

Investigating farmer attitudes towards genetically modified crops in Scotland

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Abstract

Consumer attitudes towards genetically modified (GM) food are well documented but there has been much less focus on farmer attitudes to GM crops. This paper reports findings from a study investigating farmers' attitudes to GM crops in Scotland. Initial results from a Q methodology study reveal three discourses, one apparently pro-GM and demonstrating an expectation of benefits, the second representing a more uncertain position, wary of the potential risks of the technology, but likely to be reluctant adopters, and the third describing a group demonstrating a somewhat fatalistic attitude towards the issue of GM technology adoption and impact. The paper also reports findings from a postal survey conducted as part of the Q methodology study. Results from a scenario question suggest that the majority of Scottish farmers are unsure at this stage whether they would choose to adopt GM technology or not, opting instead for a 'wait and see' position. The intention (or not) to adopt, appears to be related to a number of variables such as type of crops grown, whether or not the farmer expects to pass on the farm to the next generation of the family, and whether the farmer thinks GM crops will be good or bad for Scottish agriculture. These findings contribute to the overall GM debate by providing some insight into the differing positions held by farmers in Scotland.

Introduction

Legislation covering the commercial planting of genetically modified (GM) crops in Scotland is operational at the EU level and member states cannot unilaterally decide to grow or ban a GM crop. Once a particular modified crop has been approved for commercial release under EU Deliberate release directive 2001/18 it is the decision of the farmer that will determine if and where that crop will be grown. Hence understanding of farmer intentions and attitudes towards GM crops is central to understanding how the adoption of GM might develop across Europe.

Additionally, the challenge of deciding upon guidelines or regulation to deal with the co-existence of different farming systems in the landscape, is to be an issue for member states to address. Accordingly, policy makers will need to have knowledge of the attitudes, intentions and opinions of farmers in their country. As Austin *et al* (1998) state, in order to design robust and acceptable policy it is necessary to have a detailed understanding of the motivations of farmers.

Many studies have investigated consumer attitudes towards GM food and crops (see for example, Baker & Burnham, 2001; Gaskell *et al*, 2003; Grove-White *et al*, 1997) but investigation into farmer attitudes are largely absent from the GM debate. However, the issue of technology adoption by farmers has been studied extensively (and in a limited number of cases the adoption of GM technology specifically), and

these are informative. These studies have generally focused on either adoption processes at the firm level or on identifying characteristics of farmers that are associated with adoption decisions (see for example Alexander, 2002; D'Souza *et al*, 1993).

Beyond what can be uncovered by questionnaire surveys, a more in depth understanding of attitudes can be informative, particularly when complex and contentious issues are under consideration. In these cases discourse analysis is a valid approach (Barry & Proops, 1999). Discourse is described as all the conversations, comments, discussions and opinions that are held or made about a particular subject, event or issue. Q methodology is a form of discourse analysis and aims at an in depth understanding of the attitudes of some members of a specific part of the population, but is not intended to lead to conclusions about the opinions of the population at large (Brown, 1993).

Originally used in the field of psychology, Q methodology is now used across a range of social sciences where the aim is to investigate the attitudes and opinions that comprise the social discourse associated with a particular topic. The approach combines qualitative survey methods such as interviews, with quantitative statistical analysis, including principal components analysis and varimax rotation. The objective of the research is to identify a number of positions relating to the topic (the discourse), that represent the spectrum of views among the targeted population. In other words, clusters of farmers with similar viewpoints relating to genetically modified crops will be identified.

In this research farmers' potential adoption decisions have been further considered through an investigation of certain farm and farmer characteristics and the extent to which these can be said to relate to the intention to adopt GM technology or not. This information may be used to design policies targeted at specific groups of farmers to encourage or discourage adoption of GM crops, depending on the desired political aim.

The remainder of the paper is structured as follows: The next section describes the methodology. This is followed by presentation of results, which in turn are followed by discussion and conclusions.

