importance.

Overfishing combined with lack of oxygen has greatly decreased the numbers of cod in the Baltic Sea. Thus the amount of herring and sprat has increased, leading to smaller amounts of their stable feed, zooplankton, in turn increasing the amount of phytoplankton, leading to algal blooms.

**The past affects the present**
What complicates matters further is that the current status of eutrophication depends on nutrient emissions and loads from decades ago.

Therefore, when examining the reasons for the present status of the Baltic Sea, it is necessary to consider past practices, policies and knowledge alongside those of the present day. At the same time, the interplay between man-made and natural changes must be considered.

Nutrient loads increased steeply after World War II. The nutrient loads to the Baltic Sea peaked around 1980, since when they have decreased steadily.

**Changes take time**
High nutrient loads in combination with long residence times of water mean that nutrients discharged to the Baltic Sea remain for a long time, particularly phosphorus. In addition, the vertical stratification of the water masses increases the vulnerability of the Baltic Sea to eutrophication.

The most important effect of stratification in terms of eutrophication is that it impedes or prevents ventilation and oxygenation of bottom waters and sediments by vertical mixing of water, a situation that often leads to oxygen depletion.

**Internal loads**
Lack of oxygen also has an effect on the capacity of the sediments to bind phosphorus. In the absence of oxygen, sediments release significant quantities of phosphorus to the overlying water.

Assessments of phosphorus inputs to the waters of the Baltic Sea show that the internal loads from bottom sediments are currently larger than the influx from the drainage basin.

**Decreasing nutrient loads**
Source: Bo Gustafsson, Baltic Nest Institute (2010)

Eutrophication is the ecosystem response to addition of artificial or natural substances, such as nitrates and phosphates, through fertilisers or sewage, to an aquatic system.

**Factors affecting eutrophication**
- Wind flows and sea streams
- Rainfall amounts in a season
- The large amount of phosphorus in the Baltic Sea and the bottom sediment (internal loads)
- Inflow of new, oxygen-rich salt water from the North Sea
- Climate-related changes in precipitation and temperature
- Stratification

**Reduction of nutrient loads from farms**
Reducing nutrient loads from widespread agricultural land with variable soil characteristics, exposed to ever-changing weather conditions, is broadly speaking more complicated than cutting loads from point sources with controlled flows of waters.

The effect of an agri-environmental measure, such as use of catch crops or reduced application of phosphorus fertilisers, may take several decades before being reflected in actual reduced loads in the outlets and eventually influencing the eutrophication status of the Baltic Sea.
Farm growing cereals and sugar beet

- Size of farm: 70 ha
- Main production: Sugar beet (20 ha), cereals (50 ha)
- Crop rotation: corn, winter wheat, winter rape, clover
- Soil: Clay soil
Valuable agri-environmental measures

The farmer can reduce nutrient losses from the farm, as well as saving money, by improving practices, implementing measures and investing in best available technology. The agri-environmental advisor helps the farmer to plan effective measures.

Farm nutrient balance

The nutrient balance gives the farmer a wider picture of the farm’s total nutrient use efficiency. It shows the amounts of nutrients that have not been utilised on the farm but have either leached, volatilised, or been retained in the soil.

The farm nutrient balance is calculated for the current year to get a correct idea of the nutrient flows. The balances on a crop farm are mainly affected by the yield level every single year, so it is important to repeat the balance for coming years.

If the balances are in large surplus year after year, farming practices should be studied to find the reason for this. Inefficient use of nutrients is also a financial loss to the farmer.

Calculations lead to agri-environmental measures

Calculations show that 148 kg nitrogen per hectare enters the farm and 95 kg nitrogen per hectare is removed from the farm. This means that 53 kg/ha stays in the soil and/or leaches.

Furthermore, 22 kg phosphorus per hectare enters the farm and 19 kg phosphorus per hectare is utilised by the plants. This means that 3 kg/ha stays in the soil and/or leaches.

Based on these results, the advisor instructs the farmer on how to adjust the fertilisation according to crop requirements. The amount of phosphorus, pH and clay in the soil is also taken into account.

Soil samples

In consultation with the advisor, the farmer also decides to take soil samples to help analyse the results of the nutrient balance calculations. Soil analysis provides information about the properties and nutrient status of the soil right now.

