



COST EFFECTIVE PHOSPHORUS MANAGEMENT MEASURES

TO REDUCE LEACHING FROM INTENSIVE REARING OF LIVESTOCK



FOREWORD

The Baltic Sea continues to be affected by nutrient loading. According to HELCOM¹ “the Baltic Sea ecosystem has degraded to such an extent that its capacity to deliver goods and services to humans living in the nine coastal states has been hampered” (Holistic Assessment of the Baltic Sea, released at the HELCOM Ministerial Meeting in May 2010). The report states that “eutrophication, caused by excessive inputs of nitrogen and phosphorus, continues to be of major concern in most areas of the Baltic Sea. Further measures to reduce nutrient inputs from agriculture are of utmost importance”.

Preventing emissions to water from intensive livestock production is one important measure in order to reduce eutrophication. This report describes cost-efficient management measures to reduce leaching of nutrients, focusing on phosphorus, from intensive rearing of livestock, and suggests that these measures are implemented in national legislation. The promoted management measures can, in combination with the use of cost efficient manure treatment technologies such as anaerobic treatment and separation technologies, contribute to the national commitments within HELCOM Baltic Sea Action Plan, and the objectives of the EU IPPC Directive.

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This paper is part of the “Intensive Pig Production Program”, initiated by Baltic Sea 2020 to reduce the negative environmental impact of nutrients leaching from intensive pig farms to the Baltic Sea. It is a follow up report to an earlier study, “Best Available Technologies for Manure Treatment – for Intensive Rearing of Pigs in Baltic Sea Region EU Member States”.

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The front page shows a slurry tanker belonging to Iowa Select Farms in USA, who has an annual production of more than 3 million fatteners above, and pigs at a Swedish farm (below).

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¹ The Helsinki Commission, or HELCOM, works to protect the marine environment of the Baltic Sea through intergovernmental co-operation between Denmark, Estonia, the European Community, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden.

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KEY MESSAGES

The Baltic Sea suffers from eutrophication and is one of the most polluted seas in the world. One key source to excessive nutrients is manure from intensive animal production. Cost efficient technologies to properly treat manure are necessary to prevent leaching of nutrients from manure as well as management measures to avoid risks of over-fertilisation.

Introducing management measures to avoid risks of excessive fertilisation with phosphorus at intensive livestock farms is identified as a cost efficient method to reduce phosphorus leaching to the Baltic Sea².

Incorporating the recommendations listed below in national regulations for intensive livestock production in the Baltic Sea Region, would reduce phosphorous emissions to the Baltic Sea, and help nations to fulfil their national nutrient reduction requirements, stipulated in the HELCOM Baltic Sea Action Plan.

1. Official phosphorus norms

Official phosphorus fertiliser norms should be introduced and enforced in all Baltic Sea States when issuing environmental permits to intensive livestock farms. The norms can be determined as flat rate maximal fertiliser norms if they are combined with a phosphorus index. The flat rate phosphorus fertiliser norms should be administrated on farm level rather than on field level in order to accommodate differing needs for phosphorus fertilisation by various crops. The exact norm should be determined by each country according to prevailing crop rotations on land where manure from intensive livestock farms are used as fertiliser.

2. Official manure standards

A pre-requisite for an efficient introduction of official fertiliser norms is that national official manure standards are developed and enforced. As a minimum they should describe the amount (tons) of livestock manure produced per animal per year or per produced animal, and provide information on the composition of that livestock manure regarding the percentage of dry matter and phosphorus content (information on nitrogen and potassium is normally a part of a manure standard as well).

3. Official phosphorus index

An official phosphorus index should be developed and used in all countries as a condition for the environmental permitting of intensive livestock farms. The empirical models supporting the index should be developed regionally or country-wise by researchers, as the relevance of the parameters as well as the associated phosphorus loss-risk varies between regions and countries. The practical application of the index should be related to fields rather than field blocks or larger geographical areas. This enables farms to spread as much livestock manure and other phosphorus fertiliser as possible with a minimum of risk for phosphorus loss to the environment. The implementation and enforcement of the phosphorus index requires official standards for the different parameters in the index, set out in national regulations.

4. Training/Certification for spreading and transporting manure

Official certification of staff dealing with transport and/or spreading of large quantities of livestock manure should be introduced and enforced in conjunction to issuing environmental permits to intensive livestock farms. The certificate should be time limited and based on tests in both theoretical and practical skills connected to the latest EU and national regulations.

² "Best Available Technologies for Manure Treatment – for intensive rearing of pigs in the Baltic Sea Region EU Member States", Baltic Sea 2020, 2009 (www.balticsea2020.org)

1: BACKGROUND AND PROBLEM DESCRIPTION

The Baltic Sea is one of the most polluted seas in the world. The predominant problem is the overload of nutrients (nitrogen and phosphorus) discharged from the surrounding countries into the sea. The excess nutrients cause increased algal blooms, oxygen-free sea beds and invasions of filamentous algae in shallow coastal waters. Consequently the unique and sensitive ecosystem is seriously disturbed, to such an extent that its capacity to deliver goods and services to humans is diminished, including its recreational values.

