CONTEXT MATTERS: THE IMPORTANCE OF MARKET CHARACTERISTICS IN THE VOLATILITY OF FEEDSTOCK COSTS FOR BIOGAS PLANTS

A. MERTENS*', J. VAN MEENSEL*, K. MONDELAERS*, J. BUYSSE****
* Social Sciences Unit, Institute for Agricultural and Fisheries Research, Burg. Van Gansberghelaan 115 bus 2, 9820 Merelbeke, Belgium
**Department of Agricultural Economics, Ghent University, Coupure Links 653, 9000 Gent, Belgium

ABSTRACT

Recently, biogas plant managers in Flanders face increased financial uncertainty. Between 2011 and 2012, 20% of the Flemish biogas plants went bankrupt. Difficulties in obtaining feedstock at stable and affordable prices is one reason why the biogas sector struggles. In literature, contracting is often proposed as a way to decrease the volatility of the feedstock costs. However, these studies generally do not consider the context in which the biogas plant manager needs to buy the feedstock. Yet, this context could be of specific importance when biogas plant managers are in competition with other users of the same biomass type. Silage maize is an example of such a feedstock, as it is both used by dairy farmers and biogas plant managers. Using a combination of qualitative research and agent-based modelling, we investigated the effect of specific characteristics of the silage maize market on the acquisition of local silage maize by biogas plant managers. This paper details the institutional arrangements of the silage maize market in Flanders and the results of a scenario analysis, simulating three different scenarios. As shown by the results, the time of entry into the market, as well as the different institutional arrangements used by the biogas plant managers as opposed to dairy farmers could explain the difficulties in obtaining a stable supply of local silage maize by biogas plants. Our findings can help to develop mitigation strategies addressing these difficulties.

INTRODUCTION

After the approval of the directive 2009/28/EC on the promotion of the use of energy on renewable sources by the European Parliament in 2009, important investments in anaerobic digestion plants were made all over Europe (Eurobserv'er 2013). Also in Flanders, the northern region of Belgium, entrepreneurs established anaerobic digesters, convinced by the favourable conditions at that time: manure surpluses in areas with high livestock densities and the prospect of long-term subsidies (De Geest et al. 2013; Eurobserv'er 2013).

However, today, the circumstances have changed and Flemish biogas plant owners face increased financial uncertainty. In 2014 alone, 4 out of 40 biogas plants in the region went bankrupt and 25 approved projects were put on hold or even completely abolished (De Geest et al. 2014). These remarkable figures are explained by the high investment and operational costs, an uncertain public funding climate and low commodity prices for electricity (De Geest et al. 2013). Moreover, biogas plant managers face difficulties in achieving a stable and affordable supply of biomass. In this paper, we focus on this last aspect, since it was identified as one of the main challenges of biogas plant managers, not only in Flanders, but also in other European countries (Gold & Seuring 2010; Poeschl et al. 2010).

Several authors (Mccormick & Kåberger 2007; Emmann et al. 2013) propose contracts as a way to achieve a stable and affordable supply of biomass.

However, these studies generally do not consider the whole context in which the biogas plant managers enter the feedstock market. Yet, this context could be of specific importance when they need to compete with other users of the same biomass type.

Silage maize is an example of such a biomass type, as it is both used in biogas plants and by dairy farmers. For biogas plant managers, it is the most important energy crop (De Geest et al. 2014). For dairy farmers, it is the most important roughage feed, together with grass. Since many years, a market in silage maize exists amongst dairy farmers. To investigate the effect of the specific characteristics of this market on the price volatility of feedstock for biogas plants, we evaluated the following hypothesis: “Being a new entrant in this established silage maize market and using different institutional arrangements may explain why biogas plant managers encounter more difficulties in obtaining a stable supply of local silage maize than dairy farmers". The hypothesis was tested in three steps. First, we conducted semi-structured interviews with different stakeholders, including experts, dairy farmers and biogas plant managers. Based on the results of this qualitative research, we developed an agent-based model (ABM), simulating the trade behaviour of dairy farmers and a biogas plant managers. In the third step, we simulated three scenarios. The results of this scenario analysis provide insight in the effect of interactions between dairy farmers and biogas plant managers on the characteristics of the emergent market, including the transacted volumes and the volatility of the feed(stock) costs.

The remainder of this paper is structured as follows. The next section describes the methodology used. In the 3rd section we detail the existing institutional arrangements in the silage maize market. Furthermore, we outline the ABM, developed to test our hypothesis and present the results of the scenario analysis. In the 4th section, we discuss our results. We end with some conclusions.