Soil tests are mainly used to determine soil nutrient content and pH value. It is important to ensure that there is an optimum supply of all nutrients. A deficiency of any nutrient can limit growth. Then the risk of nitrogen losses can increase.

The availability of nutrients present in the soil depends on soil pH. In general, nutrients are most available for plant use in the pH 6-7 range. Maintaining suitable pH levels also benefits plant nutrition through better root growth, enhanced microbial activity and better soil physical properties.

Grasslands

To obtain good yield, the farmer needs to take good care of the grassland. One way to get maximum yields is to practise rotational grazing, which increases the possibility for good pasture management. Another measure is to plough and re-seed old grasslands with low productive species.

In summertime the cattle are out grazing. Clean water is available in tanks on pastures. The animals are not allowed to drink from the small stream that flows through the fields because the farmer wants to keep the banks of the stream unbroken to avoid erosion and soil entering the water.

On the farm, peas are grown to produce protein-rich feed for animals, as well as cereals. Manure and nitrogen-fixing plants are utilised as a nutrient source for plants. However these can be high risk crops if they are ploughed under at the wrong time, for example before autumn sowing.

Plant cover

Because of the grasslands, there is a lot of plant cover in the wintertime. This reduces the risk of erosion during wet periods. Grasslands also have a positive effect on soil structure and biodiversity, and reduce greenhouse gas emissions.

Calculating the farm nutrient balance

Nutrient balance = Nutrients entering the farm – Nutrients leaving the farm

Nutrients come to the farm in the form of fertilisers, feed, N-fixing plants, new animals, atmospheric deposition and seeds. Nutrients leave the farm in the form of milk, meat, eggs, harvest, manure and sold animals.

Nutrient leaching

There is always some nitrogen and phosphorus leaching from the soil, regardless of whether it is under a wheat field, a forest or a flowering meadow. The risk of nutrient leaching increases if more nutrients are added to the soil than can be utilised by the crop. Weather conditions and type of soil affect the risk of leaching.

The nutrients leached through surface or sub-surface runoff into watercourses eventually end up in the Baltic Sea.
Farm with dairy cows and cereals

Size of farm: 300 ha
Main production: Milk production and cereals
Animals: 200 dairy cows
Soil: Clay soil

Floating crust
Slurry analysis
Improved indoor environment
Trailing hoses
Co-operation with neighbours
Catch crops

Good soil structure
Crop rotation
Cultivated grassland
Fertilise efficiently

The farmer’s challenge is to use the manure in a more efficient way. He has just switched from using solid manure to slurry. To save time and work, he has also invested in milking robots in the new cow house he is building.

Floating crust
The slurry is stored in a tank with a floating crust. The floating cover is cheap for the farmer and he saves money compared with using a sealed roof. The crust mostly forms automatically, especially if peat is added.

Without a covering, 10 per cent of total nitrogen in the slurry can be lost in the form of ammonia. These ammonia losses contribute to acidification and eutrophication. If the farmer covered the slurry with a sealed roof, the gaseous losses would be even less.

Slurry analysis
To get an idea of the slurry’s nutrient content, the farmer takes slurry samples every season.

Fertiliser plan
The fertiliser plan helps the farmer to consider the appropriate amount of fertiliser used in different field parcels. This helps the farmer to minimise the risk of nutrient leaching. Soil type, soil conditions, slope, climate, crop rotation, desirable yield, nutrient storage in soil and soil pH are taken into account in the plan.

Spreading slurry with trailing hoses
Using trailing hoses to fertilise the fields reduces the farm’s gaseous nitrogen losses compared with broadcast spreading. The utilisation of nutrients by the cereals is also better when trailing hoses are used.

The aim of fertilising is to supply the right amount of nutrients at the right time. Slurry from dairy cows will be used most efficiently if supplied in spring, when around 70 per cent of the plant-available nitrogen can be utilised. Tilling afterwards has a positive effect.

Application of slurry to short-term grassland is interesting for many farms, utilising the large amount of potassium in the slurry. The spring is the best time for this, much better than during summer or autumn.

In the summer the temperature is usually too high (gaseous nitrogen losses) and it is important to choose days when it is cloudy or rainy, if possible. Spreading in the autumn increases the risk of leakage during winter.

