Beyond Cost Minimisation: Farmers' Perspectives on the Adoption of GM Fodder in Sweden

Klara Fischer
Swedish University of Agricultural Sciences, Sweden

Sebastian Hess
University of Hohenheim, Germany

Abstract

Swedish farmers were surveyed about their perceptions of genetically modified (GM) feed. Livestock in the EU are frequently given feed containing imported genetically modified (GM) crops, with GM fodder often being cheaper for farmers. However, there is also a growing market for 'GM-free' animal-based products. While public concerns about GMOs have been studied extensively, less is known about farmers' views. The limited literature on farmers and GMOs tends to focus on the economic factors influencing their adoption. The present study contributes the perspective of farmers as members of the general public, thus including a broader set of factors known to be relevant for the public perception of GMOs. The results indicated that farmers were worried about: i) unforeseen consequences for the environment, ii) unforeseen consequences for human and animal health, and iii) the dominance of multinational companies. Farmers who could expect their farm businesses to benefit from existing GMOs were more positive, whereas those who were unlikely to experience any benefits or who could expect their farm business to be adversely affected were more negative. Nevertheless, adherence to a broader set of positive or negative values suggests that Swedish farmers' perspectives on GMOs go further than pure considerations of farm management.

Keywords

GMO; biotechnology; feed; agriculture; adoption; perspective

1 Introduction

Consumer interest in animal welfare and environmental impacts has increased in recent years and includes a focus on whether animals are fed fodder that contains genetically modified organisms (GMOs) (GRUNERT et al., 2018). In many EU member states, it is common practice on conventional farms to feed farm animals with fodder that includes imported GM crops (this is not allowed on organic farms under EU certification for organic produce) (ERIKSSON et al., 2018). No trace of GMOs can be found in meat or milk from animals that have eaten GM fodder, therefore under EU regulations such products do not need to be labelled (CASTELLARI et al., 2018). However, in response to market demand in the EU for products from animals that are not fed GMOs, some producers are now labelling their animal-based products as "GM-free" if the animals have not eaten GM fodder (CASTELLARI et al., 2018; DOLGOPOLOVA and ROOSEN, 2018; SCHREINER and LATACZ-LOHMANN, 2015). For instance, in mid-2019 it was estimated that 60% of conventional milk in Germany – the EU's largest milk-producing country – was marketed as "GM-free" (VLOG, 2019).

Although GM feed is often cheaper, given the scepticism among some consumers about GM feed it can be assumed that farmers will weigh up the cost savings of using GM fodder against the potential consumer rejection of final products from animals fed GMOs (VENUS et al., 2018). The present study reports the findings from a survey of Swedish livestock farmers about their perspectives on the use of GM feed in agriculture. Unlike many other EU countries, the fodder market in Sweden remains free of GMOs (ERIKSSON et al., 2018). Due to the country's comparatively small fodder market, importers have judged that the

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costs of keeping non-GM fodder separate from GM fodder are too high. Nevertheless, GM fodder is typically estimated to be somewhat cheaper for farmers than conventionally produced fodder; estimations by ERIKSSON et al. (2018) suggest that GM fodder would be approximately 15% cheaper. Thus, some farmers and farmer organisations regularly raise the issue of allowing imports of GM fodder into Sweden.

However, this paper argues that farmers (like the general population) also have opinions about GMOs which are not directly connected to the impact of GMOs on their farm business. Farmers are not just farm managers and business owners, they are also citizens who share the same concerns as other people. Nevertheless, the literature on European public perspectives on GMOs, including the more recent literature about perspectives on feeding GMOs to farm animals (VENUS et al., 2018), is strongly oriented towards reporting consumers' perspectives (FISCHER and ERIKSSON, 2016). The limited research focusing on farmers indicates that farmers are not solely concerned with the impacts of GMOs on their farm businesses when forming their opinions. For example, the wider social environment has also been found to be important in how GMOs are perceived by European farmers (BREUSTEDT et al., 2008; BREUSTEDT et al., 2009; CONSMÜLLER et al., 2010).

The present study fills a gap in the literature by presenting findings from a survey of Swedish livestock farmers about their perspectives on feeding GM fodder to farm animals. The study takes a broader look at the GMO issue rather than merely focusing on its economic aspects. As such, it contributes to evidence about which factors are of importance when farmers are forming their views about GM fodder. It also provides some indications of the relative importance of economic factors in steering farmers' perspectives on GM fodder compared with other factors, such as concerns for health and the environment, which are important in shaping consumers' perspectives on GMOs.

The paper is structured as follows. The next section (2.1) offers a brief overview of existing research on consumers' perspectives on GMOs, indicating key factors that have repeatedly been shown to influence consumers' views of GMOs. This is followed (section 2.2) by a review of the literature with a focus on European farmers and GMOs. Section 2.3 provides some background to the structure of Swedish farming, and the wider market and policy environment influencing Swedish farmers. Section 3 describes the study's methods. Section 4.1 presents descriptive statistics about the farms in the study, followed by the findings from the analysis (section 4.2). The relevance of key findings is discussed in section 5, and the paper ends with the conclusions drawn from this study (section 6).

2 Background

2.1 Consumers and GMOs

Existing studies about public/consumer perspectives on GMOs show that the European public are sceptical overall about GMOs, but that there are significant national variations (EUROBAROMETER, 2010; GASKELL et al., 2000). The weighing up of risks and benefits, effects on health and the environment, and ethical aspects, including considerations of naturalness, have repeatedly been found to be important in determining public perception (COSTA-FONT et al., 2008). A lack of trust in the private biotech industry is an important factor in the negative attitudes to GMOs in Europe, whereas having trust in expert authorities (LEGGE and DURANT, 2010) and the government (LEGGE and DURANT, 2010; PAKSERESHT et al., 2017) leads to more positive views on GMOs. Several studies show that younger people and men are more positive about GMOs (LEGGE and DURANT, 2010; STOCKHOLM CONSUMER COOPERATIVE SOCIETY, 2018), while the role of education is more complex, with some studies indicating that educated people are more negative overall about GMOs than the average citizen (LEGGE and DURANT, 2010). Some recent studies have also found that Swedish consumers would be more willing to accept GMOs if they knew farmers would benefit (PAKSERESHT et al., 2017).

2.2 European Farmers and GMOs

The relatively few studies on European farmers and GMOs have focused on the more traditional factors seen to be of relevance for adoption. Factors frequently focused on in the adoption literature include the expected economic benefits of the new technology (for example, related to farmers' wealth, variable input costs, farm size and labour costs), risk and uncertainty, and the ease of learning about new technology (relating both to the complexity of the technology itself and its interaction with the natural environment, and farmers' educational backgrounds and their access to information through peers or advisory services) (FEDER, 1980; FEDER and UMALI, 1993; JACOBSON, 2013; KEELAN et al., 2009; WRIGHT, 2012).

Eight peer-reviewed publications were identified that address European farmers and GMOs (AREAL et al., 2012; BREUSTEDT et al., 2008; BREUSTEDT et al., 2009; CEDDIA et al., 2008; CONSMÜLLER et al., 2010; GYAU et al., 2009; HALL, 2008; KEELAN et al., 2009). Four of them focused empirically on Germany, and there is one each on Spain, Ireland and Scotland. The study by AREAL et al. (2012) is the only paper that focuses on the EU level, paying particular attention to the Czech Republic, France, Germany, Hungary, Spain and the United Kingdom. Seven studies predict adoption patterns and one publication (CONSMÜLLER et al., 2010) studied the actual adoption of GMOs, drawing on regional panel data between 2005 and 2007 when Bt maize MON810 was grown in Germany (before it was banned in the country using the safeguard clause of directive 2001/18/EC). None of these studies address the issue of GM fodder.

CEDDIA et al. (2008) studied the expected economic impacts of insect-resistant Bt cotton adoption by farmers in Andalucía in southern Spain, where cotton bollworm, an insect to which Bt cotton provides resistance, is a significant production problem (Bt cotton is not currently grown in the EU). The authors conclude that most responding farmers believe their economic performance would be significantly improved by the adoption of Bt cotton.