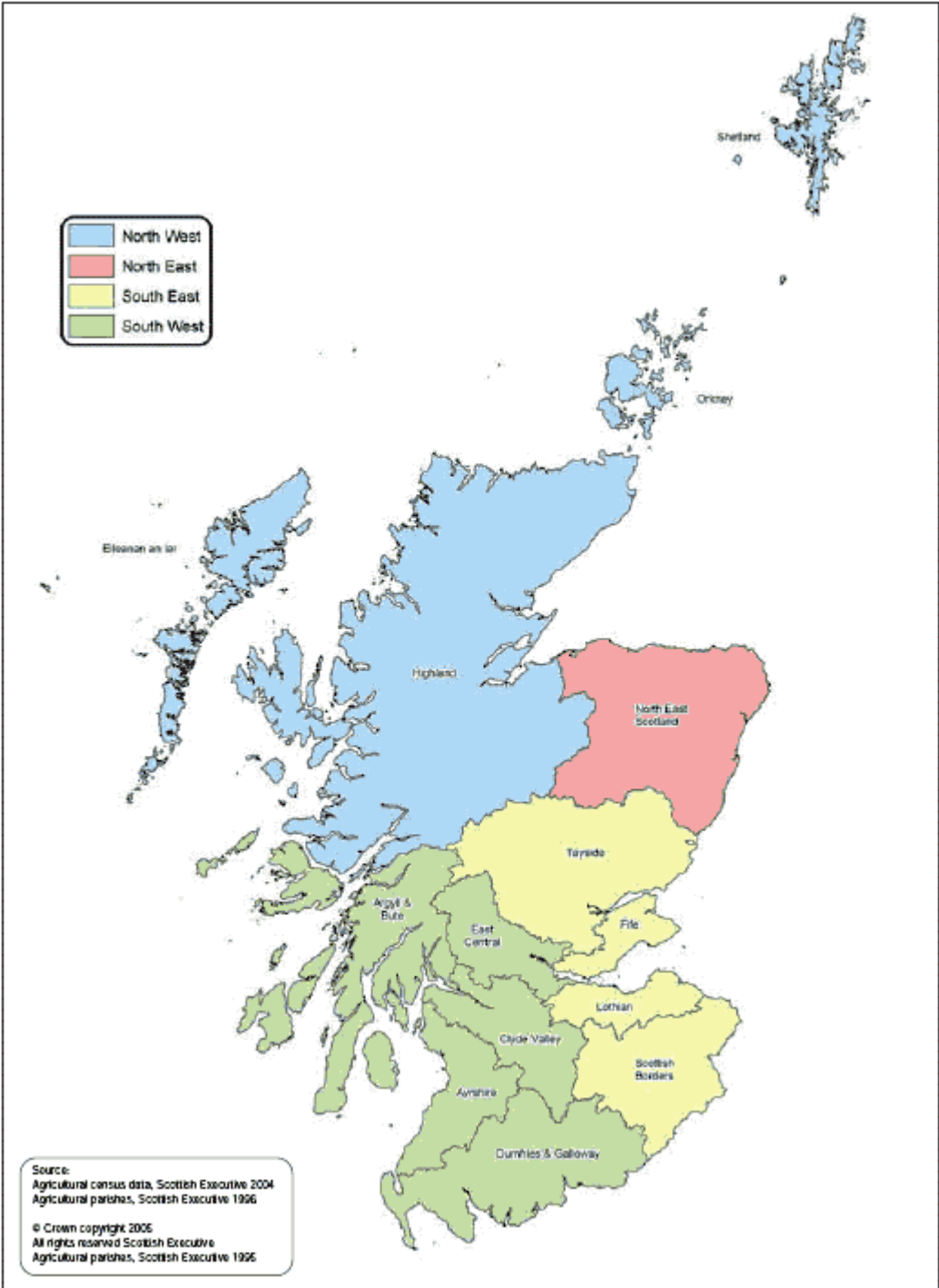
Method

Q methodology involves a number of stages, as follows. First, the researcher identifies the area of discourse and the relevant population. Having done so, the second stage involves the collection of statements (opinions) relating to the discourse. The third stage is the selection of a limited number of representative statements from all of those collected. Next, participants are required to rank or 'sort' the statements against a scale (usually agree to disagree). This is followed by the fifth stage of the process during which statistical analysis of the 'sorts' is carried out to enable the extraction of a few 'typical' sorts. Finally, these typical sorts are described and interpreted (Barry & Proops, 1999).

The second stage of the research reported here (the collection of statements from participants) was completed in spring 2005 (results are presented below). The statement collection process was completed, in this case, through the use of a postal

survey, distributed to farmers across four regions of Scotland (north east, north west, south east and south west). The regions used are those designated by the Scottish Executive for their Economic Report on Scottish Agriculture and are as shown in Map 1.

Map 1 Scottish Regions



Source: Scottish Executive, 2004. Economic report on Scottish agriculture, 2004 edition. Scottish Executive, Edinburgh

The survey contained 13, mainly open-ended questions designed specifically to elicit statements. For example, farmers were asked "What do you think will be the main advantages (if any) arising from the introduction of genetically modified crops in Scotland?". A number of the questions and their responses are discussed below. The survey also featured a question relating to the intention or not to adopt GM, and a number of socio-demographic questions, for example, age of farmer, number of years farming, whether or not the farmer took over management of the farm from a previous generation of the family, and main crops grown.

From the full set of over 700 statements (known as the *concourse*), collected via the postal survey, 48 were selected by the researcher to be representative of all views expressed by farmers. This process used a matrix, featuring, on one axis, thematic elements that arose from the statement collection process (co-existence, crop management, consumer opinion, environment, finances, safety, technology, and overall view of GM), and on the other axis, the position represented by the statement (GM positive, GM negative, neutral). Each of the 700 statements were assigned to the relevant box in the matrix (for example, under the thematic element 'Costs / finances' one of the 'GM positive statements' is "I would choose to grow GM crops if there was a bigger margin for growing them"). A process of eliminating repetitive or similar statements from boxes resulted in the reduced number of 48 statements. Depending on how frequently thematic elements were referred to, the final matrix boxes include one, two or three statements. To ensure a balance of views, the columns are equally represented. The final collection of 48 statements is known as the *Q set* (appendix one). As with sampling people in survey research, the main goal in selecting a *Q set* is to provide a miniature that is representative of the larger population (of statements) being analysed (Brown, 1993).

The next stage of the research involved face to face interviews with participants during summer 2005 and spring 2006. During the interviews farmers were required to rank (or 'sort') the 48 statements comprising the *Q set*. These statements had to be arranged on a template, against a standard likert scale. The template of 48 boxes (one for each statement) formed the shape of a quasi-normal distribution and the seven point likert scale ran from 'strongly disagree' to 'strongly agree'. The *Q study* sorting scheme is shown in table 1. The forced distribution used in *Q methodology* requires participants to place only a limited number of the statements at the extremes of the scale. In this way, they must consider which statements they feel most strongly about. In addition, as they work through the sorting exercise, participants compare every statement with every other statement and thus reveal the relative strength with which certain statements are viewed. Hence, what is demonstrated is not just their response to particular statements, but their overall attitude to the topic under consideration.

