AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

Unravelling the informal silage maize trade: a multi-agent modelling approach

Anouk Mertens[1], Koen Monderlaers[1], Dakerlia Claeys[1], Ludwig Lauwers[1], Jeroen Buysse[2]

[1] Institute for Agricultural and Fisheries Research (ILVO), Burg. Van Gansberghelaan 115, 9820 Merelbeke, Belgium anouk.mertens@ilvo.vlaanderen.be, koen.mondelaers@ilvo.vlaanderen.be, dakerlia.claeys@ilvo.vlaanderen.be, ludwig.lauwers@ilvo.vlaanderen.be

[2] Ghent University, Coupure Links 653, 9000 Gent, Belgium J.Buysse@UGent.be

Poster paper prepared for presentation at the EAAE 2014 Congress
'Agri-Food and Rural Innovations for Healthier Societies'

August 26 to 29, 2014
Ljubljana, Slovenia

Copyright 2014 by author1 and author2. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.

Abstract

This short poster paper presents ongoing research on the informal silage maize trade between specialised dairy farmers in Flanders, Belgium. We investigated the influence of transaction costs on the silage maize trade market. Additionally, we investigated the influence of the establishment of biogas plants on silage maize prices. The research indicates that with increasing transaction costs, trade between farmers declines. Furthermore, in the presence of a biogas plant, silage maize prices increase, whereas transaction distances increase.

Keywords: multi-agent-simulation, informal trade, silage maize, transaction costs, biogas

1. Introduction

Dairy cows in Flanders, the northern region of Belgium, are traditionally fed on a diet of grass and silage maize, supplemented with concentrated feeds such as sugar beet pulp, beer trot, soy, etc. In order to minimize production costs, a large majority of the farmers produces as much as possible of the roughage themselves. However, availability of rural land in Flanders is rapidly declining, due to competition with other functions, including housing, recreational and nature areas and commercial activities (Kerselaers et al., 2013). As a result, some dairy farmers are unable to produce sufficient silage maize for their livestock, leading to the emergence of an informal silage maize trade market between farmers.

Semi-structured interviews with experts and stakeholders revealed three distinct features of this market. First, given the low density of chopped silage maize, the market is characterized by high transportation costs. Secondly, the market is subject to large variability in prices, quality of the product and in yield. Finally, there is no use of formal contracts. Instead, farmers tend to build durable relationships with their trading partners over the years, in order to minimize the risk of opportunistic behaviour by their trading partners. These durable relationships are often perceived more important than saving money by buying cheaper silage maize from another farmer.

Recently, the informal trade of silage maize has been disturbed by the establishment of biogas plants in Flemish dairy farming regions. Anaerobic digestion is often cited as a promising technique, converting all kinds of biomass into biogas, which can in turn be converted to electricity and heat (Gerin et al., 2008; Bacenetti et al., 2013; De Geest et al., 2013). In Flanders, the overall production of biogas has more than doubled since 2007-2008, with a total production capacity in 2013 of 95.37 MWe (De Geest et al., 2013). Biogas plants are often located in rural areas because they are closer to biomass inputs such as manure and because the rural location is cheaper than industrial locations. However, since biogas plants relying on manure only have low yields and are therefore not economically viable, other substrates with higher energy content are added to improve their economic viability (Gerin et al., 2008; Herrmann, 2012). In this respect, silage maize is an interesting co-substrate compared to other crops: thanks to its low nutrient demand, high-water-use-efficiency and high digestibility it has one of the highest dry matter and methane yield potentials (Herrmann, 2012). Currently, about 20% of the inputs in biogas plants in Flanders is coming from energy crops, mainly silage maize. This share of energy crops in biogas plants has been increasing over the years, and it is expected that this trend will continue in the future (De Geest et al., 2013).

This paper presents ongoing research on the influence of biogas plants on the informal silage maize trade market in Flanders. More specifically, a multi-agent spatial trade model was developed to investigate the importance of transaction costs in the silage maize trade market. Additionally, the model was used to investigate the influence of the establishment of biogas plants on silage maize prices.

2. Method

2.1 Description of the informal silage maize trade model

The informal silage maize trade market results from the individual decisions of the farmers and the environment in which they operate. In order to gain insight into this informal market, it was decided to develop a multi-agent spatial trade model simulating the decisions of the different agents involved, while keeping into account the environmental constraints in which they operate. Figure 1 represents a schematic overview of the model, including the different decision possibilities of the dairy farmers with respect to silage maize. For simplicity reasons, the total farm land availability and the amount of dairy cows per farmer was kept fixed in the model.

