



UNIVERSITÀ POLITECNICA DELLE MARCHE
Repository ISTITUZIONALE

Identifying viewpoints on innovation in low-input and organic dairy supply chains: A Q-methodological study

This is the peer reviewed version of the following article:

Original

Identifying viewpoints on innovation in low-input and organic dairy supply chains: A Q-methodological study / Mandolesi, Serena; Nicholas, Philippa; Naspetti, Simona; Zanolì, Raffaele. - In: FOOD POLICY. - ISSN 0306-9192. - 54:0(2015), pp. 25-34. [10.1016/j.foodpol.2015.04.008]

Availability:

This version is available at: 11566/226833 since: 2022-06-01T10:08:08Z

Publisher:

Published

DOI:10.1016/j.foodpol.2015.04.008

Terms of use:

The terms and conditions for the reuse of this version of the manuscript are specified in the publishing policy. The use of copyrighted works requires the consent of the rights' holder (author or publisher). Works made available under a Creative Commons license or a Publisher's custom-made license can be used according to the terms and conditions contained therein. See editor's website for further information and terms and conditions.

This item was downloaded from IRIS Università Politecnica delle Marche (<https://iris.univpm.it>). When citing, please refer to the published version.

(Article begins on next page)

1. Introduction

From a business perspective, innovation is commonly considered as an essential element of competition between companies, and innovation expenditure is usually considered as the main indicator of the innovative effort of a company. Data on the food and drink industry indicate that with its 956.2 billion euro turnover and 4.1 million people employed in 274,000 companies, this is the largest manufacturing sector (16%) in the European Union (EU) (CIAA, 2012); despite the current economic downturn, this sector remains an essential pillar of the EU economy. However, the intensity of research and development (R&D) within the food business has always been relatively low. According to the European Commission (2012), innovation growth in the food industry in 2011 was 1.9%, which was low considering the EU average (6.1%), and both the level and the rate of investment in R&D by the food sector have been relatively stable at this level. Patent applications are another indicator of innovation at the company level: only 2% of all patents submitted in the manufacturing industry in the EU were attributable to the food sector in 2011 (CIAA, 2012).

In the marketing literature, innovation is regarded as a broad process that aims to fulfil the customer needs. Innovation adds value to a company, organisation, or society, by converting knowledge into new products and services that are designed to satisfy the desires of potential consumers. According to Kotler (1994), innovation “refers to any goods, service, or idea that is perceived by someone as new. The idea may have a long history, but it is an innovation to the person who sees it as new.” It is apparent from this definition that innovation does not only deal with a technological change, but it is connected to the context and to the different perspectives of the actors involved. As a consequence, innovation can be related to a product or to a process, and also to an organisation (Neely and Hii, 1998) when, for example, it refers to innovations in the market-orientation skills of a company (Grunert and Trail, 1997).

The distinction between ‘product innovation’ and ‘process innovation’ is somewhat fuzzy: a process innovation can lead to a product innovation, and *vice versa*, and different types of innovations do not mutually exclude each other. Also, it is of note that innovation goes beyond changes in the physical product; anything new in a product – distribution, price or communication – can lead to an innovation, either in a process and/or in a product, or in the eyes of one, or more, of the actors in a supply chain.

Depending on who perceives the newness, we can regard a given product as new or not. Newness in the eyes of the producer or the distributor does not necessarily translate into

innovation in the eyes of the consumer (Grunert and Trail, 1997). In the food system, for example, innovations at the level of the farmer – maybe related to new technology or resources used in the field that were not previously available (e.g., a special harvesting machine) – or innovations at the level of the distributor – maybe related to new storage strategies, or time-saving changes – might not be perceived at the consumer level, unless they translates into price reductions or increased value for money.