Table 1: Q study sorting scheme

Statement rank	-3	-2	-1	0	+1	+2	+3
Point on scale	Strongly disagree	Disagree	Somewhat disagree	Neutral / No opinion	Somewhat agree	Agree	Strongly agree
Number of statements	4	6	8	12	8	6	4

The next stage of Q methodology is the analysis of the 'sorts' using a software package designed for the process, in this case PQMethod (Schmolck, 2002). The first stage of the analysis involves correlating every sort with every other sort. Sorts are then factor analysed and rotated in order to reduce the data to a limited number of defining sorts, usually three or four, and no more than eight. The defining sorts that emerge from factor analysis represent different attitude groups that exist within the overall discourse relating to the topic under investigation.

Results

The postal survey distributed in order to collect statements was returned by 51 farmers from the four regions of Scotland. To be representative by region the percentage for each should be 33% in the south east, 17% in the south west, 28% in the north east, and 22% in the north west. The breakdown of responses was 43% from the SE, 8% from the SW, 22% from the NE, and 23% from the NW, with 4% unknown. Hence the south east is over represented in the responses and the south west under represented, with the north west and north east regions being largely representative. However, it should be noted that in Q methodology diversity of respondents is of more importance than representativeness.

Respondent details

The typical respondent has a farm of 200-299ha (31% of respondents) and has been farming for 30-39 years (31% of respondents). This compares to Scottish Executive data stating that the average farm size is 171ha (SEERAD, 2005). Typically, respondent farmers are farm owners (67%), not tenants. This is largely consistent with the situation across Scotland where approximately 70% of all farm holdings are owner occupied (Duke of Buccleuch, 2003). An overwhelming 94% of respondents were male and on average between 50-59 years old (33%). The latter is in line with the situation in farming across the UK where the average age of farmers is 57 (The Scottish Parliament, The Research Centre, 2000). The majority of respondents took over management of the farm from a previous generation of their family (71%) but typically were not certain whether they would pass on management of the farm to the next generation of their family (53% said they may, 14% said no and only 31% said yes (2% no response)). Respondents were also asked to list the main crop or crops that they cultivate. Results are as follows: 65% of respondents grow barley; 41% grass; 26% wheat and 26% other, unspecified cereal crops. 20% grow oilseed rape (OSR), 18% vegetables, 18% potatoes, 4% fruit and 4% other crops. Almost all cultivate a combination of these.

Responses to open-ended questions

The initial postal survey contained 13 questions (mostly open-ended) in order to collect the statements necessary for completion of the Q method study. Here consideration is given to some of the responses.

Farmers were asked "Do you think the introduction of GM crops into Scottish agriculture would be good or bad for Scottish farming?". In response to this, 30% said 'good' and 36% said 'bad'. The remaining 34% either said they 'don't know' or they said both 'good' and 'bad', depending on a range of circumstances, such as, public opinion, the type of modification introduced, and whether or not it was proven safe. The reasons given for saying that the introduction of GM would be 'good' were generally based on the expectation that production costs would be lower and/or yields higher. Reasons given for saying that the introduction of GM crops would be 'bad' were commonly that it would be damaging to Scottish farming because the public does not want it. There were also some concerns about possible environmental impact.

When asked 'what do you think will be the main problems (if any) presented by the introduction of GM crops in Scotland?' farmers referred to public mistrust, the potential for cross-contamination of non-GM crops by GM crops, and the possibility of the development of so-called 'superweeds' that would be difficult to get rid of. The expectation was that these problems would be experienced first and foremost by the farmers themselves, although some respondents felt that consumers would also experience problems arising from GM. In a small number of cases the response was that everyone or the whole food chain would experience problems arising from the introduction of GM. Farmers were also asked what they thought the main advantages would be and responded that these would likely be lower production costs, less chemical use and higher yields. Beneficiaries were expected to be the supermarkets but also growers and plant breeders, and in some cases, consumers, through cheaper food.

An issue that frequently arises in public debates or surveys about GM crops is the potential impact on the environment, including farmland wildlife and biodiversity. However, when the farmers were asked 'how do you think GM crops might impact on farmland wildlife (if at all)?' responses included 'no impacts', 'don't know' 'who knows?', 'cannot foresee any' 'wildlife is adaptable' and 'will benefit wildlife if less chemicals are used'. Overall, 37% of farmers commented that they did not think there would be any significant impact on wildlife, or indeed that the impact would be beneficial. 45% of respondents stated that they did not know how GM might impact on wildlife or they said that it could be good or bad, and only 18% were sure that the impact would be bad. Apparently the farmers in this survey do not share the same level of concern about the potential biodiversity impacts of GM crops as the general public.

Results from GM adoption scenario question

The survey also asked "if a GM variety of the main crop(s) you currently produce was / were to be available for commercial planting in 2008 would you choose to grow it / them or not?". Only 12% of respondents said 'yes' they would, 33% said 'no' they would not and more than half of all respondents (55%) stated that they 'don't know' (table 2). Among the reasons given for stating 'don't know' were 'lack of information',

'will wait and see', 'need more trials', 'depends on public opinion', and 'need to be convinced it's safe'. Table 2 reveals the profiles of farmers who fall into the three adoption categories – those who would adopt, those who would not adopt and those who are unsure. Variables that appear to influence the intention to adopt include average farm size, whether or not the farmer intends to hand over management of the farm to the next generation of the family, whether they are a farm owner, whether they grow barley or other, unspecified cereal crops, and whether they think GM will be good for Scottish agriculture.

