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INNOVATIVE AGRO-ENVIRONMENTAL Technologies

FOR SUSTAINABLE FOOD PRODUCTION IN THE BALTIC SEA REGION

Picture to the right: Iveta Grudovska, Vecauce Research and Training Farm, discusses with Lars Baadstorp, PlanAction, how their biogas plant could be expanded and improved.

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Knowledge Sharing

Finding solutions to manure management in Finland

By Susanna Kaasinen, Baltic Deal, Finland

Three agri-environmental projects in the Baltic Sea region, Baltic Compass, Baltic Deal and Baltic Manure, together with Finnish national project TEHO Plus, organized two seminars about the multiple purposes of manure on 7 - 8th November in Southwest Finland. Over 90 people representing farmers, authorities and advisors among others were gathered on the first day to hear presentations from the viewpoint of scientists, authorities and companies. On the second day, a smaller group of experts had a round table discussion about manure management in Southwest Finland.

The presenters and organisers of the seminar in Finland.

Photos by: Airi Kulmala

The idea for the joint seminars sprang up last April when Baltic Deal and TEHO Plus projects organized a study tour to Denmark for a group of farmers. The farmers on the tour were especially interested in new manure management technologies like separation and biogas production which at the moment are not common in Finland.

Although animal density in the whole Finland is far from the Danish figures, the concentration of animal production can be problematic in certain areas and there are difficulties in finding enough spreading area for manure. If the manure is in form of slurry and phosphorus is the factor limiting the spread amount, separating the slurry and transporting the phosphorus rich solid fraction to other areas could be one solution, suggested Henning Lyngsø Foged from Baltic Compass to the Finns in the seminars. Also regional biogas plants would be a good option. Biogas plants could produce renewable energy and the end products from the process could be used as N and P fertilizers in crop production.

However, when introducing new technology, there is always the question of money and at the moment the financial situation on farms does not allow for any extra costs. The Finnish state is giving some support but e.g. the investment support system and the new feed-in tariff for biogas production have not yet raised a lot of interest to actually start building new plants.

The presentations from the seminar on 7th November (in Finnish except for one in English) can be downloaded from the home page of the TEHO Plus project: http://www.ymparisto.fi/default.asp?contentid=397385&lan=fi&clan=fi.

Quick slurry separation, Börger AL-2 separator. Photos 2011 by Environmental consultant Elisabeth Falk, The Bornholm Advisory Service.

Biogas on Bornholm can reduce loss of nutrients to the Baltic Sea

By Frank Bondgaard, Knowledge Centre for Agriculture / Baltic Deal, Denmark

With inputs from Thorkild Qvist Frandsen, AgroTech, Carsten Mouritsen and Elisabeth Falk, The Bornholm Advisory Service, Jan Damkilde Christensen & John E. Laursen, Biokraft A/S, Henning Lyngsø Foged, Agro Business Park / Baltic Compass and inspiration from Baltic Sea 2020.

Increased use of slurry separation and cover crops on Bornholm (Danish Island in the Baltic Sea) for bioenergy production could reduce leaching of nutrients into the Baltic Sea. The use of these biomass resources on Bornholm has great potential, but to achieve a win-win situation for the farmer as well as the environment, everyone has to acknowledge the advantages.

In recent years it has been difficult for the biogas company Biokraft A/S (www.biokraft.dk) on Bornholm to obtain the necessary amount of manure to utilize the capacity of the biogas plant optimally. This is due to several factors, among others:

- The financial crisis has resulted in falling land prices, and as a result of this, it can be more attractive for the individual farmer to fulfil the harmony rules by buying land than by paying to deliver slurry to Biokraft A/S (currently app. 1.5 €/m^3).
- Holdings have grown by acquisition or lease. As a result, the Danish harmony rules (i.e. requirement to relation between livestock and area of agricultural land) are easier to fulfil and it is not necessary to deliver manure to the biogas plant.
- Several Bornholm farmers have experienced great difficulties operating the high technology separation plants on the island on an optimal level.
- The slurry delivered to Biokraft A/S has often proved too ”old” and thus having too low gas potential.

