DANISH FARMERS' PREFERENCE FOR BIO-BASED FERTILISERS - A CHOICE EXPERIMENT

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Abstract:

Within the transition towards a "circular" economy, more farmers are searching for bio-based fertilisers, which are nutrient products based on animal manure. In Denmark, there are many collaborative agreements between farmers, and the need for manure processing is relatively low. Arable farmers typically receive the manure free of charge or for a relatively low cost (application or transport costs). With higher N-norms, Danish farmers might want to use bio-based products instead of mineral fertiliser; however, this will depend on the product and the price. The purpose here is to investigate how much Danish farmers are willing to pay for bio-based fertilisers and what characteristics of bio-based fertilisers are the most important for Danish farmers to start using them. This paper uses the stated preference technique of a Choice Experiment, where respondents are presented with a choice between two bio-based fertiliser alternatives and their current mineral fertiliser, based on selected attributes. Data was collected from 202 Danish farmers. The sample consisted of more arable farms than average as the focus was on farmers who receive manure. Results indicate that the farmers reveal preferences for a higher certainty in the N-content, low volume, organic carbon and hygienisation. The ideal product, which is like mineral fertiliser which includes organic material, typically can be sold at up to 50% of the mineral fertiliser price. The analysis shows that some farmers are unlikely to accept bio-based fertilisers unless the product has the same properties as mineral fertilisers.

Keywords: *Bio-based products, willingness to pay, Manure products, important attributes in fertiliser, choice experiment*

1. Introduction

Farmers in very livestock intensive areas such as The Netherlands and Flanders import a large amount of mineral fertilisers at the same time as they export manure to France and Germany, which may involve costly processing before exporting. Other farmers have long lasting agreements with neighbouring farmers (Asai et al. 2014), which give them a certainty regarding their export options. Even though many farmers have agreements regarding selling or transporting slurry to neighbouring farms, not all farms are willing to receive organic manure for various reasons, but some might want to receive bio-based fertilisers if they have certain attributes.

In this paper, bio-based fertiliser refers to different types of fertilisers based on organic manure and can therefore be products from different types of separation, digestate from biogas plants or products which are processed further (e.g. Struvite or concentrate N). All these types of fertilisers are, in this paper, included in the term bio-based fertiliser, whereas the term animal manure covers non-processed manure. Many farmers use a combination of mineral fertiliser and animal manure, when available, in their fertiliser practices. Acidification of slurry is not included as a bio-based fertiliser in this case.

The current acceptability of animal manure from livestock as a replacement for mineral or artificial fertiliser is described in the prices livestock farmers pay to export manure. In Flanders and The Netherlands farmers have to pay 20-40 € per ton to send it to a processing plant and around half of all slurry is processed (separated and made into various products) and around 25% is then exported to Germany or France. In other, less livestock intensive regions in Europe and in Denmark the focus is on transport between farms. In half the cases the Danish livestock farmer pay for transport and application of slurry, and in the other half of the cases the arable farmer pays for both transport and application (Knudsen, 2016).The amount of slurry being separated in Denmark is much lower (<3%) than in the Netherlands and in Flanders.

EU-countries like Belgium and The Netherlands are currently hoping to be able to apply mineral concentrates based on the liquid manure fraction instead of synthetic fertiliser following a change of the Fertiliser Directive (EU no. 2003/2003). The mineral concentrates will have properties which are similar to synthetic fertiliser and the application will not be limited by the Nitrate Directive. In case this was allowed, it would be interesting to see what farmers would pay for such a product in Denmark.

One of the Danish policies in relation to nitrogen application has been the introduction of N-norms, which set a limit for the nitrogen used for a selected crop. The N-quota covers both mineral fertiliser and the organic manure (Dalgaard et al., 2014). The N-quota, in Denmark, has been below the economic optimal level and so the value of the last applied kg of N is higher than the price of mineral fertiliser. Analyses indicate that the shadow value of N in wheat is close to 2 €/kg N, whereas the retail price on N is 1.1 €/kg N. Furthermore, the utilization requirement in Denmark, regarding the use of N in organic manure, is one of the highest in the EU (Webb et al., 2010). Therefore, Danish farmers are very much aware of the N-content in the slurry they receive from other farmers and they are perhaps more reluctant to receive manure, especially if the content is uncertain. Currently, farmers are restricted in the use of organic manure by the Nitrate Directive which allows only 170 kg N (total N) per ha in order to ensure good water quality. This below optimal N-quota has been abandoned from 2016/2017 and so this might mean that farmers lower the requirements of the bio-based product as the change will reduce the value of the last kg N.

