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Policy Brief

Baltic Sea Centre | Stockholm University

Improving manure recycling in agriculture
– an important step towards closing the phosphorus cycle

Phosphorus is a finite resource; efficient usage and recycling are essential. Recycling human sewage can help close the phosphorus cycle, but only partially meets circular economy goals. Phosphorus recycling efforts must not neglect manure.

All life depends on phosphorus. But it is a finite resource for which there is no substitute. The inefficient and wasteful use of phosphorus in the agri-food system has implications for sustainability and also contributes to eutrophication of lakes, streams, and coastal areas. The responsible and sustainable use of phosphorus requires better use and re-use in all sectors of society, especially in agriculture.

The EU Circular Economy Action Plan has generated interest in recycling phosphorus contained in human sewage in agriculture. This effort is an important step in closing the phosphorus cycle. However, there is greater potential to improve the efficiency of manure used as crop fertiliser. In the Baltic Sea catchment, the amount of phosphorus in manure is more than 3 times greater than in human sewage. By using manure more efficiently, mineral fertiliser imports could be reduced by 0,11 - 0,17 million tons, compared to about 0,036 million tons by using sewage sludge. This would reduce phosphorus surpluses and the risk of leakage to inland waters and the Baltic Sea.

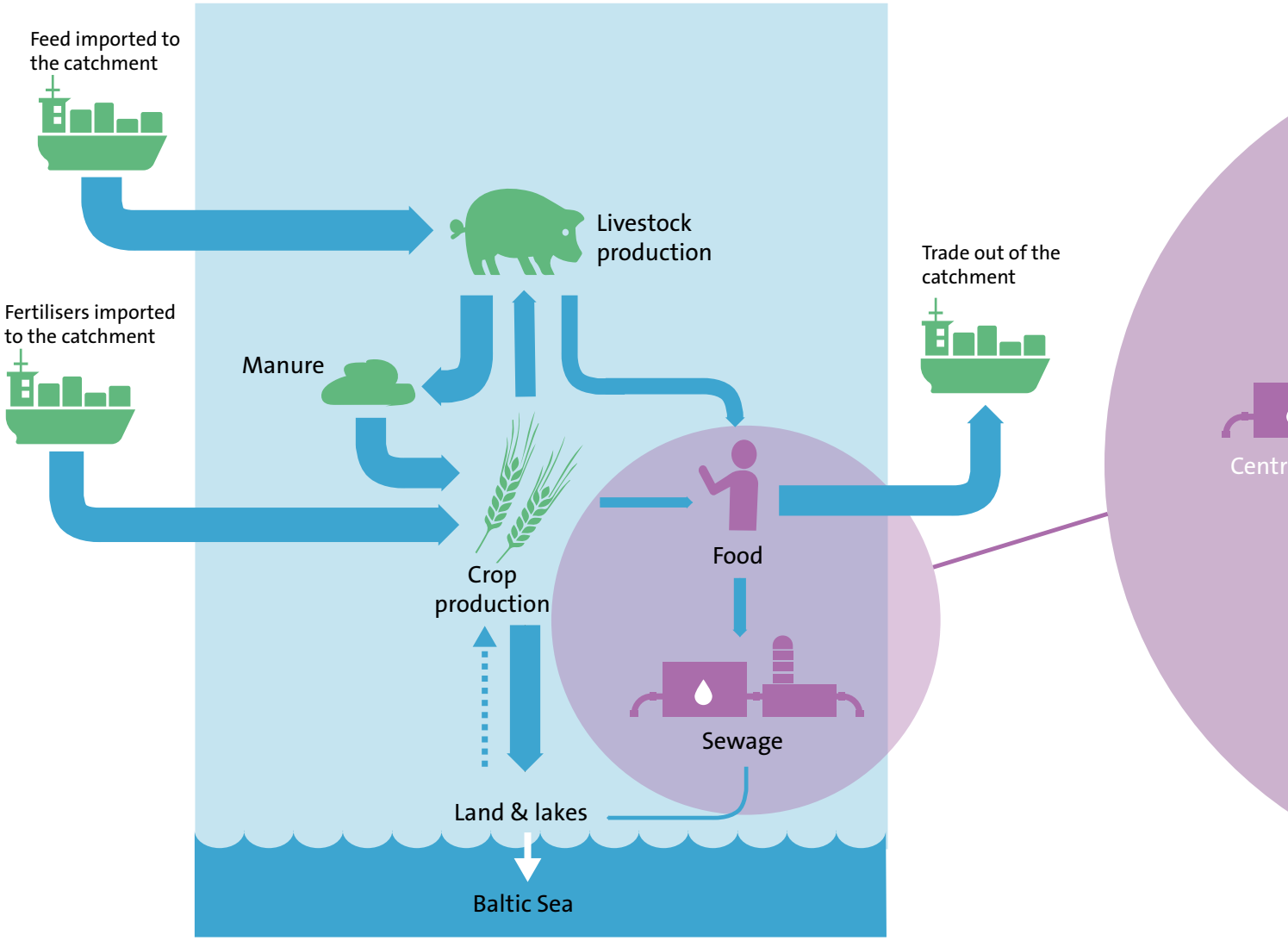
Challenge to meet Baltic Sea Action Plan reduction targets