Other studies similarly focus on economic aspects, but take a wider variety of factors into consideration. In 2008, BREUSTEDT et al. (2009) performed an experiment with 202 German farmers growing (non-GM) oilseed rape. The study found that anticipated positive economic effects, GMO-positive neighbours and farm size have a significant positive impact on adoption. The study also indicated that farmers with combined arable production and pig or poultry production are more likely to adopt GM oilseed rape than arable farmers with beef or dairy production. Additionally, female farmers are more negative about GMO adoption. The impact of what neighbours think or of the wider social environment on farmers' willingness to adopt GMOs is also addressed by GYAU et al. (2009) and CONSMÜLLER et al. (2010) who, like BREUSTEDT et al. (2008, 2009), both found that the wider social environment is important in farmers' willingness to adopt GMOs.

AREAL et al. (2012) studied the effect of EU coexistence regulations on farmers' willingness to plant herbicide-tolerant GM crops (soybean, maize and oilseed rape) which are not yet allowed in the EU. The study concluded that coexistence measures act as a barrier to adoption, but that adoption is not significantly influenced by farm size or by the farmer's age and educational level. Like AREAL et al. (2012), KEELAN et al., (2009) found that farmers' general education level is not important in determining adoption, but that their level of agricultural education is positively correlated with adoption. In contrast to AREAL et al., (2012), other European studies have found farm size to be positively correlated with adoption (CONSMÜLLER et al., 2010) or with the willingness to adopt GMOs (GYAU et al., 2009; KEELAN et al., 2009). The broader adoption literature is divided as to whether these frequently studied factors are of relevance in explaining GM crop adoption (e.g. BREUSTEDT et al., 2008; FERNANDEZ-CORNEJO et al., 2002; FINGER et al., 2009), indicating a more complex relationship. The study by GYAU et al. (2009) is the only one of the eight European studies to take risk perception into account, a factor that has otherwise been a central theme in social science studies on GMOs (e.g. HERRING, 2015; JASANOFF, 2000; SHAH, 2011; SHANKAR et al., 2008). The authors found that farmers who are strongly opposed to GMOs are less willing to take risks.

In line with the wider trend, none of the above-mentioned studies investigated what farmers actually think of GM crops. One exception is HALL (2008), who studied Scottish farmers' attitudes to GM crops. She found that farmers are quite evenly distributed between those who think that GMOs would be good or bad or neither. Those thinking GMOs would be good associated them with higher profitability, and those thinking GMOs would have a negative impact mentioned consumer rejection and to a lesser extent negative environmental impacts.

The above summary reveals that studies on European farmers' adoption of GMOs, like adoption studies in general, pay greater attention to economic factors than is the case with the literature on public perspectives on GMOs. In the adoption literature, no attention has been paid to farmers' views on environmental or health impacts or ethical aspects, factors found to be important in explaining public perspectives on GMOs. It can also be noted that the literature on adoption, like the literature on public perception, indicates a complex relationship between perspectives on GMOs and education. In summary, the existing studies on European farmers and GMOs are too few to indicate any clear trend with regard to factors that encourage or hinder GMO adoption, and even less is known about what farmers actually think about GMOs. As such, farmers' voices have gone unheard in most adoption studies.

2.3 Swedish Animal Farmers within an EU Perspective

Apart from Swedish livestock farmers not having access to (generally cheaper) GM feed, there are some other regulatory aspects that set Swedish farmers apart from their EU neighbours. Animal welfare is one such area. Sweden has decided to have stricter animal welfare legislation than the minimum legislation required by the EU, and this applies to all Swedish livestock farmers regardless of certification. It means, for example, that Swedish cows should be allowed to browse outdoors during the Swedish summer and calves should have access to roughage from two weeks of age. The most significant differences between Swedish and the minimum EU requirements for animal welfare, however, concern pig production. Routine tail-docking is prohibited, sows cannot be kept tied up, the floor is not allowed to be fully slatted, and pigs are to be given material for bedding (PREJER, 2013). Sweden also prohibited the use of antibiotics as a growth promoter in livestock production back in 1986, whereas the same prohibition only became legislation in the EU in 2006. As a result of stricter regulations and practices in Sweden, the country has the lowest use of antibiotics in livestock production in the EU (SVA, 2020). Sweden's stricter animal welfare legislation is regularly questioned by some farmers and farmer organisations because it is thought to hamper equal competition with EU neighbours (SOU, 2015: 15).

The market for organic produce in Sweden is dominated by two certifications: the EU certification for organic production regulated under (EC) No. 834/2007 and the Swedish organic standard (KRAV). KRAV fulfils the regulation for organic production (EC) No. 834/2007, but also contains even stricter producer requirements, e.g. prohibiting some additives allowed under the EU regulation for organic production, demanding that farmers maintain a system to carry out environmental work, document their environmental activities, and take steps to reduce their energy consumption. KRAV also has stricter regulations on animal welfare, for example requiring pigs to be able to browse and having more detailed regulations around slaughtering (KRAV, 2018).

3 Methods and Materials

In a survey sent out in late 2016 and early 2017, Swedish farmers engaged in livestock production were asked multiple response questions about their views on GM fodder.

Information was also collected on aspects acknowledged as relevant for adoption, such as farm characteristics, the farmers' social and economic situation, educational background, access to advisory services, social networks etc.

The statements on GMOs with which farmers were asked to agree or disagree in the survey were designed around central themes that have emerged in the literature on consumer and farmer attitudes to GMOs, as described in section 2, i.e. risks, environmental and health concerns, economic and farm production aspects, ethical considerations, and scepticism about multinational companies. As European public perception of GMOs is more negative than positive overall (section 2.1), the survey questions on GMOs were designed to reflect this overall pattern in European public opinion. As a result, only two of the eight statements (S1 and S2) were phrased positively in relation to GMOs, whereas six (S3-8) were negative statements. While this might lead to more negative responses than positive ones overall, the purpose of the study was not to analyse the balance between positive and negative responses, but rather to see how farmers' views on GMOs correspond with those of the general public (as approximated through statements S1-S8).

Farmers were asked to state yes or no as to whether they agreed with the following eight statements about GM fodder:

- S1) I think GM feed should be allowed for economic reasons
- S2) I think GM feed should be allowed because it provides me with more options when I buy feed
- S3) I do not think GM feed should be allowed because genetic engineering is going too far as regards human influence on nature
- S4) I do not think GM feed should be allowed because there could be unforeseen consequences on animal health
- S5) I do not think GM feed should be allowed because cultivation of GMO crops could have unforeseen consequences on the environment
- S6) I do not think GM feed should be allowed because meat/milk from animals that have eaten GM feed could have unforeseen consequences on human health
- S7) I do not think GM feed should be allowed because I am distrustful of multinational companies' dominance over genetic engineering
- S8) I do not think GM feed should be allowed because I am afraid of consumer resistance.

The survey was distributed to a total of 3,916 farmers engaged in livestock production across Sweden by e-mail (n = 2,228) or posted to them if email addresses were missing (n = 1,688), and a link was provided to the online survey. The response rate was 17% (664 responses, n = 614 contacted by e-mail and n = 50 contacted by regular post). Some surveys were incomplete or contained missing values in statements, leaving a sample of n = 315 respondents from across Sweden, on which the results presented here are based. However, answers overall seemed to be missing at random, with no clear pattern around any specific variables. On the basis of this, and given the broad coverage of farmers addressed by this survey, the non-responses were also interpreted as random and, therefore, the assumption was that these data represent a random sample of the population of Swedish livestock farmers.

Model: Predicting Farmers' Perspectives on GM Feed

Respondents' perceptions of GM feed were modelled according to the following conceptual framework, in which the dependent variable was formed by the respondents' yes/no answers to S1-S8, leading to *k*=1,…,8 different logit models that were estimated via maximum likelihood.

The independent variables described respondents' interactions with various partners, as well as individual and farm characteristics and variables that approximated the characteristics of the farmers' networks. Most answers were recorded either in a binary way (e.g. yes/no) or on scales with five items, for which the labels ranged from "To a low degree" to "To a high degree" as indicated by {1, 2, 3, 4, 5}. A few questions asked for numerical input, such as the number of hectares or the farmer's age. For most questions there were options such as "Don't know" and "Not relevant". In our analysis, we grouped several variables (survey questions) that addressed a broader underlying issue from different angles into six vectors.