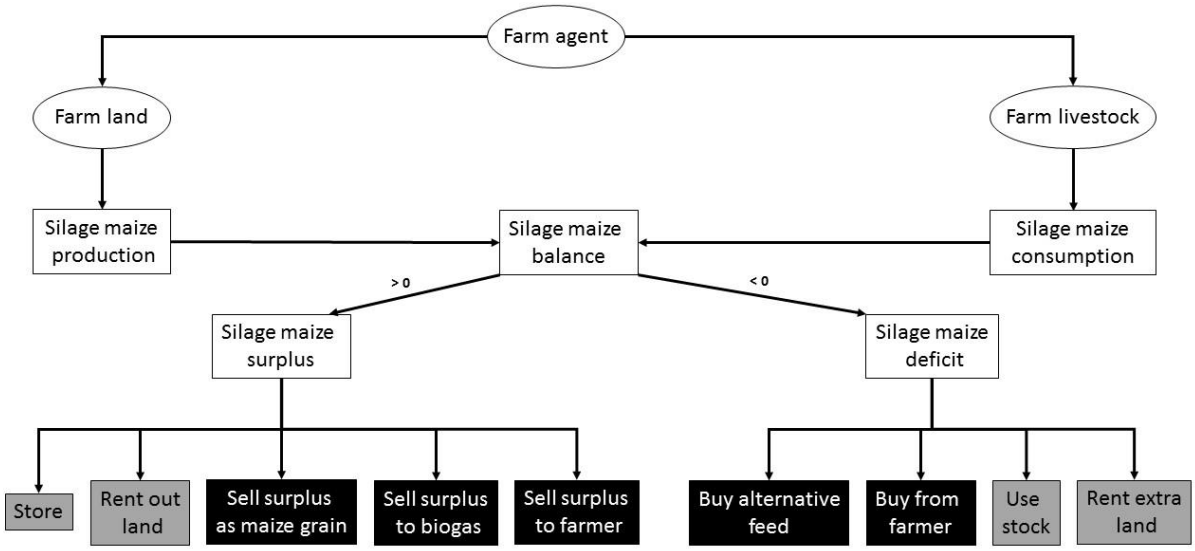

Figure 1: Schematic overview of the model. The farmers' different decision possibilities included in the model are indicated with a black background. The farmers' different decision possibilities not discussed in this document are indicated with a grey background.

In order to simulate the informal silage maize trade price, the model assumes roughage cost minimizing behaviour for farmers with a negative maize balance and revenue maximizing behaviour for farmers with a positive maize balance, in function of the transaction and transportation costs. Transportation costs are calculated based on the Euclidian distance between the farmers (d_{ij}). Transaction costs between farmer *i* and farmer *j* are subdivided into search costs (SC_{ij}), negotiation costs (NC_{ij}) and enforcement costs (EC_{ij}) (Williamson 2004), which are influenced by the social (soc_i) and negotiation (neg_i) capacities of the farmers, as well as the tendency for opportunistic behaviour (opp_j) by their trading partner. Equation (1) calculates the total transaction costs between farmers *i* and *j*.

$$TC_{tot,ij} = \left(soc_i * soc_j * SC_{ij}\right) + \left(neg_i * \frac{1}{neg_j} * NC_{ij}\right) + \left(opp_j * EC_{ij}\right) \quad (1)$$

The objective function of the model is given in equation (2). The equation contains following parameters: $P_{grain,i}$, price of maize grain expressed in € per ton; P_{transp}, the transportation costs of silage maize expressed in € per ton; $P_{alt,i}$, the price of alternative feed, expressed in € per ton and following positive variables: $V_{grain,\,i}$, the volume of silage

maize sold as maize grain; $V_{sil,ij}$, the volume of silage maize bought by farmer i from farmer j expressed in ton; $V_{alt,i}$ the volume of alternative feed bought expressed in ton.

$$\text{Maximize } \sum_i((V_{grain,\,i} * P_{grain,i}) - \sum_j TC_{tot,ij} - \sum_j(V_{sil,ij} * d_{ij} * P_{transp}) - (V_{alt,i} * P_{alt,i})) \quad (2)$$

Farmers in the model are subject to a number of constraints. First of all, farmers need to make sure they provide enough feed for their dairy cows. Therefore, the remaining deficit in silage maize needs to be compensated by the purchase of alternative feed, as is expressed by equation (3), with $TotCons_i$ the total silage maize consumption by the dairy cows of farmer *i* expressed in ton, and $TotProd_i$ the total silage maize production of farmer *i*. The shadow price of this constraint reveals the willingness to pay (WTP) for silage maize, which is the main outcome of this model.