Table 2: Farmer profiles

Variable	Yes would adopt GM (12%)		No would not adopt GM (33%)		Don't know if would choose to adopt GM (55%)	
	Mean	SD	Mean	SD	Mean	SD
Farm size (ha)	355.5	337.26177	188.5	121.77527	300.5	337.64200
Number of years in farming	29	11.30781	33	11.17212	32	11.44664
30-39 years old (0=false, 1=true)	.1667	.40825	.1176	.33211	.1481	.36201
40-49 years old (0=false, 1=true)	.3333	.51640	.1765	.39295	.1852	.39585
50-59 years old (0=false, 1=true)	.1667	.40825	.4118	.50730	.3333	.48038
60-69 years old (0=false, 1=true)	.3333	.51640	.4118	.43724	.2593	.44658
Over 70 years old (0=false, 1=true)	0	0	.0588	.24254	.0741	.26688
Took over management from previous generation (No=0, Yes=1)	.8333	.40825	.7647	.43724	.6667	.48038
Will hand over management to next generation (0=false, 1=true)	.5000	.54772	.3529	.49259	.2593	.44658
Will not hand over management to next generation (0=false, 1=true)	0	0	.2353	.43724	.1111	.32026
May hand over management to next generation (0=false, 1=true)	.5000	.54772	.4118	.50730	.6296	.49210
Owner only (0=No, 1=Yes)	.3333	.51640	.8125	.40311	.7037	.46532
Tenant only (0=No, 1=Yes)	.1667	.40825	.1875	.40311	.0741	.26688
Both owner and tenant (0=False, 1=True)	.5000	.54772	0	0	.2222	.42366
Grow barley (0=No, 1=Yes)	.33	.516	.82	.393	.63	.492
Grow wheat (0=No, 1=Yes)	0	0	.2941	.46967	.2963	.46532
Grow grass (0=No, 1=Yes)	.6667	.51640	.4706	.51450	.3333	.48038
Grow vegetables (0=No, 1=Yes)	.3333	.51640	.1176	.33211	.1852	.39585
Grow OSR (0=No, 1=Yes)	.3333	.51640	.1765	.39295	.1852	.39585
Grow fruit (0=No, 1=Yes)	0	0	.0588	.24254	.0370	.19245
Grow cereals (0=No, 1=Yes)	.5000	.54772	.1765	.39295	.1852	.39585
Grow potatoes (0=No, 1=Yes)	.1667	.40825	0	0	.2963	.46532

Grow other (0=No, 1=Yes)	0	0	0	0	.0741	.26688
Think GM will be good for Scottish agriculture (0=false, 1=true)	.8333	.40825	.2353	.43724	.2222	.42366
Think GM will be bad for Scottish agriculture (0=false, 1=true)	.1667	.40825	.4706	.51450	.2593	.44658
Unsure if GM will be good or bad for Scottish agriculture (0=false, 1=true)	0	0	.2941	.46967	.5185	.50918

Results from Q sorting

As noted above, a sample of 48 statements were selected from those collected from the postal survey using a sampling matrix. These 48 statements were then printed onto individual cards and presented to 15 farmers during farm interviews, for ranking against a likert scale. The ranked statements formed each farmer's Q sort. The Q sorts collected during the farm visits formed the basic unit of data for analysis. The initial stage of the analysis was the construction of a correlation matrix of all the sorts. This is useful as it provides an indication of patterns of similarity between sorts. The Q sorts were then factor analysed, using Principal Components Analysis (PCA). In this process the correlation matrix was examined to determine how many different families or groups (factors) existed. Hence the purpose of factor analysis was to determine if there was a smaller number of Q sorts that constituted patterns of discourse among the participants. Q sorts that were highly correlated with one another could be said to have a 'family' resemblance, and those belonging to one group were highly correlated with one another but uncorrelated with the sorts in other groups (Brown, 1993).

After conducting PCA an initial set of 'factor loadings' were derived for each of the Q sorts. The loadings showed the extent to which each Q sort was associated with each factor. The original set of eight factors (the default setting in PQMethod) was of interest only to the extent that it provided the basis for investigating the factors further. The next stage of Q methodology is to rotate factors (using varimax rotation) to "find the simplest structure in the data that can explain the greatest amount of variability" (Swedeen, 2006). In this study rotation was conducted four times, on two, three, four and five factors. The three factor solution was the one that provided the most coherent explanation of the sorts, hence the study reveals three factor groups.

To interpret these three factors factor scores were used. A factor score is the score for a statement that is an average of the scores given to that statement by all of the Q sorts associated with the factor. Hence factor scores were derived by taking the factor loadings of the sorts and weighting them to account for the fact that some were closer approximations of the factor than others. The weights were elicited by dividing each factor loading by 1 minus the square of the factor loading. The sort with the highest factor loading (in the case of factor one this is the sort labelled 'Cluny'), was given the most weight ($0.75/(1-0.75^2)$)= 1.70. Weighted scores were calculated in PQMethod for all 48 statements, based on how each sort associated with the factor scored that statement in the original sorting procedure. For convenience, the weighted scores were returned to the original Q sort format, such that the four statements with the highest weighted composites were assigned +3, the next six highest assigned +2 and so on.

As noted above, analysis of the Q sorts revealed three factors and the converted factor scores were then used to interpret how the statements were ranked both within and between factors. The factor scores identified which statements had some degree of common ranking across factors, and which ones had a high degree of disagreement between factors. Differences of two or more between factor scores can be considered significant. Using converted factor scores helped to identify which statements typify a particular factor. The 48 statements with their factor scores are shown in table 3. Figure 1 further demonstrates distinguishing statements and consensus statements. These results are discussed below.