One of the key sources of nutrients in the Baltic Sea is manure from intensive animal production which is not properly managed and treated. The nitrogen and phosphorus content in livestock manure is high, 3-4 times higher than in waste water from all of the households in the region. Intensive livestock production is furthermore expected to increase as the economies in the region are growing.

Nitrogen loads from livestock manure is regulated by the Nitrates Directive, setting a maximal load of nitrogen to 170 kg N/ha and year. There is no equivalent EU regulation for maximal phosphorous loads. This poses a special challenge for national and regional authorities to regulate and minimize discharges of phosphorus from intensive animal production.

The EU IPPC directive³ regulates that Best Available Techniques shall be used by farms with intensive rearing of pigs and poultry, in order to prevent emissions of nutrients to water. Proper management of nutrients in manure is furthermore stipulated in the HELCOM Convention, Annex III which also determines a maximal load of phosphorus in livestock manure to 25 kg P/ha and year.

In order to reduce the negative impact of nutrients stemming from intensive livestock production, Baltic Sea 2020 initiated the project “Best Practice Manure Treatment” in 2009. The purpose was to identify the best available technologies to reduce leaching of nutrients from intensive livestock production in the Baltic Sea rim states, focusing on pig production. In conclusion, three technologies were recommended⁴:

- Separation technologies to enable a balanced use of pig slurry as fertiliser for the crops
- Anaerobic digestion to improve the field effect (bio-availability) of the nitrogen
- Management measures to avoid risks of over-fertilisation with phosphorus and spills and incautious disposal of livestock manure

It is important to identify cost efficient measures to reduce the risk for over-fertilisation, especially for phosphorus which is not specifically regulated by an EU directive. One key measure is to ensure that all farms with intensive livestock production manage manure properly with regards to its' phosphorus content.

2: METHOD AND ORGANISATION

This report has been produced by Baltic Sea 2020 and is based on the expert technical analysis and specifications provided by The Innovation Centre for Bioenergy and Environmental Technology (CBMI). All recommendations have been developed by Baltic Sea 2020.

CBMI was engaged to prepare this back ground report, based on analysis of management measures presented in the 2009 report “Best Available Technologies for manure treatment - for intensive rearing of pigs in Baltic Sea Region EU Member States”. The objective was to present pragmatic proposals that could be incorporated into national and EU legislation. Suggestions for EU legislations are made in a separate report.⁵

In addition, a survey of P-management measures implemented in the EU Member States around the Baltic Sea was carried out (see Appendix B).

³ Directive 2008/1/EC of the European Parliament and of the Council of 15 January 2008 concerning integrated pollution prevention and control

⁴ Best Available Technologies for Manure Treatment - for Intensive Pig Production in the Baltic Sea Region EU Member States, Baltic Sea 2020, 2009

⁵ Proposal to the revision of the IPPC Directive and the Reference document for intensive rearing of pigs and poultry, chapter 4; Cost Effective Phosphorus Management Measures, Baltic Sea 2020, 2010

The following persons were consulted in the preparation of this document:

- Goswin Heckrath, University of Aarhus, Department of Agroecology and Environment, Research Centre Foulum.
- Hans Estrup Andersen, National Environmental Research Institute
Department of Freshwater Ecology, Aarhus University
- Morten Toft, BioCover

3: PROPOSED MANAGEMENT MEASURES TO AVOID RISKS OF OVER-FERTILISATION WITH PHOSPHORUS AT FARMS WITH INTENSIVE REARING OF LIVESTOCK

This chapter describes the rationale for using the proposed management measures, how they work and any prerequisite they may have. It also recommends how they should be used and incorporated into national legislation.

3.1: PHOSPHORUS NORMS

The HELCOM Convention (2008) states that “To ensure that manure is not produced in excess in comparison to the amount of arable land, there must be a balance between the number of animals on the farm and the amount of land available for spreading manure, expressed as animal density. The maximum number of animals should be determined with consideration taken of the need to balance between the amount of phosphorus and nitrogen in manure and the crops’ requirements for plant nutrients.” Further the Convention determines, that “The amount of livestock manure applied to the land each year including by the animals themselves should not exceed the amount of manure containing:

- 170 kg/ha nitrogen
- 25 kg/ha phosphorus

with a view to avoiding nutrient surplus, taking soil characteristics, agricultural practices and crop types into account”.

3.1.1: Use of phosphorus fertilizer norms in the Baltic Sea Region

A sensible and constructive way for the HELCOM Member States to fulfil their commitments given by signing the HELCOM Convention would be to implement the compulsory use of (official) phosphorus norms in the planning of fertiliser use for crops. This has, however, not yet happened in Denmark, Lithuania, Latvia or Poland.

