

Farmer Responses to Nitrate Vulnerable Zone Designation in Scotland

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Abstract:

Nitrate Vulnerable Zones (NVZ) were introduced in response to the Nitrates Directive (91/676/EEC) which states that all EU countries must reduce the nitrate in drinking water to a maximum of 50mg/l. Farmers within a designated NVZ must adhere to strict rules over the timing and application of nitrogen from organic and inorganic sources. In Scotland, four NVZ regions were designated in 2003, covering around 14% of the land area.

This paper outlines the results of a recent study to understand farmer activities in response to and attitudes towards NVZ regulations. A telephone survey of 177 farmers was administered, supplemented by four workshops held in each NVZ region. This was to explore, both quantitatively and qualitatively, farmer behaviour and attitudes when operating within these regions.

Farmers have only responded to a small extent to the tighter restrictions placed on them after designation in 2003. The bulk of farmers claim to have made little capital

investment, the major activity predominantly being in stock-proof fencing. Furthermore, few farmers have invested in increased slurry storage facilities, claiming to have had enough storage capacity before designation to cover the imposed closed period.

Farmer attitudes indicate a mostly negative view towards the perceived environmental benefits, water management and towards compliance. This can be explained by a number of concerns raised by farmers towards the scientific basis for designations. Furthermore, farmers viewed the restrictions placed on farming practices within NVZs as too inflexible.

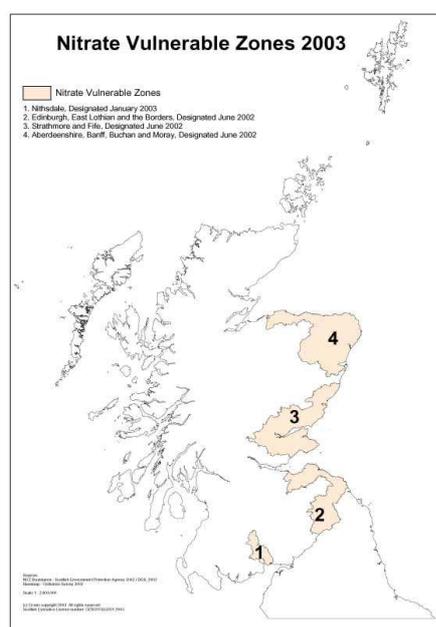
This raises a number of issues; i) it suggests that the NVZ regulations adopted by the Scottish Government do not seem to have had a great effect on compromising activity levels, ii) it suggests that transfer of information has not helped to raise awareness of environmental issues; iii) farmers feel their concerns are not likely to be taken into account in terms of the future direction of the regulations; and iv) adoption of best practice is hindered by a belief of 'victimisation', regarding the NVZ designations.

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Introduction

The application of the Nitrates Directive (91/676/EEC) and the establishment of Nitrate Vulnerable Zones (NVZ) is a concerted effort by the European Union to reduce nitrate pollutants at catchment level. NVZs impose strict limits on the timing and the application of organic and inorganic nitrogen-based sources on agricultural land. As of 2003, four regions within Scotland have been designated NVZ status, which affects around 12,000 farmers and covers 14% of land. These regions are shown in Figure 1 below.

Figure 1. Geographic areas of Nitrate Vulnerable Zones in Scotland



The requirements of the Directive have been transposed into Scottish law through a number of regulations². The Action Programme for Nitrate Vulnerable Zones (Scotland) Regulations 2003 (SI 2003 no 51) establishes the current Action Programme, the monitoring, the offence procedures where the rules have been contravened and appeals procedures. In particular, the schedule to these regulations sets out the rules on i) the quantities, timing and application conditions for applying nitrogen fertilisers to land; ii) storage capacity for livestock manures; and iii) the planning and recording of fertiliser use.

² <http://www.scotland.gov.uk/Topics/Agriculture/Environment/NVZintro/NVZlegislation>

The Directive requires Member States to submit four-yearly reports to the European Commission about the NVZs, including water quality monitoring results and the measures in the Action Programme. The Scottish Government have recently consulted on a number of modifications and changes to the Action Programme³, following which some amendments may be proposed to the regulation⁴. Table 1 outlines the restrictions farmers within Scotland must abide by⁵:-