The farmer has invested in a slurry tank large enough to store the manure for a year, which means that he does not have to spread the slurry during autumn anymore.

Improved indoor environment
Ammonia volatilises when manure comes into contact with air. When constructing new houses the farmer should try to minimise unnecessary areas with manure, especially areas with no access to automatic manure handling. Smaller areas mean lower ammonia losses.

In the new cow house the temperature is lower than before, to minimise the risk of gaseous ammonia losses. Cattle can handle a lower indoor temperature than feels comfortable for humans.

Incorporation of peat in deep straw bedding can also minimise ammonia losses, as can use of chopped straw instead of intact straw.

Catch crops
Catch crops are fast-growing crops that are grown simultaneously with or between successive plantings of a main crop. They take up nutrients after the harvest of main crops and reduce surface run-off and soil erosion. Catch crops can be incorporated in the autumn, but it is even better if the catch crop remains until the next main crop cultivation.

Injection spreader
Some farmers choose to invest in an injection spreader. Losses of ammonia can be reduced even more by injection than by using trailing hoses. Odour problems are also reduced. The injection can injure plant roots slightly in grasslands, but on the other hand some hygiene problems can be avoided.

Injection of slurry involves cutting slots in the soils, injecting the slurry and then closing these slots after application. This reduces the risk of nutrient run-off and gaseous losses to the air.

Injecting slurry as opposed to applying it to topsoil makes it possible to directly reach the active soil layer and nutrients are better available for plants.

Catch crops are chosen in relation to
- climate
- soil type
- crop rotation
- turnover rate
- main purpose of the catch crop

Examples of catch crops are perennial ryegrass, white and yellow mustard and oil radish.
Size of farm: 200 ha with cereals, short-term grass leys and natural pasture.

Main production: Cattle production

Animals: Cattle and sheep

Crop rotation: Oats and grass seed, grass-clover ley (3 years), winter wheat, leguminous crop

Soil: different types of mineral soils rich in organic matter
Benefit from nature

Effective use of wetlands is an example of how the farmer can benefit from natural resources. Another way to make major savings and obtain environmental benefits, is for example by reducing the concentrated fodder during periods with good access to pasture.

Production grazing areas
If the area is limited, strip grazing is effective, but it is labour intensive. Production grazing areas, where the cows have the possibility to satisfy most of their nutritional needs, is a good way to utilise the nutrients in manure.

Crop nutrient uptake can be balanced by the manure contribution. The risk of nutrient leaching increases if the grazing area is small compared with the amount of animals.

On farms with limited grazing areas and a smaller proportion of grazing in the feeding plan, the cows can stay indoors a few extra hours in connection with milking and feeding. Then there will be more manure in the house and the nutrition contribution in the grazing area will be lower.

Healthy and contented animals result in optimal production and ultimately in a lower environmental impact.

Management of solid manure
An important way to avoid nitrogen and phosphorus losses from spreading solid manure is to not apply amounts that exceed crop requirements. It is equally important to choose timing carefully, even though practical considerations must be taken. One example of a high-leaching situation is when manure is applied early in autumn on grass that is to be ploughed under. This causes high losses even if winter cereals are sown and should be avoided.

To avoid ammonia losses, it is important to have rapid incorporation into the soil after spreading and to choose cloudy and rainy days without too much wind.

Varied crop rotation and fallow
A crop rotation consisting of leguminous crops, cereals and grass keeps soil structure in good condition and reduces the risk of nutrient losses. A varied selection of plants also helps to control plant diseases and pests.

The farm tries to avoid bare fallow because the risk of nutrient losses is high. Sometimes it is necessary to control weeds. The bare soil period is kept as short as possible, and e.g. a catch crop or winter cereal is sown on the field soon after the fallow period.

Wetland to capture nutrients
To capture nutrients efficiently from run-off water, a sufficiently large wetland in relation to the catchment area can be constructed. A drainage channel leads into the wetland.

A chain of sedimentation ponds before the constructed wetland slow down the water flow and let the particles settle out. Wide buffer zones along watercourses also help to reduce erosion.

