



Livestock farmer perceptions of successful collaborative arrangements for manure exchange: A study in Denmark



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ABSTRACT

Fulfilling the targets of the European Nitrate Directive (91/676/EEC) and the Water Framework Directive (2000/60/EC) has required governments to take action to prevent excessive application of livestock manure. In Denmark, where intensive livestock production has caused serious nitrogen leaching to underground water, self-governing manure exchanges have been widely organised among farms in local communities. This allows large livestock farms to achieve the required balance between manure production and the agricultural production area although the importer rarely pays the full nutrient value for the manure received. Despite the potential for improved efficiency of manure use, few studies have examined livestock farmers' perceptions of coordinated arrangements with recipient farms and factors in successful arrangements. A total of 644 manure exporters were asked about factors they consider important in identifying and selecting a new partner for manure export, including factors regarding the potential partner and the function of the partnership. They evaluated a total of 18 statements relating to possible perceptions. The results revealed that exporters appreciated especially four qualities: (1) timely communication regarding establishment of a contract; (2) the potential for a long-term partnership; (3) physical and social accessibilities to the partner/s; and (4) flexibility of acceptance of manure. Multiple regressions were then performed to detect associations between the variables on farm/farmer characteristics and on existing collaborative arrangements, and the factor scores derived from principal component analysis (PCA) of farmers' perceptions. The results provided practical insights into how socio-demographic characteristics of farmers, their production enterprises, their past experiences of transactions and spatial location of farms influenced their decision-making in establishing partnerships. For instance, organic dairy farmers seemed to place less emphasis on the distance to and accessibility of their partner. Exporters on the islands where crop production dominates were significantly more concerned about the characteristics of the partner with respect to his/her professional skills and business expertise. Social aspects, e.g. previous knowledge of the partner, were perceived as more important by older than by younger farmers, while this aspects appeared to be less important for farmers with large business units as their primary aim of making agreements seems to comply with the regulations. These findings are applicable in intensive livestock production areas in other European countries.

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1. Introduction

Since 1991, fulfilling the targets of the European Nitrate Directive (91/676/EEC) and the Water Framework Directive (2000/60/EC) has required member states to take actions against excessive

application of manure and other fertilisers. The first step includes the identification of areas where groundwater have nitrate concentrations of more than 50 mg/l nitrate, and this knowledge is used to find the area which, as a minimum, should be designated as Nitrate Vulnerable Zones (NVZs) (DEFRA, 2009; Macgregor and Warren, 2006; Smith et al., 2007; van Grinsven et al., 2012). Farmers with land in NVZ must adhere to strict rules over the timing and application of nitrogen from organic and inorganic sources (Barnes et al., 2009). In Denmark, intensive livestock production has caused serious nitrogen leaching to underground water reserves at national scale (Kronvang et al., 2008). The Danish government, along

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with a number of other European countries (Finland, Ireland, Lithuania, Luxembourg, Malta, The Netherlands, Slovenia, Germany and Austria), has thus adopted country-wide designations, implying that as a starting point, all farmers must follow the same regulations regardless of regional variations in production environments and socio-economic conditions. Currently each Danish livestock holding must ensure a balance between agricultural land and the number of livestock units corresponding to a maximum of 170 kg ha⁻¹ yr⁻¹ of nitrogen from manure for cattle holdings and 140 kg ha⁻¹ yr⁻¹ of nitrogen for all other livestock holdings, which is stricter than the standard requirements of 170 kg ha⁻¹ yr⁻¹ of nitrogen from manure in the Nitrate Directive (Mikkelsen et al., 2010). The area included, when calculating the livestock density, can be owned, rented and covered by an agreement, which allows a given amount of livestock manure to be applied. The Danish derogation from the Nitrate Directive permits a maximum of 230 kg ha⁻¹ yr⁻¹ of nitrogen, and applies to cattle holdings with an average of 90% of agricultural land available for manure application, cropped by crops such as clover grass and other crops with a high nitrogen uptake potential (Commission of the European Communities, 2002; Smith et al., 2007). This regulation has helped to keep the livestock density in Denmark at 1.1 Livestock Units (LU) per hectare, which is somewhat lower than the livestock density in other livestock intensive areas such as The Flanders in Belgium and The Netherlands (Danish Statistics, 2013; van Grinsven et al., 2012). One Danish livestock unit is 100 kg N from the storage and it is currently equal to 0.75 dairy cow or 4.3 sows with piglets up to 7 kg.