Table 1. Nitrate Vulnerable Zone Action Programme Regulations for Scotland

<p>Record Keeping</p> <p>Records must be kept annually on the use of all organic and inorganic (chemical) nitrogen (N) fertilisers, on a field by field basis.</p> <p>A Fertiliser and Manure Plan must be prepared and implemented each year.</p> <p>Nitrogen Application Limits</p> <p>There are farm and field based limits for the quantity of N that can be applied in the form of organic manure.</p> <p>N from organic and inorganic sources must not exceed the crop or grassland requirement.</p> <p>Closed Periods</p> <p>For inorganic (chemical) fertilisers the closed periods cover the months where there is unlikely to be plant uptake and the risk of nitrate leaching is highest.</p> <p>For slurry, poultry manure and liquid digested sewage sludge closed periods cover sandy and shallow soils during the times when nitrate leaching is most likely.</p> <p>Storage of slurry/poultry manure and farmyard manure</p> <p>The capacity of storage facilities must be sufficient to hold all the slurry/poultry manure that cannot be applied due to closed periods.</p> <p>Manure produced in excess of the storage requirement must not be used in a manner that will cause harm to the environment.</p> <p>Field middens must be sited away from inland and coastal waters, wells, boreholes or similar water supplies.</p>

³ <http://www.scotland.gov.uk/Publications/2006/11/16095031/0>

⁴ <http://www.scotland.gov.uk/Resource/Doc/1057/0049769.pdf>

⁵ Detailed information on guidance is available at: <http://www.scotland.gov.uk/Resource/Doc/47074/0017579.pdf>

All farmers within a designated NVZ are required by law to observe these regulations, and principal monitoring is through the Scottish Government, who inspect 5% of farms within the NVZs annually. No studies have been conducted which measures response of farmers since designation in 2003. However, an understanding of the goals, attitudes and perceptions of farmers in NVZs is crucial to help formulate effective policies which meet the desired goals of society and minimises any friction between policy makers and affected parties.

Accordingly, this paper aims to assess farmer responses to these regulations and understand farmer attitudes guiding these responses, in particular their attitudes to water pollution. The structure of the paper is as follows, i) conceptual background and literature review, ii) farmers' practices and responses to the 2003 NVZ designations, iii) measurement of attitudes of NVZ farmers, and iv) conclusions.

Conceptual Background

The Theory of Reasoned Action (TORA) was the first model to demonstrate a consistent link between attitudes towards a behaviour and actual performance of a behaviour (Burton, 2004). It assumes individuals have full volitional control over their actions and that, barring unforeseen events, a behaviour is performed if an individual intends to perform it. Intention becomes the focus because this allows some discrimination between those likely to carry out an action and those unlikely to.

The problem then becomes one of understanding which factors influence the formation of behavioural intentions. TORA postulates that behavioural intentions (and hence actual behaviour) are guided by two factors: beliefs about the consequences of attributes of the behaviour and their evaluation (behavioural beliefs), and beliefs about the expectations of others and the motivation to comply with this referent group (subjective norms).

As individuals are assumed to have limited knowledge about the possible outcomes of an action, they will only consider outcomes that easily come to mind. TORA therefore assumes that modification of beliefs is sufficient to change attitudes, subjective norms, and hence intentions to perform a behaviour, and the actual carrying out of the behaviour. Collection of other variables external to the theory such as demographics, financial situation and personality is not necessary as they are considered to have direct influences on the individuals' beliefs (Burton, 2004).

The main focus of the agricultural based studies employing TORA-based frameworks is to examine the influence of attitudes on behaviour and decision-making (e.g., Potter and Gasson, 1988; Brotherton, 1991; Wilson, 1992; Ward and Lowe, 1994). In attempting to understand the cause of behavioural actions, it is argued that this behaviour could be predicted by a producer's intentions. These intentions can also be determined by the farmer's attitudes and the influence of other reference groups. These attitudes are critical in determining the cause of particular behavioural effects (e.g. Lynne et al., 1998). In turn both behaviour and attitudes are affected by a set of antecedent variables, including socio-economic and structural factors, such as policies, financial pressures, family concerns, ethical principles and values (Potter and Gasson, 1988; Brotherton, 1991; Wilson, 1992; Ward and Lowe, 1994; Colman, 1994; Young *et al.*, 1995).

Past Studies on Farmer Attitudes

Gasson's (1973) study of farmer behaviour led to a growth in literature concerning the attitudes, motivations and non-economic attitudes of farmers. The bulk of these studies tend to follow Gasson by classifying farmers according to their production and non-production orientated goals. Other studies have examined the effect of structural and socio-economic factors on the decision to become more environmentally friendly (Shucksmith (1993); Potter and Lobley (1992) Battershill and Gilg (1997).