Discussion of results

Factor 1 – Benefit believers

The results presented in table 3 and figure 1 suggest that Factor 1 represents a position that is inclined to be positive towards the idea of GM. The factor does not appear to be adamantly pro-GM but importantly is not as cautious towards the technology as factor 2 or as fatalistic as factor 3. This factor demonstrates some concern about safety, recognising that it needs to be proven to be safe (statement 4, converted factor score +3) but this does not mean that farmers in this factor are likely to be hesitant to adopt the technology because of safety fears (42, -2). Over and above considerations of safety this factor sees the potential technological advantages of GM (46, +2; 25, +2). The position presented by factor 1 does not see any difference in the quality or safety of GM food compared to conventionally produced food (5, +1). In fact, this factor is not concerned about other farmers growing GM crops nearby (9, -3), the potential of cross-contamination (31, -2), or potential future risks (23, -3). Farmers in this factor are also likely to be unconcerned about the impact on wildlife (41, -1).

This factor could be said to describe optimists, those who tend not to be risk-averse, or perhaps even those who are irresponsible risk-takers, depending on interpretation. Those represented by this factor believe farmers would benefit from lower costs and increased yields (46, +2) but do not expect it to be a magic formula for all farmers (19, 0). It is likely that those in this factor are generally more inclined to be technology-adopters and whilst recognising that safety may be an issue with new technologies, are far more inclined to believe that the potential benefits are likely to outweigh any potential risks. It is likely that this position would refer to any new technology, suggesting that to Factor 1, GM technology is little different to any other agricultural development. In line with their largely pro-technology stance, farmers represented by this factor believe that protesters should be dealt with by the courts (37, +3), presumably as they are hindering technology development. Neither do they see any purpose in remaining GM-free as an island, as this is unlikely to provide any competitive advantage (10, -2; 34, -3). Indeed discussions during farm interviews revealed that some farmers believe that the longer this country remains GM-free the greater likelihood that we will find ourselves in a competitively disadvantaged position.

Factor 2 – Risk perceivers

The position represented by this factor is much less inclined than Factor 1 to be supportive of GM but is not necessarily anti-GM (6, +3). The factor group is certainly concerned about the potential risks (23, +2; 41, +2; 3, +1) and is much less sure of the possible benefits than Factor 1 (19, -2; 46, -1). Importantly, unlike Factor 1, this

factor sees that being GM-free could be an advantage (10, +2). The position represented by this factor also shows recognition of, and concern about, public reaction and consumer demand (17, +3; 40, +3). Overall, the position represented by this factor is one that demonstrates much more concern about the potential risks than factor 1 and is also less convinced that GM will inevitably play a role in the future of farming in Scotland. Farmers in this group are likely to be reluctant adopters (if at all) (35, +3) and would probably be more willing to consider other options, such as GM free, recognising that consumers may prefer this and be willing to pay for it (10, +2).

Factor 3 – Fatalists

Factor three results describe a somewhat fatalistic attitude towards GM technology and the problems that it might create (32, +1). They demonstrate uncertainty about who might benefit (24, +3) and what might lead them to adopt the technology (8, +2). They are somewhat cynical about the idea of a lasting market for GM-free produce, assuming that the public will eventually accept it (30, +3). They appear to be unconcerned about the idea of protesters arriving on their farm should they grow GM crops (20, -1). They also appear to be unconcerned about the possibility of risk to wildlife (41, -3). Equally, however, they do not believe that all farmers would benefit (19, -3) and are unlikely to go ahead and adopt GM simply in the name of technology development (11, -2). Overall this group appears to hold a somewhat cynical view of the world, not demonstrating a particularly strong viewpoint either in favour or against GM, and suggesting a position that believes what will be will be.

Consensus statements

Although the factors clearly represent different positions, there are a number of points of consensus between them (figure 1). The consensus statements represent the pragmatic farmer viewpoint that they all share. Hence, they all agree that the technology is acceptable as another technological development if it is shown to be beneficial and without risk to the environment (statement 6; converted factor scores 3, 1, 3). Also, they all foresee that the farmer would be impacted by and blamed for any problems that arose (1; 1, 2, 1). Further, they agree that genetic modification may offer a solution to common agricultural challenges (i.e. nitrogen fixation) (45; 2, 1, 2). None of them agree that GM technology would reinforce 'input-dependent industrial agriculture' (12, all -1) and also, they all disagree that farmers might end up with fields of crops that they cannot sell (18, all -1). All of these consensus statements appear to be grounded in practical farming experience and it is therefore this common experience that binds together the farmers represented by the different factors. They all operate in the same 'real-world'.

Overall, in line with many responses to the questions in the postal survey, and comments made during interviews, all factors demonstrate a circumspect approach to the possibility of introducing GM crops. They are differentiated by the degree of caution and concern about potential risks and the expectation of potential benefits. Factor 1 describes a discourse that is less risk averse, more pro-technology, and more sure of the benefits likely to be realised through GM technology. Factor 2 describes a discourse that is less certain of the potential benefits and more open to other possibilities for the future of farming. Factor 3 suggests a position that is largely fatalistic, certainly not ignorant of potential risks and benefits but not leaning in any particular direction.