The on-going structural change in the Danish livestock sector towards larger farms makes it difficult for livestock farmers to achieve the required balance between the crop area and manure produced at the farm level. This is more severe when coupled with the frequent shortage of available land in livestock-intensive areas. Many livestock farmers thus use the option offered in the regulation to export their excess manure to other farmers. A previous study showed that about 50% of Danish farms were involved in manure exchange and had either exported or imported manure to/from other farms (Asai et al., 2012b). Farmers exporting manure are required to submit information about the manure receiver, including the amount (N kg) and types of manure exported. This information is cross-checked by the authorities in order to ensure that all animal manure is registered and applied correctly. The below economic optimal N-application norm adopted in Denmark means that the costs of fictive manure agreements is relatively high as the total N-application, at the outset, is under the economic optimum. The level of fictive manure agreements in Denmark is perceived to be rather low and so there is no GPS control with manure transport and no official sampling of the nutrient content as is the case in e.g. The Netherlands (Jacobsen, 2011; OECD, 2005; Oomen, 2012).

In other livestock-intensive regions in Europe, various collective actions for handling surplus manure are also being developed (e.g. DEFRA, 2009; Lopez-Ridaura et al., 2009). However, few of these involve such a large population of collaborative arrangements as that in Denmark. The exporters are mainly larger livestock farms (14% of the sample) and the importers (29% of the sample) are mainly arable farms (Asai, 2013). A total of 6% are both importers and exporters of manure. The level of manure export from the farms is also large in e.g. The Netherlands and Belgium (around 50% in The Netherlands), but there, a considerable share is exported long distance and to other countries, which is not the case in Denmark (Oomen, 2012).

Asai et al. (Forthcoming) explored the nature and function of these collaborative arrangements. As regards the objective of continuously reducing environmental impacts, collaborative arrangements on manure exchange have been seen as opportunities for

nutrient recycling through the area-wide integration of livestock and crop productions (Entz et al., 2005; Wilkins, 2008). Despite the potential of such arrangements for improved utilisation of nutrient resources, there is a lack of studies providing a more nuanced understanding of livestock farmers' perceptions of successful collaborative arrangements with manure receivers, and the factors they consider important for these. Although these collaborative arrangements are policy-driven, selection of the partner and management of the manure exchange are the responsibility of the individual farmer. Farmers' decisions are adapted to the local production environment and socio-economic conditions (Reidsma et al., 2010; van Ittersum and Rabbinge, 1997). Analyses show that keeping the manure on your own farm is the cheapest option and exporting manure to neighbours often means, that Danish farmers are not paid the full value of the manure (Jacobsen, 2011). In fact, the exporting farmer often has to pay for the transport or the application and he is very rarely paid for the nutrient value of the manure. Buying land is another option, but high livestock intensity often generates high demand, and thereby high prices on land. Arable farms could receive the manure, but they are sometimes reluctant to do so for a number of reasons, such as lack of knowledge regarding nutrient content and the disadvantages of heavy manure application machinery on their fields. Here also the price of mineral fertiliser plays a part as arable farmers are more likely to accept manure and the disadvantages mentioned, if the price of mineral fertiliser is high, as was the case in 2008. The need to export manure is seen in several livestock intensive areas in Europe and has even led to export of manure across borders from e.g. The Netherlands to France and from The Netherlands to Germany.

Hence, it is clear that the way to handle to problem of excess manure is by no means simple for the individual livestock owner. However, the lack of knowledge on the reasoned actions of manure exporters trying to find the most appropriate option means that there are few useful insights for policy makers, farm advisors and researchers seeking to promote collaboration as a way to achieve sustainable nutrient management, on the considerations behind the choice of solutions for manure export, and the weight given to different aspects of the choice of partner.

The present study aimed to provide empirical insights into: (1) what manure-exporting farmers perceive as important for successful collaborative arrangements for manure exchange in addition to direct costs, and (2) how these perceptions are influenced by the local production environment, the individual farm and the production type, as well as the farmers' previous experiences of manure exchange arrangements.

2. Analytical framework

2.1. Theoretical background

In order to understand the farmers' perceptions of successful collaborative arrangements for manure exchange, we found experiences from transaction cost economics (TCE) and organisational theory useful as input to construct an analytical framework. TCE is one of the theoretical approaches within the new institutional economics. With the transaction as the unit of analysis, TCE makes the assumption that there are three types of costs to carry out any exchange (Hobbs, 1997). These include information (or search) costs (*ex ante* costs of identifying suitable exchange partners), negotiating costs (costs of carrying out the transaction, commission costs, costs of negotiating the exchange terms, and costs to make a contract), and monitoring or enforcement costs (*ex post* costs of ensuring that the terms of the exchange are respected) (Hobbs, 1997).

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