MATERIAL AND METHODS

Qualitative research

Using semi-structured interviews, we obtained insight into the trade of silage maize in Flanders. This kind of interviewing is a useful way to obtain a large amount of information in a limited amount of time (Bernard 2006). In total, we conducted 14 interviews with 3 experts, 5 dairy farmers, a middleman, 2 dairy farmers that owned a biogas plant and 3 biogas plant managers. Once we had the impression that no additional qualitative information was obtained by doing extra interviews, we ended the qualitative research.

Model development

Next, the results of the qualitative research needed to be transformed into a model to be able to investigate the effects of different market situations on the overall market properties. Markets are examples of complex adaptive systems, defined by Tesfatsion and Judd (2006) as systems “composed of interacting units” that “exhibit emergent properties, that is, properties arising from the interactions of the units that are not properties of the individual units themselves” (Tesfatsion & Judd 2006, p.836). Therefore, we found that Agent-based Computational Economics (ACE) was the most suitable approach to capture the different market characteristics into a model. In this bottom-up approach, the behaviour of the individual agents, as well as the environment in which they operate, is modelled explicitly. The interactions and transactions between the agents result from these behavioural rules and are thus modelled implicitly. More detailed information on ABMs and ACE can be found in

(Tesfatsion & Judd 2006; North & Macal 2007). We developed the ABM in the software package Netlogo.

RESULTS

Qualitative research: Informal versus formal silage maize market

Since many years, silage maize is traded amongst dairy farmers in Flanders. The semi-structured interviews revealed that this silage maize market is characterized by distinct institutional arrangements. In this section, we focus on the differences between the institutional arrangements used in transactions amongst dairy farmers and those used in transactions between dairy farmers and a biogas plant manager.

The unit of transaction is the first main difference. Dairy farmers with the intention to trade silage maize, negotiate on a price for a particular plot cultivated with silage maize. Before an agreement is made, a limited volume and quality check is carried out by walking through the field. This practice is not only time consuming, but also demands a certain experience. Next, a price agreement, in €/ha, is made orally, which usually includes that the seller is responsible for the cultivation of the maize, while the buyer is responsible for harvesting and transportation. Since biogas plant managers generally need hundreds of hectares of silage maize yearly, walking through every field they intend to buy is considered too time consuming. Therefore, in order to ascertain themselves of the volumes bought, biogas plant managers prefer €/ton as unit of transaction.

The second main difference results from the first. The use of different transaction units leads to the use of different safeguard measures against opportunistic behaviour. Since oral agreements are difficult to enforce legally, dairy farmers make use of a specific safeguard measure; relational governance (Cannon et al. 2000; Poppo & Zenger 2002). By creating the expectation of continuity and longevity of the relationship, the wish for immediate return on investment is reduced and farmers focus on the profits that can be made in the long run. Over the years, feelings of trust, loyalty and solidarity grows between the trading partners, which further reduces the risk for opportunistic behaviour (Poppo & Zenger 2002). Because the development of such trust relationships demands a lot of time and resources, biogas plant managers prefer to work with annual, legally enforceable contracts. Each year a new price is negotiated and each year the farmer can decide whether or not to sell his silage maize to the biogas plant.

Model description

In the second step, we developed an ABM using the results of the interviews and data from the Flemish Farm Accountancy Data Network of 2012. The model simulates decisions with regard to the purchase and sale of silage maize for the two agent types (dairy farmers and a biogas plant manager) located in a high density dairy farming region (Figure 1). It assumes feed(stock) cost minimizing behaviour for agents with a silage maize deficit and revenue maximizing behaviour for agents with a surplus. In order to include bounded rational behaviour and the development of durable relationships, agents make their decisions by calculating a score, which makes a trade-off between buying or selling silage maize at the best price and staying loyal to previous trading partners (Klos & Nooteboom 2001). As agents trade more often with each other, the loyalty between them gradually increases and becomes more important when calculating the score.

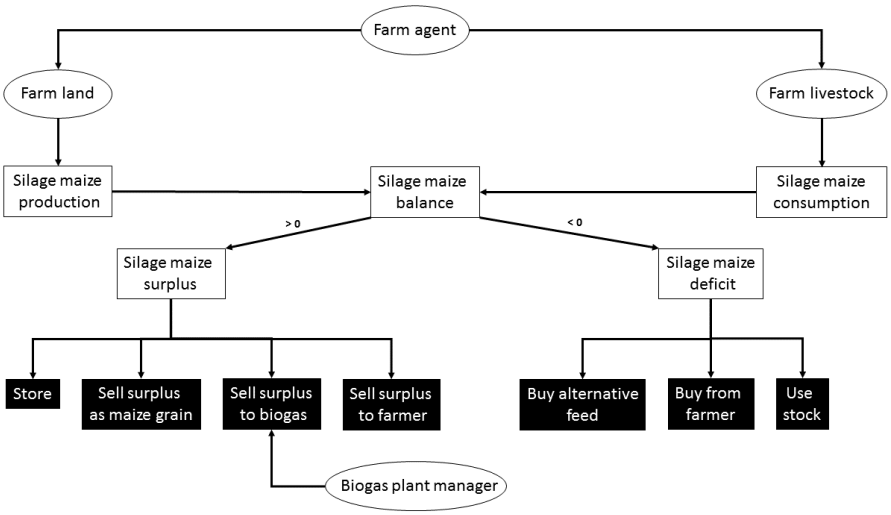

Figure 1: Schematic overview of the ABM. The dairy farmers' and biogas plant manager's different decision possibilities included in the model are indicated with a black background.