Of these studies, Willock *et al.* (1999) is the most relevant to this research as it is the first large study in Scotland. The 'Edinburgh Study of Decision Making on Farms' consisted of identifying a number of attitudinal factors concerned with business and environmental performance and asking farmers their thoughts on a number of statements. On surveying a random sample of farmers within the East of Scotland, it was found that statements of success of objectives (e.g. 'best livestock and crop pastures', 'farm production is something to be proud of') and openness in farming (e.g. 'allowing visits by members of the public', 'consulting with professional advisors') were correlated with improved business orientated behaviour. Furthermore, they also identified the most prevalent characteristics for environmental behaviour. Attitudes towards chemical use and conservation objectives were highly correlated to positive environmental behaviour. Similarly, openness attitudes towards farming (e.g. allowing access by the public) and size of farm also contributed to influencing farmer decision making regarding the environment.

Participation in environmental protection programmes has gained increasing attention and is frequently used as a tool for accomplishing environmental objectives (Segerson and Miceli, 1998; Carraro and Lévêque, 1999). Several case studies have found that despite generally pro-environmental attitudes *per se* (Newby *et al.*, 1977; Potter and Gasson, 1988; Paniagua Mazorra, 2001) farmer attitudes towards the environment are stronger when programmes compensate or support them (Lütz and Bastian, 2002).

There has also been recognition of the importance of motivation, and especially the source of motivation in attempting to explain farmers' propensity to participate in agri-environmental programmes (AEP). For instance Saltiel *et al.* (1994), Wilson and Hart (2000) and Mathijs (2003) suggests that social capital plays an important role in farmers' motivation. Also, a lack of profitability and credit constraints are considered influential to the adoption of environmental technologies (Cary and Wilkinson, 1997; Nowak, 1987), as is the degree of effort necessary to implement the behaviour (Edwards-Jones *et al* 1998, Saltiel *et al.*, 1994).

A small number of studies have examined diffuse water pollution issues, generally finding among participants a general lack of knowledge about them. Some work exists on watershed resource management in other countries (Revnborg and Guerreo, 1999). This latter study found that farmers operating within the catchment had a 'neutral to slightly positive environmental attitude' overall.

The most relevant study this research is Macgregor and Warren (2006) as it is the only study concentrated on the awareness of, and sustainable farm management practices within, a Nitrate Vulnerable Zone in Scotland. They undertook a qualitative study of a small sample of mostly arable farmers within the Strathmore and Fife NVZ and investigated three major areas, namely i) farmer knowledge of wider environmental impacts; ii) farmer attitudes to wider environmental protection; and iii) environmentally problematic management practices.

The authors found that none of the farmers felt responsible for any negative environmental impacts either on or off the farm, and when asked about 'potential' environmental problems, most were concerned only with on-farm issues, e.g. soil erosion, sub-soil compaction, soil structure decline and wind erosion. Very few showed any concern for the off-farm wider issues of marine and coastal water quality because it is easy to externalise the negative impacts of conventional farming (Pretty

et. al., 2000). However, farmers had a clear sense of what practices within their nutrient management were most likely to cause significant problems, such as excessive applications of fertilisers and manure, poor timing of applications, inadequate or poorly maintained manure, as well as slurry and silage storage. However, the authors noted that many denied responsibility for any problems, and most used this position to justify their reluctance to consider changing their current practices, making it clear to the authors that the farmers were not likely to be proactive in adjusting to regime changes.

Overall farmers saw little connection between their farm management practices and elevated nutrient levels in rivers and the coastal zone. The farmers blamed these issues on point source polluters. The authors argued for a clear need to quantify the agricultural contribution to nutrient surpluses, and, thereby, to demonstrate the links between agricultural practices and downstream nutrient enrichment of rivers and estuaries. However, it has to be emphasised that this was only a small study of arable farmers within one catchment and it is difficult to generalise findings across other farm types and NVZs within Scotland.