The market is affected by consumer distrust in new products and by product failures. Failure rates for new products in consumer food markets have been reported to vary a lot, ranging from 33% up to 80% (Doan and Chambers, 2012; Ionghen and Meulenberg, 2005). Many studies have extensively investigated the reasons for success or failure, across a wide range of new products and different industries. The results here have shown that the consumer level of acceptance of innovations is only part of the issue. Consumer needs should be taken into consideration as a point of departure for an effective new product-development strategy, but R&D is only one of the steps that determine whether innovations are successful or not (Grunert and Trail, 1997). Extensive knowledge of the marketplace, along with company skills and communication in cross-functional teams involved in new product development, and as well as communication along the supply chain, are all together the factors that will improve the chances of success of innovations (Ionghen and Meulenberg, 2005; Capitanio et al., 2009). In particular, from among these strategies, cooperation along the supply chain, which has also been referred to as ‘co-innovation’, is an important element of success for innovations in the food industry (Omta and Folstar, 2005).

Fostering innovations in the food system should be profitable at the farm level, to produce competitive food products in the market place, as well as producing environmentally sustainable and energy-efficient products at the same time (SCAR, 2008). The capacity of a company to produce innovations that will be accepted and understood along the supply chain, until the final consumer, is of utmost importance. Hence, having a deep understanding of the levels of acceptance of innovations along the supply chain is just as important as understanding consumer acceptance. However, to date, most investigations into food innovations have been from the *consumer* side. There is little literature on acceptance of innovative technologies and products in the food area along the supply chain, compared to the literature on examining consumer acceptance of food innovations (Ronteltalp et al., 2006).

The present study investigates the role of innovation in organic and low-input dairy supply chains as an instrument to improve the competitiveness of the dairy system. The purpose is to contribute to the understanding of the expectations of organic and low-input

dairy supply-chain members in relation to innovations along the whole supply chain that enhance the sustainability of the farming systems.

The European dairy industry, with a turnover of 53 billions euros in 2011, of which 8,1 billion exported (DG Agri, 2012), contributes to 14% of total agricultural production (Marquer, 2013). Despite some country differences the milk production of the 28 EU Member States has been increasing over the last decade, making the EU one of the world's leading milk producers. According to Eurostat, the EU milk production in the year 2012 was forecasted to exceed 157 billion tons from over 23.1 million heads.

Nevertheless, the European milk system, operating within the framework of milk quotas – set to address the issue of surplus production since 1984 but to be abandoned in April 2015 – is going to face new challenges. Dairy supply chain members are going to operate in a rapidly changing environment; increased competition on world markets, but also the need for a sustainable development of the European milk sector, as contributor to the total agricultural product value (economic dimension) and fostering the rural communities (territorial dimension) are expected to affect the sector's competitiveness. This process will induce more innovation at both the farm level (e.g., organic milk) and the processing level (e.g.: high quality, branding and product innovation) (DG Agri, 2012).

Supply chain perspectives towards innovations that facilitate the use of breeds and feeding strategies to maintain productivity, improve animal health and welfare while meeting the market requirement for high quality milk, can be relevant.

We have applied Q methodology to investigate the perspectives of the supply-chain members towards innovations in organic and low-input dairy supply chains. This methodology is particularly suited to the study of the subjectivity and attitudes of people towards new issues. First, we provide a brief description of Q methodology and of our specific application to innovation in dairy systems. The data are then presented and discussed, with specific reference to the EU dairy sector. Our conclusions focus on both supply-chain member consensus and the differing viewpoints on innovations, to define how more sustainable farming systems can be achieved while enhancing the competitiveness of organic and low-input dairy systems.

2. Materials and methods

Q methodology was developed in the 1930's by William Stephenson, one of the most gifted students and assistants of Charles Spearman, the 'inventor' of factor analysis (Stephenson,

1936a, 1936b, 1953; Burt and Stephenson, 1939). Stephenson introduced his new method as a means of systematically and holistically identifying types of viewpoints about a topic.

In the Stephenson approach, we shift from *by-variable* factor analysis (the standard approach, which in Stephenson's papers was addressed as the 'R methodology') to *by-person* factor analysis (Q methodology) (Watts and Stenner, 2012). By inverting the rows and the columns of a typical factor analysis, Q methodology moves the focus from variables and patterns across variables to the inter-correlations and patterns across individuals (Previte et al., 2007). As Q methodology focusses on correlations between individuals (not between variables), factor analysis is used to group the people with similar opinions. The strength of Q methodology is the chance to use the data according to the groups of people, to suggest decisions in different fields (e.g., political, social, environmental).