$$V_{alt,i} \geq TotCons_i - TotProd_i - \sum_j V_{sil,ij} + \sum_j V_{sil,ji} + V_{grain,i} \quad (3)$$

Secondly, farmers are not able to sell more silage maize than the silage maize they produce themselves, as is expressed by equation (4)[1].

$$TotProd_i \geq \sum_j V_{sil,ij} - \sum_j V_{silji} \quad (4)$$

The model simulates silage maize transactions over a period of ten years. Over consecutive transactions, farmers learn about their trading partners and build up a durable relationship. As a result, information asymmetry declines, which leads in turn to declining transaction costs. In the model this is incorporated as follows. Over consecutive transactions search and negotiation costs become zero. Enforcement costs decline using the trust function of (Klos and Nooteboom 2001), as is shown in equation (5). In this equation, *x* is the number of years simulated, *b* = 0.5 and *f* = 0.5, and *z* the number of transactions between farmer *i* and farmer *j*.

$$EC_{ij\,(x+1)} = EC_{ij\,(x)} * (1 - (b + (1 - b) * \left(1 - \frac{1}{fz + 1 - f}\right) \quad (5)$$

In order to simulate the influence of a biogas plant, this model is adjusted by adding a biogas plant as an extra agent. For simplicity reasons, a biogas plant agent is not able to produce its own silage maize, nor does the agent has any dairy cows.

2.2 Data

The data from the Flemish Farm Accountancy Data Network (FADN) of 2011 were used for the model. We took a subsample of 44 specialised dairy farmers located in the north of Flanders. Table 1 shows some aggregated data used in the simulation. With regard to the biogas agent, we used data for a realistic but hypothetical biogas plant in Flanders. In the data used there is an overall silage maize surplus in absence of a biogas plant and in presence of a small biogas plant and an overall silage maize deficit in presence of a large biogas plant.

Table 1: Aggregated data used in the simulation

Variable	Value
Total silage maize demand from farmers (ton/year)	10,036
Total silage maize demand from small biogas agent (ton/year)	3,000
Total silage maize demand from large biogas agent (ton/year)	8000
Total silage maize production (ton/year)	14,715
Total silage maize balance – no biogas plant (ton/year)	4,678
Number of farmers with negative silage maize balance	5
Number of farmers with positive silage maize balance	39

[1] In future versions of the model, we could investigate the effect of leaving this restriction out.

3. Results

3.1 The impact of increasing transaction costs on trade

Since only indicative data on transaction costs between farmers were available, we conducted a sensitivity analysis for this parameter. The results show that with increasing initial transaction costs, the number of transactions declines. The average distance between the trading farmers varies between 1.5 and 2.5 km (see Table 2). Moreover, we found that in case of increasing transaction costs, transactions mainly occur between farmers with a large surplus and farmers with a large deficit and the average volume of maize transacted increases. This can be explained by the fact that the transaction costs are counted per transaction, independent of the volume traded. Furthermore, the average willingness to pay (WTP) for feed by farmers with a negative maize balance increases. This can be explained by the decreasing number of buyers willing to buy silage maize from another farmer due to the high transaction costs. These farmers prefer to buy alternative feed on the formal market, however at a higher price.

Table 2: The impact of increasing transaction costs on informal silage maize trade

	Initial total transaction costs (€)	Number of selling farms	Number of buying farms	Total number of transactions	Average volume silage maize transacted per transaction (ton)	Average distance of transactions (km)	Average WTP for silage maize by farmers with a negative maize balance (€/ton)
Without biogas plant	300	6	5	7	28	2.5	161
	1800	3	3	3	55	1.5	214
	3000	1	1	1	66	1.5	232
With small biogas plant	300	16	5	18	178	3.8	179
	1800	14	4	15	212	3.8	197
	3000	14	3	14	225	3.9	214
With large biogas plant	300	39	2	39	125	4.6	250
	1800	37	2	37	131	4.7	250
	3000	34	2	34	140	4.7	250

3.2 The impact of a biogas plant on the informal silage maize market

The results of the sensitivity analysis of the transactions in the presence of a biogas plant can be found in Table 2. The results show the same trends as the results in absence of a biogas plant. Comparing the results of the simulations in presence and in absence of a