Annex B includes an overview of the regulated use of phosphorus norms in the EU Member States around the Baltic Sea. It demonstrates that phosphorus norms are determined as a maximal allowed, flat rate⁶ phosphorus fertilisation in Sweden and Estonia. Finland and Germany have somewhat more detailed regulations; in both cases the methodologies are comparable to the combination of P norms with simple P-indices.

3.1.2: Need for official manure standards

Official manure standards are a prerequisite for the enforcement of fertiliser norms. Official norms cannot be enforced unless standards are in place, which for the major livestock types, productivity levels / feed intensities, bedding types and production systems describes:

- Amount (tons) of livestock manure produced per animal per year or per produced animal
- Composition of that livestock manure, describing at least percent dry matter, nitrogen, phosphorus and potassium.

According to information provided by authorities in the Baltic Sea countries (see Annex B), official manure standards do not exist in Latvia (due to be issued during 2010), Lithuania or Poland. Estonia has some standards, but according to the Ministry of Environment they are in need of revision. The lack of official manure standards hampers the

⁶ Flat rate meaning without dependency on crop, soil type, soil analysis or any other parameter.

enforcement of the Nitrates Directive, the IPPC Directive and the Water Framework Directive since the actual amount of nutrients in manure cannot be calculated.

3.1.3: Recommendations

Official phosphorus fertiliser norms should be introduced and enforced in all Baltic Sea countries in connection with issuing environmental permits to intensive livestock farms. The norms can be determined as flat rate maximal fertiliser norms, if combined with a phosphorus index. The flat rate phosphorus fertiliser norms should be administrated on farm level rather than on field level, in order to accommodate for the different need of phosphorus fertilisation to different crops. The exact norm should be determined by each country according to prevailing crop rotations on land where manure from intensive livestock farms is used as fertiliser.

A pre-requisite for an efficient introduction of official phosphorus fertiliser norms is that official manure standards are developed and enforced in all countries. The standard should, as a minimum, describe:

- *the amount (ton) of livestock manure produced per animal-per year, or per produced animal⁷*
- *the composition of the livestock manure regarding the percentage dry matter and the content of phosphorus*
- *information on nitrogen and potassium should also be part of manure standards, to enable proper dosing of these nutrients when fertilising with manure*

3.2: PHOSPHORUS INDEX

A phosphorus index is a tool to analyse the relative risk of phosphorus loss at field level or at larger units, based on easily accessible data (see examples in 3.2.1 below). The index is an empirical model for weighing several risk parameters into a combined risk factor, which can be used as guidance for selection of field management practices. The phosphorus index is relevant to use as basis for decisions on the level of phosphorus fertilisation on a specific field, and in particular whether it is safe to spread livestock manure on that field.

Phosphorus indices were first developed in the USA in the 1990's, and are now used by advisors, specialists, farmers and environmental authorities in all American states.

Heckrath et al. (2007) have reviewed phosphorus indexing tools in Denmark, Sweden, Norway and Finland, and concludes that "Compliance with the Water Framework Directive (WFD) will require substantial reductions in agricultural phosphorus (P) losses in the Nordic countries Denmark, Norway, Sweden and Finland. Falling P surpluses in agriculture for more than a decade and voluntary programmes of good agricultural practice have not reduced P losses to surface waters, while general regulatory measures have primarily focused on nitrogen. Without addressing the role of critical source areas for P loss, policy measures to abate diffuse P losses are likely to be ineffective."

According to Annex C, phosphorus indices have been developed and piloted in Denmark, Sweden and Finland, while Germany has gone a step further and have decided to implement a German P index from mid 2010.

3.2.1: Parameters in a phosphorus index

Researchers from different regions or countries will design their phosphorus index differently, depending on the main reasons for phosphorus loss in their region.

The following table lists examples of parameters which could be included in a phosphorus index. The list is not exhaustive nor is it in order of priority; it is rather given to illustrate what a phosphorus index is.

⁷ Normally figures are provided per animal per year, but in case the animal doesn't get one year old before finally produced, the amounts are indicated per produced animal.

Table 1: Examples of parameters, which could be used in empirical phosphorus index models (different sources).

#	Parameter	High risk association
1	Phosphorus soil analysis, including share of water soluble phosphorus	High phosphorus analysis figures and high share of water soluble phosphorus
2	Fertiliser and manure spreading method (placed on the soil surface or incorporated into the soil)	Fertiliser placed on soil surface
3	Draining	No draining in case of soil surface run-off, but, opposite, associated with high risk in case of macropore transport and leaching through the soil layers.
4	Water saturation, irrigation, precipitation	High amount
5	Slope of the field	Steep and long slope
6	Field surface roughness of the field, here under earth barriers and vegetation	Low roughness, no vegetation
7	Distance to surface waters, including buffer strips	Short distance
8	Rate of phosphorus application (crops needs)	Higher rate than removed amount with the crop
9	Soil cultivation methods	For instance drilling row crops in same direction as field slope
10	Type of phosphorus fertiliser (mineral or organic)	Organic
11	Flooding frequency	High flooding frequency

3.2.2: Comparison with conventional fertiliser planning

From the listed parameters in the table above only parameters no. 1 and 8 would generally be considered in calculation of fertilising requirements by conventional methods, as they are developed to clarify the fertilising need for various crops. However, basing phosphorus fertilisation on these two parameters alone results in low accuracy with regard to the risk for P loss to water from soils. P loss to water is heavily influenced by factors such as water flow and soil erosion (Mallarino et al., 2005). The phosphorus index provides a supplementary calculation of the phosphorus loss-risk associated with fertilisation and helps to observe the fertilising with phosphorus from an environmental perspective.