Benefits of wetlands:
• Reduce nutrient leakage
• Improve biodiversity (important habitats for birds, fish and vegetation, for example)
• Bring variety and diversity to landscape
• Used for recreation
• Storage for irrigation water
• Control water levels during floods

Constructing a wetland
The wetland is constructed to be relatively shallow, because this is best for both reducing nutrient leaching and improving biodiversity.

The costs depend on the size and structure of the wetland. Most costs come from digging, planting and management. The choice of location affects the costs because, for example, damming would be cheaper than digging.

Plants will eventually find their way to the wetland, but the farmer can speed up the process by planting and seeding. Plants are important for the wetland to have an impact on nitrogen loading, because organic matter is needed in the denitrification process.

Effect of wetlands
A Swedish study estimated the capacity of wetland to retain nutrients based on water samples and modelling. The 50 wetlands in the study retained on average 59-105 kg of nitrogen and 1.7-5.3 kg of phosphorus per hectare of wetland surface and year.

However, there was large variation and better retention results could be achieved with wetlands constructed specifically for nutrient retention.

A Finnish study made a comparison of the nutrient retention capacity of three wetlands (one natural and two constructed wetlands) based on monitoring and modelling. The nutrient load reduction for total nitrogen was -8 – 38 per cent and for total phosphorus -6 – 67 per cent. The constructed wetland with the longest water residence time showed the best performance, retaining annually about 25 kg of TP and 300 kg of TN per hectare. The results of the study indicate the great importance of wetland size for the load reductions.
**Pig farm**

- **Size of farm:** 400 ha
- **Main production:** Sows, piglets, fattening pigs
- **Animals:** 1,200 sows, 33,600 piglets, 4,000 fattening pigs
- **Crop rotation:** Winter barley, winter rape, winter wheat and spring barley
- **Soil:** Loam soils
Manure investments

Opportunities for environmental measures in pig production are high. They are important to prevent leaching of nutrients at farm level. The agri-environmental advisor helps the farmer to go through the field and fertiliser plan for the season.

Fertiliser plan
The target of the plan is the highest profit, the best crop quality and the lowest environmental impact. The optimal strategy depends on the crop.

Together with the farmer, the advisor looks at the demand for different nutrients by different crops. Winter rape utilises the phosphorus and potassium in manure best, but the results from soil analysis must also be considered so fields with low contents of phosphorus and potassium receive manure as well.

Slurry separation helps to reduce any excess phosphorus from livestock production. The urine and dung are mixed in the stables. Slurry separation is a technical processing of slurry, which creates a liquid fraction and a solid fraction. These fractions are very different from the slurry with regard to dry matter, composition and concentration of nutrients.

The solid fractions are used in the farm biogas plant or sent to a biogas company to produce electricity. They can also be sent to farmers with only arable production.

The liquid fraction is spread with trailing hoses or injected in the soil.

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Slurry separation
Separation of livestock manure will in general split 100 kg slurry into a 5 kg fibre fraction with about 25-35 per cent dry matter, holding roughly 20 per cent of the nitrogen and 80 per cent of the phosphorus. The 95 kg liquid fraction holds 1 per cent dry matter, 80 per cent of the nitrogen and 20 per cent of the phosphorus.

Biogas plant
The farmer has a small biogas plant which produces electricity and heat for the farm-house and the piglet houses and the energy for slurry cooling. Part of the electricity is sold to neighbours.

Feeding planning
An effective measure to reduce the nutrient content in animal manure is to adjust the feed protein supply to the nutritional demand of the pigs. Phytase can also be added to the diet to reduce the manure’s phosphorus content.

The feeding plan adjusts the protein supply to the pigs’ nutritional needs. This is to minimise the amount of nitrogen and phosphorus in the manure.

The diet also includes forage grown on the farm. The farmer is very precise in forage management – when it is cut, how it is dried and how it is stored. This makes good quality forage and thus the need for supplementary concentrate is less, which benefits both the environment and the farm’s budget.
Egg production and cereals

Size of farm: 450 ha
Main production: Cereals and egg production
Animals: 54,000 laying hens
Crop rotation: Winter rape seed, winter wheat, oats, barley, peas, winter wheat, fallow.
Soil: Clay soil
Invest in modern and traditional techniques

By combining modern and traditional techniques, this conventional, large-scale farm has halved nitrogen leaching to surrounding waters. The farm has a large plant for grain handling and its own feed formulation for the poultry.