Data Collection Method

Telephone Survey

A questionnaire was developed to understand farmer responses, attitudes and understanding of the NVZ regulations. The basis for this was outlined in Willock et al. (1999) and consisted of a number of sections aimed at measuring the influence of farmers' attitudes, goals and external constraints on farming behaviour (farm size, farm type etc). Four scales were specifically developed for the study. These were:-

- i) *Farm information*
- ii) *Farming attitudes to conservation, pollution , NVZ legislation, business approach*
- iii) *Farming goals or objectives to the above,*
- iv) *Farming behaviour directly related to the above.*

If these attitudes have an important influence on a farmer's motivation then it is also necessary to design and measure how important they are to the individual. Thus

attitude items were evaluative statements, while objectives were measured by how important the particular concept was to the farmer. Actual reported behaviour was investigated using a similar set of items, such as “*Have you taken any active conservation measures in the past 3 years?*”

A telephone survey was conducted over the period February to March 2007. Names and telephone numbers of 700 holdings were provided by the Scottish agricultural census, which were stratified by each of the four administrative regions, and by size of holding. In total 177 responses were received, giving a return rate of around 26%. Table 2 shows responses were evenly distributed across the four regions.

Table 2. Responses by NVZ region

NVZ Region	Responses (numbers)
Strathmore & Fife	40
Moray Aberdeenshire Banff	51
Lower Nithsdale	41
Lothian & Borders	46

The majority of NVZ farms (72%) were owned outright, with the remainder being either tenanted or partially tenanted. In addition, most farms (60%) were trading on a partnership basis, around 30% were sole traders, whereas around 10% were a limited company. Table 3 shows the distribution of farms by farm type.

Table 3. Distribution of farms, percentage

Farm Types	Responses (number)
Arable and General Cropping	56
Mixed	9
Cattle and Sheep	24
Dairy	4
Pigs and Poultry	6

** includes partially within*

Around 41% of those farms within NVZ boundaries were classified as Less Favoured Area (LFA) and showed an even distribution across size classifications. Generally, average areas for farms had a mean arable ha of 133 ha, grassland of 110 ha and rough grazing of 159 ha. Across all farms sampled only a small percentage (8%) had

certified organic production. High proportions of farmers in NVZs claimed to keep production records and also to keeping annual financial budgets.

Workshops

To follow up the telephone survey, four workshops were held in June and July 2007, one in each of the four NVZ areas. The overall aim of the workshops was to add qualitative discourse to the results of the survey. Specifically, it was to add more context, detail and in-depth understanding of farmer attitudes to the results obtained.

In total, 36 farmers attended the four workshops; Nine were at Thainstone in the Aberdeenshire, Banff, Buchan and Moray NVZ, eight at Perth in the Strathmore and Fife NVZ, seven at Gifford in the Edinburgh, East Lothian and Borders NVZ, and 12 at Dumfries in the Lower Nithsdale NVZ. Participants also varied in terms of age, from 20s through to over 65s. It was evident from discussions that participants were involved in a variety of farming activities, including arable, dairy, beef, sheep and horses, and many operated mixed farms. Examining the first part of participants' postcodes (i.e. the first three or four digits only, such as AB51 or DG3) there was a total of 19 different codes. Hence, crucially, there was significant diversity among participants.