3.2.3: Calculation methodology

Phosphorus indices might be organised as a combined risk index, or in sub-indices with or without a combined index. For example, Heckrath (2009) has described a Danish phosphorus index which according to major phosphorus transport routes consists of four sub-indices. Whereas, Mallarino et al. (2005) see the parameters in the lowa phosphorus index as belonging to either of three components:

- Erosion component
- Runoff component
- Subsurface drainage component

In all cases, the parameters are parts of algorithms, where coefficients express the correlation of specific parameters to loss of phosphorus. In the end the different parameters, weighed with its coefficients, are added together to express the risk of phosphorus loss from the field (or in some cases larger areas).

Algorithms have to be designed as to express the final index or sub-index on a specific scale, for instance from 0 to 5 (Iowa) or from 0 to 100 (Denmark).

3.2.4: Organisational issues

The practical application of a phosphorus index should be connected to fields or blocks of fields. A Danish study⁸) carried out under an Interreg IVB project⁹, concludes that P-indices generally are considerably lower when based on field-specific data, rather than on field-block-specific data (www.NP-risikokort.dk).

A precondition for the efficient enforcement of phosphorus indices is that the used parameter values have their basis in officially established standards. The soil analyses require for instance approved laboratories and standardised analysis methods. Draining is another example where it is necessary with a clear definition of the understanding of draining, so that farms and their advisers are not left to arbitrary rules for calculation of phosphorus indices.

It is vital that the developed P indices are validated and that the uncertainties involved are assessed prior to official use in order to ensure general credibility among all stakeholders.

National regulations should determine the relation between phosphorus indices and the possible use of livestock manure as fertiliser on the individual fields.

3.2.5: Recommendations

Official phosphorus indices should be implemented and enforced in all Baltic Sea countries. Such a program is most effectively included in the procedure for providing environmental permits to intensive livestock farms. The empirical models behind the indices should be developed regionally or country-wise by researchers, as the relevance of the parameters as well as the associated risk for phosphorus loss varies between regions and Member States. The practical application of the indices should be connected to specific fields rather than blocks of fields or larger geographical areas. Such an approach enables farms to spread as much livestock manure and other phosphorus fertiliser as possible with a minimum of risk for phosphorus loss to the environment. The implementation and enforcement of the phosphorus indices needs to be based on official standards for the different parameters in the index and be part of national regulations.

3.3: CERTIFICATION OF STAFF SPREADING OR TRANSPORTING LIQUID MANURE

Today almost all intensive pig farms have stables with fully or partly slatted floors. Pig manure is consequently produced mainly in the form of slurry, which is kept in slurry tanks according to national rules until it is spread on fields as fertiliser. In some cases the slurry undergoes some processing or treatment underway.

A pig farm with 750 sows with piglets up to 30 kg¹⁰ produces around 3,500 ton slurry per year, and 2,000 fatteners⁸ around 1,000 ton slurry (Danish Agricultural Advisory Centre, 2005). Many intensive pig production farms are even larger, and the corresponding area for spreading the slurry is similarly large (around 350 ha for spreading of 10,000 ton pig slurry according to Danish regulations). Machinery with large capacities is used to handle this slurry.

The large amounts of slurry need to be transported to fields where it can be spread, and the length of the transport increases with the structural development of the pig production. Buffer tanks are used more frequently to enable the transport on public roads by conventional trucks, rather than with the spreading machinery. The transportation/spreading machinery is expensive, a slurry wagon like the one shown on the picture below with a capacity of 25 ton slurry costs € 150,000 - 300,000, depending on the exact configuration, and the tractor to pull it typically € 100,000 - 200,000. In order to obtain the lowest possible capacity costs of the machinery, it is often operated by specialised machine pools. In most countries, no special training except a drivers licence is required for the driver.

⁸ Danish Agricultural Advisory Centre (Dansk Landbrugsrådgivning) and others, not dated

⁹ Investing in the future by working together for a sustainable and competitive region

¹⁰ The minimum threshold size of the production which requires environmental approval according the IPPC Directive.



Picture 1: Typical machinery for transporting and spreading slurry, here configured with band laying system with a 24 metres wide boom.