Q methodology has traditionally been applied in psychology and medical research (McKeown and Thomas, 1988), although it is now used in a broader range of social sciences disciplines (Hall, 2008; Barry and Proops, 1999). The application of Q methodology in agricultural research is relatively limited to date (Brodt et al., 2006; Davies and Hodge, 2007; Eden et al., 2008; Hall, 2008; Kristensen and Enevoldsen, 2008; Fairweather, 2010; Kristensen and Jakobsen, 2011; Augustin et al., 2012), although its use is slowly expanding.

Q methodology was used to identify different farmer goals and management styles that characterise different farming approaches (e.g., Environmental Stewards, Production Maximizers, and Networking Entrepreneurs; Brodt et al., 2006) and different environmental management styles (e.g., Environmentalists, Progressives, Commodity Conservationists, Jeffersonians and Yeomen; Davies and Hodge, 2007). It has also been used to identify the attitudes of farmers towards genetically modified (GM) crops (e.g., pro GM, uncertain position, or a fatalistic attitude towards the adoption and impact of GM technology; Hall, 2008). Fairweather (2010) applied Q methodology to dairy-farming systems in combination with a causal mapping technique, to define a new model of socio-ecological dairy systems. Relevant Q studies on the dairy sector have also been reported in other studies. Kristensen and Enevoldsen (2008) explored farmer expectations in relation to participation in a health management programme by the describing of four factors: Teamwork, Animal welfare, Knowledge dissemination and Production. Then Kristensen and Jakobsen (2011) investigated the perception of risk of disease and the importance of biosecurity for dairy farmers. Augustin et al. (2012) described the contribution of the dairy industry to global food security, highlighting the importance of an integrated approach across the whole supply chain, to improve the sustainability of the dairy industry.

Kramer et al. (2003), applying Q methodology to investigate different perspectives of dairy producers non-participating to a dairy herd improvement project, identified four different viewpoints sometimes critical for program improvement: productive efficiency; unaware producers; economic resources; social pressures.

Few studies adopted Q methodology as a means to identify and understand the viewpoints of different group of individuals. Group comparisons, that is studies showing the same Q sample to different group of people (different P set), are usually studied when several countries are involved and previous knowledge of the country – cultural and linguistic – differences is relevant in the concourse preparation (Brown and Feist, 1992; Rhoads & Brown, 2002; Webler & Tuler, 2006; Courtois et al., 2013). Even fewer Q studies compare groups of people with different cultural background in a specific topic (e.g. consumers and producers like in the present study): Deignan (2009) compares students and teachers perspectives on the same educational programme, while Deignan (2012) compares viewpoints of North-England university students with dyslexia and their specialist dyslexia support staff in a context of a policy change in relation to dyslexia support. Finally, Donaldson et al. (2010), in their yet unpublished study, compare views of different groups in different countries in the context of a healthcare EU project

2.1. Procedure

Q methodology consists of five steps (McKeown and Thomas, 1988): construction of the concourse, development of the Q sample, selection of the P set, Q sorting, and Q factor analysis¹.

As the aim of our study was to investigate the perception of dairy supply-chain members in relation to innovations in farming practices relating to the organic and low-input dairy supply chains, we started with the construction of the concourse. In Q methodology, the concourse refers to, “the flow of communicability surrounding any topic” (Brown, 1993), which is represented by a collection of all of the possible statements that respondents might make about the subject at hand (Van Exel, 2005). In other words, the concourse should include all of the existing materials around the topic under investigation. In the present study, the concourse included all of the materials on innovation uptake across the broad range of dairy-farming systems. The concourse was constructed by combining materials obtained from previous studies on innovations in the dairy-farming system with the answers derived from a

¹ For further details on the Q methodology, see Brown (1980).

questionnaire sent by email to the Sustainable Organic and Low-Input Dairying (SOLID) European project partners – including the small and medium enterprises and the academic partners – and policy stakeholders in organic and low-input dairying. The questionnaire was designed to collect data on the innovations in farming/ supply-chain practices that the subjects would like to see for the organic dairy sector in their country, and those they would like to see for their own organic business or for those that they represent.