Today Bornholm is working more towards mobile low technology separation plants with high capacity. By this hoping that the technological challenges concerning separation of slurry from the farms are resolved. However, the low technology plants are not able to separate 100 per cent of the organically bound nitrogen in the slurry.

Another challenge has been that part of the slurry that Biokraft A/S has received, has often proved to be ”too old”. As a result, Biokraft A/S is now working on getting the separated manure quickly into the biogas plant, as a considerable amount of methane otherwise can be lost – even after a few weeks of storage. After a month in a slurry tank, the gas potential in pig manure might have decreased significantly.

On Bornholm the biogas company is not owned by farmers, it is owned by Østkraft A/S, which is a power company owned by Bornholm Municipality. This means that pure market economy has to drive the incentive to deliver manure to the biogas plant. The Bornholm farmers have to pay for their deliveries of manure. For this reason farmers without “harmony problems” do not have any immediate incentive to deliver manure. Falling land and rental prices means that there might be an advantage in leasing land. They want instead to use their own manure production for fertilising here instead of delivering it to a biogas plant. The same problem may apply to the rest of Denmark, if 50 per cent or more of the total amount of manure - according to several political statements – is to be used for biogas production. Danish farmers need a financial incentive to provide slurry for biogas production in the future. For this reason it is important that e.g. the price of electricity or gas adds up to a level to meet this challenge.

Photos from the Biokraft regional biogas plant at Bornholm. Photos 2011 by Project Manager Frank Bondgaard, BalticDEAL, Knowledge Centre for Agriculture.

Biomass self-sufficiency on Bornholm

The biogas production on Bornholm is based on "self-sufficiency" with biomass. Biomass for biogas production should be produced on Bornholm, and the same goes for residues and waste products, that could be used for the biogas production. Located in the middle of the Baltic Sea, Bornholm is situated 135 km from the nearest Danish coast to the west, and 40-100 km from Sweden, Poland and Germany, which means that an import of biomass for Bornholm biogas production would be at high transport costs.

The questions are therefore whether Bornholm has the amounts of biomass needed to exploit the capacity of the existing Biokraft A/S biogas plant, and is it possible to replace the current consumption of maize (see table 2 below) by separation solids?

We have estimated the total slurry production, which can be utilised in the biogas plant on Bornholm, to 7,310 tonnes dry matter of pig slurry and 2,640 dry matter tonnes of cattle slurry (table 1). A total production of 9,950 tonnes of separation solids in dry matter from slurry.

Today Biokraft A/S has an environmental permit based on treatment of maximally 100,000 tonnes biomass with 16.5% dry matter, equal tons 16,500 tonnes dry matter. Today approximately 10,000 tonnes of dry matter is used in the plant (see table 2). This means that there is "room" for digestion of another app. 6,000 tonnes of dry matter in the plant. According to Biokraft A/S it would be desirable to increase the proportion of separated slurry from 4,300 tonnes to 8-10,000 tonnes and to have a larger amount of ordinary slurry delivered to hit the correct dry matter percentage in the biogas reactor.

Table 1: Livestock production on Bornholm and potential dry matter production in separation solids from slurry.