Spring tillage
Spring tillage is a simple and effective measure, which many can perform. The soil is warmer, which may result in earlier germination and growth. The manure effect may be better when spread early in spring and ploughed or tilled in directly. Nitrogen leaching may decrease by as much as 25 per cent with a change to spring tillage.

However, spring tillage is not suitable on heavy clay soils. Furthermore, since nitrogen leaching from these soils is much lower than from lighter soil type, the beneficial effect of spring tillage is not as great.

Precision farming
The N-sensor, indicates the amount of nitrogen a plant needs and allows fertilisation to be adjusted to requirements.

This helps to reduce environmental effects whilst maximising potential profit. The N-sensor determines a crop’s nitrogen demand by measuring the crop’s light reflectance as the tractor passes over.

Phosphorus dam
The farm’s phosphorus use is optimised by good planning in the fertiliser plan. The farmer has also dug a phosphorus pond, which reduces phosphorus leaching by slowing down the water flow and letting the particles settle out by sedimentation.

A phosphorus pond is a “small wetland”. It can also be combined with ditch filters.

A phosphorus pond retains around 23–42 per cent of the phosphorus in drainage water.

Co-operation around catchment area
To secure good water quality and safe drinking water, the farmers in the area have merged and formed a catchment area-based protection group.

They organise water walks where they, with expert management, discuss possible improvements. Some of the things they have done together are to reduce phosphorus leaching by soil tillage management, ditch cleaning and drainage. Ditch cleaning and functioning drainage create a balance between oxygen and water in the soil profile, which increases soil fertility. Functioning drainage helps crop roots to better utilise the nutrients, which decreases leaching.

Liming
The farmer limes to improve soil structure and increase biological activity. The calcium in lime improves the aggregation between clay particles, thus improving drainage.

Other beneficial effects of liming are an increase in the number of earthworms, as they thrive best in neutral soil. Liming also makes the nutrients more available to plants by increasing the pH of soil. The availability of most nutrients is best around pH 6.5.

The need for liming and the amount spread are dependent on the field’s soil type, soil organic matter content, pH and crop and should always be based on recent soil fertility analysis.

The natural acidity of the soil is different in e.g. clay soils and peat soils. The higher the organic matter content, the lower the pH. There are a lot of H+ ions in peat soil compared with other soil types. In peat soils, 25 tons of carbonates per hectare are needed to increase the pH by one unit, while in coarse-grained mineral soils 7.5 tons are sufficient. The clay content of the soil also has an effect. The more clay in soil, the more carbonates needed to decrease the acidity of the soil.

Some crops such as barley and sugar beet are sensitive to acid soils, while others such as oats tolerate acidity better.

Benefits from using N-sensor
Practical experience shows that the N-sensor can increase yields by up to 10 per cent over standard farm practices, boosting profits and minimising environmental losses.

The financial benefit of differentiated nitrogen fertilisation with the sensor is between 50 and 100 €/ha in cereals and about 80 €/ha in winter oilseed rape.

Structure liming
Structure liming is a new method being tested in Sweden. Burnt lime (CaO) or slaked lime (Ca(OH)2) is spread on clay soils and tilled under shortly after spreading.

The purpose is to improve soil structure and reduce phosphorus leaching. Burnt or slaked lime has a higher concentration of calcium ions than e.g. the calcitic limestone that is used in “conventional” liming, and therefore the same action on soil structure can be attained more strongly and more quickly. Spreading can be done using the same machinery as in conventional liming.
Size of farm: 50 ha
Main production: Milk production, forage.
Animals: 50 cows
Soil: Clay soil
Planned feeding

Losses of ammonia can be decreased by using a trailing hose spreader. Trailing hoses reduce nitrogen evaporation and the utilisation is better than with broadcast spreading. Neighbouring farmers can buy the spreader together, to save money.

Slurry management
A floating crust covers the slurry, to reduce gaseous emissions. It is important to reduce the risks of leaching in every way possible, for example by avoiding spreading the manure at high risk times, e.g. on wet soils, days with high temperature or when it is windy.

Feeding planning
The crude protein content in the diet of dairy cows affects the amount of nitrogen in the slurry, particularly in the urine. The nitrogen amounts can be decreased without affecting milk production only if there is overfeeding.