In Denmark, under 3% of the total amount of slurry is separated into a thick fraction and a liquid fraction, whereas this share is 8% at the EU level (Case et al., 2017). Some of this separation happens in relation to biogas production. In 2014 around 7% of the slurry in Denmark was processed in a digester in order to produce biogas (Jacobsen et al., 2014), but the share has increased and it is estimated to be close to 15% in 2017 (Energy Agency, 2017). The key problem is again that the processing of organic manure will increase the cost of the end product. If the receiving farmer does not find that the product has a higher value, he will pay less than the current price for mineral fertiliser.

The purpose of this paper is to extract knowledge about Danish farmers' willingness to pay (WTP) for bio-based products, differentiated according to properties such as form, volume, certainty in N-content as well as the presence of organic carbon and hygenisation. This could be products based on Danish manure, but could also be bio-based product produced in e.g. Belgium and The Netherlands.

The paper is innovative as it tries to link WTP-estimates to bio-based manure and the manure regulation, using Denmark as a case looking at different products. By using a Choice Experiment approach we hope to get a clearer knowledge of which attributes are most important and what farmers are willing to pay for bio-based products based on different attributes. By estimating prices for different products, it also allows for a discussion as to whether it is possible to process manure and create the product at a price which farmers are willing to pay. As the questionnaire has also been used in other EU countries, it is possible to compare the results from the Danish farmers with estimates from farmers in other EU-countries (Tur-Cardona et al., 2017).

2. Methodology

We elicit Danish farmers' preferences for bio-based fertilisers using the stated preference technique of a Choice Experiment (CE) (see Adamowicz et al., 1998). The survey used in the present study elicited preferences for changes in attributes relating to bio-based fertilisers. Prior to the choice sets, the respondents were presented with a scenario description, introducing seven different attributes of the bio-based fertilisers: form, volume, uncertainty about N-content, presence of organic carbon, presence of pests and diseases, as well the speed of nutrient release. These attributes were selected as the form is important for the machinery used and the application rate. The N-content is important, especially if there is a limit, but also to apply the expected amount of N to a given crop. Reduced volume will reduce the transportation costs. The share of organic carbon gives an idea of the amount of carbon added to the soil, and the speed of the nutrient release indicates when the N is available. Pest and deceases are included in relation to hygienisation when exporting to other countries. Livestock manure is distributed to EU-member states under Animal byproduct regulation (EU 1069/2009 and EU 142/2011) where the prevention of (animal) diseases is essential and a sanitation by heating (1 hour at 70° Celsius) is required (Bral et al., 2015). The odour of the product was also suggested as an attribute, but most of the participants from the six countries did not find the attribute to be important.

A percentage reduction in the bio-based product price compared to the respondents' present chemical fertiliser price was used as the level of payment that the farmer is willing to pay. The attributes and their levels were identified firstly by experts, then at stakeholder meetings and interviews with farmers. The attributes were presented to the respondents with the descriptions shown in Table 1. (Tur-Cardona et al., 2017).

Table 1. Attributes and attribute levels

Attributes	Attribute levels
Price	Same as artificial fertiliser
	20% cheaper
	40% cheaper
	60% cheaper
Form	Liquid
	Granulate
	Semi-solid
	Combination of liquid and solid
Advised volume of bio-based fertiliser needed compared to artificial fertiliser	Same as current artificial fertiliser
	×2 volume
	×4 volume
	×6 volume
Uncertainty about the N-content	Certainty about N-content
	Possibly 25% variation in N-content
	Possibly 50% variation in N-content
	Possibly 75% variation in N-content
Organic carbon	No organic carbon
	As much organic carbon as in straw-containing stable manure
Pests and diseases	Not made hygienic
	Made hygienic
Rate of nutrient release	Slow
	Fast

Note: Made hygienic does in this case mean that the manure can be exported across boarders. The slurry needs to hygienised at 70° for one hour.

A statistically efficient choice design combining the attribute levels shown in Table 1 into alternatives and choice sets was constructed using Ngene, which is a software for designing choice experiments (ChoiceMetrics 2012). Figure 2 shows an example of a choice set used in the questionnaire. It should be noted that along with the two bio-based fertiliser alternatives, the respondents were also given the option to opt-out and instead choose their current fertiliser (ASC).