Table 3: Factor Q-sort values for each statement

Statement	Factor 1 score	Factor 2 score	Factor 3 score
1 Problems arising from the introduction of GM crops would impact on farmers as they are perceived as being custodians of land and are easiest to target	1	2	1
2 I don't know how GM crops might impact on farmland wildlife but wildlife is pretty adaptable	0	-2	-2
3 Problems arising from the introduction of GM crops would impact on the environment, that in turn affects everyone and everything	-1	1	-2
4 If proven 'safe' the introduction of genetically modified crops into Scottish agriculture would be good for Scottish farming	3	0	-1
5 I don't believe there is any difference in quality / safety of eating either GM or non-GM so cross-contamination would not be a problem	1	-2	-2
6 I might be encouraged to grow GM crops by clearly demonstrated advantages and no long or short term risks to environment	3	1	3
7 It would be better if Scotland is seen to be GM free	-2	1	0
8 I can't say what factors might encourage me to grow GM crops – it will depend on the features produced by the GM and which crop it is	1	0	2
9 If a farm nearby decided to grow genetically modified crops I would not be happy as I would not want my soil contaminated with GM pollen. I should have the right to decide what happens on my land	-3	0	1
10 I would not choose to grow GM crops because crops grown in countries which are completely GM free may get higher prices due to consumer demand	-2	2	0
11 I would choose to grow GM crops because technology should be embraced	1	1	-2
12 The main problem that would arise from the introduction of genetically modified crops in Scotland would be that it would reinforce the existence of input-dependent industrial agriculture	-1	-1	-1
13 I cannot understand the argument about contamination of GM crops - cross pollination or contamination are emotive words and we have always accepted it	0	-2	-3
14 The only advantage I can see from introducing GM crops would be being able to produce a crop at a lower cost, but this, as with all crop marketing, will just force us to take a lower price	0	-1	-1
15 The introduction of GM crops in Scotland should benefit wildlife because there is the potential for less spray to be needed	1	-1	1
16 Personally I can see no reason for not having GM crops other than the problem of bad publicity	2	-1	-2
17 I am not sure whether the introduction of genetically modified crops into Scottish agriculture would be good or bad for Scottish farming but until the public is in favour of GM crops they are a non-starter	0	3	0
18 Problems arising from the introduction of GM crops would impact on farmers who will have fields of crops they cannot get rid of	-1	-1	-1

19 All growers would benefit if GM crops were introduced to Scotland	0	-2	-3
20 I would be discouraged from growing GM crops by the risk of having groups of objectors arriving on our farm	0	0	-1
21 We have already seen a reduction in wildlife species due to natural habitat loss – GM crops would exacerbate this problem	0	-2	-1
22 I would choose to grow GM crops if there was a bigger margin for growing them	1	-3	2
23 I would not choose to grow GM crops because the risks are unknown and future generations should not be put at risk	-3	2	0
24 I don't know who would benefit if GM crops were introduced in Scotland	-1	0	3
25 I might be encouraged to grow GM crops by the fact that the modified plants may be easier to treat for mildew and many of our common everyday problems	2	0	0
26 I don't know if I would choose to grow GM crops. It would depend on press coverage	-2	0	1
27 The existence of both genetically modified crops and non-genetically modified crops in Scotland would mean that the natural, good food image of Scotland would be jeopardised	-1	2	0
28 The introduction of genetically modified crops into Scottish agriculture would be good for Scottish farming in as much as it may reduce costs of growing them	2	-2	2
29 I don't believe there would be any problems arising from the existence of both genetically modified crops and non-genetically modified crops in Scotland	1	-3	-3
30 The existence of both GM & non-GM crops would lead to problems for the purity of non-GM product but this is only relevant if a market continues to exist for guaranteed non-GM produce and that may become doubtful	0	0	3
31 The existence of both genetically modified crops and non-genetically modified crops in Scotland would lead to cross pollination and this must not be allowed to happen	-2	0	0
32 I do not think contamination of non-GM crops by GM crops can be prevented and it would just have to be accepted	0	-3	1
33 In future we may be able to grow GM crops for specific purposes or in conditions other than their natural environments which could be an advantage	1	0	1
34 Don't introduce GM crops - we are an island, we may be able to trade worldwide on our GM-free status	-3	3	2
35 I might be encouraged to grow GM crops when every one else is and the profitability of the crop make it necessary to go with the tide	0	3	0
36 I don't think there is any need for genetically modified crops as we are struggling to get a decent price for what we grow	-3	1	0
37 Interference from activists to trial crops should be dealt with severely in the law courts as the activists are only hindering the interests of mankind	3	-2	-1
38 I might be encouraged to grow GM crops if there was demand from consumers	2	2	0
39 The introduction of genetically modified crops into Scottish agriculture would be good for Scottish farming provided the correct characteristics are introduced e.g. disease control	3	1	3
40 I think the introduction of genetically modified crops into Scottish agriculture would be bad for Scottish farming but only	0	3	0

because the public perceive it as bad			
41 I'm not sure if the introduction of GM crops is likely to be a problem but there may be a problem with the surrounding environment, i.e. insects, birds and wildlife	-1	2	-3
42 I don't know if I would choose to grow GM crops because I still need to be convinced it is safe and not just commercial	-2	1	2
43 Contamination of non-GM crops by GM crops should be dealt with by crop destruction	-2	0	-2
44 If only 'natural' genes are added to GM plants then it's ok but if it involves using genes from a different species then it's not ok	0	-1	1
45 There would be very few advantages to the farmer from the introduction of GM crops in Scotland but if a nitrogen fixing gene could be implanted in cereals, together with disease resistance then long term security of food supply with low oil-based inputs could be guaranteed	2	1	2
46 Farmers would benefit from lower costs and increased yields if GM crops were introduced in Scotland	2	-1	0
47 I don't think there is a place for both GM crops and non-GM crops – it will have to be either one or the other	-1	-3	-1
48 Introducing GM crops may mean more attractive-looking products like bright red smooth tomatoes, although this may put buyers off because they will look as if they are GM and not natural	-1	0	1