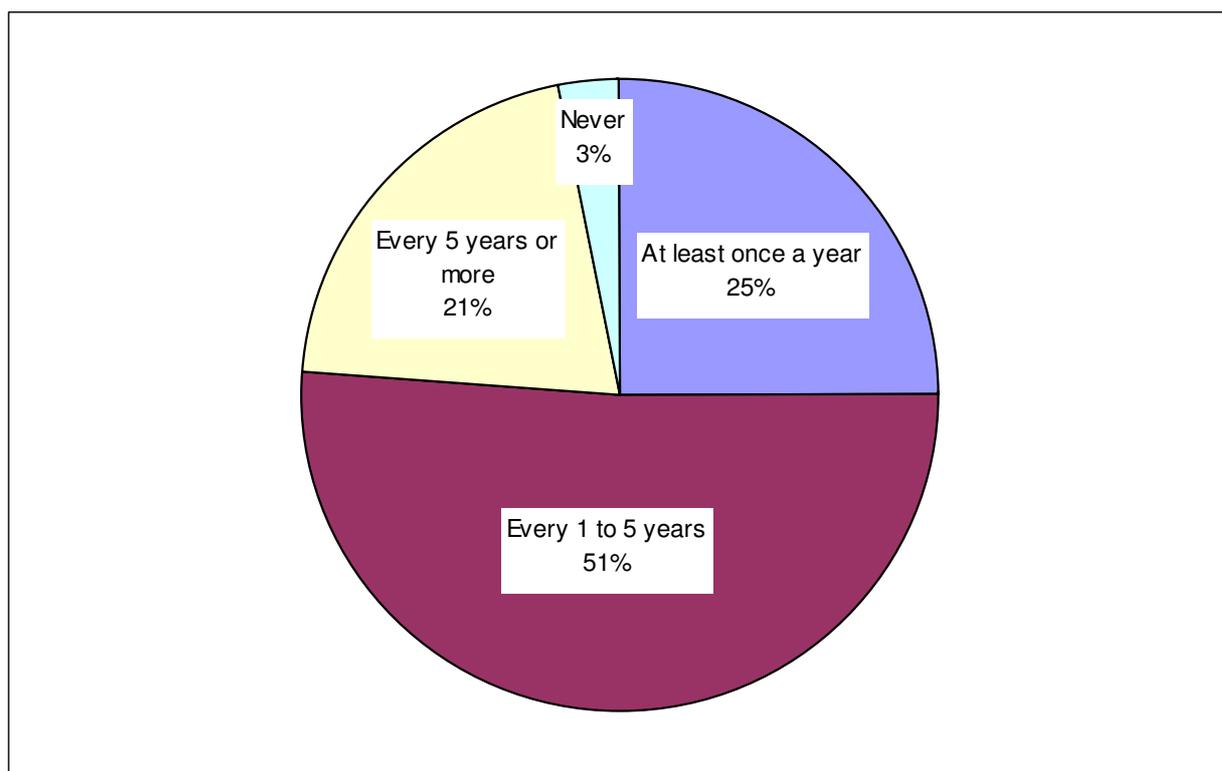
Results

The telephone survey, supplemented by the workshops, gave insight into a number of areas. Firstly, farmer responses to the NVZ designations were explored. These are outlined below. This was followed by measurement of farmer attitudes and awareness of regulations and water pollution issues.

Farm Practices

A number of questions were directed at the farmer's use of water management. Figure 2 shows the frequency by which farmers conducted a soil analysis. Generally, it seems that NVZ farmers are conducting soil analyses reasonably frequently.

Figure 2. Frequency of conducting a soil analysis, percentage



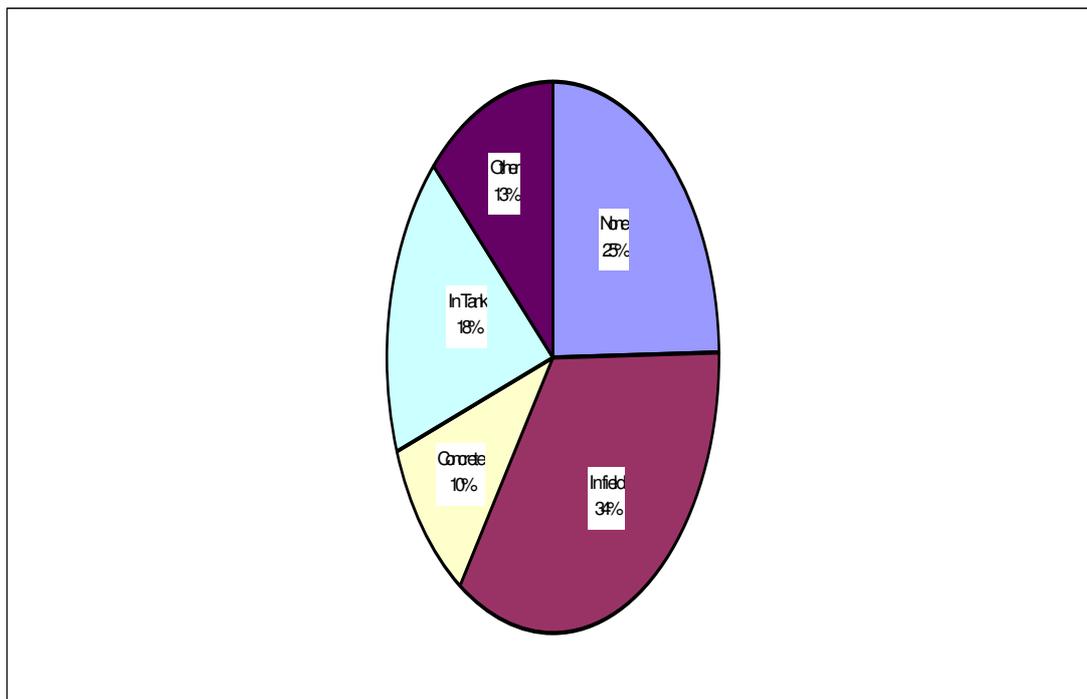
Around 62% of farmers within an NVZ claimed to prepare a nutrient management plan. In addition, around 90% of these farmers claimed to keep records of fertiliser and manure applications for individual fields.