	Bio-based fertiliser A	**Bio-based fertiliser B**
Price	Same price as artificial fertiliser	40% cheaper
Form	A combination of liquid and solid forms	Liquid
Advised volume of bio-based fertiliser needed compared to artificial fertiliser	2x volume	Same volume as current artificial fertiliser
Uncertainty about the N-content	Possibly 50% variation on N-content	Certainty about N-content
Organic carbon	No organic carbon	No organic carbon
Pests and diseases	Not made hygienic	Made hygienic
Speed of nutrient release	Slow	Slow

Please indicate the fertiliser that you prefer:

- ❍ Bio-based fertiliser A
- ❍ Bio-based fertiliser B
- ❍ Current artificial fertiliser (ASC)

Figure 2. Example of a choice set.

2.1 Choice model specification: Latent class model

Latent Class Models (LCM) account for the heterogeneity in preference among respondents by dividing them in groups (McFadden and Train, 2000). The fundamental theory of this model suggests that individual behaviour will depend on the described attributes and on a latent heterogeneity defined by unobserved factors to the analyst. The heterogeneity of preferences might be captured by the differently described groups, each defined by relatively homogeneous preferences. The resulting classes might differ in their preference structure. By allowing a different number of classes, the heterogeneity in preferences can be accommodated to different groups. The membership to a specific group is related to their attitudes or the characteristics of the respondents (Birol et al., 2006).

The standard LCM specification assumes a random utility model, where according to Greene and Hensher (2003), an individual *i* will obtain the maximum utility from selecting an alternative *j* at choice situation *t* given the class *c* is:

$$U_{jit}=\beta_c' x_{jit} + \varepsilon_{jit} \qquad \text{eq.1}$$

where the first part of the equation relates to the specific attributes (β_c) and the second captures the attributes and characteristics of the utility function. The optimal number of classes is formed based on the pseudo R2, Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC) (Colombo et al., 2009; Ruto et al., 2008).

Two groups without class specific variables were formed. Once the groups are formed, information about the different groups can be examined to better define the formed groups. To identify significant differences between the distribution of the groups and the general sample, Chi-square test and T-test were used. An important difference between the identified groups is their attitude towards the ASC option. As it is specified, this difference indicates that a group of farmers have preference for the bio-based fertilisers, while the other group will prefer to keep using their current mineral fertiliser.

3. Results

The collection of data was carried out through both online and postal surveys. The addresses were sampled from a group of all Danish farmers used in different projects (Asai et al. 2014 and Case et al. (2017). From this group, a sub group, which has used imported animal manure, was extracted, and the final respondents were randomly sampled from this sub group. The online questionnaire was sent to 5,000 farmers and the postal questionnaire was sent to another 2,000 farmers.

A total of 202 responses were received from Danish farmers. Of these, 110 (54%) of responses were received through the online survey, while the rest (92) were collected with a postal survey. The low response rate in this survey (2%) can be explained by several factors. A key factor is that Danish farmers are not familiar with the term bio-based fertilisers as they mainly use manure from neighbours. It is not uncommon that choice experiments are found to be more difficult as they often take longer to answer. The questions posed in a similar Danish questionnaire (Case et al., 2017) were more directed towards Danish conditions and the questionnaire was shorter and without choice experiments, which was a clear advantage (response rate of 28%).

The data was collected as part of the EU project INEMAD (Improved Nutrient and Energy Management through Anaerobic Digestion) which aims to reconnect livestock and crop production so the Danish results can be compared with the European results (Tur-Cardona et al., 2017). In recent papers (Case et al., 2017) and Hou et al., (2016), farmers' perception of organic waste products in Denmark has also been discussed but not valued.

3.1 Descriptive Statistics

The overview in Table 2 shows, that farmers in the sample primarily are arable farmers who use mineral fertiliser (for other results see appendix A) and animal manure. Compared to the average full time Danish farmer in 2013, the farmers in the sample have about the same ages as the Danish average and the farm size is also the same. Their share of processed manure is close to the average.

Table 2. Comparison between sample farmers and average Danish full time farmers in 2013.

	Sample (n=202)	Danish average (full time)
Age (years)	55[a]	52
Size of farm (ha)	144	160
Owned (ha)	107	109
Share of manure	3-4%	3%

processed (%)		
Arable farms (%)	79%	22%

Source : Danish statistics (2014) and own calculations

Note: The age of the sample is calculated assuming that respondents over 50 years old (the highest age group answer possibility) are all 60 years old.