The explanatory variables fell into the following categories, i.e. 'vectors' for respondent i, with *i=1,…,315*:

$$P(y_i^k = 1|Part_i + Soc_i + Hea_i + Ser_i + Comp_i + Econ_i + X_i + Z_i)$$
$$= \frac{\exp(\beta_0+\beta Part_i+\beta Soc_i+\beta Hea_i+\beta Ser_i+\beta Comp_i+\beta Econ_i+\beta X_i+\beta Z_i)}{1+\exp(\beta_0+\beta Part_i+\beta Soc_i+\beta Hea_i+\beta Ser_i+\beta Comp_i+\beta Econ_i+\beta X_i+\beta Z_i)} \quad (1)$$

Part: participation, democracy and social status
Soc: networks and social relations
Hea: health, safety and working environment
Ser: service and communications
Comp: competition and room for action
Econ: economic situation, equality, employment, balance of power
X: farm characteristics
Z: socioeconomic characteristics.

Table A1 in the appendix details the survey questions grouped under each vector.

The reason behind the grouping is to address a common problem with the analysis of survey data in economics, namely that complex topics often have to be proxied by several separate survey questions. For instance, the opinion of farmers with respect to economic aspects of GMOs in feed may have to be assessed from different directions, such as cost savings, negative consumer reactions, involvement in international supply chains etc.

Typically, each of these dimensions is addressed through at least one separate survey question, thus the resulting dataset may include a large number of variables (one for each survey question). For subsequent regression analysis, such large datasets often have the problem that some of the variables are statistically correlated, which could lead to collinearity in the regression. Thus, a large number of coefficients would have to be estimated, while many of them will turn out statistically insignificant because their explanatory power with respect to the dependent variable somewhat 'overlaps' due to this collinearity.

In order to reduce the collinearity of these variables, factor analysis (with varimax rotation) was applied to the vectors Part, Soc, Hea, Ser, Comp and Econ. Factor loadings from the retained factors were recorded for each observation and subsequently used as explanatory variables. For instance, the first component calculated for the "econ" group according to the factor analysis procedure had an eigenvalue of 3.9 and could explain 44% of the variance in the "econ group" of variables. The second factor had an eigenvalue of 1.3 and could explain 14% of the variance in the econ group. Thus, these two factors could explain close to 60% of the variance within these nine variables in "econ". The Kaiser criterion suggests that only factors with eigenvalues greater than 1 should be considered.

Equation 1 was estimated as eight individual logit models to which robust standard errors were applied in order to correct for heteroscedasticity. The eight individual logit models were estimated in two different specifications: the first specification was more parsimonious, and for each of the vectors Part, Soc, Hea, Ser, Comp and Econ, only the loadings from the factor with the highest eigenvalue were used. As a robustness check, all the models were also estimated in an alternative specification. For the alternative specification, the vectors Part, Soc, Hea, Ser, Comp and Econ were represented by their corresponding two to three retained factors with an eigenvalue >1.

The suitability of each group for the application of factor analysis was tested according to the Kaiser, Meyer and Olkin (KMO) criterion and Bartlett's test. KMO measures the sampling adequacy for application of a factor analysis, with values ranging between 0 and 1. The higher the KMO, the more suitable the data, with a recommended minimum of 0.6. Bartlett's test checks the null hypothesis that the variables are completely uncorrelated. The results of these tests are provided for each vector in Table A1 and indicate that all the vectors were well suited to application of the procedure, i.e. our grouping of survey questions into the corresponding vectors was not rejected by the data. However, given that the survey had to cover quite a few dimensions, few variables could be measured in great detail. As a result, many explanatory variables are binary (dummies).

Our survey was developed to explore a topic (farmers' perspectives on GMOs) for which there is still limited empirical evidence. Therefore, the survey aimed to include a broad set of factors that could be relevant determinants for farmers' opinions on this topic. This means that our empirical results were based on eight dependent variables and a much larger set of potentially relevant explanatory variables. However, interpretation of the estimated regression coefficients from these eight different models is complicated because the binary dependent variables forced us to adopt the logit framework rather than conventional ordinary least squares regression (OLS). Due to the non-linear relationship between the dependent variable and the explanatory part of the model, estimated coefficients had to be interpreted either as odds ratios or in terms of marginal effects.

For an interpretation in terms of odds ratios, the following holds: log odds = log $(\frac{P(y=1)}{1-P(y=1)})$= β so that $odds\ ratio = \frac{odds\ after\ 1\ unit\ increase\ in\ x}{odds\ before\ 1\ unit\ increase\ in\ x} = e^{\beta}$.
For example, assuming the dependent variable is "Respondent is against GMOs in feed = 0" vs. "…in favour of GMOs in feed = 1", and β(Gender) has been estimated at 1.695, then $e^{1.695}$ = 5.44, which implies that the odds of male respondents being in favour of GMOs in feed is 5.44 times the odds of female respondents being in favour of GMOs in feed. While this interpretation of estimated coefficients is obviously cumbersome for a large number of estimated coefficients (as in our case), the derivation of marginal effects requires statistical simulations and is not free from assumptions either. However, the interpretation of the signs of the estimated coefficients can be directly undertaken with the estimated coefficients since a positive (or negative) sign reported for an estimated coefficient means an increase (or decrease) in the probability of the dependent variable falling into the category y = 1. For simplicity, we therefore decided against a more refined quantitative evaluation, e.g. in terms of marginal effects or odds ratios. Consequently, the interpretation here focuses mainly on the question of if, and to what extent, a statistical relationship between variables can be identified within the multivariate context of the research question, and whether the estimated coefficients bear a positive or negative sign.

Future surveys could be designed based on what we know from this study to be the most relevant factors. As such, these surveys could be subject to more detailed investigations. Based on our findings presented here, future research should particularly evaluate the role of explanatory variables that capture farm size, farm specialisation and marketing channels. The explanatory role of these variables and their interactions with respect to farmers' stated opinions on GM feed might be measured in more detail, e.g. in a more focused survey with selected sub-groups of farmers.

4 Results

4.1 Descriptive Statistics

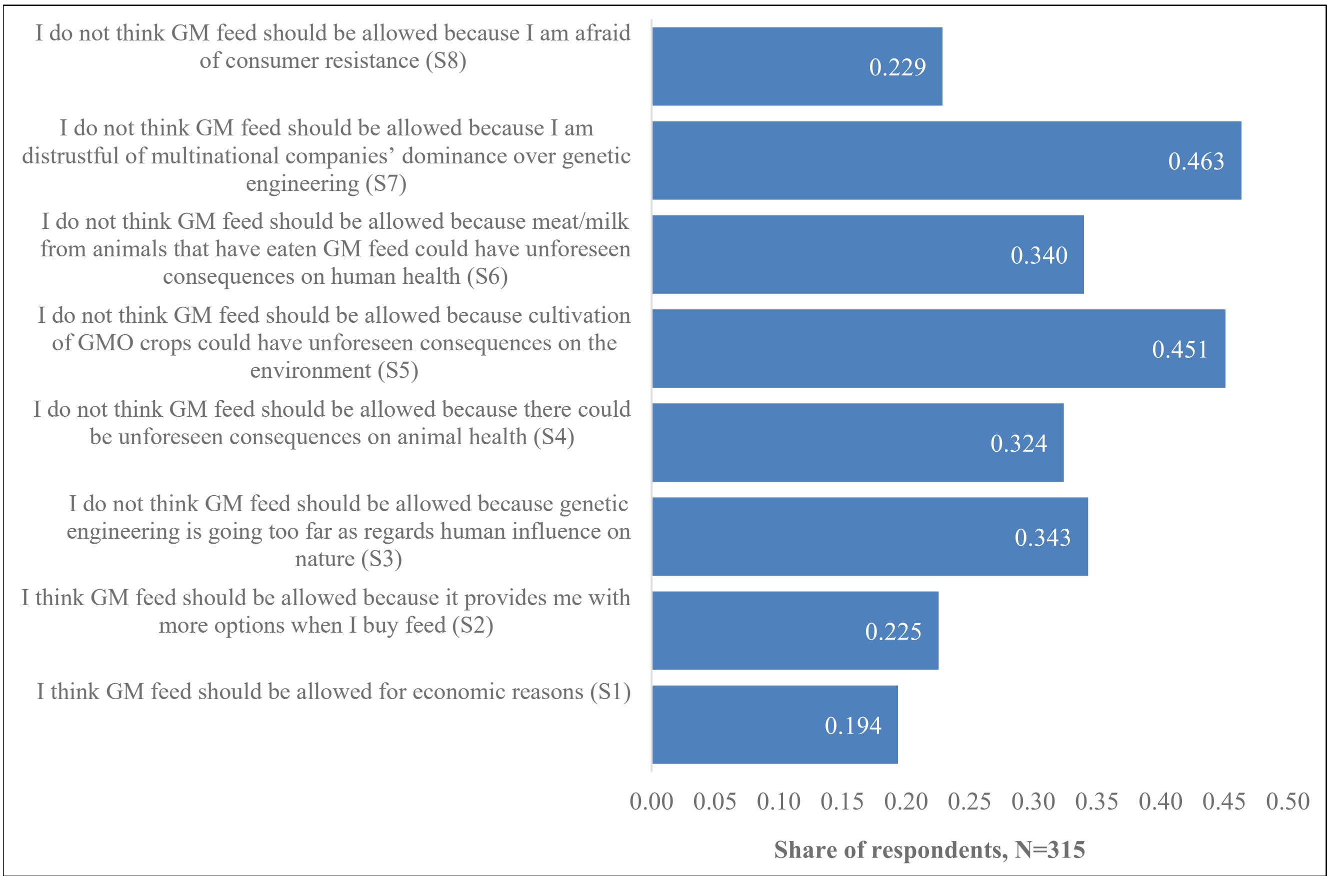
This section provides some descriptive statistics of the data set. Although farmers engaged in livestock production were specifically targeted, Swedish farmers are rarely engaged in just one type of production. To the question of what their main farming activity was, farmers were allowed to give a maximum of two answers. While more than 95% of respondents considered themselves professional animal producers, 68% of them were also engaged in crop production and 63% stated that they were engaged in forestry. The majority of farms were smaller than 100 ha, with 9% of the sample being larger than 300 ha. Of all the farms in the sample, ca. 52%, 30% and 8% regarded beef, dairy or pigs, respectively, as their main activity. Unfortunately, there were no data on the size of their herds. About 22% of the farmers reported that they were certified organic under the Swedish label for organic farming (KRAV) and 7% were EU organic.