Table 4. What type of fertiliser do you use, cropping and mixed, percentage

	Arable and General Crop	Mixed	Cattle and Sheep	Dairy	Pigs	Chickens
None	1	6	2	12	40	22
Manure	17	6	26			33
Inorganic	22	6	10			11
Mixed	60	83	63	88	60	33

Table 4 shows the distribution by type of fertiliser used. Generally, NVZ farmers who, whilst having half the levels of manure usage, tend to use more mixed fertilisers. Figure 3 below shows the distribution of storage methods. Generally, the most popular method is in-field storage.

Figure 3. How do you store manure slurry, percentage



Out of the farmers who answered concerning storage capacity for slurry, around two thirds claimed to have enough storage capacity.

Changes since 2003

A number of questions were directed at understanding how farmers in NVZs have changed behaviour since the 2003 regulations. Table 5 outlines the investment activity which could have occurred over this period.

Table 5. Investments since 2003 of NVZ farmers, percentage

	Invested in stock-proof fencing	Invested in advice for improved record keeping	Bought more slurry/manure space/expanded present storage
Large investment	36	10	7
Little investment	47	39	5
No investment	16	45	85
Conducted before 2003	1	6	3

The only detectable investment has been in stock-proof fencing, principally to keep animals from water courses. A small number have invested in obtaining farming or agronomic advice for improved record keeping. As outlined above, the NVZ regulations now require an increased amount of record keeping, specifically in terms of crop N requirements and field level applications and some investment in advice would be understandable. Also, around two thirds of farmers claimed to have enough storage capacity for slurry in their present farming practices, this is reflected in the relatively low levels of investment for increasing storage capacity. The NVZ regulations impose a closed period of around 1 month which increases the burden of storage. A possible answer to this is transportation of slurry, however table 6 shows that the majority (94%) have not begun to transport more slurry off the farm. This seems to indicate that farmers have enough storage capacity to carry the increased burden for slurry storage. In addition, only 10% of farmers had received a grant under the NVZ scheme since 2003, which covers 40% of the costs of increased capital investment.

Table 6. Farming practices since 2003 for NVZ farmers, percentage

	Transport more slurry off farm	Adopted any environmental schemes?	Joined a farmer co-op	Used manure management software	Started to use record keeping software
Yes	5	42	9	17	34
No	94	53	78	80	55
Did before 2003	1	6	13	3	12

Table 6 shows the percentage of the sample who have made changes to their farming practices since 2003. Generally speaking the bulk of farmers have not changed to accommodate any of these practices. However, some (34%) have started to use record keeping software, and a smaller number (17%) have begun to use manure management software.

Around 42% of the sample have adopted environmental schemes since 2003, such schemes would include the rural stewardship scheme, environmentally sensitive area

scheme etc. Similarly, of most relevant is the adoption of PEPFAA best standards⁶. More than half of those farmers joining environmental schemes have adopted some form of best practice over the time period since the current regulations were introduced in 2003.

Accordingly, it seems that those farmers who have been designated within an NVZ have not been fundamentally affected by the imposition of these restrictions. Very few have sought support for capital investment and principal activity has focused on stock-proof fencing. Though some have begun to adopt practices to improve the efficiency of resources, these include joining environmental schemes and using record-keeping and manure management software. The next question aims to explore the underlying reasons for this response by assessing attitudes and objectives of these farmers.

Farmer attitudes to NVZ regulations

The telephone survey was designed to encompass a range of variables related to farming attitudes, goals/intentions and behaviours in NVZ areas. The following attitude themes were identified.

⁶ The PEPFAA code is a voluntary scheme to ensure best practice for reducing diffuse water pollution.