3.3.1: Conditions around transporting/spreading of liquid manure that is of environmental concern

There are several aspects connected to transporting/spreading of livestock manure that is of environmental concern and which should be clearly understood by the driver of the slurry transportation or spreader:

- It is important that the rate of application follows the fertiliser plan and is done evenly on the field. The driver needs to be familiar with adjustment of speed, dosing and capacity. Modern slurry tankers are equipped with flow metres, which via a computer guided interface automatically adjust the dosing. In those cases, the driver needs to be familiar with how the computer interface can be used to optimize dosing of N and P, in accordance of the fertiliser plan.
- Slurry, and livestock manure in general, can have great differences in chemical composition in different parts of the manure storage. The driver must therefore be familiar with possibilities for homogenising the livestock manure before loading, and with possibilities for use of quick test methods for assessing the amount of phosphorus and other plant nutrients in the manure, as well as ways to align the spreading dose to the varying chemical composition.
- Where spreading takes place on fields not belonging to the farm where the liquid manure is produced, there are specific requirements to report the moving of the livestock manure to another farm. It is the livestock farmer who bear the responsibility for reporting movements to the authorities, but it is relevant that persons who transport and spread slurry are familiar with the rules and procedures for this.
- Accidental spills mainly happen in connection to loading, transport or spreading of slurry or other liquid manure. The driver must therefore understand precautions, alarm systems and safety procedures to avoid spills, as well as actions in case of spills. It can be mentioned that a search of the Danish word “gylleudslip” (In English: slurry spill) on Google gives 46,000 hits, indicating that spills of slurry is a problem of scale.
- Almost all Member States regulate the transport and spreading of livestock manure with regard to the timing (season, weekdays, holidays), temperature/climate, field slope, buffer zones/strips, distances, etc. It is crucial that the drivers are aware of these regulations.
- Innovative technology such as the acidification of slurry in connection to spreading, or the use of GPS/GIS systems during spreading, require specific knowledge and understanding from the driver, and it must be ensured he/she has skills to deal with such technology.
- Legal requirements to the spreading technology must be respected, for instance in cases injection must be used rather than broad spreading or band laying. Today, probably more than 50% of all slurry in Europe is spread with broad spreading technique, but several countries tighten the regulations about this. The driver must be aware of legal requirements and environmental considerations in relation to spreading technology.

- Complying with traffic rules is important to avoid accidents. The machinery is very heavy, especially when fully loaded. A pre-condition for obtaining a certificate must be that drivers have a normal drivers license, or at least a tractor drivers license.
- Good management practices should be envisaged by the driver, for instance forewarning neighbours about slurry spreading although this is not legally required, as well as practices for cleaning of equipment and hindering dripping on transport roads.

3.3.2: Content of training/certification

The list above clarifies that drivers who transport/spread liquid manure needs to have both theoretical and practical skills, and training therefore should contain both practical and theoretical lessons as well as tests.

3.3.3: Organization of training/certification

The suggested certification can in many aspects be compared with the requirement for a field spraying licensing – see Annex D. This is for instance organised as a course with 20 lessons at institutions, who are officially accredited to perform the training and testing, and issue the licenses. In most countries the most obvious place to organise the training are agricultural colleges, who have expertise in agricultural education. In other countries the training can take place at regional agricultural departments.

In order to ensure that licensed persons get their skills updated along with the introduction of new innovative technologies, the certificates should have a limited validity, for instance 5 years.

3.3.4: Recommendations

Baltic Sea States should establish an official training and certification of persons, who deal with transportation and/or spreading of large quantities of livestock manure. The certification should be based on tests in both theoretical and practical skills connected to EU and national regulations. The certification should therefore be specific in relation to each country. The certificate should be valid for a limited period, for instance 5 years, in order to ensure that persons who transport or spread livestock manure are familiar with handling of new innovative technologies and new legislation regarding manure management.

A combination of certification and licensing of the companies, which organise the transport and/or spreading of livestock manure could be considered. Companies take over part of the responsibility for compliance with regulations in relation to spreading/transporting livestock manure in the Netherlands (Foged, 2009) and USA (Foged, 2009). Alternatively, the certification of persons could be combined with an approval system for the equipment, similar to the system for approval of field sprayers.

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ANNEX A: SURVEY

A survey of P-management measures implemented in the EU Member States around the Baltic Sea was carried out for this report. The following questions were asked:

1. Is the use of official Phosphorus norms (regulation of maximum amounts of P in livestock manure applied to land each year including by the animals themselves) compulsory in fertilizer planning?
If so, how are they defined?
2. Have official manure standards been established in the legislation (definition of the N/P/K content/ton manure from different animals, taking into account bedding type, feed intensity and stable system)
3. Has P indices been developed on research level? Has it been tested for functionality and relevance? Has it been taken into use by farmers or administrations?
4. Are there any official educational requirements for becoming owner of a farm? Would it be feasible to offer certification in connection to this education? Are there other current ways of organizing certification of staff working within farming industry?

ANNEX B: DETAILS CONCERNING IMPLEMENTATION OF PHOSPHORUS NORMS

The following table show the present official use of phosphorus norms in eight EU Member States in the Baltic Sea Region. The table is based on a survey made in connection to the preparation of this report.

Table B.1: Overview of official phosphorus fertiliser norms and their definition in eight EU Member States in the Baltic Sea Region.