3.2. Latent Class

As shown in Table 3, the expected signs of the coefficients are observed, in that attributes expected to contribute positively to utility have a positive sign in their coefficient and vice versa. According to rational choice theory, we would expect that farmers will pay more for products which have attributes that they prefer.

The positive sign on the price reduction coefficient indicates that a reduction in price contributes positively to the respondents' utility in accordance with basic economic theory. The parameter coefficient estimates denote the sample average marginal utility associated with a change from the status quo displayed in Table 1. All the bold and italic values in Table 3 are significant values. The model displayed in Table 3 shows that there are two classes in our sample of farmers. The first class represents 67% of the farmers while the second class contains 33% of respondents. Both classes show a preference for reducing price, uncertainty in the nitrogen content and volume of fertiliser required. In this case, the classes are found based on the use of a membership function regarding selected attributes which are significant.

It can be noted that the Class 2 farmers have a lower negative value for higher volume and they are very positive towards attributes like hygienic and fast release. The ASC coefficient for the Class 2 farmers has a negative sign, which suggests that respondents in this class have a preference for staying with their current artificial fertiliser. The class 2 farmers are here called "older and not interested". The WTP estimates for the Class 2 farmers show that they would require a large price reduction of almost 50% compared to the price of their current fertiliser before they would use bio-based fertilisers as indicated by the WTP estimate for the ASC (49.3%). Conversely, the Class 1 farmers appear to have a positive perception to alternatives to their current fertiliser as indicated by the positive sign for the ASC coefficient, thereby indicating that respondents in this class have a preference for one of the bio-based fertiliser alternatives.

The Class 1 is therefore called the "young and interested". Other differences between the classes include the Class 1 farmers have a significant preference for the granulate form.

Table 3. WTP estimates expressed as a % of the mineral price of N [lower 95% confidence interval, upper 95% confidence interval]

	ALL		Class 1 "The young and interested" (0.66)		Class 2 "The older and not interested" (0.33)	
Granulate vs S-L	***15.34****	***[9.2, 21.5]***	***16.3****	***[9.1, 23.4]***	8.8	[-8.7, 26.2]
Liquid vs S-L	1.18	[-7.0, 9.4]	-0.4	[-11.0, 10.1]	4.9	[-13.6, 23.4]
Semi-solid vs S-L	0.67	[-6.5, 7.8]	-0.8	[-9.7, 8.1]	-0.9	[-16.6, 14.8]
Higher volume (x2)	***-3.68****	***[-5.8, -1.5]***	***-2.9****	***[-5.5, -0.3]***	***-6.6****	***[-12.0, -1.2]***
Uncertainty N (%)	***-1.06****	***[-1.2, -0.9]***	***-1.2****	***[-1.4, -0.9]***	***-1.2****	***[-1.7, -0.6]***
Organic C	***9.95****	***[-15.3, -4.6]***	***8.6****	***[17.3, 2.5]***	***19.1****	***[36.1, 2.1]***
Hygienic	***14.67****	***[9.4, 19.9]***	***11.5****	***[5.4, 17.6]***	***29.8****	***[13.3, 33.2]***
Fast nutrient release	0.07	[-2.4, 7.6]	-3.9	[-9.5, 1.7]	***25.7****	***[11.1, 40.2]***
ASC	***-13.79****	***[1.1, 26.4]***	***+14.9****	***[-30.4, 0.6]***	***-33.8****	***[4.9, 62.7]***

Note: * indicate significance at 10% level.

The results of the groups generated with the model of classes were compared with those of the sample obtaining the potential differences that explain the groups. As depicted in table 4, there are some differences in the farmers' characteristics among the two groups. Differences are found in the age, average area of the farm, type of soils, experienced deficiencies in fertilization with manure and interest in fertilisers in the future. Class 1 are the younger farmers who have tried different bio-based products

Class 2 represents a smaller class with less interest in bio-based fertilisers, as indicated by their preference for ASC and also as stated when asked about the interest in different bio-based fertilisers. Class 1 is represented by younger farmers with larger extensions of owned and rented land. This second class, despite not using bio-based fertilisers at the moment, shows more interest in using them in the future. Farmers, who in the past experienced deficiencies using manure as fertiliser, are more likely to be in this group. In this case, farmers believe that the processing will reduce these deficiencies. Thus farmers attach some value to the reduction of N content uncertainty and attach also some value to a granulate form of fertiliser easier to distribute.

Table 4. Description of the differences between the two generated classes.