On pastures, conserving nutrients is about keeping the grazing areas in good condition, to give good yield. One way to maximise the yield is to have many fields, thus increasing the opportunities for good grazing control.

Cultivated grassland
The farmer usually cultivates ley for three years. As the ley grows older, grass yield decreases. Then the ley is ploughed under to make way for cereals in the coming year, after which a new ley can be established.

Nutrient leaching from ley is usually small but if there is a slope on the field there is a risk of surface runoff of fertiliser or manure.

Normally, the risk of leaching is largest when the farmer tills the grassland. If the grassland consists of much clover or lucerne, it is better to let it remain during winter and till it under in spring or late in autumn just before frost comes.

A pure grass sward does not contain as much nitrogen and a mixed grass-legume sward, so the risk of nitrogen leakage is much smaller, even if the ley is broken up in early autumn.

Forage management
With good quality forage there is less need for supplementary concentrate, which benefits the environment and the budget.

Careful inspection of the sward before cutting and sending in samples for analysis gives a good picture of how protein, energy and fibre content is changing up to harvest.

Based on the results, the optimal time of harvest can be calculated.

By improving the quality of the forage, the proportion of forage in the diet can be increased from 30 to 40 per cent and the amount of purchased feed can be decreased accordingly.

Storing of forage
During baling, it is important to get the right dry matter content. In a bunker silo a dry matter content of over 30 per cent is sufficient. However, in round bales the dry matter content should lie between 45-50 per cent.

If the silage is too dry, there is a risk of yeast and mould. If it is too wet, clostridia can grow, leading to butyric acid fermentation.

It is also important that it is well packed. This applies for both round bales and bunker silos. The sequence needed is chop, pack, cover. It is important to get anaerobic conditions as quickly as possible.

Function of buffer zones
A “normal” buffer zone is between 6-20 metres wide and runs alongside water, for example a stream, river or lake.

The risk of surface runoff is greatest on hilly fields and in times of heavy rains. The risk is higher also when the crop is fairly undeveloped so that the soil is poorly covered by the crop, the roots do not bind the soil and the crop has small water consumption.

Effects of buffer zones:
• losses of particulate phosphorus from arable land are decreased
• losses of nutrients and pesticides to rivers, lakes and seas are reduced
• biodiversity is increased
• the landscape is enriched
• the areas can be used for recreation
• the areas can be used to drive machines on

Studies of phosphorus losses show that 90 per cent of phosphorus transportation often happens on 10 per cent of the area during 1 per cent of the time. With the right location and design, buffer zones are very useful.
Size of farm: 200 ha
Main production: Cereals and vegetables
Crop rotation: onion, spring wheat, green set-aside, grass and clover mixture, beetroot, spring wheat, broccoli
Soil: fertile, medium to rich in clay, rich in humus
Good soil structure can increase profitability

Soil tests over several years help the farmer to determine soil nutrient content and pH value, to ensure that there is an optimum supply of all nutrients. If there is a deficiency in one element other elements may not be utilised well and the risk of nitrogen losses increases.

**Good soil structure**

The farmer decreases phosphorus losses by increasing the stability of soil aggregates, lessening soil compaction and having a good tillage strategy. This is done through good drainage, structure liming and adding organic material.

Everything that improves the soil structure is good both for the crop and for decreasing the phosphorus losses.

Soil structure affects water and air movement through soil, soil temperature and how easily soil can be cultivated. When the structure is good, water infiltration into the soil is fast and soil granules are durable.

Soil structure is not stable over time, as there is natural variation and farming practices have an effect on it. Structure can also be different in different soil layers.

Consequences of soil compaction:

- Lower yields
- Increased need for fertilisers
- More nutrients left in the soil after harvest, with higher risk of leaching.

Less water is often taken up by plants too, so the quantity of water in soil is increased. This in turn increases the risk of nitrogen leaching.

**Soil humus content**

Vegetables grown in wide rows contribute to the degradation of the humus which is important for soil structure. All crop residues are left on the field or composted. Also waste material from the preparation of vegetables for sale and peat from seedlings production is recycled back to the fields. Vegetable washing waters contain a lot of soil from the root plants and remains of plants. It is circulated on the compost and used in the fields later.