Table 1. Socioeconomic characteristics of the sample

	Mean	Median	Std Dev	Min	Max
Year of birth	1961	1960	9.88	1936	1988
Highest education primary	0.130	0	0.337	0	1
Highest education secondary	0.444	0	0.497	0	1
Highest education university/college	0.356	0	0.479	0	1
Highest education other (not included in any other category)	0.07	0	0.256	0	1
Gender: male, female	*n* = 266 (84.4%), *n* = 49 (15.6%)				

Source: own data, based on survey

Figure 1. Share of respondents agreeing with a statement about GM feed; multiple answers (n = 315)



Source: own data, based on survey

Of the farmers in the sample, 14% had completed junior secondary school or similar (compared with 11% of the entire Swedish population), 43% had completed upper secondary school (which is the same percentage as Sweden as a whole), and 35% had a university education (compared with 28% in the wider Swedish population). Most responding farmers in the data set were older men (Table 1), which corresponds well with the reported situation on Swedish farms overall (Röös et al., 2019).

Figure 1 illustrates the overall answers given by farmers to the multiple response questions in focus in this study.

Figure 1 indicates that the respondents were more negative than positive about GM fodder overall. The two positive statements (S1 and S2) received the lowest response rates. Among the statements indicating negative views on GM feed (S3-8) in particular, many respondents were sceptical about the dominance of a few multinational companies in the sector, and were worried about unforeseen consequences on the environ-ment. The negative statement that received the lowest response rate was worry about consumer resistance. Overall, this indicated that Swedish livestock farmers' views on GM feed were not obviously steered by economic factors (as indicated in S1, S2 and S8).

4.2 Estimation Results

The estimation results from the eight different logit models are presented in Table 2. They show that the overall explanatory power of each of these models was satisfactory according to the number of cases predicted correctly. The estimated coefficients indicated that respondents were more likely to agree with S1 and S2 (positive about GMOs for economic and market-related reasons) when they had also stated that they had relatively strong social ties and networks. These respondents also tended to farm relatively large farms in terms of the number of hectares, and were less likely to be certified organic. In terms of gender, these respondents were significantly more often male than female, and tended to have a relatively high education at university or college level (although it should be noted here that respondents were highly educated on average). Surprisingly, respondents who agreed with both S1 and S2 stated that their perceived access to community services and infrastructure was relatively poor. As these farms were comparatively large, one possible reason for this is that the farms were more often located further away from urban centres.

The statistical significance of the explanatory variables regarding the models for S3-6 (i.e. being negative towards GM feed due to worries about animal and human health impacts, environmental impacts or moral concerns regarding human interference with nature) revealed relatively similar patterns. For all of these, a perceived negative economic situation had a statistically significant effect on the probability of agreeing with any of the statements: i.e. farmers who viewed their own economic situation negatively were also negative about GM feed for reasons related to animal and human health impacts, environmental impacts or moral concerns regarding human interference with nature. Bearing in mind that the economic variable here concerned a self-perceived rather than actual economic situation, it might be possible to argue that a negative self-perceived economic situation could be correlated with being more risk averse, which then explains the concerns about the unforeseen effects of new technologies on health and the environment. No evidence was found in the analysis that factors concerning participation, social networks, psychological situation, access to services or perceived competition had any significant influence on respondents' answers to any of the statements S3-S6. Farmers certified under the Swedish organic label KRAV were more likely to agree with S3-6, whereas those certified under the somewhat less stringent EU organic certification were only more likely to agree with S3 on moral concerns about human interference with nature.

In the case of S7 concerning scepticism about multinational companies, where there was the most agreement among respondents (Fig. 1), the only variables that significantly impacted the response to this statement were being a beef farmer, being female and being certified under KRAV.

Overall, farmers certified under KRAV were significantly more likely than others to disagree with positive statements about GM feed (S1-2) and to agree with all the negative statements about GM feed (S3-8). However, this did not apply to farmers certified as EU organic who (according to the statistical significance versus the non-significance of the explanatory variables) only answered that they did not want to allow GM feed because it would go too far in terms of human interference with nature (S3).

Beef farmers also tended to worry about unforeseen consequences on human health (S6), felt that genetic modification was going too far with regard to human interference with nature (S3), and were worried about consumer resistance (S8). Farmers who considered dairy cattle to be their main activity did not seem to have the same views as beef farmers, except with regard to their statistically significant concern about negative consumer resistance if they were to use GM feed. For all other questions, respondents' orientation towards dairy production was statistically insignificant.

In contrast, farmers of larger farms according to the number of hectares (which are likely to be larger crop farms) were more positive about GM feed overall. They agreed with S1-2 on allowing GM feed for economic reasons, and were significantly less likely than the sample average to be concerned about human interference with nature (S3 and S5).

Respondents' age was statistically insignificant across all eight models. The role of education also appeared to be relatively limited: the only effect of education was that respondents with a university or college education were more likely to disagree that genetic engineering is going too far as regards human influence on nature. For all other statements, the education variables proved to be insignificant.

Table A2 in the appendix presents the same set of models with additional factors from the factor analysis included as a robustness check. The models in Table A2 are somewhat more complex, but also explain the data slightly better according to the number of cases predicted correctly. Regarding the variables on farm

Table 2. Estimation results from Logit models with only first factors included (n = 315)