The concourse consisted of over 200 statements. To reduce these to a manageable number that could be presented and ranked by the respondents, a subset of statements was drawn from the concourse, which formed the so called Q sample. This is a crucial step in the procedure. To make these statements fully representative of the concourse, the Fisher experimental design principles were applied, as suggested by Brown (1970, 1993). By applying this approach, a large number of potential statements can be grouped into theoretical categories. These categories can usually be created via a *deductive* approach, which is based on *a-priori* hypothetical or theoretical concepts (as in Dryzek and Berejikian, 1993), or an *inductive* approach (e.g., Glaser and Strauss, 1967), where the categories emerge from patterns that are observed during the collection of the statements (McKeown and Thomas, 1988). In the present study, a deductive factorial design was used. Through this approach, two dimensions were defined that were grounded on the key areas of interest of research into *organic* and *low-input* dairy farming systems; *Breeds*, *Feeds* and *Management practices*. The *conventional* dairying category was added for completeness and benchmarking, although it was not immediately relevant for the present study. The structured matrix for the sampling of the statements is reported in **Table 1** (McKeown and Thomas, 1988). The 200 statements were reduced to a Q sample of 34 statements (the Q set), each of which should be included in only one of the matrix categories (Watts and Stenner, 2012). Each matrix cell contained an unequal number of statements, to guarantee coverage of the original concourse population. All of the statements were randomly numbered and printed onto separate cards.

The number of respondents is referred to as the P set. A Q methodological study requires only a limited number of respondents: “all that is required are enough subjects to establish the existence of a factor for purposes of comparing one factor with another” (Brown 1980). This is why the representativeness of the sample, as well as the number of the respondents, is of minimum importance compared to the breadth and diversity of the perspectives included in the participant sample (Brown, 1996). The P set was not random. It was a structured sample of respondents who were theoretically relevant to the problem under consideration (Van Exel, 2005). A P set will usually range from 20 to 50 respondents.

The fourth step is the Q sorting (Brown, 1993). During the Q sorting process, the participants are usually forced to rank a set of items in a predetermined quasi-normal distribution (Figure 1), according to a specific condition of the instructions (e.g., from disagree [-4] to agree [+4]). The kurtosis of this distribution is set according to the researcher *a priori* knowledge or hypotheses about the controversiality of the topic (Van Exel, 2005): since in our case the knowledge of the respondents about innovations in the dairy systems was expected to be low, the distribution was steep, to leave more room for ambiguity, indecisiveness or error in the middle of the distribution. The participants in the survey were asked to read the cards and to divide them into three groups: the statements they most like, the statements they least like; and the statements that they felt neutral about. They were then asked to sort the 34 statements from ‘least like’ (+1) to ‘most like’ (+9). A positive linear scale, instead of the traditional bi-polar scale, was used to facilitate the Q sorting exercise. The neutral point was set at 5 in the central point of the distribution. This peculiar scale was used since - in a pilot exercise - the participants voiced out their difficulties if they were forced to allocate a negative ranking to an innovation. They had to rank the statements in terms of which kind of innovation would be their best choice in organic and low-input dairy farming. By cross-comparing and placing the statements in the score sheet, each respondent had the opportunity to reveal their own patterns of subjectivity. At the end of the Q sorting, personal interviews or group discussions were used to allow participants to explain their points of view, especially for the statements at the ends of the scale, as those that they had scored as +1 and +9.

Once all of the participants had completed the matrix of cross-correlations between all of the Q sorts, the data were factor analysed to identify patterns across individuals (Previte et al., 2007; Barry and Proops, 1999). Usually, most of the Q sorts produce less than three factors that can explain the majority of the variance. Each factor extracted describes a specific point of view relating to the topic under investigation, and each factor loading gives the extent to which a participant agrees or disagrees with any particular factor. According to the methodology, respondents who have sorted the statements in similar ways usually have loading on the same factor.