Progress has been made in reducing nutrient inputs to the Baltic Sea. Since 1995, nitrogen inputs have decreased by 22% (250 000 tons) and phosphorus by 33% (15 000 tons).

To achieve the goals of the HELCOM Baltic Sea Action Plan, further nutrient reductions are needed. Compared to average inputs for the 2012-2014 period, nitrogen inputs must decrease by 12% (122 000 tons) and phosphorus by 55% (14 000 tons) to reach maximum allowable inputs.

Nutrients that cycle in the agri-food system contribute to eutrophication by, for example, leakage from agricultural soils, and discharge of sewage effluent to water bodies.

Photo: Bengt Ekberg/Azote



Within the agri-food system, phosphorus from imported fertilisers and feed are transformed into manure, feed, and food products. A large portion of phosphorus moves through the livestock sector. Only about 60% of phosphorus in fertiliser and manure are converted to harvested crops. Excess phosphorus can be stored in soils or leak to lakes, streams, and the Baltic Sea. The fate of phosphorus in human sewage is not well dokumented, but a portion is recycled in agriculture (0,027 million tons) and some is discharged in effluent (0,016 million tons). The relative magnitude of the phosphorus flows is shown by arrow widths. Data from Hong et al. 2017 and Eurostat.

Past inefficient use has led to the accumulation on land

In the past 50 years, countries around the Baltic Sea have applied about 35 million tons of mineral phosphorus fertilisers to agricultural soils.

Decades of inefficient use of phosphorus in crop production has led to the accumulation of huge amounts of nutrients in soils. Earlier, farmers were advised to apply large amounts of mineral fertiliser and manure to build up soil phosphorus levels. Soils in several regions now contain so much phosphorus that only small amouts need to be applied to maintain yields.