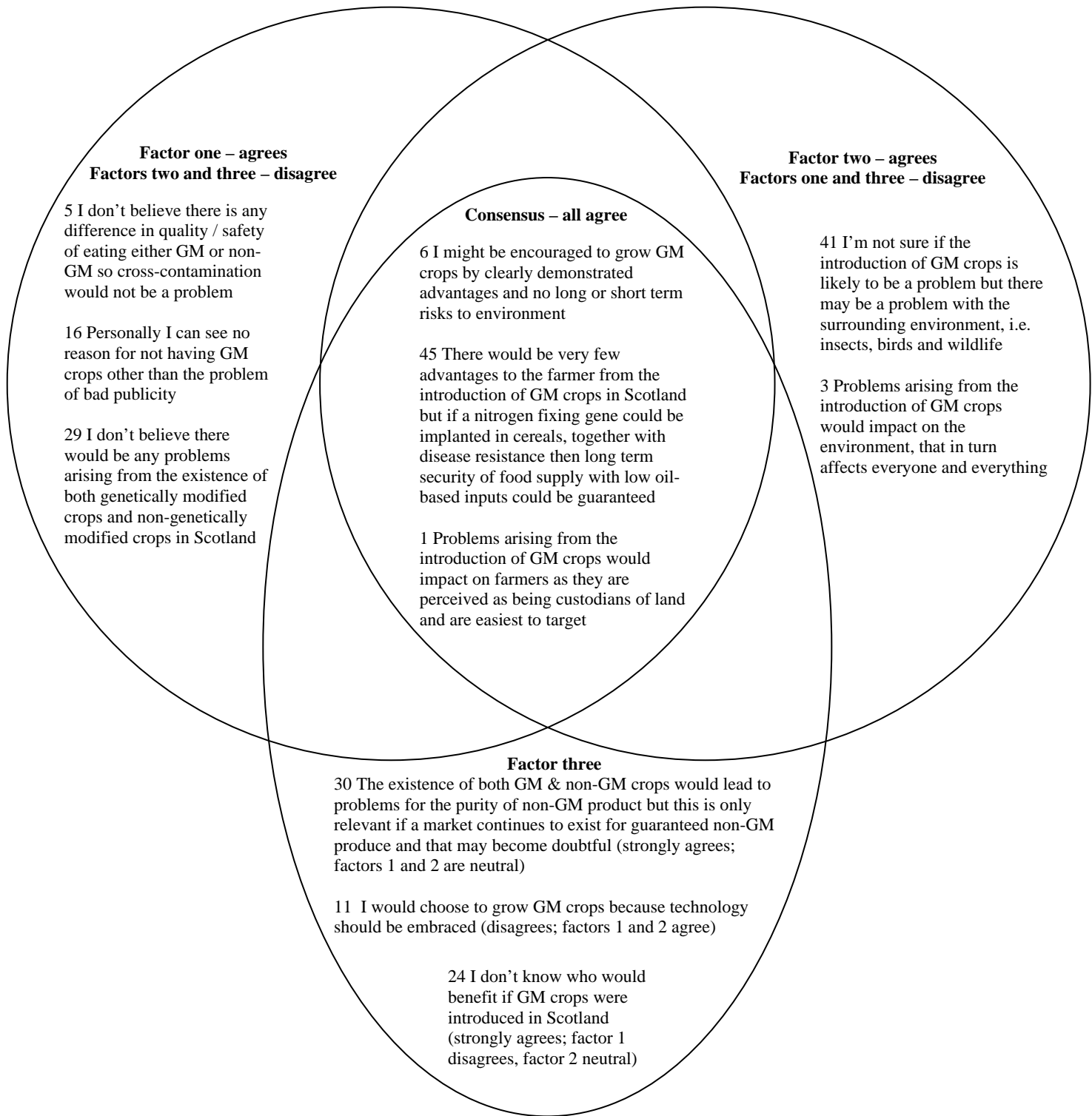


Figure 1 Disagreement and consensus between factors

Conclusions

Results suggest that farmers involved in this study are concerned about a range of issues that might arise from the introduction of GM crops, and have good awareness of the potential risks and benefits.

The Q method analysis reveals three discourses, one leaning towards being pro-GM, and demonstrating a belief in the benefits to be offered by new technology, another more inclined to be opposed and concerned about a range of potential risks, and the third demonstrating a somewhat fatalistic attitude towards GM technology development. However, in line with results from the postal survey and findings from farm interviews, none of the factor groups demonstrate a clear commitment to being either pro-GM or anti-GM, opting instead for a much more pragmatic stance.

Results from the postal survey indicate the profile of farmers who might choose to adopt GM crops, were viable varieties to be approved for cultivation within the European Union. The intention (or not) to adopt, appears to be related to a number of variables such as type of crops grown, whether or not the farmer expects to pass on the farm to the next generation of the family, and whether the farmer thinks GM crops will be good or bad for Scottish agriculture.

Overall the results from the study demonstrate that there are, as with most groups of individuals in any field, a variety of views towards GM crops. Nevertheless there are also a number of binding issues. In many cases it is the reaction of the public and the need for demand for GM products that is recognised as being key. Second, there is significant awareness and understanding of potential risks and benefits. Third, there is understanding that GM technology may provide practical solutions to agricultural challenges. The overriding sense therefore is that if these three criteria are satisfied – if there is public acceptance and consumer demand, the ‘right’ balance of risk and benefit, and technologically ‘useful’ solutions, then GM crops in Scotland will be no bad thing. What remains to be resolved therefore is what the correct balance of risk and benefit might be, and whether in fact the public will continue to be concerned about the issue.