Question		Sample	Class 1 (33%)	Class 2 (66%)
Age*	20-30	1 %	1 %	0
	30-40	7 %	10 %	3 %
	40-50	22 %	25 %	15 %
	>50	70 %	64 %	82 %
How much land owned?*	Owned	107 ha	119 ha	83 ha
How much land do you rent?*	Rent	18 ha	22 ha	13 ha
What kind of soil? ***	Sandy soil	37 %	39 %	30 %
	Mix of sandy and clay soil	45 %	49 %	38 %
	Clay soil	18 %	12 %	32 %
Have you experienced that the fertilization seemed insufficient after the use of animal manure?***	Yes - NPK	43 %	50 %	26 %
	Yes - Micronutrients	1 %	1 %	0 %
	No	57 %	49 %	74 %
Are you interested in using bio-based fertilisers in the future?	Digestate	20 %***	28 %	4 %
	Ammonium sulphate	17 %***	23 %	2 %
	Struvite	17 %***	23 %	0 %
	Concentrated manure*	20 %	24 %	8 %
	Biochar	28 %	38 %	18 %
	Other (e.g. compost)	10 %***	15 %	0

Note: ***, **, * indicate significance at 1%, 5%, 10% level, respectively across the two classes.

3.3. Willingness to Pay (WTP)

Based on the results in Table 3 it is now possible to calculate the willingness to pay for predefined products shown in Table 5. The three products chosen are named bio-product 1-3, where bio-product 1 has properties similar to slurry, but in a granulate form; Bio product 2 is also granulate, but with lower volume and still some uncertainty; Bio product 3 has all the positive properties including granulate, the same volume as mineral fertiliser, with no uncertainty and with organic carbon. In other words, Bio product 3 is a mineral fertiliser based on manure and with organic properties. The price farmers are willing to pay has been calculated as the value based on the attributes in the second column. This is then corrected for the preference with respect to mineral fertiliser so that the values of the attributes plus the ASC value is the actual price farmers are willing to pay.

Table 5 shows that the average farmer will not pay for Bio product 1. Class 1 farmers will pay 8% of the mineral price, but Class 2 farmers will not pay for this product. For the Bio product 2, the average farmer is willing to pay 6% of the average mineral fertiliser price. The Class 1 farmers will pay a little more than 33%, but the Class 2 farmers are not willing to pay for this product (negative value). Finally, the Bio product 3 can be sold at 26% of the mineral fertiliser price to the average farmer. It is noticeable here that the Class 1 farmers are willing to pay 51%, but now the Class 2 farmers are willing to pay 41% of the mineral fertiliser price. It should be noted that without the fast nutrient release attribute for Class 2 farmers (25.7 %), the willingness to pay for the whole sample (all) would be in the middle of the two groups (Class 1 and 2). The result comes as the attribute (fast release) has a large effect only on Class 2 farmers.

So the Class 2 farmers will pay a high price when the attributes they value highly are included in the Bio-product 3. Class 2 farmers have a comparably larger WTP for the hygienic attribute (29.8%), and fast nutrient release (25.7%), than those for the Class 1 farmers. In other words, the Class 2 farmers do not use many bio-based products today and they are sceptical towards new products, but should they use bio-based products, the products should have properties which are similar to mineral fertiliser and they do value more carbon in the soil. The results show that it is difficult to get farmers to pay more than 50% of the mineral price for a bio-based product.

Table 5. Price of N for different bio-based products compared to mineral fertiliser and organic N in Denmark. (% of mineral N price)

		Bio-product 1	Bio-product 2	Bio-product 3 (optimal product)
Description of the product		Granulate, x7 volume, 10% uncertainty, with organic carbon	Granulate, x4 volume, 5% uncertainty, with organic carbon	Granulate, x1volume, no uncertainty, with organic carbon and fast release of nutrients
All	Attributes	-11.10	19.91	39.95
	+ASC (-13.8 %)	***-24.9***	***6.13***	***26.16***
Class 1	Attributes	-7.01	18.95	36.32
	+ASC (+14.9 %)	***7.85***	***33.81***	***51.19***
Class 2	Attributes	-38.6	16.75	74.6
	+ASC (-33.8 %)	***-72.45***	***-17.1***	***40.8*** *)

Note: The cost of application of slurry is 10 DKK per ton and with 5 kg N per ton which is around 2 DKK/ kg N. Application of mineral fertiliser is around 1.1 DKK/kg N. In the questionnaire, it was indicated that this cost should be included in the values so the value was N applied on the field.