Scenario analysis

Finally, we simulated three scenarios to investigate the effect of interactions between dairy farmers and biogas plant managers on the characteristics of the emergent market. In the first scenario, the reference scenario, the biogas plant manager enters the market at the same time as the dairy farmers and is able to build up trust relationships with his silage maize suppliers. The second scenario is the same as the first, only the biogas plant manager enters the market only after 10 years. The third scenario differs from the second, because the biogas plant manager is not able to build up trust relationships with his suppliers. We performed the scenario analysis for the situation where there is a structural shortage of silage maize in presence of the biogas plant.

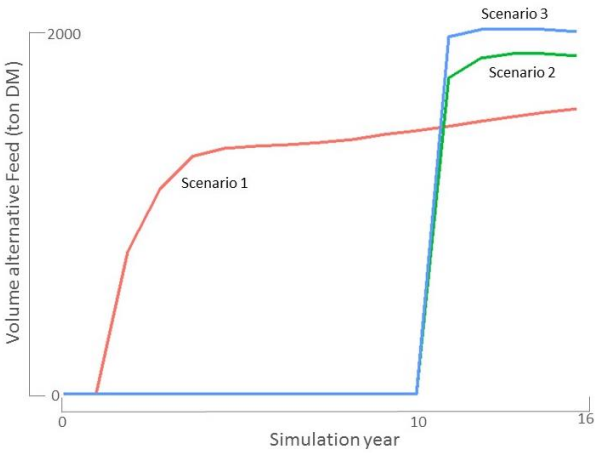

Figure 2: Volume of alternative feedstock purchased by the biogas plant manager for the three scenarios

Figure 2 shows the volume of alternative feedstock (ton DM) bought by the biogas plant manager over a simulation period of 16 years for the three scenarios. In case of a late entry in the market (scenario 2 and 3), the biogas plant manager buys more alternative feedstock than in case of a simultaneous entry (scenario 1). This implies that he is able to acquire less silage maize on the local market. When the biogas plant manager builds up trust relationships with his suppliers (scenario 2), he needs to purchase less alternative feedstock than when he does not develop trust relationships (scenario 3).

Figure 3 shows the total volatility of the overall feed costs for dairy farmers and overall feedstock costs for the biogas plant manager. A late entry in the market largely increases the volatility of the overall feedstock costs for the

biogas plant manager. The difference between scenario 2 and 3 is insignificant.

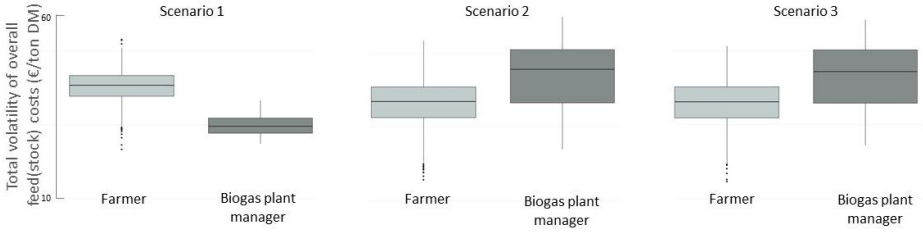

Figure 3: Total volatility of the overall feed(stock) costs of dairy farmers (light grey) and the biogas plant manager (dark grey) for the different scenarios.

DISCUSSION

The model results confirm our hypothesis: being a new entrant in this established silage maize market and using different market approaches may explain why biogas plant managers face more difficulties in obtaining local biomass than others. The late entry in the market has the largest effect. Due to a-the late entry, biogas plant managers are able to buy less silage maize, are forced to purchase more alternative feedstock and their overall feedstock cost volatility increases. We can therefore agree with the conclusions of Gold and Suering (2010); local rootedness and social capital can help in reducing the difficulties in local biomass supply (Gold & Seuring 2010). Investing in trust relationships can reduce the need to buy alternative feedstock but has no significant effect on the total volatility of the overall feedstock costs. Since the development of trust relationships is costly, both in terms of time and human resources, we can conclude that the game is not worth the candle.