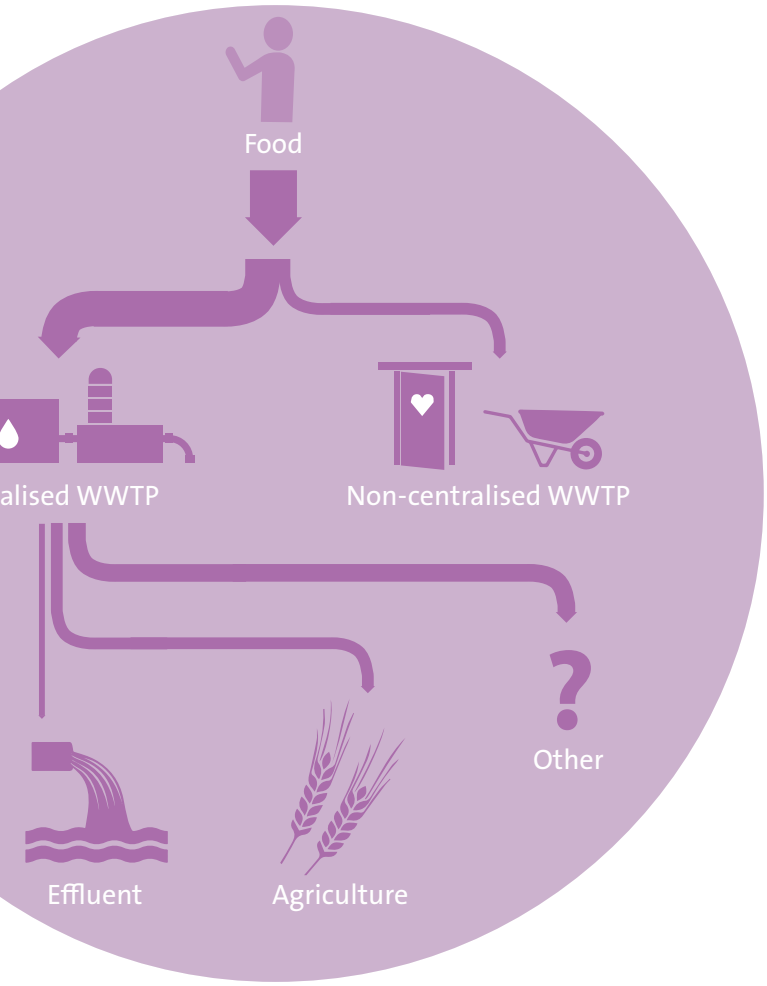
For the Baltic Sea catchment as a whole, the amount of accumulated phosphorus in agricultural soils is the same order of magnitude as two decades of crop nutrient needs. There is large potential to decrease application rates of mineral fertilisers and manure in areas with substantial phosphorus surpluses.

The surplus of phosphorus, which leads to accumulation, increases the risk of losses to lakes, streams, and the Baltic Sea. Since large amounts of feed and fertiliser are imported, phosphorus continues to accumulate.

The buildup of phosphorus on land can be slowed by reducing imports of feed and mineral fertilisers through more effective recycling of nutrients in manure and human sewage and by avoiding over-fertilisation.


Photo: Bent Christensen/Azote

Illustration: Robert Kautsky/Azote



Recycling could reduce mineral fertiliser imports

Agricultural systems will never be perfectly efficient because of unavoidable nutrient losses. But in the Baltic Sea region, there is room for improvement.

Each year, the 23 million pigs, 16 million cows, and 244 million chickens in the region produce manure that contains over 0,35 million tons of phosphorus. Much of the phosphorus in the manure originates from imported animal feed. Even though over 70% of crops grown in the Baltic Sea catchment are fed to livestock, this is insufficient to meet the animals' nutrient requirements. As a result, two-thirds of the phosphorus needed by livestock is imported, mostly as soy from South America.

A recent study shows that the average phosphorus use efficiency in crop production in the Baltic Sea region is only about 60%, but it varies greatly between countries. If phosphorus use efficiency increased to 70 - 90%, imports of mineral phosphorus fertilisers could be reduced by 0,11 to 0,17 million tons.

Specialisation and spatial separation of crop and livestock production systems can cause excessive phosphorus application in animal-dense regions that have large amounts of manure in relation to crop area. There is potential to use manure more efficiently by redistributing "excess" manure nutrients from regions specialising in livestock production to regions specialising in crop production and, ultimately, reduce mineral fertiliser imports.

Recycling sewage sludge could reduce fertiliser imports

About 75% of people in the Baltic Sea region are connected to centralised sewage systems, while the remainder are connected to non-centralised systems, such as septic- and cesspit-type systems. Centralised sewage treatment practices have improved substantially in the past few decades; however, phosphorus removal efficiencies vary greatly, between 63% (Latvia) and 97% (Finland, Germany, and Sweden).

