Managing phosphorus cycling in agriculture

Tentative results from innovation studies in a nutshell

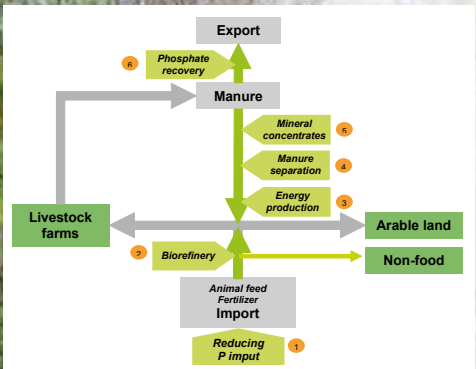

Figure 1. National agricultural P cycle and the interventions studied.

Introduction

For decades, intensive livestock farms face increasing economic costs for manure disposal, because of the limited land area and decreasing application limits over time. Farmers have been forced to drastically lower the protein and phosphate contents of the animal feed and to outcompete inorganic nitrogen and phosphorus fertilizers from the market. Export of animal manure to other countries and manure treatment has also contributed to lowering the manure 'burden'. However, manure treatment has not contributed much to relieve pressure on the 'manure market', because

- Treatment of animal manure into marketable products is relatively expensive compared to the costs of other pathways for manure disposal. Furthermore, the market for new manure products has not been developed and explored properly.
- Entrepreneurial and Innovative farmers were not compensated for the investments in case success failed.
- The cost of manure disposal will go down when manure processing becomes profitable, which will benefit all livestock farms, except the farmers who made the investments ('prisoners dilemma').

Solutions for better management of the manure surplus call for revolutionary thinking towards a more market oriented approach in co-operation with stakeholder industries, which are capable to distribute products derived for manure. Supply and demand of manure products have to be in balance. The focus is on phosphate, because forecasts indicate that some 60 million kg of phosphate has to be taken out of the manure market by 2015, mainly because of the lowering of the phosphate application limits.

At the request of the Ministry of Agriculture, Nature and Food Quality, Wageningen UR has made an inventory of potential innovations which may contribute to a drastical decrease of the pressure on the manure market (Figure 1). This factsheet summarizes the results of the individual innovation studies The separate studies are discussed in detail in factsheets No. 23 to No. 29.

Methods and results

A primary goal should be the decrease of the import of phoshate in a cost effective way, through decreasing the use of inorganic phosphate fertilizer and decreasing the phosphate content of animal feed (also through bio-refinery of feed stock ingredients) (Route 1, and 2). Secondly, the export of phosphate containing products has to increase, also through recovery of phosphate from manure and wastes (Route 6 in combination with 3). Thirdly, the use of phosphate from manure in the Netherlands has to be optimized (routes 4 and 5 in combination with 3). The status and practical applicability of the interventions vary.

1. Reducing the phosphorus content in feed

Reducing the phosphorus content in feed with 20% offers the best prospects for a substantial reduction of the manure burden with about 9 million kg of phosphate. The phosphorus needs by animals vary with animal category (Van Krimpen et al, 2010; factsheet No. 29). Technically, a reduction of the phosphorus content of animal feed by 20% is possible at short term. Furthermore, such modest lowering of the phosphorus content has a limited impact on the price of animal feed. However, there is a lack of sufficient incentives to induce the animal feed industry to pursue this strategy.

2. Biorefinery

Through biorefinery, the feed-manure-cycle can be further optimized, by improving the composition of feed, and increasing the amount of easily digestible phosphorus in relation to the total amount of phosphorus in feed. In this way the phosphate import can be

Factsheets Wageningen innovation studies on manure processing:

No. 23 Tentative results from innovation studies in a nutshell
No. 24 Phosphate recovery from animal manures
No. 25 Reduction of Dutch agricultural phosphorous load through bio-refinery
No. 26 Pretreatment of manure
No. 27 Biochars from digested fattening pig slurry
No. 28 Market survey into reduction of phosphorous in pig feed
No. 29 Feeding management to reduce phosphate in animal husbandry
No. 30 Slurry separation justifies differentiation of manure application thresholds

reduced without negative consequences for intensive husbandry. Preliminary experiments on a laboratory scale show that it is technically possible and cost neutral to separate phosphates, protein and potassium from the raw feed resources (Meesters en Sanders, 2010; factsheet No. 25). It is expected that the total phosphate input into agriculture can be decreased by 1 - 5 million kg per year Option 2 makes option 1 cheaper and therefore, creates opportunities to further implement option 1.

3. Bio-energy
Producing energy from manure through anaerobic digestion does not change the phosphate content balance. However, it is necessary to dry the manure to enhance the export and/or to make manure processing more profitable. The best perspectives are obtained if bio-energy is produced in large scale plants (Timmerman en Rulkens, 2009; factsheet No. 26).

4. Manure separation
Because of the step-wise lowering of application standards of nitrogen and phosphate and an increasing number of dairy cattle, farmers will not be able to dispose all animal manure on their farm and therefore have to export manure. The use of manure fractions with different ratios of nitrogen-to-phosphate can increase precision fertilization, whereby farmers have to export less manure. Separation techniques can split the cattle slurry into a liquid fraction that is rich of nitrogen and that often can be applied on their own agricultural land, and a solid fraction that is relatively rich of phosphate which can be exported. The reduced volume of the wet solid fraction will lower transportation costs. Simple separation techniques are relatively cheap and easily applicable (Schröder e.a., 2009; factsheet Slurry separation justifies differentiation of manure application thresholds). It is expected that due to application of separation techniques the manure surplus can be reduced with 1 - 5 million kg phosphate per year.

5. Mineral concentrates
Separation of animal slurries and reversed osmosis of the liquid fraction can be use for the development of so-called mineral concentrates. This approach is developed in order to substitute the application of fertilizer nitrogen by mineral concentrates (Velthof et al., 2010; factsheets No. 2 to No. 13 *in Dutch*). This technique will not reduce the phosphate balance but will help further manure processing, especially regarding the re-use and processing of the liquid fraction of manure.

6. Phosphorus and phosphate recovery
At the short term the national phosphate surplus can be reduced substantially by the suggested interventions in routes 1 to 5, although not sufficiently. Via recovery of phosphate from animal manure into phosphate fertilizer, biochar and elementary phosphorus, the phosphate surplus can be further decreased (route 6 in combination with 3). These routes require an integrated approach of manure separation and processing techniques with active participation of many stakeholders, because the recovery of phosphate from animal manure requires significant investments (Schoumans et al., 2010; factsheet No. 24). It is expected that these routes have the potential to achieve a 'zero-balance' for the national phosphate input-output balance.

Conclusions

The exploratory studies of Wageningen UR showed that the phosphate surplus can be decreased by some 60 million kg phosphate through a combination of measures. Some of these measures can be implemented rather easily in the short term, while others require significant investments and institutional arrangements. A number of options can be effective at short notice, but need incentives which will induce suppliers and/or consumers to act accordingly. Furthermore, the dissemination of the outcome of the studies to the stakeholders is essential. It is equally important that the national authorities facilitate the whole process and support the actors with research that is needed to implement manure processing in such a way that valuable phosphate resources are applied to their full potential.

Voor meer informatie:
Oene Oenema, Alterra
Oscar Schoumans, Alterra
Marinus van Krimpen, ASG
Geert van der Peet, ASG
Maikel Timmerman, ASG
Nico Verdoes, ASG
Koen Meesters, FBR
Johan Sanders, VPP
Wim Rulkens (adv.)
Alex Bikker, LEI
Harry Kortstee, LEI
Wim de Hoop, LEI
Jaap Schröder, PRI

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