**Drainage**

Efficient drainage is the basis for good soil structure. If the soil is too acidic, then liming is needed to enhance plant growth and conditions for soil microbes.

Soil aggregation can be improved by management practices that decrease the disturbance of many soil processes, improve soil fertility, increase organic inputs, increase plant cover, and decrease soil organic matter decomposition rate.

**Recycling of irrigation waters**

Irrigation also increases the risk of nutrient leaching if more water is used than soil can absorb. The farmer has constructed a system where irrigation water can be recycled on the parcels. This requires a basin suitable for the collection and storage of run-off waters sufficiently close to the arable area.

The availability of clean fresh water might sometimes be restricted. In these situations the importance of the water recycling is high.

In the future the farmer has planned to try also controlled drainage. With controlled sub-surface drainage the farmer can lift or lower the ground water level of the field. The purpose is that crops have water as much as possible in use during the growing season. At the same time the leaching of nutrients and pesticides through drainage is reduced.

**Crop rotation**

The farmer follows a planned crop rotation sequence where consecutive crops are of a different genus, species or subspecies. E.g. cereals are often grown after cruciferous vegetables. Farmer utilizes also grasses and clovers in crop rotation.

The proper crop rotation increases the margins the farmer can achieve, as it for example minimizes pest and disease problems and improves soil quality, which have a positive impact on yield.
Demonstration farms

Farmers around the Baltic Sea are working actively to decrease nutrient losses from their farms. A network of over 100 demonstration farms in seven countries has been set up to demonstrate cost-efficient agri-environmental investments, practices and measures.

Learn more about good agricultural practices and find your closest demonstration farm at balticdeal.eu/farms
**General information**

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<tr>
<th>Country’s total land area, hectare</th>
<th>Sweden</th>
<th>Finland</th>
<th>Estonia</th>
<th>Latvia</th>
<th>Lithuania</th>
<th>Poland</th>
<th>Denmark</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>44 996 400</td>
<td>39 092 000</td>
<td>4 523 000</td>
<td>6 458 900</td>
<td>6 530 000</td>
<td>31 267 900</td>
<td>4 310 000</td>
</tr>
<tr>
<td>Population</td>
<td>9 413 000</td>
<td>5 351 427</td>
<td>1 340 122</td>
<td>2 236 910</td>
<td>3 239 032</td>
<td>38 100 000</td>
<td>5 534 738</td>
</tr>
<tr>
<td>Population density per km²</td>
<td>21</td>
<td>17,6</td>
<td>31</td>
<td>34,7</td>
<td>52,0</td>
<td>122</td>
<td>126</td>
</tr>
<tr>
<td>Cultivated area/utilised agricultural area in per cent of total area</td>
<td>6</td>
<td>7,5</td>
<td>21</td>
<td>17,2</td>
<td>53,0</td>
<td>51,7</td>
<td>61,70</td>
</tr>
<tr>
<td>Total Nitrate Vulnerable Zones, per cent</td>
<td>62</td>
<td>100</td>
<td>7,5</td>
<td>6,24</td>
<td>100</td>
<td>1,49</td>
<td>100</td>
</tr>
</tbody>
</table>

**Farms and livestock information**

<table>
<thead>
<tr>
<th>Total number of all farms</th>
<th>Sweden</th>
<th>Finland</th>
<th>Estonia</th>
<th>Latvia</th>
<th>Lithuania</th>
<th>Poland</th>
<th>Denmark</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>72 000</td>
<td>62 042</td>
<td>19 700</td>
<td>132 663</td>
<td>200 080</td>
<td>2 565 969</td>
<td>40 024</td>
</tr>
<tr>
<td>Average farm size in hectare</td>
<td>36,7</td>
<td>36</td>
<td>38,9</td>
<td>25,5</td>
<td>48,30</td>
<td>8,44</td>
<td>65</td>
</tr>
<tr>
<td>Total number of farms with sows/piglets/pigs</td>
<td>2 000</td>
<td>2 041</td>
<td>2 888</td>
<td>2 206</td>
<td>62 756</td>
<td>297 764</td>
<td>5 041</td>
</tr>
<tr>
<td>Total number of farms with dairy cows inclusive heifers</td>
<td>6 100</td>
<td>11 159</td>
<td>4 378</td>
<td>36 835</td>
<td>85 082</td>
<td>495 000</td>
<td>4 311</td>
</tr>
<tr>
<td>Total number of cattle incl. heifers</td>
<td>1 538 000</td>
<td>925 789</td>
<td>236 200</td>
<td>379 494</td>
<td>740 800</td>
<td>5 757 000</td>
<td>1 540 000</td>
</tr>
<tr>
<td>Total number of dairy cows</td>
<td>360 000</td>
<td>289 327</td>
<td>95 700</td>
<td>166 000</td>
<td>352 700</td>
<td>2 733 000</td>
<td>563 000</td>
</tr>
<tr>
<td>Total pig population</td>
<td>1 500 000</td>
<td>1 329 870</td>
<td>373 000</td>
<td>323 087</td>
<td>860 400</td>
<td>15 825 000</td>
<td>12 369 000</td>
</tr>
</tbody>
</table>