Table 7. Attitude themes and example statements

Attitudes	Example statements
Attitudes to Production:	<i>On a farm of this size you must be oriented towards production if you are to survive; farmers should fully utilise their resources</i>
Green Attitudes	<i>If farming in the UK is to be sustained you must reduce chemical fertiliser applications; farmers have to do their bit to reduce environmental pollution</i>
Responsibility for Environmental Damage	<i>Other industries pollute more than farmers. other industries are not penalised sufficiently for environmental pollution</i>
Attitudes to Compliance	<i>It is fair that farmers should be held responsible for water pollution in this area; it is unfair that certain farmers have to bear the cost of complying with NVZ regulations</i>
Water Management Attitudes	<i>Water quality can affect my health; groundwater pollution is an important environmental issue</i>

A 5-point Likert scale was used to measure farmer responses to statements related to issues which include production, environmental issues, responsibility for environmental damage, compliance with the regulation, and water management. These sections were built around a series of statements and required farmers to indicate agreement or disagreement with the statement utilising a standard five point Likert scale.

Figure 4. Level of agreement with attitude sub-sets by farm type

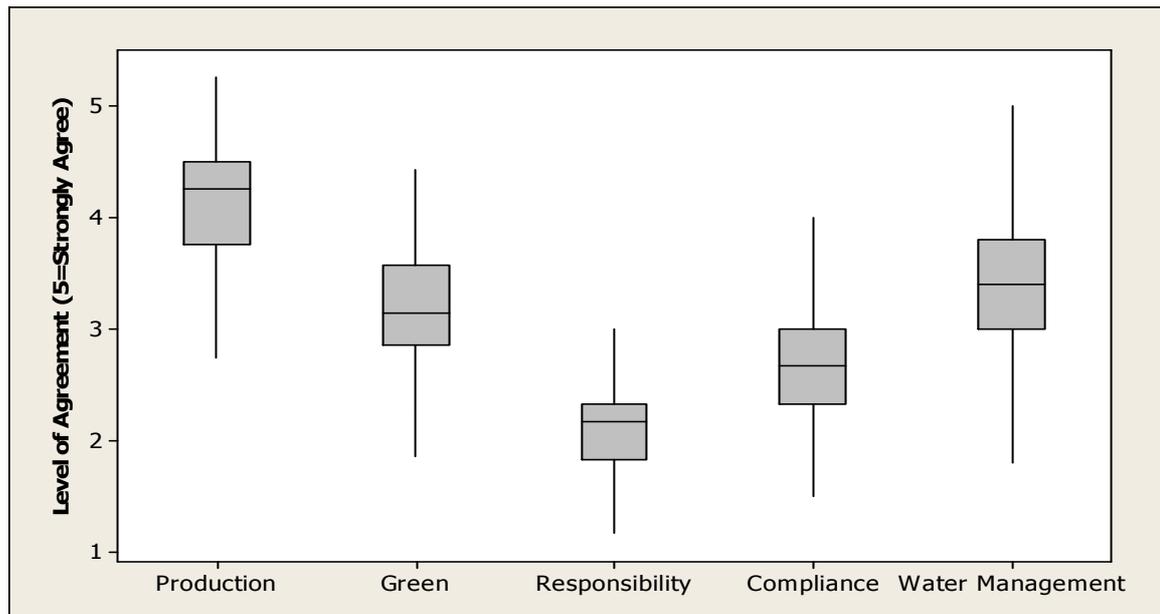


Figure 4 shows the responses along the 5-point Likert scale to the statements, with 5 being the strongest agreement, to a composite of statements making up the attitude themes (all weighted equally). The statements related to production seem to register the highest response. Within this theme, farmers in NVZs tended to agree quite strongly with the statement *'farmers should fully utilise their resources'*. However, it seems that those statements which make-up farmer responsibilities to the environment were ranked the lowest, and seemed to vary at minimal levels also. In particular, the statement which registered the highest level of agreement was *'adapting to environmental regulations reduces your income'*.

The other themes are ranked around the mid-point value of 3, which equates to 'no opinion' on the Likert scale. These themes include green attitudes, attitudes to compliance of NVZ regulations and to management of water resources generally. Some attitudes show a level of variance, with a small number of farmers disagreeing strongly with all this set of statements. However, some differences were observed between agreement of various statements, with the statement *'It is unfair that certain farmers have to bear the cost of complying with NVZ regulations'* in which, around 38% of farmers in NVZs strongly agreed. Secondly, when posed the statement *'Nitrate pollution is a problem in this area'* a large proportion of farmers in NVZs claimed to be unsure of this statement, which highlights that farmers may be sceptical of the underlying reasons for NVZ designations. When comparing by farm type there was some significant disagreement from chicken farmers, as well as cattle

and sheep farmers. In addition, further disagreements were found on small farms (less than 49 ha).