Pig production on Bornholm		Cattle production on Bornholm	
20,000 sows per year	4.700 AU*	5.000 dairy cows	6,740 AU
560,000 piglets 7-32 kg	2.800 AU	1825 breeding 0-6 months	339 AU
450,000 finishers 32-107 kg	12.530 AU	3675 breeding 6-27 months	1,880 AU
Total number of Animal Units	20.030 AU	Total	8,959 AU
Estimated total production in tonnes of slurry	423.000 tonnes	Estimated total production in tonnes of slurry	146,900 tonnes
Estimated amount that is not slurry	48,000 tonnes (ca. 2,272 AU)	Estimated amount that is not slurry	36,900 tonnes (ca. 2,250 AU)
Potential amount manure (and corresponding no. of animal units)	375,000 tonnes (17,758 AU)		110,000 tonnes (6,709 AU)
Total potential amount manure (pig + cattle) (and corresponding no. of animal units)	ca. 485,000 tonnes (24,467 AU)		
Separation solids production 375,000 tonnes * 78 kg/ton	29,250 tonnes	Separation solids production 110,000 tonnes * 96 kg/ton	10,560 tonnes
Separation solids in dry matter 29,250 tonnes * 78 kg/ton*0,25 % dry matter (approximately)	7,310 tonnes	Separation solids in dry matter 110,000 *96 kg/ton*0,25 % dry matter (approximately)	2,640 tonnes
Potential separation solids production for biogas production on Bornholm	9,950 tonnes dry matter		

*1,0 AU = 1,0 Animal Unit = 100 kg nitrogen ex storage

Views from Bornholm, august 2011. Photos by Project Manager Henning Lyngsø Foged, BalticCOMPASS, Agro Business Park.

Table 2 shows that the use of animal manure currently in slurry corresponds to app. 4,824 (774 + 3,600 + 450) tonnes of dry matter in separation solids, but that only 774 tonnes are delivered as such. The table shows that freight of many tonnes of "slurry water" could be saved, if more separation solids and less raw slurry were delivered.

According to table 2, corn silage corresponding to app. 2,700 tonnes of dry matter is purchased.

By comparing the manure production and potential separation solids production in table 1 with the current consumption in table 2, it is evident that the manure based biogas production on Bornholm could be increased substantially. Delivering only the separation solids to the Biokraft biogas plant would be cheaper in transport costs and as well save the environment for NOx and CO2 from transport, leave the separation liquids with high nitrogen fertiliser value on the farms, and only incur transport costs on the separation solids with biogas potential.

Table 2: Expected consumption of biomass in Biokraft A/S in 2011

Expected production amounts in 2011	Input of biomass, ton	Dry matter percentage (estimated)	Dry matter amount in tonnes (estimated)
Slurry fibre from separation	4,300	18	774
Solid dung/poultry manure	4,000	45	1,800
Cattle slurry	45,000	8	3,600
Pig slurry	10,000	4.5	450
Corn silage	9,000	30	2,700
Other biomasses	2,300	(20)*	(460)*
Total	75,000		9,784

*Different dry matter percentage.

As further explained below, the remaining capacity on the Biokraft biogas plant could be used for digestion of catch crops.

More ammonium nitrogen for the fields

The advantage of treating manure in a biogas plant is that approx. half of the organically bound nitrogen is converted into ammonium nitrogen, which is plant available. The slurry also smells less and seeps easier into the ground, so that the bio-availability of the nitrogen in the slurry becomes higher, at least if it is used in the spring for fertilising growing crops. If all slurry on Bornholm was treated in the biogas plant, this would equal to 15 kg ammonium nitrogen per hectare, which fertilising effect is a benefit for the crop production. This means that the organically bound nitrogen in the slurry with potential risk of leaching in autumn is converted to mineralised nitrogen, which can be absorbed by the plants in the growing season.

Less nitrogen leaching due to higher bioavailability of nitrogen in digested slurry into consideration

Various measures for reduction of nitrogen leaching have been described in a catalogue, written by Chief Adviser Leif Knudsen and Adviser Camilla Lemming, the Danish Knowledge Centre for Agriculture. In this catalogue it is assumed that there is a yearly reduction in nitrogen leaching of 3 kg N per hectare by applying digested slurry rather than raw manure, when the input of nitrogen in commercial fertilisers is reduced in an amount equal to the additional allocation of inorganic nitrogen in the digested slurry. The

catalogue also states that as long as the utilisation requirement for digested manure is the same as that of untreated manure, reductions in nitrogen leaching cannot be expected.