Country	Is the use of official Phosphorus norms (regulation of maximum amounts of P in livestock manure applied to land each year including by the animals themselves) compulsory in fertilizer planning? If so, how are they defined?	Legal document
Denmark	No, recommendations only.	Ministeriet for Fødevarer, Landbrug og Fiskeri, 2008
Sweden	Yes, 22 kg P per ha	Förordningen om miljöhänsyn i jordbruket, 1998:915, JV föreskrifter 2009:82 (2004:62)
Finland	No/Yes. P norms are voluntary, but they must be complied with in order to receive environmental support. The P limits are based on crops grown and the soil P content. If only manure is used as P-fertilizer then 15-30 kg of manure total P can be spread depending on crop and soil P content (unless the soil P content is not very high, then spreading is prohibited).	<ul style="list-style-type: none"> 931/2000: Statsrådets förordning om begränsning av utsläpp i vattnen av nitrater från jordbruket Förbindelsevillkor för Miljöstöd för Jordbruket 2010
Estonia	Yes. 25 kg/ha year + mineral fertilizer depending on the crop..	The Estonian Water Act
Latvia	No	-
Lithuania	No, but plans to introduce a maximum of 40 kg P ₂ O ₅ ¹¹ per ha in Lithuania	-
Poland	No	-
Germany	Yes. P balance of 20 kg P ₂ O ₅ per ha as average of last 6 years. This value may be exceeded if soil content of P is underserved. There is no distinction between organic or mineral P origin.	German regulation on fertilizer use (Düngeverordnung, §6)

Sources: Innovation Centre for Bioenergy and Environmental Technology (Denmark), Swedish Board of Agriculture, The Central Union of Agricultural Producers and Forest Owners (Finland), Estonian Ministry of Environment, Latvian Union of Farmers Parliament, Lithuanian Environment Protection Agency, Polish Ministry of the Environment, the State Agency for Agriculture, Environment and Rural Areas of the State Schleswig-Holstein.

The table illustrate that phosphorus norms are determined as a maximal allowed, flat rate phosphorus fertilisation in Sweden and Estonia, while Finland and Germany have taken a more developed regulation into use, in both cases methodologies that actually are comparable to the combination of P norms with simple P-indices. Phosphorus fertiliser norms in Denmark, Lithuania, Latvia and Poland are recommendations only. It should be noted that there is much difference between official and recommended (phosphorus) fertiliser norms:

- Official norms describe the maximally allowed use of the plant nutrient, while the typical farmer perception of a recommended norm is that it describes how the crops as a minimum should be fertilised in order to give an expected yield.

¹¹ P = 0,4364 x P₂O₅

- Official norms are built into the legislation, and enforced via control and sanctions, while recommended norms are to be considered as advices.
- Recommended norms often relate to several parameters, whereas official norms normally are flat.

In Latvia, recommended fertiliser norms for a field relates to the following parameters (ZM & LLKC, 2008):

- Crop
- Yield level
- Previous permanent grasslands
- Soil type
- pH
- Soil analysis
- Soil incorporated green manure from previous crop
- Livestock manure after effect from previous two years
- Balance in the soil (if previous years fertilising was not following the norms)

In Denmark, recommended phosphorus norms are available in annual instructions on fertilisation, issued by the Ministry of Food, Agriculture and Fisheries. The recommended phosphorus norms are part of tables with the following information (Ministeriet for Fødevarer, Landbrug og Fiskeri, 2008):

- Crop
- Preceding crop
- N effect
- Expected yield and corresponding nitrogen norm for different soil types (coarse sand, fine sand, irrigated fine sand, sand-mixed clay soils, clay soils)
- Nitrogen correction for deviation in expected yield
- Recommended fertilising with phosphorus
- Recommended fertilising with potassium

The recommended phosphorus norms in Denmark, and the parameters for calculation of the phosphorus needs according Latvian methodology illustrates that different crops have different phosphorus needs, and that these needs furthermore depends on parameters like soil analysis and more.

The recommendation to use official flat-rate phosphorus norms, despite the illustrated variation in crops' need for phosphorus, is based on the following prevailing conditions:

- Flat-rate norms are already taken into use in five of the eight observed EU Member States around the Baltic Sea. The easiest implementation is secured by continuing practice as usual in the Member States who already took the flat-rate norms into use.
- The HELCOM Convention 25 kg phosphorus as a maximal phosphorus fertilisation is also a flat-rate norm.
- Methodology based norms are complicated to enforce legally.

The recommendations to use official flat-rate phosphorus norms are made with the following prerequisites:

- A parallel use of phosphorus indices on individual field basis, to minimise the risk for phosphorus loss.
- Flat-rate norms are administrated on farm level rather than on field level, because, as illustrated by the Latvian and Danish examples, that the actual needs are different for the different crops and due to other parameters. Administration of a phosphorus norm on farm level rather than on field level is comparable with the way the 170 kg nitrogen flat level, given by the Nitrates Directive (1991), is administrated; this is not a limit per field, but a limit in average for the entire farm.