Note: D. = dummy variable; n = 315		1. Should be allowed for economic reasons			2. Should be allowed for more purchase options			3. Should not be allowed due to too much human influence on nature			4. Should not be allowed due to unforeseen consequences on animal health		
		Coef.	*p-val*		*Coef.*	*p-val*		*Coef.*	*p-val*		*Coef.*	*p-val*	
const		8.8175	0.8221		-25.4485	0.4481		-2.1401	0.9395		36.9384	0.2220	
Factor loadings of explanatory vectors:	Part_FAC1_1	-0.1460	0.5116		0.0473	0.7726		-0.1347	0.3315		0.0208	0.8828	
	Soc_FAC1_1	0.4187	0.0521	*	0.3872	0.0693	*	-0.0026	0.9866		0.0586	0.7127	
	Hea_FAC1_1	-0.1261	0.5907		0.0185	0.9281		0.0414	0.7830		0.1310	0.3844	
	Ser_FAC1_1	-0.5165	0.0123	**	-0.3596	0.0571	*	0.0833	0.5821		-0.1425	0.3438	
	Comp_FAC1_1	0.0856	0.6836		-0.0099	0.9529		-0.1871	0.2028		-0.1861	0.2409	
	Econ_FAC1_1	0.1815	0.3147		0.0912	0.5522		-0.2788	0.0526	*	-0.4514	0.0016	***
Is your farm certified under…	Svenskt Sigill (Swedish environmental certification) (D. = 1 if yes)	0.2329	0.6800		0.2518	0.6325		-0.0526	0.9165		0.1281	0.7941	
	EU organic? (D. = 1 if yes)	-0.1745	0.7674		-0.5879	0.3526		0.8496	0.0914	*	0.5544	0.3051	
	Swedish organic label KRAV? (D. = 1 if yes)	-1.1045	0.0366	**	-1.4666	0.0017	***	0.5556	0.0768	*	0.6575	0.0355	*
	Any other certification? (D. = 1 if yes)	0.7927	0.1049		0.0654	0.9016		-0.2214	0.6399		-0.3156	0.5192	
	How many hectares do you farm? (number)	0.2841	0.0196	**	0.2334	0.0322	**	-0.1439	0.0893	*	-0.1407	0.1032	
What production do you regard as your main activity?	D. = 1 if "milk", zero otherwise	0.0022	0.9955		-0.6390	0.1046		0.2499	0.4560		0.3463	0.2987	
	D. = 1 if "beef", zero otherwise	-0.2092	0.5213		-0.4903	0.1153		0.8494	0.0061	***	0.4315	0.1378	
	Gender (female = 1 if yes, otherwise 0)	-2.8286	0.0121	*	-1.8779	0.0040	***	0.3205	0.4193		0.2204	0.5738	
	What year were you born? (year)	-0.0048	0.8131		0.0127	0.4597		0.0009	0.9494		-0.0192	0.2157	
What is your highest education? (Omitted: primary, elementary, junior)	D. = 1 if secondary education	-0.2597	0.6917		-0.0244	0.9676		-0.0482	0.9112		0.6143	0.1599	
	D. = 1 if university/college	0.8552	0.1831		1.0062	0.0854	*	-1.2504	0.0056	***	-0.2816	0.5303	
	D. = 1 if highest education not included elsewhere	0.7241	0.3111		-0.4058	0.6216		-0.9712	0.1105		-0.5981	0.3680	
	McFadden R-squared		0.2017			0.1733			0.1214			0.1075	
	Adjusted R-squared		0.0789			0.0603			0.0276			0.0117	
	Akaike criterion		285.2			315.9			393.9			392.1	
	Share of cases correctly predicted		83.50%			81.60%			68.30%			68.60%	

Table 2 (cont.). Estimation results from Logit models with all relevant factors included (n = 315)

Note: D. = dummy variable; n = 315		5. Should not be allowed due to unforeseen consequences on environment			6. Should not be allowed due to unforeseen consequences on human health			7. Should not be allowed due to distrust of multinational companies			8. Should not be allowed due to fear of consumer resistance		
		Coef.	*p-value*		*Coef.*	*p-value*		*Coef.*	*p-value*		*Coef.*	*p-value*	
	const	32.0187	0.2789		-9.6082	0.7509		19.1993	0.5009		52.6105	0.1096	
Factor loadings of explanatory vectors	Part_FAC1_1	-0.0845	0.5238		-0.1566	0.2577		-0.1807	0.1624		0.2492	0.0887	*
	Soc_FAC1_1	0.0329	0.8238		0.1024	0.5020		0.0663	0.6219		0.1564	0.3129	
	Hea_FAC1_1	0.1029	0.4794		0.1234	0.4068		0.0697	0.6314		-0.3831	0.0462	**
	Ser_FAC1_1	-0.1181	0.3806		0.0843	0.5835		-0.0380	0.7689		-0.0036	0.9817	
	Comp_FAC1_1	0.1178	0.4249		-0.1064	0.5018		-0.0583	0.6799		0.3076	0.0822	*
	Econ_FAC1_1	-0.3447	0.0189	**	-0.3278	0.0272	*	-0.1610	0.2293		-0.0136	0.9333	
Is your farm certified under…	Svenskt Sigill (Swedish environmental certification) (D. = 1 if yes)	-0.0562	0.9021		0.4327	0.3561		-0.0960	0.8216		1.3139	0.0074	***
	EU organic? (D. = 1 if yes)	0.1669	0.7126		0.2967	0.5561		0.2237	0.6301		-0.4193	0.5385	
	Swedish organic label KRAV? (D. = 1 if yes)	1.2156	0.0001	***	0.7083	0.0186	*	0.7185	0.0164	**	0.6888	0.0426	**
	Any other certification? (D. = 1 if yes)	-0.1656	0.7193		-0.8646	0.1628		0.5106	0.2360		0.1079	0.8451	
	How many hectares do you farm? (Number)	-0.2627	0.0021	***	-0.1313	0.1241		-0.0625	0.4551		-0.0864	0.4278	
What production do you regard as your main activity?	D. = 1 if "milk", zero otherwise	0.6383	0.0469	**	0.2858	0.3865		0.4739	0.1352		0.9903	0.0137	**
	D. = 1 if "beef", zero otherwise	0.3083	0.2553		0.8750	0.0023	*	0.8475	0.0018	***	0.5937	0.0724	*
	Gender (female = 1 if yes, otherwise 0)	0.5483	0.1524		0.9392	0.0104	*	0.6951	0.0539	*	-0.5504	0.2613	
	What year were you born? (year)	-0.0166	0.2761		0.0039	0.8023		-0.0104	0.4772		-0.0272	0.1076	
What is your highest education? (Omitted: primary, elementary, junior)	D. = 1 if secondary education	1.1713	0.0124	**	0.7418	0.1129		0.0580	0.8891		-0.4936	0.3040	
	D. = 1 if university/college	0.3183	0.4893		-0.2606	0.5775		-0.3938	0.3452		-0.4986	0.2934	
	D. = 1 if highest education not included elsewhere	0.8991	0.1087		0.5006	0.4342		0.0297	0.9596		-2.3967	0.0117	**
	McFadden R-squared		0.1256			0.1212			0.0724			0.1243	
	Adjusted R-squared		0.0380			0.0271			-0.0149			0.0121	
	Akaike criterion		417.2			392.8			441.5			334.6	
	Share of cases correctly predicted		67.90%			69.50%			64.10%			79%	

Source: own data, based on survey

size, certification under KRAV, gender, age, education and the main focus on beef versus dairy production, the sign of the estimated coefficients and the level of statistical significance at 10% or better remained similar overall, as was the case with the models in Table 2. This indicates that respondents with larger crop farms tended to favour GM feed for economic reasons and were less concerned about the unforeseen consequences of genetic engineering than those with smaller crop farms. Furthermore, beef cattle farmers tended to be more concerned than dairy cattle farmers, while certification under KRAV would seem to go hand in hand with elevated scepticism about genetic engineering.

For the vectors Part, Soc, Hea, Ser, Comp and Econ, the second factor proved to be statistically significant in a small number of instances in Table 2. While the first factor captured positive loadings on each vector, the second factor often captured negative loadings on the corresponding vector. It was, therefore, plausible that the observed sign of the estimated coefficient on the second factor in Table 2 was often the opposite of that of the estimated coefficient on the first factor. Overall, however, the total number of statistically significant explanatory variables for the vectors Part, Soc, Hea, Ser, Comp and Econ remained limited in both Table 2 and Table A2. This implied that relatively more explanatory power seemed to come from the farmer's socioeconomic characteristics (namely vectors X and Z).

Table A3 presents the same model as Table A2, except that the orientation towards dairy as the main activity has been replaced by an orientation towards pigs as the main activity. The survey questions asked "What do you consider your main activity?", with multiple response options (dairy, beef, poultry etc.) from which respondents could choose two. Thus, for each of these options, we have one variable in the dataset that takes a value of 1 if a respondent has chosen this as one of her/his two main activities, and zero otherwise.

When dummies are added for dairy, beef and pigs together, the situation of almost perfect collinearity arises because very few farmers did not regard "dairy", "beef" or "pigs" as one of their two main activities. Thus, not all of them could be included in the model at the same time.

In the regressions in Table A3 we, therefore, exchanged the dummy for "dairy as the main activity" with "pigs as the main activity" in order to assess the robustness of our results. This did not affect the sample size since no observations were added or removed from the dataset.