Obviously, interpretation of the model results needs to be done in light of three main assumptions that were made. First, we assumed a market with a structural silage maize deficit in presence of a biogas plant. Currently, we are investigating whether our conclusions hold in two other market situations: one in which there is more or less enough silage maize in presence of a biogas plant, and one in which there is a structural silage maize surplus in presence of a biogas plant. Secondly, farmers cannot change their cultivation plan or the number of dairy cows. In reality, the introduction of a biogas plant could influence these parameters. Finally, we did not take into account all the possible market mechanisms that could also influence the price formation or the trust relationship. For example, a farmer might want to pay more for the silage maize if he could deposit his manure on the fields of the supplier, trust relationships could break if farmers get into a fight over other issues, or yields could be totally destroyed due to bad environmental conditions. Deciding to leave these details out of the model was a trade-off between increasing complexity to approximate reality and maintaining the ability to interpret the results. As our purpose was not to predict exact outcomes but to acquire insight in the way market mechanisms could influence market outcomes, we decided to only incorporate the most essential elements in the model. For future research we could look at the effect of the use of multiannual contracts or of hedging on the acquisition of local biomass. However, for now, we believe that our results could already contribute to the development of mitigation strategies for feedstock cost volatility.

CONCLUSION

This paper presents the results of a mixed method research involving semi-structured interviews and agent-based modelling applied on the silage maize

market in Flanders. The interviews revealed that the silage maize amongst dairy farmers in Flanders is characterized by distinct trade rules and institutional arrangements, which differ significantly from the institutional arrangements used between biogas plant managers and dairy farmers. Translating these findings into an ABM to carry out a scenario analysis, we found that a late entry in an informal market by biogas plant managers, and to a lesser extent, the use of different institutional arrangements could explain the difficulties of biogas plant managers in acquiring local biomass. Previous studies on the purchase of biomass by biogas plant managers often did not include the local context in which these managers need to operate. With this study we demonstrate the importance of local context. Our findings could therefore help in the development of mitigation strategies to address the difficulties in obtaining a stable and affordable supply of local biomass by biogas plant managers.

ACKNOWLEDGEMENTS

The work of Anouk Mertens is supported by the Agency for Innovation by Science and Technology of Flanders (IWT Vlaanderen, 131479).

REFERENCES

Bernard, H.R. (2006) Research methods in antropology: qualitative and quantitative approaches. 4th Ed. Oxford: Altamira press

Cannon, J.P., Achrol, R.S., Gundlach, G.T. (2000) Contracts, norms and plural form governance. Journal of the Academy of Marketing Science. 28 (2), p. 180-194.

Emmann, C.H., Guenther-Lübbers, W., Theuvsen, L. (2013) Impacts of biogas production on the production factors land and labour - Current effects, possible consequences and further research needs. International Journal on Food System Dynamics. 4(1), p. 26-38.

Eurobserv'er (2013) The state of renewable energies in Europe - Edition 2013. [Online] Available from: http://www.energies-renouvelables.org/observer/stat_baro/barobilan/barobilan13-gb.pdf [Accessed: 7th August 2014].

De Geest, V., De Mey, J., Vanacker, K., Meers, E. (2013) Voortgangsrapport 2013 Anaerobe vergisting in Vlaanderen. [Online] Available from: http://www.biogas-e.be/sites/default/media/rapporten/Voortgangsrapport_2013.pdf [Accessed: 7th January 2015].

De Geest, V., De Mey, J., Vanacker, K. Wynsberghe, T., Meerst, E. (2014) Voortangsrapport 2014 - Anaerobe vergisting in Vlaanderen, stand van zaken werkjaar 2013-2014. [Online] Available from: http://www.biogas-e.be/sites/default/media/rapporten/Voortgangsrapport_2014.pdf [Accessed: 7th January 2015].

Gold, S., Suering, S. (2010) Securing feedstock supply of biogas plants - a managerial challence. Proceedings of Corporate Resonsibility Research Conference, p. 1-16.

Klos, T.B., Nooteboom, B. (2001) Agent-based computational transaction cost economics. Jpurnal of Economic Dymamics & Control. 25, p. 503-526.

McCormick, K., Kåberger (2007) Key barriers for bioenergy in Europe: Economic conditions and institutional capacity, and supply chain co-ordination. Biomass and Bioenergy 31, p. 443-452.

North, M.J., Macal, C.M. (2007) Managing business complexity - Discovering strategic solutions with agent based modeling and simulation. New York: Oxford University Press.

Poeschl, M., Ward, S., Owende, P. (2010). Prospects for expanded utilization of biogas in Germany. Renewable and Sustainable Energy Reviews 14, p. 1782-1797.

Poppo, L., Zenger, T. (2002) Do formal contracts and relational governance function as substitutes or complements? Strategic Management Journal 23, p. 707-725.

Tesfatsion, L., Judd, K.L. (2006) Handbook of computational economics - Agent-based computational economics volume 2. Amsterdam: North-Holland.