Costs of reducing nutrient losses in Denmark
- Analyses of Different Regulation Systems and Cost Effective Measures

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Abstract

The economic calculations carried out prior to the Plan for the Aquatic Environment III included a comparison of regulation systems aimed at reducing nitrogen leaching, analyses of measures for reducing phosphorus losses and estimation of administrative costs. The conclusions were that taxation of the N-surplus introduced at the sector level was the most cost effective regulation when compared with administrative regulation and set a side. For phosphorus a balance between incoming and outgoing phosphorus is very costly as this requires that much slurry is transported from the western to the eastern part of Denmark. The final plan for the Aquatic Environment III from 2004 included a 13% reduction of N-leaching until 2015 based on cost effective administrative measures like wetlands and catch crops. Also a tax on mineral phosphorus in feedstuffs was included in order to half the phosphorus surplus. The measures in the Plan will have to be supplemented by more measures to meet the targets in the EU's Water Framework Directive.

Key words: Cost-effectiveness, cost of reducing nitrogen leaching, phosphorus, administrative costs
JEL: Q51, Q52 and Q53

Introduction

The purpose of the poster is to describe the methods and results from the economic analyses carried out in 2003 prior to the Plan for the Aquatic Environment III from 2004 (PAE III). The purpose of the work was to analyse the economic consequences for agriculture and for society of different measures to reduce nitrogen leaching and phosphorus surplus. The analyses were carried out both at the national and regional level, where the catchment area for Odense Fjord, Denmark was the case area for the regional analyses. Furthermore, the purpose was to calculate and compare the cost-effectiveness of different measures, where the costs are related to the reduction in nitrogen leaching and phosphorus surplus respectively. The analysis involves both analyses and procedures, which will similar to the ones used in analyses related to the implementation of the Water Framework Directives in Denmark.

Methods

A comparison between different measures and regulation systems is a very complex task, which requires integration of economic and environmental models. Several types of economic models have been used. In order to estimate the sector economic consequences, the ESMERALDA sector economic model has been adopted. At the farm level, the income has been modelled based on farm characteristics for the selected farms. This FOI Land Rent model provides an econometric estimated land rent assessment for all farms in Denmark based on size, crop rotation and livestock. The land rent value is especially useful when deciding which land to take out of production and the effects of increases in animal production. Furthermore, calculations of the administrative costs for the agricultural sector and the government have been included. To assess the costs for society as a whole, welfare economic calculations have been undertaken, where the additional effects related to environmental goals have been priced and included in the net cost analysis.

Results on nitrogen

Taxation has not yet been used to regulate the usage of nitrogen in Danish agriculture. The most effective taxation system was found to be taxation on the nitrogen surplus imposed at the sector level as a taxation of the N-surplus at the farm level would require nutrient accounts from each farm, where the N-surplus cannot be established with a certainty required for tax purposes (in line with experiences form The Netherlands). The N-surplus is well correlated with the related environmental impact and the implementing

of the system only affects relative few companies, when N-fixation is not included. When using a tax on nitrogen surplus all nitrogen supplied to agriculture is taxed and all nitrogen sold from the farm is subsidised, so that only the net nitrogen loss is taxed. The requirement regarding the relationship between the number of animals and the farmed area is maintained.

Calculations show that a replacement of the administrative regulation will require a tax of approx. 0,4 € per kg N. It is estimated that this change would reduce costs by 8-9,4 million € whilst still obtaining the present environmental goal. The estimate is uncertain and is expected to be a lower estimate of the actual gain. A further reduction of 10 percent would require a tax of 1,6 € per kg N which will cost approx. 2,7 € per kg in reduced N-leaching, if the revenue is transferred back to the agricultural sector.

The total costs of reducing nitrogen leaching by 10 % in relation to PAE II using administrative measures, is 49 million € yearly. The small difference is due to relatively inexpensive measures like the replacement of catch crops from arable farms to dairy farms, which is not included in the ESMERALDA model analysis.

In the welfare economic analyses, the cost-effectiveness is calculated both with and without inclusion of the additional effects covering emissions of CO_2 and NH_4. The value of these is set at 1,1 € pr. kg NH_4 and 16,1 € pr. Kg CO_2.. The value of the additional effects varies with the different measures from 0,3 to 1,7 € per kg in relation to the reduced N-leaching. The value of additional effects related to taxation and reduced fertiliser norms are approx. 0,8 DKK per kg N, while the value of reducing livestock is almost 3,4 € per kg N in reduced leaching. The calculations show that the welfare economic ranking of the different measures is unchanged by the inclusion of additional effects. The welfare economic ranking of the measures is similar to the ranking based on the direct costs for the state and the sector.