In contrast to the farmers certified under KRAV, farmers oriented towards pig production agreed with all the statements that were positive about GM feed and disagreed with the negative statements. For S4, S5, S6 and S7, the statistical significance of the estimated coefficients tended to support this observation: pig farmers wanted to allow GM feed as it would give them more choice (S2), they did not believe that GM feed would have unforeseen consequences on the environment or on human or animal health (S 4-6), and they did not distrust multinational companies (S7).

5 Discussion

An important finding from this study is that although the results indicate that farmers' views of GM feed have a rational economic foundation (in that farmers who were more negative have economic reasons for being so and vice versa), the opinions stated by farmers who were positive or negative overall were broader and did not only relate to direct economic concerns. Those farmers who could reasonably expect economic benefits from the introduction of GM feed in Sweden (pig farmers and large crop farmers) were more positive about GM feed overall. Farmers who could expect not to benefit from Sweden opening up to the import of GM feed or where benefits were unsure (such as beef farmers and some organic farmers) were more negative. This finding supports the suggestion that a farm's economic situation is important in relation to how farmers form their opinions about GMOs. However, at the same time farmers frequently expressed their positivity or negativity to GMOs according to dimensions that went beyond farm-specific economic self-interest. These key findings and their connection to previous research are detailed in the sections below.

5.1 Economic Opportunities have an Impact on Farmers' Views about GM Fodder

Farmers of larger crop farms who were more positive about GM fodder in the present study have also been found to be more positive about GMOs in earlier findings elsewhere in Europe (BREUSTEDT et al., 2009; BREUSTEDT et al., 2008; CONSMÜLLER et al., 2010; GYAU et al., 2009; KEELAN et al., 2009), indicating that the effect of farm size on GMO adoption applies across many contexts. This is probably because the GMOs that have so far been marketed facilitate returns to scale.

Swedish pig farmers who were found to be positive to GM fodder in the present study are highly dependent on imported feed (ERIKSSON et al., 2020) and are thus likely to benefit financially from the use of GM feed in Swedish livestock farming because it will give them access to cheaper feed (ERIKSSON et al., 2018). The finding that pig farmers were more positive about GM feed than other farmers also supports the findings of BREUSTEDT et al. (2008, 2009), which indicates that these views might be applicable across many European contexts.

In contrast, those farmers who aim to take market shares based on product or process differentiation, such as organic, natural grazing or local production, are not as obviously expected to benefit from using imported GM fodder because this might have a negative impact on their brand. In addition, allowing GM fodder imports into Sweden would lower feed costs for other farmers and thus increase competition. Therefore it is just as economically rational for these farmers to be negative about GMOs, which indeed was found to be the case in this study.

In line with studies on public perception of GMOs, men were more positive about GM feed overall than women (LEGGE and DURANT, 2010; STOCKHOLM CONSUMER COOPERATIVE SOCIETY, 2018). This can be explained by men generally being less risk averse than women (FEHR-DUDA et al., 2006) and women generally being slower to adopt new technologies (RAGASA, 2012). Together with the finding that farmers who perceive their financial situation to be comparatively poor are more negative about GM feed, this indicates that farmers who are generally more risk averse also are more negative about adopting GM feed (bearing in mind that the perceived rather than actual economic situation was being studied here, negative perceptions of a farm's financial situation are interpreted as being somewhat related to risk aversion). This is similar to the finding of GYAU et al. (2009) that German farmers who are negative about GMOs are also less willing to take risks.

The findings about the overall statistical insignificance of education on farmers' perspectives of GM feed also supports the conclusion that their perspectives are guided by deeper-seated values than farm-specific economic self-interest. The finding also contributes to the mixed empirical evidence in other studies of the role of education in the views and adoption of GMOs (AREAL et al., 2012; LEGGE and DURANT, 2010).

5.2 Cultural and Context-Specific Factors have an Impact on Farmers' Perspectives on GM Fodder

Swedish beef farmers, who were found to be particularly negative towards GM feed, partly feed their animals through grazing on open pastures. This production system is frequently promoted by Swedish producer organisations and retail chains as a more environmentally friendly option that also contributes to keeping landscapes open through grazing. Open landscapes have strong positive connotations for Swedish people due to their strong Swedish cultural value (FISCHER and RÖÖS et al., 2018). It is, therefore, unlikely that these findings in relation to beef farmers are inherent to the type of animal being farmed. Instead, the particular negativity towards GMOs among Swedish beef farmers (as compared with other livestock farmers) is probably influenced by beef farming in Sweden largely relying on outdoor grazing, as well as the particular cultural values attached to open landscapes in Sweden.

It is relevant to note here that beef farmers did not express more concern about consumer resistance than other farmers, and indeed concern about consumer resistance was the least stated reason overall for negativity about GM fodder. The results instead show that beef farmers stated more often than pig or dairy farmers that they are not in favour of genetic modification because it involves too much interference with nature. This indicates that beef farmers might not only be negative towards GM fodder because they would lose market share, but possibly more importantly because they align their values with the general Swedish culture of valuing open landscapes.

The results show that farmers certified under the Swedish organic label KRAV were significantly negative about GM feed, while producers certified under the EU organic label were not. This finding also supports the argument about more deeply-rooted values influencing farmers' perspectives on GM feed. Sweden has a long tradition of organic farming (PADEL et al., 2009) and LUND et al. (2002) found that farmers who have been certified for a considerable time are more likely to align their views with that of the certification than those who were certified more recently. The Swedish KRAV label also stems from a producer-driven initiative, and might thus come with a stronger sense of belonging and shared values than the EU organic label does.

GM crops on the market today are controlled by a handful of multinational companies (OECD, 2018), and this has been identified in the present study and elsewhere (HELLER, 2006) as an important reason for farmers' negative attitudes towards GMOs. These findings suggest that more locally developed GM crops with no connection to large multinationals, from which farmers more obviously benefit and where modifications can be aligned more clearly with other values in farming, such as reducing the need for inputs in local crop varieties, are more likely to be received positively by farmers.

6 Conclusions

Academic literature and the policy debate on public perspectives on GMOs currently tend to focus primarily on members of the public, particularly consumers, rather than on farmers. It is also commonly assumed that farmers would have an economic self-interest in using GMOs if it reduced their production costs. The present study was therefore designed to contribute much-needed empirical evidence about farmers' views of GM feed, not least since it is farmers who are the main target for GMOs on the market.

The findings from this study indicate that farmers form their opinions about GMOs on the basis of economic considerations only to a moderate extent. More frequently, they articulate their negativity in broader and mainly non-economic terms. One possible conclusion from this study is that farmers express their negative or positive opinions in ways that are heavily influenced by what is considered culturally appropriate and fits with the wider public discourse. With respect to future research, it is concluded that the relationship between farms' economic interests and farmers' personal opinions requires further investigation. In particular, the question remains of the extent to which farmers' statements about GMOs would be in line with the actual adoption decisions on their farms. Furthermore, in the case of Swedish beef farmers, this study has shown that fairly specific regional attributes of the production process and marketing strategy may influence their opinions about GMOs. Further studies with a focus on regional value chains in Europe are therefore warranted.

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Contact author:
DR. KLARA FISCHER
Department of Urban and Rural Development,
Swedish University of Agricultural Sciences
Ulls väg 27, 756 51 Uppsala, Sweden
e-mail: klara.fischer@slu.se