It would in connection to the introduction of an official flat rate phosphorus fertiliser norm be relevant to consider whether the norm should be split into two norms:

- Overall, official flat-rate phosphorus fertiliser norms, irrespective of phosphorus fertiliser type; and
- Official flat-rate phosphorus fertiliser norms for the part of the fertilisation that is provided through livestock manure – this norm would logically be lower than the overall norm.

It appears from the survey that Estonia and Finland have chosen to implement the second type of norm, regulating loads of phosphorus in livestock manure only. However, it might be insufficient, seen from an environmental point of view, to have a norm only for the fertilisation with livestock manure, if fertilisation with phosphorus in mineral fertiliser is without official limits. An official flat rate flat-rate phosphorus fertiliser norm, irrespective of phosphorus fertiliser type, is to prefer.

The following table show whether official manure standards exists definition in eight EU Member States in the Baltic Sea Region. The table is based on a survey made in connection to the preparation of this report.

Table B.2: Overview of official manure standards in eight EU Member States in the Baltic Sea Region.

Country	Have official manure standards been established in the legislation (definition of the N/P/K content/ton manure from different animals, taking into account bedding type, feed intensity and stable system)	Legal document
Denmark	Yes	Ministeriet for Fødevarer, Landbrug og Fiskeri, 2008
Sweden	Yes, regulations for max number of livestock for complying with the limit of 22 kg P per ha	"Allmänna råd, riktlinjer för gödsling och kalkning" and in "Gödsel och miljö"
Finland	No, but it is possible to use table values or own analyses in applications for environmental support	-
Estonia	No, there are no official regulations standards regarding manure standards. There are decrees by the Environmental Ministry and the Ministry of Agriculture regarding water standards; however they need to be revised.	-
Latvia	No, standard was elaborated already at 2008, but still it is not approved by official authorities.	Currently document works as recommendations. http://www.zm.gov.lv/doc_upl/1_standarts.pdf
Lithuania	No official manure standards have been established in the legislation. Only scientific data is established.	-
Poland	No, fertilizer plans for IPPC installations should be based on "Code of Good Agricultural Practice" (GAP) where general rules for manure management are set. In this code some general information and requirements concerning manure standards and NPK index is available. Code of GAP is only obligatory for farmers operating IPPC installations.	Code of Good Agricultural Practice
Germany	Yes. In the German regulation on fertilizer use are standards for each animal concerning N. These standards are differentiating in animal species and performance group (Leistungsgruppe), but there is no differentiation to stabling. The feeding intensity is globally calculated on the bases of the performance group (e.g. on milk performance) or on the basis of specific feeding systems (e.g. N-P-reduced pig feeding). The expected amount of slurry or liquid manure is predefined. In the German Criteria System for Sustainable Agriculture (KSNL) - over and above German regulations - a farm balance (Hoforbilanz) is calculated on the basis of natural P freights, so fodder P is included.(Düngeverordnung appendix 5) On Federal State level Germany has comparable regulations for P as part of the Federal State explanations to the German regulation on fertilizer use.	German regulation on fertilizer use (Düngeverordnung, §5)

Sources: Innovation Centre for Bioenergy and Environmental Technology (Denmark), Swedish Board of Agriculture, The Central Union of Agricultural Producers and Forest Owners (Finland), Estonian Ministry of Environment, Latvian Union of Farmers Parliament, Lithuanian Environment Protection Agency, Polish Ministry of the Environment, the State Agency for Agriculture, Environment and Rural Areas of the State Schleswig-Holstein.

Summing up, there are only official manure standards for phosphorus in two of eight EU Member States (Denmark and Sweden) in the Baltic Sea Region, while Germany and Estonia also have some regulations concerning the phosphorus loads from livestock production.

ANNEX C: DETAILS CONCERNING USE OF PHOSPHORUS INDICES

The following table show the current situation for development and implementation of phosphorus indices in the eight EU Member States in the Baltic Sea Region. The table is based on a survey made in connection to the preparation of this report. In brief, only one of the eight countries uses official phosphorus indices (Germany), while Denmark, Sweden and Finland has developed and pilot tested phosphorus indices.

Table C.1: Overview of use of phosphorus indices in eight EU Member States in the Baltic Sea Region.