There is a potential amount of around 485,000 tonnes of slurry corresponding approx. 24,500 Animal Units available on Bornholm (see table 1). If using a separation method that does not segregate the organic fraction in animal manure 100 per cent, the leaching reduction will be smaller than the stated 3 kg per hectare, and maybe in the range of 1,5 – 3,0 kg of nitrogen per hectare. This means that if the potential amount of slurry and separated slurry were treated in a biogas plant, the leaching of nitrogen on Bornholm could theoretically be reduced with approx. 36,500 – 73,500 kg per year with the current number and AU. This will however require a biogas plant that is twice as big as the current plant.

Views from Bornholm, august 2011. Photos by Project Manager Henning Lyngsø Foged, BalticCOMPASS, Agro Business Park.

Bioenergy production from catch crops and grass for cutting

In a cooperation with AgroTech and Biokraft A/S, Aalborg University are in 2012 conducting experiments with catch crops for bioenergy production at the biogas plant on Bornholm in the project ”Catchcrops2bioenergy”.

In relation to nitrogen leaching, it has great perspectives if farmers could make double use of their fields by both producing a normal crop and a catch crop for bioenergy production in one harvest year. This would mean crop growth in the fields most of the year and give the farmers an economic incentive to grow catch crops. This would most probably also lead to reduction in leaching of nitrate nitrogen. Such scenario would be profitable for Biokraft A/S, the farmers as well as the environment.

Other benefits of catch crops instead of e.g. corn or grain, is that catch crops are not sensitive to world market prices on cereals and that catch crops cannot readily be used for human consumption. Furthermore the growing season in Denmark would be exploited in a better way.

Currently we are missing knowledge of the gas potential in different catch crops, and of how catch crops function in large scale biogas production. The project Catchcrops2bioenergy will help clarify this issue.

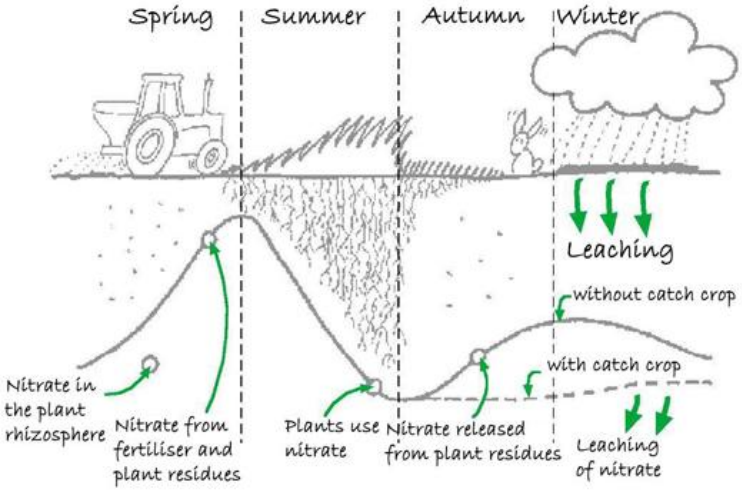


Figure 1. Illustration from the report from 1990: Kvadratnettet 1986-1989 (the grid 1986-1989).

In autumn catch crops such as yellow mustard and fodder radish, as well as pastures, have a very positive effect on the leaching of nitrate. Is short illustrated in figure 1.

On Bornholm is grown a large area with grass seed, especially ordinary ryegrass and Italian ryegrass, which are currently used as compulsory catch crops. However, in principle this is a poor use of established crops, because especially Italian ryegrass can be harvested with a high yield of dry matter per hectare at the second cut in autumn. This second cut has low value on cattle feeding and could be used for biogas production.