Appendix

Table A1. Grouping of survey questions into explanatory vectors

Vector	Survey question: To what extent…
"Part"	... do you have the opportunity to influence decisions at a national level that are important to you?
	... do you have the opportunity to influence decisions at a local level (municipal and county level) that are important to you?
KMO: 0.731	... are the authorities you want to be in touch with available?
	... are you listened to and respected by society at large?
Barlett's Test: 0.000	... are you listened to and respected by friends, neighbours and acquaintances in your immediate area?
	... are there organisations that represent your interests successfully (e.g. Federation of Swedish Farmers, Sweden's Animal Farmers, Organic Farmers etc.)?
	... do you feel that you are appreciated for your farming activities by society at large?
	... do you feel that you are appreciated for your farming activities by friends, neighbours and acquaintances in your immediate area?
	... are you proud of your own farming?
"Soc"	... do you have the opportunity to participate in local associations and networks?
	... do you have the opportunity to exchange services with other farmers and get help yourself when you need it?
KMO: 0.77	... do you have close friends in your neighbourhood?
	... do you have good relationships with your neighbours?
Barlett's Test: 0.000	... do you have the opportunity to create a desirable family situation?
	... do you feel lonely?
"Hea"	…are you and your family healthy?
	... do your animals have a good life?
	... do you have a work situation with a manageable level of stress?
KMO: 0.741	... is your farm a safe and secure workplace?
	... do you have reasonable working hours?
Barlett's Test: 0.000	... do you have the opportunity to be free from work?
	... do you feel that your job is meaningful?
	... do you feel that administration and paperwork is unnecessarily burdensome?
	... do you feel confident about the future of Swedish farming?
	... do you feel confident about the future of your own farm?
"Ser"	... do you have access to relevant consulting services?
	... do you have access to relevant training and courses within agriculture and business enterprise?
KMO: 0.694	... do you have access to public and commercial services, such as school, healthcare, shops, public transport, pharmacy etc.?
	... do you have access to broadband, roads, a stable power supply and other infrastructure?
Barlett's Test: 0.000	... do you have access to vets and other services related to animal production?
	... do you have the opportunity to hire labour with the right skills (provided you can afford to do so)?
"Comp"	... do you get a fair price for your products through this sales channel?
	... is it possible for you to influence the price of what you sell?
KMO: 0.668	... do you think you are competing on the same terms as other manufacturers within your product range in Sweden?
	... do you think you are competing on the same terms as other manufacturers within your product range within the EU?
Barlett's Test: 0.000	... do you have the option to choose suppliers of feed, manure, fuel and other inputs?
	... can you manage your farm as you wish without being hindered by rules?
	... do you have sufficient control over the land you farm (by ownership or long-term lease)?
"Econ"	... can you live off your farming?
	... do you have access to alternative sources of income, such as snow clearance, tourism etc.?
KMO: 0.809	... do you have a healthy financial situation?
	... do you have the same standard of living as people you associate with?
Barlett's Test: 0.000	... do you feel worried about your financial situation?
	... can you afford to hire the labour you think you need?
	... are you satisfied with your life situation as a farmer?
	... does your life situation as a farmer match your expectations?
	... does your ideal life situation as a farmer match your current life situation?

Source: own data, based on survey

Table A2. Estimation results from Logit models with all relevant factors included (n=315)

Note: D. = dummy variable; n = 315		1. Should be allowed for economic reasons			2. Should be allowed for more purchase options			3. Should not be allowed due to too much human interference with nature			4. Should not be allowed due to unforeseen consequences on animal health			5. Should not be allowed due to unforeseen consequences on the environment			6. Should not be allowed due to unforeseen consequences on human health			7. Should not be allowed due to distrust of multinational companies			8. Should not be allowed due to fear of consumer resistance		
		Coef.	*p-value*		*Coef.*	*p-value*		*Coef.*	*p-value*		*Coef.*	*p-value*		*Coef.*	*p-value*		*Coef.*	*p-value*		*Coef.*	*p-value*		*Coef.*	*p-value*	
	const	24.753	0.569		-19.728	0.604		-20.055	0.507		28.139	0.396		25.734	0.411		-22.593	0.492		5.990	0.844		56.321	0.122	
Factor loadings of explanatory vectors	Part_FAC1_1	-0.040	0.856		0.174	0.303		-0.002	0.989		0.146	0.376		-0.044	0.767		-0.154	0.340		-0.127	0.378		0.204	0.213	
	Part_FAC2_1	0.384	0.081	*	0.333	0.143		0.253	0.094	*	0.303	0.066	*	-0.026	0.870		0.338	0.054	*	0.009	0.950		-0.328	0.091	*
	Soc_FAC1_1	0.333	0.134		0.290	0.192		-0.063	0.710		-0.034	0.842		0.017	0.917		0.030	0.858		0.133	0.373		0.274	0.140	
	Soc_FAC2_1	-0.371	0.058	*	-0.218	0.288		-0.030	0.868		-0.153	0.385		-0.129	0.438		-0.094	0.589		0.049	0.757		0.262	0.207	
	Hea_FAC1_1	0.101	0.687		0.155	0.480		0.024	0.902		0.184	0.293		0.063	0.715		0.091	0.627		0.085	0.623		-0.739	0.001	***
	Hea_FAC2_1	0.136	0.508		0.217	0.309		-0.258	0.153		-0.133	0.494		-0.102	0.554		-0.037	0.848		-0.440	0.013	**	-0.161	0.441	
	Hea_FAC3_1	0.078	0.710		0.193	0.297		-0.007	0.963		-0.048	0.750		0.085	0.543		-0.104	0.512		-0.192	0.188		0.019	0.918	
	Ser_FAC1_1	-0.431	0.031	**	-0.435	0.033	**	-0.019	0.904		-0.242	0.145		-0.181	0.216		-0.017	0.923		0.025	0.868		0.107	0.535	
	Ser_FAC2_1	0.112	0.580		-0.236	0.222		-0.060	0.690		-0.155	0.328		-0.107	0.487		-0.234	0.125		0.125	0.401		0.479	0.016	**
	Comp_FAC1_1	0.010	0.962		-0.110	0.520		-0.158	0.323		-0.207	0.217		0.119	0.431		-0.100	0.541		-0.004	0.980		0.406	0.032	**
	Comp_FAC2_1	-0.337	0.082	*	-0.085	0.641		0.426	0.006	***	0.341	0.035	**	0.234	0.109		0.160	0.305		-0.037	0.796		-0.172	0.301	
	Comp_FAC3_1	-0.434	0.031	**	-0.017	0.923		-0.044	0.792		-0.142	0.377		-0.053	0.706		0.162	0.281		-0.023	0.869		-0.035	0.842	
	Econ_FAC1_1	0.287	0.135		0.179	0.300		-0.317	0.051	*	-0.454	0.005	***	-0.296	0.067	*	-0.311	0.059	*	-0.198	0.179		0.006	0.975	
	Econ_FAC2_1	-0.111	0.619		-0.139	0.505		-0.140	0.420		-0.053	0.762		0.178	0.277		0.057	0.750		-0.063	0.705		0.354	0.053	*
	Econ_FAC3_1	-0.075	0.730		-0.353	0.083	*	-0.085	0.574		0.046	0.767		0.075	0.615		0.205	0.182		0.162	0.268		-0.152	0.351	
Is your farm certified under	Svenskt Sigill (Swedish environmental certification) (D. = 1 if yes)	0.214	0.712		0.162	0.765		-0.117	0.804		0.083	0.863		-0.070	0.881		0.576	0.233		-0.075	0.872		1.332	0.015	**
	EU organic? (D. = 1 if yes)	-0.192	0.763		-0.741	0.289		1.160	0.036	**	0.833	0.132		0.344	0.467		0.257	0.616		0.242	0.623		-0.660	0.411	
	Swedish organic label KRAV? (D. = 1 if yes)	-1.126	0.045	**	-1.455	0.002	***	0.748	0.026	**	0.763	0.021	**	1.269	0.000	***	0.622	0.051	*	0.722	0.023	**	0.933	0.010	***
	any other certification? (D. = 1 if yes)	0.699	0.144		0.030	0.956		0.026	0.958		-0.093	0.854		0.058	0.904		-0.580	0.357		0.492	0.276		0.007	0.990	
How many hectares do you farm? (Number)		0.293	0.037	**	0.184	0.082	*	-0.185	0.059	*	-0.143	0.147		-0.263	0.005	***	-0.097	0.311		-0.006	0.943		-0.169	0.187	
What production do you regard as your main activity?	D. = 1 if "milk". zero otherwise	-0.241	0.580		-1.004	0.032	**	0.067	0.855		0.238	0.513		0.718	0.039	**	0.283	0.422		0.477	0.165		1.142	0.010	***
	D. = 1 if "beef". zero otherwise	-0.142	0.689		-0.549	0.106		0.910	0.004	***	0.431	0.154		0.357	0.212		0.810	0.007	***	0.952	0.001	***	0.737	0.036	**
Gender (female = 1 if yes, otherwise 0)		-2.763	0.015	**	-1.954	0.005	***	0.339	0.393		0.269	0.496		0.613	0.125		0.981	0.011	**	0.795	0.038	**	-0.557	0.289	
What year were you born? (year)		-0.013	0.558		0.010	0.605		0.010	0.510		-0.015	0.387		-0.013	0.404		0.011	0.535		-0.004	0.799		-0.029	0.120	
What is your highest education? (Omitted reference: highest education is primary, elementary, junior secondary)	D. = 1 if secondary education	-0.160	0.798		-0.081	0.894		-0.103	0.814		0.595	0.186		1.185	0.015	**	0.572	0.237		0.132	0.761		-0.510	0.304	
	D. = 1 if university/college	1.096	0.062	*	1.019	0.070	*	-1.458	0.002	***	-0.448	0.334		0.242	0.613		-0.559	0.245		-0.308	0.469		-0.399	0.417	
	D. = 1 if highest education not included elsewhere	0.820	0.233		-0.384	0.655		-1.162	0.057	*	-0.802	0.225		0.740	0.201		0.339	0.591		0.061	0.918		-2.609	0.002	***
McFadden R-squared			0.240			0.203			0.153			0.135			0.138			0.146			0.100			0.170	
Akaike criterion			291.204			323.870			398.877			399.089			429.703			400.791			447.679			337.022	
Share of cases correctly predicted:			0.845			0.816			0.730			0.708			0.679			0.746			0.654			0.797	