2.2. Data collection and sampling

After a pilot study held in Aberystwyth in December 2011, we refined the statements included in the final Q sample and their actual wording. Due to the trans-national nature of this study, the concourse and the final Q sample were developed in English. Each statement was

translated and back translated, from English to the national languages of the countries involved in the survey (Finland, Belgium, Italy, the United Kingdom), to test the comprehension of the statements in a way that was understandable in any cultural context (Brisling, 1970). The pilot study aim was twofold: it allowed checking the consistency of the Q sample – out of the concourse gathered through a diversity of sources –, but also solving problems of comprehension out of the target population. To tackle the issue of different ‘social’ languages between consumers, farmers and retailers/processors, following Deignan (2012), we allowed for heteroglossia and the plural nature of subjectivity by wording statements in the least (technically) complex language: that of consumers, to be sure that understanding was not biasing values and viewpoints.

The fieldwork started in March 2012 and ended in July 2012. Focus group sessions and one-to-one interviews were organised in each country to collect the individual data on the Q sorts and then to discuss the participant choices. Each respondent elaborated their own a Q sort that reflects their specific personal point of view about the topic under investigation.

The study focused on the understanding of the points of view of three categories of dairy supply-chain members: Consumers, Farmers and Retailers & Processors. As the focus of Q methodology is on the extent to which the subjects are similar or dissimilar to each other rather than on the sample size (Brown, 1991), we planned to analyse the opinions of at least five participants in each category in each of the countries involved in the study (Belgium, Italy, Finland, the United Kingdom). The study population were dairy farmers (particularly those interested in organic and low-input farming) and agricultural supply-chain members (including retailers, processors and consumers). The participants were recruited in each country. The final P set included 36 ‘Consumers’, 33 ‘Farmers’ and 30 ‘Retailers & Processors’ (**Table 2**).

3. Results

The analysis of the Q sorts was carried out using the PQMethod software (Schmolck, 2002). We transformed the original scores (+1 to +9) and used the customary scale from (-4) to (+4) to present data of the factor scores (**Table 7**). A correlation matrix of the Q sorts was built, which partitioned the P set into the three categories, as the Consumers, Farmers and Retailers & Processors. Then, the Q sorts of each group were factor analysed, using centroid factor analysis with varimax rotation (Watts and Stenner, 2012). To extract significant factors, the Brown rule was applied (Brown, 1980). The number of factors was determined by selecting

the factors with factor loadings – correlations between Q sorts – that were statistically significant at the 0.01 level; i.e., those exceeding ± 0.44 ($\pm 2.58 \times \text{standard error [SE]}$; with $SE = 1/\sqrt{\text{number of statements}}$). The rotated factor loadings for each of the three supply-chain groups, which explain the degree of correlation of each respondent with each Q sort, are shown in Table 3, Table 4 and Table 5. Therefore, only the first two factors were selected for each category; this solution accounted for most of the total variance (**Table 6**) for each supply-chain level. For the category of Consumers, the two factors accounted for 36 Q sorts and 47% of the explained total variance. For the group of Farmers, the two factors accounted for 30 Q sorts and 49% of the explained total variance. In the category of Retailers & Processors the two factors accounted for 30 Q sorts and 51% of the explained total variance.

A scree test – plotting of the eigenvalues on a line graph – also confirmed the choice for the three categories. In the scree test, the number of factors to extract was selected by looking at a sort of ‘elbow’ in the graph, as “the point at which the line changes slope” (Watts and Stenner, 2012). Once the two factors were selected, the varimax rotation was used “to maximize the amount of study variance explained” (Watts and Stenner, 2012).

The interpretation of factors proceeded in terms of factor arrays (Addams, 2000): the scores obtained for each statement as a sort of weighted average of the scores given to that statement by the Q sorts related to that factor (Addams and Proops, 2000). The factor scores were automatically calculated by the PQMethod software. The distinguishing statements with their factor arrays are shown in **Table 7** for each category of respondents (Consumers, Farmers, Retailers & Processors).

The factors are the subjective composite viewpoints that emerged from the participants in the Q sorting process. Distinguishing statements outline different attitudes or viewpoints on the discourse surrounding the topic being investigated. For each supply chain category, distinguishing statements – ranked statistically significantly differently by the factor group – and eventually consensus statements i.e., similarly liked or disliked between the 2 factors – were identified for understanding the positions represented by the factor groups.

3.1. Consumers

Animal welfare appeared relevant for both factors, although with differing underlying motivations; in the first factor, the focus was on the animal; in the second factor, the quality and its effects on human health appeared to be more relevant. Factor 1 explained 27% of the study variance and 20 participants were significantly associated with this factor. Factor 2

explained 20% of the study variance and 16 participants were significantly associated with this second factor.