PHOSPHORUS USE EFFICIENCY VARIES GREATLY AROUND THE BALTIC SEA

	Outputs	Inputs			
Tons P	Crop harvest	Fertiliser	Livestock excreta	PUE*	Human excreta
Belarus	36 400	69 400	46 300	0,3	5 400
Denmark	45 400	11 200	55 200	0,7	7 200
Estonia	6 400	3 000	3 800	0,9	1 400
Finland	21 600	12 200	15 600	0,8	6 600
Germany	55 000	19 200	34 100	1	6 500
Latvia	12 700	7 100	5 900	1	2 300
Lithuania	25 300	14 400	12 200	0,9	4 100
Poland	165 100	170 300	154 000	0,5	45 000
Russia	4 500	2 600	16 800	0,2	13 200
Sweden	34 000	10 500	22 700	1	11 800
Total	406 400	319 900	366 600	0,6	103 500

In countries with low phosphorus use efficiency, there is the opportunity to reduce imports of imported mineral fertilisers by avoiding over-fertilisation and by substitution with animal manure (excreta). Phosphorus in human excreta can also be better recycled in agriculture, further reducing the region's dependence on fertiliser imports. Only parts of Belarus, Germany, and Russia that are within the catchment are included in the estimates. Data from Hong et al. 2017. *PUE is phosphorus use efficiency in crop production, the ratio of crop harvest (outputs) to the sum of fertiliser and livestock excreta (inputs).

There is opportunity to recycle phosphorus from sewage sludge that is collected in centralised systems. Today, only about one-third of the sewage sludge in the region, which contains about 0,027 million tons of phosphorus, is used in agriculture, but practices differ among countries in the region. The remaining sludge, corresponding to 0,036 million tons of phosphorus, could be used in agriculture and reduce fertiliser imports.

Phosphorus that is not removed from sewage as sludge in centralised sewage systems is discharged to surface waters in effluent. Thus, improving sewage treatment capabilities is an effective way to prevent phosphorous from entering lakes and rivers that drain to the Baltic Sea. Currently, an average of 16% of phosphorus in human excreta (0,011 million tons) becomes effluent.

Phosphorus is a finite resource

Mineral phosphorus fertlisers derive from phosphate rock, which is a finite resource, like fossil fuels. Unlike fossil fuels, however, there is no substitute.

Today, 85% of phosphate rock reserves are controlled by three countries: Morocco, China, and Algeria. The European Commission has added it to the list of 20 Critical Raw Materials for which supply security is at risk and economic importance is high.

In fact, society currently operates outside the planetary boundaries of the phosphorus cycle. This is not sustainable. Therefore, recycling existing phosphorus within agriculture better, and reducing the overall import of new phosphorus to the Baltic Sea region, not only mitigates eutrophication but also leads to a more sustainable use of a finite resource.

RECOMMENDATIONS

There is potential to make progress towards the goals of the Baltic Sea Action Plan by increasing the recycling of phosphorus in agriculture and reducing over-fertilisation.

- National actions should not neglect manure.
- Increase the use of locally produced feed in animal husbandry in order to reduce imports of phosphorus to the Baltic Sea region.
- Facilitate the trade of recycled fertilisers by, for example, supporting the proposed EU fertiliser trade legislation.
- Improve the use efficiency of manure use in agriculture by, for example, setting legal limits for fertilisation of soils and supporting farm extension on nutrient management, including soil nutrient mapping.

All countries around the Baltic Sea should urgently comply with the EU Urban Waste Water Directive. The directive needs to be reviewed and sharpened.

Photo: Bengt Ekberg/Azote

BALTIC EYE – BRIDGING THE GAP BETWEEN SCIENCE AND POLICY

This policy brief is produced by Baltic Eye, a part of the Stockholm University Baltic Sea Centre.

Baltic Eye is made up of a team of scientists, policy, and communication experts who analyse and synthesise scientific research on the Baltic Sea - and communicates it to stakeholders in the decision-making process.

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CONTACT

Michelle McCrackin, Limnologist
+46 (0)8 16 17 78, michelle.mccrackin@su.se

Annika Svanbäck, Agronomist
+46 (0)8 16 31 50, annika.svanback@su.se

Science and communication with focus on the sea
+46-8-16 37 18 | ostersjocentrum@su.se | su.se/ostersjocentrum

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