The two statements which ranked the lowest for management of water resources, were concerned with water quality and how they affected both livestock and crop health. Only 19% of those farmers within NVZs agreed with the statement '*water quality could affect the health of livestock*'. This seems to infer that NVZ farmers are less concerned about water quality and its impacts on production and health. When examined by farm type, dairy farmers showed the highest level of disagreement with these statements.

Farmer Workshop Discussion

Further exploration of attitudes was conducted within the four workshops held in the NVZ regions: Perth (Fife), Thainstone (Aberdeen), Gifford (Lothian), and Dumfries (Nithsdale). Although the group dynamics of the four groups were very different, and there were obviously regional differences in terms of farming activity and environmental conditions, there were, importantly, some very consistent messages from the participants. Views and opinions gathered in the four workshops could be grouped according to theme and are listed below.

Negative Points

Key points arose from three of the workshops related to the belief that the scientific basis for designation of the NVZ areas was flawed. In general farmers either did not believe the evidence related to the designations, or wanted to see proof that reductions in application levels may have some positive impact.

Other key points arising from the workshops related to the restrictions placed on farming practice from the NVZ regulations. In effect, they wanted more flexibility on closed periods that better reflect seasonal and weather conditions. In addition, they also voiced concern that fertiliser limits restrict potential crop yields and impact profits.

These points indicate a frustration over the centralised and generalising nature of the NVZ legislation. Essentially, farmers require more flexibility to respond to changing conditions and have a belief in their own judgement and awareness of management of their own natural resources over and above 'blanket' limits.

Farmers within NVZs also revealed some dissatisfaction at the extra levels of paperwork they are required to produce when operating within the NVZ areas. They considered these to be too complicated, requiring additional cost and time.

A number of farmers voiced discontent at the unfairness of the designation of the NVZs. In some way this relates to their argument over the scientific basis, but offers another dimension as it reinforces the opinion of 'victimisation' evident in the farmers' discussion about operating within an NVZ. Key points from the discussions reveal that farmers felt unfairly penalised by the restrictions placed on them, compared to those outside the zones.

Several statements were made by the workshop participants which related to their perceptions and understanding of information. Information to farmers in NVZs is not adequate since some are not aware of the regulations at all, others are not aware of details such as grant funding and consultation about revisions. Evidently, some farmers felt dissatisfied with the information provided by the then Scottish Executive and felt that their grievances were not listened to.

Positive Points

Whilst some positive points about farming in NVZs were extracted from the workshops, the general feeling of the group tended to indicate that any positive comments in no way balanced the negative comments. However, two particular points do emerge from the workshop exercises which need to be highlighted, namely:-

- Improves efficiency of N usage
- Improvements in water quality

In a number of workshops farmers agreed that the main advantage of operating within an NVZ region, was that having to pay especial attention to applications and use of N, raised farmers' awareness of how much they were using, and in some cases helped to improve efficiency of use. Furthermore, some members of the workshops identified with the environmental goal of NVZs in that a positive benefit for society would be an improvement in water quality.

Discussion

It seems that farmers currently operating within the NVZ regions of Scotland have not unduly changed their behaviour to accommodate the greater restrictions imposed after designation. The main costs which would be expected to occur emerge from storage of slurry. However, the majority have not invested, nor have they transported more slurry off-farm, indicating that the closed period of 1 month has been accommodated with past investment in storage facilities. When examined closer, the most activity has centered on investment in stock-proof fencing to restrain animals.

This can be seen as a response to the NVZ regulations, and the predominant productivist attitudes of farmers operating within these zones. Whereas market prices and production efficiencies are pursued, there are relatively neutral responses to environmental and, especially, diffuse water management issues.

A possible reason for this is found in the scepticism of producers over the designation process itself. This tallies with the findings of Macgregor and Warren (2006), who also found that farmers carry a suspicion of victimisation. Coupled with the fact that benefits in water quality only emerge over a number of years (Nimmo-Smith *et. al.*, 2007), it is difficult for producers to accept a constraints on their desire for increased production.

A number of issues emerge for policy makers, in particular, it seems that changing attitudes may be enabled from clearer information over the purpose of the NVZ designations, in particular with the science of the designation, from the Scottish Environmental Protection Agency. Thus, the scientific messages must be made clearly and more convincingly. Some effort may be made towards emphasising the scientific background in terms of the original designations, the links between farming activities and nitrate pollution, any positive impact of the regulations and the science behind the nitrate limits imposed on farmers.

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