The analysis of the administrative costs for the agricultural sector, government, county and municipality shows that the costs for the sector with respect to fertiliser plans and accounts constitute a yearly cost of 255 € per Danish farmer. On top of that there are costs for the state related to area measures, like wetlands, which constitute just over 8 % of the total amount paid in compensation. The analyses show that a change from fertiliser accounts to taxation (N-surplus model) will not reduce administrative costs if N-fixating crops (e.g. clover and peas) are included. The sector costs related to fertiliser accounts will remain almost unchanged as taxation on nitrogen will also require detailed fertiliser planning at the farm level.

For the Odense Fjord catchment area, an analysis of the costs of achieving a reduction in the nitrogen loss to the Fjord by 300, 600 and 1,200 tonnes N (60 percent) respectively have been calculated. The cost of reducing nitrogen leaching in the Odense Fjord is lower than in the national analyses, as the calculated costs related to wetlands are based on an estimate of the actual land rent loss for specific farms, whereas the national cost is based on subsidies needed to achieve voluntary agreements. Typically, the compensation using voluntary schemes will be higher than the direct cost for the farm, in order to provide the necessary incentives, including transaction costs.

The overall picture is that taxation generally is cheaper, although the way the fertiliser accounts have been implemented in Denmark has allowed a flexibility which reduces the costs of this system. Taxation has limits and so for large reductions and for area specific purposes taxation can not be the sole regulation system.

Results on phosphorus

As opposed to nitrogen, more detailed economic analyses of the costs of reducing phosphorus surplus or leaching have not been carried out in Denmark before. The environmental effects of given measures are therefore not as well founded as for N. A change in the feeding will reduce the phosphorus (P) surplus by 15,000 tons to 19,000 tons P, which is equivalent to 7 kg P per ha. Increases in the use of phytase and the use of phase feeding is almost cost neutral. This change is taking place and the use of phytase is common practice in feedstuff used on most pig farms by the beginning of 2005. The development will be further promoted by the use of taxes on P in feedstuff. However, taxation on P in feedstuff is not analysed in the report.

A norm on phosphorus, limiting the surplus to 10 kg P per ha, will reduce the surplus by 2 kg P per ha to 6 kg per ha. It is assumed that the use of norms will be implemented after the change in feeding practice has been implemented. The analyses indicate that a maximum surplus of 10 kg P per ha would lead to a redistribution of 5 % of all manure. Intensive dairy and poultry farms are especially affected by this require-

ment. The additional costs are 2,4 million € and the cost savings on P in mineral fertiliser are 2,3 million €, resulting in low net costs.

Balance between incoming and outgoing phosphorus at the farm level is expected to cost around 47 million €. This requirement will lead to substantial redistribution of animal manure from West to East Denmark. Here there is a need for more thorough analyses of the implications as the cost estimates are very uncertain. Among the area related measures which can contribute to a reduction in the phosphorus loss, the analyses show that wetlands are the most cost-effective measure. Furthermore, wetlands also reduce nitrogen losses. The report here proposes to calculate the cost in relation to nitrogen units, where the reducing in nitrogen and phosphorus leaching is combined. This requires that the environmental effect on e.g. visibility for both N and P has been established in order to find a N:P ratio.

The final plan

The Plan for the Aquatic Environment III (PAE III) was agreed in April 2004. The aim is a further reduction in N-leaching of 21.150 tonne N (13% reduction) until 2015. Half the reduction is expected to come from reductions in the agricultural area and effects of EU's 2003 reform. The other half will be achieved through increased use of catch crops, and increased area with wetlands and forest. The total costs of Action Plan III is estimated at 25-35 million € yearly. The cost effectiveness is 2.5 – 3.5 € pr. kg N, which is slightly higher than Action Plan II as the selected measures give a reduction of 9,950 tons N (Jacobsen, 2004).

The aim of PAE III is also to half the national P-surplus of 32,700 tonne P in 2001 before 2015. This is supported by a tax on mineral P in feedstuffs on 0,53 € per kg P. In the plan there are also initiatives to reduce smell and ammonia emission.

PAEIII is a first step towards fulfilling the requirements in the Water Framework Directive (WFD), but more measures will have to be employed to reach the target of good ecological status. It is not unlikely that another 200,000 ha (10%) will have to be taken out of production, but the environmental targets have not been finalised in Denmark yet. Analyses concerning other European countries indicate that they also will have to impose stringent measures to reach the environmental goals in the WFD, and achieving these by 2015 seems difficult at present. Many economic analyses will have to be carried out in order to find the most cost effective measures, looking at many and complex aims and measures. The focus on high risk areas with respect to both N and P losses will further increase the need for site specific area related analyses and measures. Finally, the possibilities of derogations from the WFD will probably require development of procedures for cost-benefit analyses which will be accepted by the Commission.

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