**Baltic Deal project**

Baltic Deal gathers farmers and farmers’ advisory organisations around the Baltic Sea in a unique effort to raise the competence concerning agri-environmental practices, measures and investments. The aim is to support farmers to reduce nutrient losses from farms, with maintained production and competitiveness.

**Advisory services**

All participating countries have agricultural extension services with many years of activities. The ownership and organisation differs a bit between the countries.

In Sweden and Finland the advisory companies and organisations are total private and independent from the state or Farmers Federations. The dominating advisory service in Denmark is private but owned by the Farmers’ Federation.

The advisory services in Estonia, Latvia, Lithuania and Poland are public and some of them have a mixed ownership.

**EU regulations**

All seven Baltic Deal countries are members of the EU, and have to comply with regulations from the Nitrates directive. The directive demands regulation of storage and spreading of manure and nitrogen fertilisation. Four countries (Estonia; Latvia; Sweden and Poland) have designated Nitrate vulnerable zones, which are areas with more stringent regulations than in the rest of the country, while in three countries (Denmark; Finland; Lithuania) the whole country is designated as Nitrate vulnerable zone, and the same regulations apply for all regions.

**Cross-compliance**

All countries have introduced cross-compliance for farmers, who receive EU subsidies. Concerning counselling, this poses some challenges as the number of advisors compared to farmers varies quite a lot in the individual countries. In many of the Baltic Sea countries, the number of advisors is very low compared to the number of farmers.
Voices from farmers and advisors

Marian Rak, Poland. Winner of the WWF Baltic Sea Farmer of the Year Award 2011.
– Running a progressive conventional farm I think it’s important to take care of natural environment. I have observed that the number of plant species has been declining since I was a child. I want to protect those which exist and regain those which has become extinct. When I had built my first pond I observed that new plants and animal species appeared around it. I have planted hedge on my farm to increase biodiversity. Hedge is excellent shelter for animals. At the moment I have 2,5 km different type of hedges. I’m also growing alders and willows by flows because they take nitrogen and phosphorus from flowing waters.

Karsten West, Brændegaard Farm, Denmark
– I have very good use of separated slurry and slurry from biogas plants in my fields.

Carl F. Bruun, Esromgaard Farm, Denmark
– The Yara N-sensor applies nitrogen to the fields according to measured information about the current nitrogen content, which ensures a more uniform crop. It is an important tool for me in the effort of reaching a high and uniform level of protein in the crop and distributing chemicals according to the crop requirements.

Guntars and Valentina Dolmane, Farm Lielkrūzes, Latvia
– We have an organic pond farming based on the collection of agricultural runoff, we use terrain features in fish-farming and livestock farming and conservation of biodiversity, says Valentina Dolmane. – A pond cascade as nitrogen catcher is important for the circulation of nitrogen, tells Guntars Dolmanis.

Marek Krysztoforski, Agricultural Advisory Centre in Brwinow Branch Office in Radom (CDR), Poland
– Buffer zones are the key to increase biodiversity in the landscape and also very important to limit flows of nitrogen and phosphorus load to the Baltic Sea. On the CDR farm we also grow intercrops, which are very important for soil and water protection.

Didzis Neimanis, Dālderi farm, Latvia
– Fertilisation through leaves and non-root fertilisation is an innovative and exciting new measure.

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