Source: own data, based on survey

Table A3. Estimation results from Logit models with all relevant factors and pig farms included (n=315)

Note: D. = dummy variable; n = 315		1. Should be allowed for economic reasons			2. Should be allowed for more purchase options			3. Should not be allowed due to too much human interference with nature			4. Should not be allowed due to unforeseen consequences on animal health			5. Should not be allowed due to unforeseen consequences on the environment			6. Should not be allowed due to unforeseen consequences on human health			7. Should not be allowed due to distrust of multinational companies			8. Should not be allowed due to fear of consumer resistance		
		Coef.	*p-value*		*Coef.*	*p-value*		*Coef.*	*p-value*		*Coef.*	*p-value*		*Coef.*	*p-value*		*Coef.*	*p-value*		*Coef.*	*p-value*		*Coef.*	*p-value*	
	const	25.785	0.552		-11.207	0.767		-20.808	0.490		26.988	0.410		18.422	0.545		-24.561	0.453		1.614	0.957		42.372	0.216	
Factor loadings of explanatory vectors	Part_FAC1_1	-0.059	0.780		0.096	0.563		0.002	0.990		0.152	0.353		0.001	0.992		-0.151	0.354		-0.092	0.516		0.284	0.076	*
	Part_FAC2_1	0.354	0.091	*	0.247	0.235		0.257	0.076	*	0.330	0.043	**	0.036	0.817		0.367	0.036	**	0.050	0.726		-0.189	0.289	
	Soc_FAC1_1	0.349	0.110		0.351	0.114		-0.059	0.713		-0.035	0.833		-0.025	0.873		0.016	0.923		0.108	0.460		0.187	0.293	
	Soc_FAC2_1	-0.364	0.067	*	-0.188	0.365		-0.023	0.901		-0.136	0.437		-0.150	0.365		-0.088	0.611		0.043	0.791		0.230	0.282	
	Hea_FAC1_1	0.109	0.663		0.184	0.394		0.027	0.891		0.203	0.257		0.034	0.848		0.091	0.630		0.069	0.696		-0.738	0.001	***
	Hea_FAC2_1	0.142	0.487		0.220	0.307		-0.267	0.135		-0.151	0.448		-0.129	0.449		-0.053	0.788		-0.457	0.009	***	-0.225	0.270	
	Hea_FAC3_1	0.080	0.707		0.178	0.340		-0.022	0.891		-0.080	0.592		0.083	0.560		-0.140	0.385		-0.197	0.178		0.018	0.918	
	Ser_FAC1_1	-0.440	0.026	**	-0.477	0.023	**	-0.020	0.897		-0.245	0.149		-0.155	0.288		-0.014	0.935		0.037	0.805		0.142	0.405	
	Ser_FAC2_1	0.107	0.592		-0.230	0.229		-0.067	0.656		-0.165	0.312		-0.102	0.512		-0.239	0.124		0.134	0.368		0.501	0.016	**
	Comp_FAC1_1	0.054	0.784		0.004	0.983		-0.148	0.334		-0.207	0.205		0.051	0.726		-0.103	0.515		-0.046	0.741		0.252	0.166	
	Comp_FAC2_1	-0.326	0.090	*	-0.082	0.649		0.447	0.005	***	0.392	0.021	**	0.250	0.091	*	0.204	0.209		-0.027	0.855		-0.168	0.320	
	Comp_FAC3_1	-0.430	0.033	**	-0.032	0.850		-0.037	0.821		-0.128	0.422		-0.048	0.733		0.182	0.226		-0.014	0.922		-0.016	0.925	
	Econ_FAC1_1	0.279	0.148		0.069	0.672		-0.299	0.061	*	-0.434	0.008	***	-0.223	0.161		-0.269	0.101		-0.153	0.305		0.081	0.638	
	Econ_FAC2_1	-0.095	0.671		-0.086	0.666		-0.137	0.429		-0.071	0.682		0.151	0.342		0.040	0.821		-0.077	0.639		0.267	0.175	
	Econ_FAC3_1	-0.052	0.803		-0.226	0.229		-0.108	0.473		-0.021	0.897		-0.016	0.911		0.151	0.323		0.100	0.486		-0.254	0.131	
Is your farm certified under…	Svenskt Sigill (Swedish environmental certification) (D. = 1 if yes)	0.282	0.049	**	0.122	0.268		-0.170	0.080	*	-0.112	0.248		-0.216	0.020	**	-0.068	0.475		0.030	0.732		-0.097	0.390	
	EU organic? (D. = 1 if yes)	0.285	0.624		-0.268	0.659		0.303	0.592		0.985	0.084	*	0.378	0.458		1.398	0.027	**	0.336	0.534		1.504	0.017	**
	Swedish organic label KRAV? (D. = 1 if yes)	-0.135	0.829		-0.625	0.412		1.156	0.043	**	0.838	0.137		0.272	0.571		0.251	0.638		0.202	0.696		-0.786	0.328	
	any other certification? (D. = 1 if yes)	-1.126	0.044	**	-1.534	0.002	***	0.763	0.024	**	0.808	0.018	**	1.297	0.000	***	0.680	0.035	**	0.747	0.019	**	0.956	0.008	***
	How many hectares do you farm? (Number)	-0.014	0.542		0.006	0.774		0.011	0.492		-0.014	0.403		-0.010	0.542		0.012	0.492		-0.002	0.914		-0.022	0.216	
What production do you regard as your main activity?	D. = 1 if "pigs", zero otherwise	-0.147	0.799		1.279	0.026	**	-1.240	0.148		-3.170	0.008	***	-1.381	0.031	**	-2.463	0.029	**	-1.269	0.054	*	-0.877	0.246	
	D. = 1 if "beef", zero otherwise	-0.148	0.686		-0.224	0.514		0.787	0.012	**	0.202	0.520		0.111	0.706		0.578	0.062	*	0.752	0.008	***	0.475	0.147	
	Gender (female = 1 if yes, otherwise 0)	0.697	0.142		-0.264	0.639		0.150	0.769		0.072	0.892		0.322	0.509		-0.410	0.526		0.703	0.144		0.241	0.694	
	What year were you born? (year)	-2.776	0.019	**	-1.779	0.006	***	0.301	0.440		0.205	0.599		0.520	0.185		0.920	0.016	**	0.722	0.055	*	-0.706	0.201	
What is your highest education? (Omitted: highest education is primary, elementary)	D. = 1 if secondary education	-0.151	0.806		-0.043	0.944		-0.065	0.883		0.679	0.138		1.159	0.014	**	0.619	0.207		0.141	0.750		-0.557	0.248	
	D. = 1 if university/college	1.104	0.058	*	1.124	0.050	*	-1.450	0.002	***	-0.462	0.321		0.131	0.778		-0.601	0.215		-0.376	0.381		-0.554	0.248	
	D. = 1 if highest education not included elsewhere	0.855	0.215		-0.371	0.671		-1.151	0.069	*	-0.825	0.221		0.713	0.214		0.344	0.589		0.075	0.903		-2.584	0.003	***
	McFadden R-squared	0.24			0.203			0.161			0.167			0.141			0.168			0.106			0.152		
	Akaike criterion	291.43			323.99			395.69			386.36						391.69			444.69			343.25		
	Share of cases correctly predicted	0.844			0.816			0.727			0.724			0.673			0.749			0.654			0.794		

Source: own data, based on survey