Another possibility for reducing nitrogen leaching is to grow grass for cutting with a high dry matter production instead of compulsory catch crops or growing maize. There is a greater risk of nitrogen leaching from a maize field than from a grass field. Grass for cutting would be a "win-win" crop, as it can reduce leaching of nitrogen in the crop years and it can be used as biomass for biogas production as well. Seen through the eyes of Bornholm grass for cutting would be much preferable to the compulsory catch crops – yellow mustard and fodder radish. These catch crops can be difficult to establish on Bornholm in autumn. The reason for that is the often very dry climate on Bornholm in July, August and September and the result is often a catch crop producing a very little plant biomass, and thus not always have the intended effect.

The biogas potential of grass is increased considerably by extrusion before the digestion. Extrusion is a mechanical pre-treatment of the biomass, in which the plant cells are destroyed by a combination of crushing and grinding of the biomass under pressure. This treatment will probably be able to increase the gas production by 20-30 percent and thus make the catch crops more attractive financially. The Biokraft A/S biogas plant is however, not readily designed to use grass and it would require a rebuilding of the plant to go in this direction. Look for further details on: http://agrsci.au.dk/nyheder/artikel/mere-baeredygtigt-energi-fra-landbruget-er-muligt/

Silage from maize is presently used to boost the biogas production from livestock manure at Biokraft biogas plant. Photo by Project Manager Henning Lyngsø Foged, BalticCOMPASS, Agro Business Park.

Table 3: Potential dry matter production in catch crops on Bornholm.

Crop	Tonnes of dry matter per hectare (estimated)	Hectare (estimated)	Total tonnes of dry matter (estimated)
Second harvest on ordinary ryegrass	2.5 - 35	1,000	2,500 - 3,500
Second harvest on Italian ryegrass	3-4	500	1,500 - 2,000
Harvesting of catch crops: Yellow mustard and fodder radish	0 – 2	2,500	0 - 5,000
Potential production of catch crops			4,000 – 10,500 tonnes

Conclusion

On Bornholm there is a potential for production of approx. 9,950 tonnes separation solids in dry matter (table 1) and a potential dry matter production of approx. 4,000 – 10,000 tonnes (table 3) of catch crops. A total potential production of approx. 14.000 – 20.000 tonnes of dry matter on Bornholm in separation solids and catch crops and grass for cutting. The Biokraft A/S biogas plant today treats approx. 10,000 tonnes of dry matter (table 2), but has an environmental approval for treating 16,000 tonnes, which means that the current plant capacity is not fully exploited, wherefore it should be considered to exploit the biogas potential of separation solids and catch crops.

If an increased share of the slurry was separated and taken to the biogas plant, and if catch crops were used for bioenergy production, it would not be necessary to use crop land for production of maize silage to the biogas plant. The current consumption of 9,000 tonnes of maizesilage equals approx. 150 – 200 ha of crop.

The value of especially catch crops for biogas production require further studies, and the same for separation solids, although a few scientific tests already are available concerning this.

There are potentially sufficient amounts of separation solids and dry matter from catch crops available for biogas production on Bornholm, but the exploitation of this potential requires further scientific valuation of its biogas potential. It has to be attractive for farmers to deliver biomass to the biogas plant.

There is no doubt that biogas production can help reduce nitrogen leaching as the organically bound nitrogen in the manure is converted to mineralised nitrogen during the digestion process. Similarly catch crops for bioenergy production would have an important environmental effect as the risk of loss of nitrogen decreases with plant growth on the fields in autumn.

Can the farmers on Bornholm be motivated to deliver more slurry to biogas production during the current financial crisis? Only a correct pricing on the separation solids can determine that, because farmers without harmony problems do not have any incentive to deliver their manure to biogas plants.

The project Catchcrops2bioenergy can provide some answers with respect to the value of catch crops for bioenergy production. The right politically decided frameworks conditions in combination with fair compensation from the biogas plant to the farmer suppliers will determine whether potential resources can be utilised.