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Appendix one: Statements selected for Q sorting (the Q set)

Possible position Thematic element	GM positive	GM negative	Unsure or neutral
Overall view of GM	All growers would benefit if GM crops were introduced to Scotland	It would be better if Scotland is seen to be GM free	I don't know who would benefit if GM crops were introduced in Scotland
Crop management	<p>I might be encouraged to grow GM crops by the fact that the modified plants may be easier to treat for mildew and many of our common everyday problems</p> <p>Farmers would benefit from lower costs and increased yields if GM crops were introduced in Scotland</p>	<p>Problems arising from the introduction of GM crops would impact on farmers who will have fields of crops they cannot get rid of</p> <p>Problems arising from the introduction of GM crops would impact on farmers as they are perceived as being custodians of land and are easiest to target</p>	<p>I can't say what factors might encourage me to grow GM crops – it will depend on the features produced by the GM and which crop it is</p> <p>The introduction of genetically modified crops into Scottish agriculture would be good for Scottish farming provided the correct characteristics are introduced e.g. disease control</p>
Consumer opinion / demand / market	<p>I might be encouraged to grow GM crops if there was demand from consumers</p> <p>Personally I can see no reason for not having GM crops other than the problem of bad publicity</p> <p>Interference from activists to trial crops should be dealt with severely in the law courts as the activists are only hindering the interests of mankind</p>	<p>I would be discouraged from growing GM crops by the risk of having groups of objectors arriving on our farm</p> <p>If a farm nearby decided to grow genetically modified crops I would not be happy as I would not want my soil contaminated with GM pollen. I should have the right to decide what happens on my land</p> <p>The existence of both genetically modified crops and non-genetically modified crops in Scotland would mean that the natural, largely organic, good food image of Scotland would be jeopardised</p>	<p>I am not sure whether the introduction of genetically modified crops into Scottish agriculture would be good or bad for Scottish farming but until the public is in favour of GM crops they are a non-starter</p> <p>I don't know if I would choose to grow GM crops. It would depend on press coverage</p> <p>I think the introduction of genetically modified crops into Scottish agriculture would be bad for Scottish farming but only because the public perceive it as bad</p>

<p>Environment / wildlife</p>	<p>The introduction of GM crops in Scotland should benefit wildlife because there is the potential for less spray to be needed</p> <p>I might be encouraged to grow GM crops by clearly demonstrated advantages and no long or short term risks to environment</p>	<p>Problems arising from the introduction of GM crops would impact on the environment, that in turn affects everyone and everything</p> <p>We have already seen a reduction in wildlife species due to natural habitat loss – GM crops would exacerbate this problem</p>	<p>I'm not sure if the introduction of GM crops is likely to be a problem but there may be a problem with the surrounding environment, i.e. insects, birds and wildlife</p> <p>I don't know how GM crops might impact on farmland wildlife but wildlife is pretty adaptable</p>
<p>Costs / finances</p>	<p>I would choose to grow GM crops if there was a bigger margin for growing them</p> <p>The introduction of genetically modified crops into Scottish agriculture would be good for Scottish farming in as much as it may reduce costs of growing them</p>	<p>I don't think there is any need for genetically modified crops as we are struggling to get a decent price for what we grow</p> <p>I would not choose to grow GM crops because crops grown in countries which are completely GM free may get higher prices due to consumer demand</p>	<p>The only advantage I can see from introducing GM crops would be being able to produce a crop at a lower cost, but this, as with all crop marketing, will just force us to take a lower price</p> <p>I might be encouraged to grow GM crops when every one else is and the profitability of the crop make it necessary to go with the tide</p>
<p>Information / Safety</p>	<p>If proven 'safe' the introduction of genetically modified crops into Scottish agriculture would be good for Scottish farming</p>	<p>I would not choose to grow GM crops because the risks are unknown and future generations should not be put at risk</p>	<p>I don't know if I would choose to grow GM crops because I still need to be convinced it is safe and not just commercial</p>
<p>Co-existence</p>	<p>I don't believe there would be any problems arising from the existence of both genetically modified crops and non-genetically modified crops in Scotland</p> <p>I cannot understand the argument about contamination of GM crops - cross pollination or contamination are emotive words and we have always accepted it</p> <p>I don't believe there is any difference in quality / safety of eating either GM or non-GM so cross-contamination would not be a problem</p>	<p>Contamination of non-GM crops by GM crops should be dealt with by crop destruction</p> <p>The existence of both genetically modified crops and non-genetically modified crops in Scotland would lead to cross pollination and this must not be allowed to happen</p> <p>Don't introduce GM crops - we are an island, we may be able to trade worldwide on our GM-free status</p>	<p>The existence of both genetically modified crops and non-genetically modified crops in Scotland would lead to problems for the purity of non-GM product but this is only relevant if a market continues to exist for guaranteed non-GM produce and that may become doubtful</p> <p>I don't think there is a place for both GM crops and non-GM crops – it will have to be either one or the other</p> <p>I do not think contamination of non-GM</p>

			crops by GM crops can be prevented and it would just have to be accepted
Technology	<p>I would choose to grow GM crops because technology should be embraced</p> <p>In future we may be able to grow GM crops for specific purposes or in conditions other than their natural environments which could be an advantage</p>	<p>The main problem that would arise from the introduction of genetically modified crops in Scotland would be that it would reinforce the existence of input-dependent industrial agriculture</p> <p>Introducing GM crops may mean more attractive-looking products like bright red smooth tomatoes, although this may put buyers off because they will look as if they are GM and not natural</p>	<p>There would be very few advantages to the farmer from the introduction of GM crops in Scotland but if a nitrogen fixing gene could be implanted in cereals, together with disease resistance (drought tolerance) then long term security of supply of food with low oil based inputs could be guaranteed</p> <p>If only 'natural' genes are added to GM plants then it's ok but if it involves using genes from a different species then it's not ok</p>