Logistics issues in manure-to-energy supply chains

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INTRODUCTION

There is a significant unutilised potential in producing energy from manure, e.g. in a Swedish context about 700 GWh of heat and electricity or biogas could be produced from horse manure. However, the logistics of horse-manure-to-energy represents a major barrier due to high cost of transport and handling. Therefore, the purpose of this paper is to identify the underlying attributes that make the horse-manure-to-energy supply chain costly and explain how the supply chain can be designed for efficient energy conversion.

Figure 1: Storage space for horse manure

METHOD

Manure-to-energy logistics, such as horse manure, is in large overlooked within the literature. Horse-manure-to-energy supply chains have distinct attributes, e.g. biological properties, that sets conditions for how the supply chain can be designed. Along with a literature review on related fields, this paper is based upon a multiple case study. Observations and interviews with representatives from seven stables, interviews with three transportation companies and a survey constitute empirical data.

Figure 2: A container used for horse manure handling

FINDINGS

Key attributes of horse-manure-to-energy supply chains affecting the supply chain efficiency identified include:

• Energy conversion benefits from economies of scale
As with most production units, energy conversion processes are more cost-efficient when done in large scale. However, the larger the production unit is, the larger the procurement area becomes, and there is hence a trade-off between logistics efficiency and overall energy efficiency. Also, there is a lack of suitable business models for an effective utilisation of horse manure, and therefore stable owners often have to pay a lot to get rid of their manure.

• Individual solutions
Stable owners in general pay little attention to manure and merely want to get rid of it, and do not get much support from transport companies on logistics issues. As a result, stable owners have highly individual solutions when it comes to transport and physical design of storage and handling which are not effective nor efficient. Therefore, standardised solutions, based on a supply chain perspective, with e.g. adapted containers need to be developed.

• Size of stables
Stables are of varying sizes (a few up to hundreds of horses). This makes it a significant challenge in developing a number of standardized solutions, and the small volumes available at small stables makes it hard to draw advantage from economies of scale within transportation.

• Geographical spread.
Stables are spread across great areas, which makes consolidation of small volumes a key issue for efficient logistics and make planning of transport routes a key issue for transport efficiency.

• Estethical requirements
It should be remembered that manure is a by-product that most stables simply want to get rid of, and that offering an attractive environment to private customers that want to rent boxes for their horses is the main business. Therefore, its important with a clean and esthetically appealing environment, which hence sets conditions for where and how manure is handled.

Besides these exemplified attributes, there are additional ones that sets conditions for logistics efficiency such as (1) poor quality of roads which prohibits large-scale trucks, (2) lack of space for efficient storage and loading, (3) weather impacts on manure properties (4) legislation on storage which makes storage costly (5) and ergonomic issues of handling manure in stables.

CONCLUSIONS

Horse manure holds a significant potential for energy conversion. However, the attributes of horse-manure-to-energy supply chains causes low logistics efficiency. Therefore, (1) effective business models for biogas production that include the use of horse manure need to be developed, (2) the logistics knowledge along the supply chain need to be increased and (3) standardised logistics solutions that takes a supply chain perspective need to be developed in order to, in a cost-effective manner, access the unutilised potential of horse-manure-to-energy. In particular, future solutions could benefit from utilizing knowledge and experience from related research fields such as forest-biomass-to-energy supply chains. Future research also needs to assess under which conditions it is suitable with biogas production and under which conditions it is suitable to produce heat instead.

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