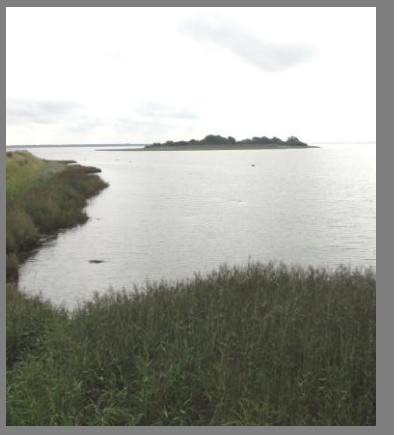
It is important to be open to new opportunities if farmers and society as well the environment shall be winners.

On Bornholm, Baltic Deal and Baltic Compass cooperate with farmers, advisors, Biokraft A/S and AgroTech to solve the challenges facing the farmers on Bornholm and Biokraft A/S.

Inspiration from the report from Baltic Sea 2020: "Best available technologies for pig manure biogas plants in the Baltic Sea region".

There is cooperation between Baltic Deal and Baltic Compass and other actors around the Baltic Sea in order to find the best possible solutions to environmental challenges. Look for further details on www.balticdeal.eu and www.balticcompass.org.

The two Baltic Sea Programme co-financed projects BalticDEAL and BalticCOMPASS cooperates to find win-win solutions for farming and environment.



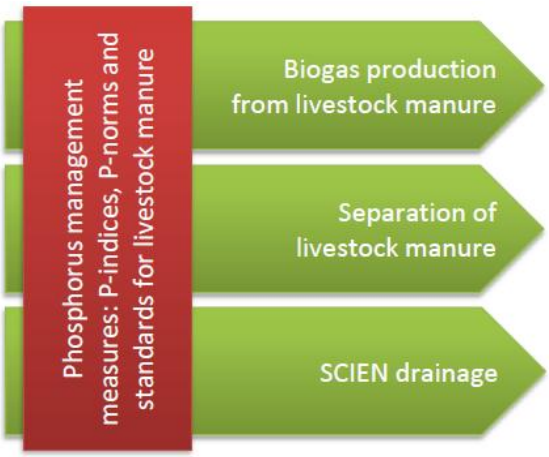
The pumping station at Hoffmansgave Estate (upper picture) pumps drain water from the main, open ditch channel out into the environmentally and nature sensitive and polluted Odense Fjord (lower picture) behind the dike. Photos by Project Manager Henning Lyngsø Foged, BalticCOMPASS, Agro Business Park.

Pilot investments in prioritised technologies are lined up

By Henning Lyngsø Foged , Agro Business Park / Baltic COMPASS

Work package 4 of Baltic COMPASS has the goal to stimulate the use of selected and prioritised innovative agro-environmental technologies. We are doing this in different ways, and one of them is direct investments in such technologies.

The prioritised technologies were presented in newsletter No. 2 and are biogas production on livestock manure, slurry separation, SCIEN drainage, and then the cross-cutting issue: phosphorus management.



Most of the technical topics treated in the newsletters so far have dealt with these technologies; we have in newsletter No. 3 informed about a draft Sector Study, and in newsletter No. 4 about we are about to establish to give better access to validated information about these and other technologies.

We will during the next year carry out concrete investments in pilot installations with the purpose to demonstrate for the public the function, economic feasibility, environmental effects etc. of the technologies in order to pave the road for wider use of them.

The planned investments comprise:

Biogas: Agro Business Park will invest in an extruder in connection to the research biogas plant at Aarhus University in Foulum, as part of a larger expansion of the facilities. The extruder is expected to increase the biogas yield of high lingo-cellulosic biomass with 30%. The extruder will be used for otherwise un-utilised meadow grass harvested from the banks of the nearby Nørreå river. In this way the nutrients are returned to the agricultural production rather than lost to the aquatic environment, which apart from the water quality is especially important for organic farming, where nitrogen fertiliser typically is the most limiting factor in the production.

RUE Scientific-Practical Centre of the National Academy of Sciences of Belarus will at their research cattle farm invest in improved equipment for slurry spreading on the fields. Presently slurry is broad-spread, which typically leads to large emissions of ammonia. Better slurry application technology becomes more important in the future, where there soon will be established a biogas plant; digestate contains more volatile nitrogen than raw slurry.