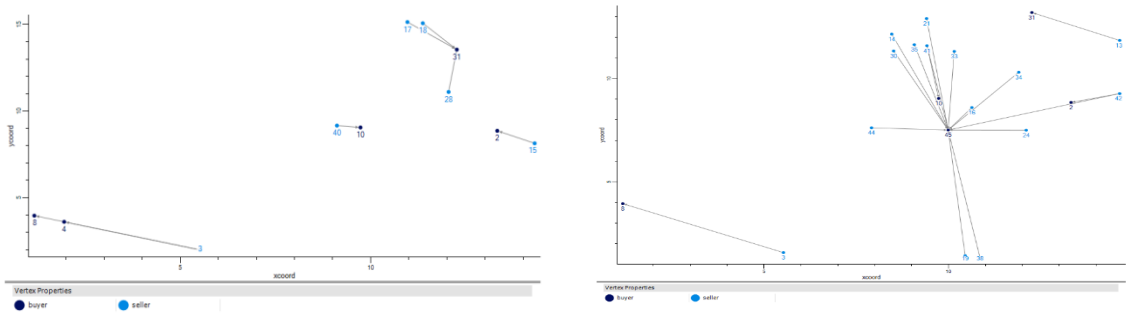

Figure 2: Graphic presentation of informal silage maize transactions between farmers with initial total transaction costs 300€. Only farmers that are involved in transactions are represented. Left: Transactions in absence of a biogas plant. Right: transactions in presence of a small biogas plant

biogas plant also reveals some differences. In the presence of a biogas plant, the number of transactions is higher. More farmers with a silage maize surplus are selling there silage maize to the biogas plant. Furthermore, the average WTP for feed by the dairy farmers with a negative maize balance – not including the WTP of the biogas plant - is higher than

in absence of a biogas plant. In case of a large biogas plant, these trends are even more explicit. This finding supports the claim that biogas plants indeed put pressure on the local informal silage maize trade market and increase local silage maize equilibrium prices. Additionally, transactions happen over larger distances: varying between 3.8 and 4.2 km in case of a small biogas plant and between 4.6 and 4.7 km in case of a large biogas plant (see Table 2 and Figure 2).

4. Discussion

The simulations show that with increasing transaction costs, the number of transactions between farmers decline, the average volumes transacted increase and the average WTP for silage maize by farmers with a silage maize deficit increases as well. Additionally, the results of the model show that due to the presence of a biogas plant, the demand for silage maize largely increases, leading to a higher willingness to pay for silage maize. As a result, more farmers with a positive maize balance are willing to sell their silage maize to a biogas plant, while less farmers with a silage maize shortage are willing to take part in the informal silage maize trade. Furthermore, transactions in presence of a biogas plant take place over a larger distance.

It is important to note that the results given in this short poster paper are only indicative. To make the results more realistic, in the model, farmers should also be able to store part of their surplus silage maize or be able to rent extra land to produce more silage maize. Finally, we plan to do simulations to test the influence of a biogas plant on the robustness of the durable relationships between the farmers.

5. Conclusion

This research indicates that with increasing transaction costs, informal silage maize trade between farmers declines. Furthermore, in the presence of a biogas plant, silage maize prices rise, leading to an increase in the number of transactions. However, transactions happen over larger distances.

References

Bacenetti, J., Negri, M., Fiala, M., González-García, S. (2013). Anaerobic digestion of different feedstocks: Impact on energetic and environmental balances of biogas process. *The Science of the Total Environment* 463-464: 541-551.

De Geest, V., De Mey, J., Vanacker, K., Meers, E. (2013). Voortgangsrapport 2013: Anaerobe vergisting in Vlaanderen. Biogas-E: Kortrijk: Biogas-E.

Gerin, P., Vliegen, F., Jossart, J.M. (2008). Energy and CO_2 balance of maize and grass as energy crops for anaerobic digestion. *Bioresource Technology* 99 (7): 2620-2627.

Herrmann, A. (2012). Biogas production from maize: current state, challenges and prospects. 2. Agronomic and Environmental Aspects. *BioEnergy Research* 6 (1): 372-387.

Kerselaers, E., Rogge, E., Vanempten, E., Lauwers, L., Van Huylenbroeck, G. (2013). Changing land use in the countryside: Stakeholders' perception of the ongoing rural planning processes in Flanders. *Land Use Policy* 32: 197-206.

Klos, T.B., Nooteboom, B. (2001). Agent-based computational transaction cost economics. *Journal of Economic Dynamics & Control* 25: 503-526.

Williamson, O.E. (2004). Transaction cost economics and agriculture: An excursion. In Van Huylenbroeck, G., Verbeke, W., Lauwers, L. (eds), *Role of Institutions in rural policies and agricultural markets*. Amsterdam: Elsevier B.V., 19-39.