Country	Has P indices been developed on research level? Has it been tested for functionality and relevance? Has it been taken into use by farmers or administrations?	Legal document
Denmark	Yes, developed on research and pilot basis. Not implemented in practice.	-
Sweden	Yes, a Swedish model for P index exists, developed at Swedish University of Agricultural Services (SLU). It is tested in pilot cases but not yet implemented in practice.	-
Finland	No. Probably some pilot research has been made.	-
Estonia	No, there are no P-indexes used, maybe when Water Act is improved in the future.	-
Latvia	No, mainly N is analyzed at research level and also used by farmers and administration, since regulation of Cabinet of Ministers No.531 regulates nitrate issues, especially for nitrate vulnerable zones, in relation with Nitrate Directive.	-
Lithuania	No.	-
Poland	No, fertilizing plans are checked by competent Agricultural/Chemical Stations where content of NPK in organic fertilizers is checked and compared with results of soil analysis. There is also appropriate norm for P content in various soil types. Those measures are used in every case, not only for IPPC installations.	-
Germany	Yes. Concerning risk of erosion and corresponding P discharge, starting 01.07.2010 the farmer has to do field specific risk assessment. Parts of the field (Feldblöcke) get categories of risk of erosion levels (CC-water 1, CC-water 2, CC-wind). Category dependent usage restrictions (Nutzungseinschränkungen) are defined. Noncompliance is sanctioned according Cross Compliance rules.	-

Sources: Innovation Centre for Bioenergy and Environmental Technology (Denmark), Swedish Board of Agriculture, The Central Union of Agricultural Producers and Forest Owners (Finland), Estonian Ministry of Environment, Latvian Union of Farmers Parliament, Lithuanian Environment Protection Agency, Polish Ministry of the Environment, the State Agency for Agriculture, Environment and Rural Areas of the State Schleswig-Holstein.

ANNEX D: DETAILS CONCERNING ORGANISING CERTIFICATION OF PERSONS THAT TRANSPORT AND SPREAD LIVESTOCK MANURE

The following table show the current situation for farmer educations in the eight EU Member States in the Baltic Sea Region, and the possibility to implement a certification for transporting and spreading livestock manure in connection with that. The table is based on a survey made in connection to the preparation of this report.

Table D.1: Overview of farmer education and certification in relation to the possibility for implementing a certification for transporting and spreading livestock manure in eight EU Member States in the Baltic Sea Region.

Country	Are there any official educational requirements for becoming owner of a farm? Would it be feasible to offer certification in connection to this education? Are there other current ways of organizing certification of staff working within farming industry?	Legal document
Denmark	No , not after 2010, where a new agricultural law is introduced. Education exists and the certification could be offered in connection to that. A similar certification of persons spraying with pesticides exists, and also for obtaining a tractors divers license.	-
Sweden	No . Previously there were training requirements for buying a farm, but not any longer. Training is conducted at SLU and several Agricultural Colleges. Requirements for certification exist concerning spraying with pesticides, use of chain saw, driving tractor, etc. There are optional courses for spreading manure on fields, skills training through the "Focus on nutrients".	-
Finland	Yes/No . In order to qualify for farm subsidies, an agricultural education of 20 credits/weeks is required (160 credits required for a university degree, for comparison). Certification is required for use of pesticides. The certification is managed by ex. schools and agricultural branch institutes as well as advisory organizations. There are no certification requirements in relation to manure management.	-
Estonia	No , there are no official educational requirements to own a farm / be a farmer. If a farmer wants to get financial support / subsidy from a governmental organization, obligatory and specialized training hours must be fulfilled.	-
Latvia	No , there are no specific education requirements to become a farmer (owner of farm). There are few requirements for personnel certification for specific issues: work security; plant protection chemicals application; transport of dangerous substances. For the future it would be interesting to discuss development of certification of farming personnel. For example – 1-2 days course once in 5 year period, with certificate.	-
Lithuania	Yes . If you want to get the certificate of the farmer, you have to have the education in the field of agriculture or to pass the training on farming. No training is needed if your age is more than 50 years. If you have not the certificate on farming the approach to EU funding is impossible.	-
Poland	Yes . Educational requirements are stated in Polish legislation. Every fertilizer user is required an appropriate certificate. Only graduates from Agricultural Universities are exempt from this requirement.	-
Germany	No , Germany has no restrictions becoming owner of a farm. Restrictions are existing for sub-areas: <ul style="list-style-type: none"> • using machines, tractors, etc. one need a driver license • applying pesticides requires a user certificate or a job training with associated degree 	-

-
- Germany, (cont.)**
- safety at work: one have to attend specific seminars getting a certificate or one have to contract external specialists
 - instructing trainees: one need a job training with an associated master degree or an university degree

The degrees are controlled within the CC regulations.

Sources: *Innovation Centre for Bioenergy and Environmental Technology (Denmark), Swedish Board of Agriculture, The Central Union of Agricultural Producers and Forest Owners (Finland), Estonian Ministry of Environment, Latvian Union of Farmers Parliament, Lithuanian Environment Protection Agency, Polish Ministry of the Environment, the State Agency for Agriculture, Environment and Rural Areas of the State Schleswig-Holstein.*

The conclusion is that only Poland and Lithuania has educational requirements to become owner of a farm, which means that slurry tankers like the one on the picture in section 3.3 can be driven by anyone. However, Finland and Estonia has also some educational requirements, which are linked to the obtaining of subsidies.

All countries have requirements to specific certification for pesticide spraying, while some have similar requirements for labour safety, tractor drivers' license, chain saw license, and for transport of dangerous substances. This means that it would be possible to organise a certification in transport and spreading of livestock manure in ways that are similar to existing certification schemes.