Separation: Agro Business Park will invest in a new type of mobile separation technology for a small supplier society of pig farmers, who wish to

Left, treated, and right, untreated clover grass silage. Picture from: http://www.okologi.dk/landmand/fagomraader/klima-og-energi/oekologi-og-klima/bio-extruderen.aspx.

Bio-extruder. Picture from: http://www.okologi.dk/landmand/fagomraader/klima-og-energi/oekologi-og-klima/bio-extruderen.aspx.

deliver separation solids to the regional Biokraft biogas plant at Bornholm isle. The specific separation technology is expected to make separation cheaper and secure that separation solids are more fresh when delivered to the biogas plant because it can such the slurry direct from the stables. Raw pig slurry and in specific the separation solids of it, is losing its biogas potential quickly after it is being produced. By only transporting separation solids to the biogas plant the air is saved for 90% of the pollution that otherwise would happen with CO2 and NOx. Separation solids will be used instead of maize silage, which is ethically and environmentally questionable for biogas production.

SCIEN drainage: Landesamt für Landwirtschaft, Umwelt und ländliche Räume des Landes Schleswig-Holstein (LLUR) will invest in various small-scale innovative drainage technologies to secure better management of the water resources as well as the plant nutrients, to the benefit of both farming and the aquatic environment. This is being still more important along with the increasing climate change effects.

Agro Business Park will invest in controlled drainage at the Hoffmansgave Estate near to the sensitive and polluted Odense Fjord. More than half of the crop fields in the Baltic Sea Region are drained, wherefore we must anticipate that a very big share of agricultures' part of anthropogenic loads of plant nutrients is arriving at the Baltic Sea via drains. A new approach to drainage is therefore needed.

Apart from this there will be made a travelling exhibition to be shown in several Baltic Sea countries, and which will exhibit details of especially the mentioned prioritised technologies and investments. The investments are also backed by a number of technology-focus seminars in the countries, whereof one of them recently held in Turku in Finland is presented above.

We anticipate that we soon will get the principal approval of the investments from the Baltic Sea Programme.

The role of open drain ditches for the eutrophication of the Baltic Sea

We don't know enough about the role of open drain ditches in relation to the eutrophication of the Baltic Sea. This is one of the conclusions in a report from the Swedish University of Agricultural Sciences (SLU) and BalticSea2020 which compiles current knowledge about "Measures to improve the phosphorus retention in open ditches in high-risk run-off agricultural areas round the Baltic Sea". The report also suggests that there often is lack of knowledge about the efficiency of different measures to reduce phosphorus leaching from agricultural ditches. An experimental site is therefore suggested, where different actions can be tested and evaluated under controlled conditions.

The report is in Swedish, and can be downloaded from http://www.balticsea2020.org.

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Upcoming events

Seminar: Sustainable Utilisation of Phosphorus

Venue: Agro Business Park, Tjele, Denmark

Date: 14 December, 2011

The event: Innovation Network for Biomass (INBIOM) organises a seminar about better utilisation and recirculation of phosphorus in residual products from agriculture, bioenergy and municipal sewage sludge.

More info: http://www.inbiom.dk/en/_03.htm

Seminar: Slurry Injection in the Future

Venue: Agro Business Park, Tjele, Denmark

Date: 15 December, 2011

The event: Come and join this interesting seminar about slurry injection, where the results from a multi-year development project concerning slurry injection in growing crops are presented.

More info: http://www.inbiom.dk/en/_04.htm

Colophon

This electronic newsletter is sent out quarterly with the purpose to support innovation and investments within agro-environmental technology in the Baltic Sea Region by publishing relevant knowledge about the field to the Baltic Compass Network.

To read more about the project please go to:

http://www.balticcompass.org

We encourage everyone to contribute with content to this newsletter by contacting the editors.

For subscription or un-subscription, please notify one of the editors via e-mail.

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