*) Without the fast nutrient release attribute for Class 2 farmers (25.7 % in table 3), the willingness to pay for the whole sample (all) would be in the middle of the two groups (Class 1 and 2). The result comes as the attribute (fast release) has a large effect only included for the Class 2 farmers.

4. Discussion and conclusion

This paper has looked at Danish farmer's willingness to pay for bio-based products. The WTP for the most optimal bio-based product with all the preferred attributes will be 51 % for the Class 1 farmers while for the Class 2 farmers; the value is 41 % of the mineral fertiliser price. Class 1 farmers shows preference for the granulate form of the fertiliser, the presence of carbon and the hygienization of the product, with a positive perception (around 25%) towards an alternative bio-based fertiliser. Given the WTP attached to the perception of bio-based fertilisers by Class 2, only a hygienic product with fast release will result in a product that farmers in this group will accept to pay for. The young farmers in Class 1 will be more willing to buy different bio-based products from e.g. Belgium and The Netherland.

The Danish farmers stand out as they choose current chemical fertiliser use (ASC) in more cases than in other countries (43%) as opposed to 16-30% in six other EU countries (Tur-Cardona et al., 2017). It can be explained by the different policy options implemented in the past and the different technological solutions farmers are exploring in the Danish context. The Danish focus has been on policies which impose a strong restriction on the number of animals, reducing the problem of nutrient surplus and where the utilisation requirements are high. Results for Denmark indicate a relatively low value attached to the nutrients in bio-based fertilisers even with hygienization, presence of organic carbon, certainty in the content and concentrated volumes.

It has not directly been a part of this paper to investigate the costs of processing manure in order to produce the bio-based products with the properties described in Table 5. However, it is relevant to link the prices farmers will pay with a calculation of the required processing cost. For processing plants to be able to deliver a bio-based product at around 50% or 0.5 € per kg N in the field, they are likely to have to be paid to receive the manure as is the case in The Netherlands and Belgium. In these countries the processing plant receives up to 20-30 € per ton (4-5 € per kg N) with the slurry and so it is probably possible to sell the product at e.g. 50% of the mineral fertiliser price. The processing costs could then be around 5 € per kg N.

In the Danish case, where the processing company would receive the slurry free of charge or for a low fee (e.g. up to 5 € per ton of slurry or 1 € per kg N), it is less likely that the processing company could sell the best products at 0.5 € per kg N as it would only leave 1.5 € per kg N (or 7 € per ton of slurry) for the processing. The analysis indicates that the economic options for carrying out processing are better in The Netherlands and Belgium than in Denmark given the current manure market.

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Table A. Respondent and farm characteristics (n=202)

Size of your farm (ha agricultural land)	144[a] ha	Disadvantage of animal manure	
Land distribution in 2013		Uncertain composition	39%
Owned	107[a] ha	Not enough for crops	5%
Leased	18[a] ha	Cultivation impossible when fertilisation is required	2%
Fertiliser agreements	47[a] ha	Do not own machinery required	10%
Age		Legislation	24%
20-30	1%	Uncertain yield	9%
30-40	7%	Other	13%
40-50	22%	Animal manure treated	
>50	70%	Yes, on own farm or together with farmers elsewhere	3%
Main agricultural activity		Yes, manure is brought to a processor	1%
Arable cropping	79%	No	96%
Livestock farming	21%	Insufficient fertilisation after use of mineral fertiliser	
Horticulture	0%	Yes, lack of N/P/K	51%
Artificial fertiliser used		Yes, lack of micronutrients	3%
Yes	97%	No	47%
No	3%	Heard of bio-based fertilisers	
Advantage of mineral fertilisers		Digestate	12%
Price	20%	Nutrient rich water from air scrubbers	7%
Ease of use	30%	Struvite	5%
Certainty in yields	32%	Nutrient concentrates from animal manure	8%
Certainty in nutrient content	13%	Biochar	53%
Other	5%	Other	7%
Organic products (fertilisers) used		None/no answer	8%
Yes, more than allowed	34%	Bio-based fertilisers used already	
Yes, max	33%	Yes	4%
Yes, less	26%	No, but I am interested	19%

No	7%	No	77%
Advantage of animal manure?			
Availability	11%		
Price	51%		
Higher yields	5%		
Better soil structure	28%		
Other	5%		

[a] Sample mean values

Size of your farm (ha agricultural land)	144[a] ha	Disadvantage of animal manure	
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