3.1.1. Factor 1: Natural Animal Health and Welfare Purism

For this factor, the three top-ranked distinguishing statements show that innovations aimed at improvements to animal welfare and health were highly valued. Innovation in animal housing was relevant to increased animal welfare (**16**, +4)², together with prolonged maternal feeding (**12**, +4) and innovations that eliminate the use of antibiotics (**13**, +3). Innovations focused in other areas were less interesting.

The importance of animal welfare, as explained by the participants during the post-sort discussions and interviews, was related to ethical reasons. Consumers in this group are strongly reluctant for innovation that might have negative impacts on animal welfare or might change the ‘rhythms of nature’. Ethical concerns, specifically in relation to standards of animal welfare, explain the reason why any chemicals processing should be banned and indoor dairy systems should be improved. For example, this factor rejected the innovation of improving the digestibility of feeds via physical, chemical, or other processing (**32**, -3); while improving animal welfare in indoor dairy system (**34**, +3), is a mean to provide the animals in organic dairy systems – already free range systems – with higher levels of welfare.

3.1.2. Factor 2: Quality Advocacy

This factor represents the viewpoint that “we are what we eat”. Therefore, what the cows eat will influence the health of the cow and the milk quality. The idea of this factor is that using better forage could influence the quality of milk (**7**, +4). Another relevant innovation for this group was related to the use of herbs in pastures with phytotherapeutic properties (**6**, +4). This factor supported improving the milk quality by applying innovations only when they follow natural cycles, promote a “natural” feeding, by herbs in pastures, animal health or better use of forage. Within this factor there were those Consumers who prefer innovations relating to changes and improvements in the use of forage and related to various aspects of the farming system. For example, this factor was concerned with the development of soil biodiversity, to increase the feed value of forage (**4**, +3), and was interested in the (quality) benefits of short dairy supply chains (**31**, +3). The possibility of controlling the traceability of milk (**14**, +2)

² In the brackets from this point on, there are the number of the statement (**in bold**) and the factor(s) average Q scores (arrays).

was also an important aspect. Unless factor one, this factor rejected, with a very negative ranking, 100% indoor-housing solutions (**34**, -3).

3.2. Farmers

Both factors (**Table 7**) recognized the importance of new solutions for efficient use of home-grown feed (**19**, +3, +4). Factor 1 explained 25% of the study variance and 18 participants were significantly associated with this factor. Factor 2 explained 24% of the study variance and 13 participants were significantly associated with this factor. Three Q-sorts were not associated significantly with either factor.

3.2.1. Factor 1: Customer Focus

This factor appears to involve two different kinds of innovations: those aimed at animal welfare (which we know were highly valued by Consumers), and those aimed at increasing the services of a dairy supply chain. This factor is certainly concerned about the improved efficiency and customer convenience of the short supply chains in the dairy sector (**31**, +4), and favours innovation related to the processing of raw milk in the dairy systems (**15**, +2). Animal welfare was a clear concern (**16**, +3; **6**, +3).

3.2.2. Factor 2: Farm Management

Factor two highly ranks innovations in feeding and in soil management. More in general, this factor supports innovations that can help the organic and low-input ‘farming systems’ in an efficient way. As the ‘farm managers’, they are concerned about increasing crop and soil management to improve the nitrogen cycle (**23**, +3), and about developing approaches to manage health problems during the transition between gestation and lactation (**25**, +2). According to post-sorts interviews, useful and concrete innovations are highly appreciated only if they can reduce production costs.

3.3. Retailers & Processors

The two factors focuses on distinct innovation areas, but they both show preference for animal welfare (**16**, +3, +2; **13**, +2, +1). Factor 1 explained 30% of the study variance and 16 Q-sorts were significantly associated with this factor. Factor 2 explained 21% of the study variance and 14 Q-sorts were significantly associated with this.

3.3.1. Factor 1: Low Input Forerun

The top three top-ranked distinguishing statements in this factor were essentially related to innovations connected to a strong interest in ecological and efficiency issues. Developing the use of herbs in pastures (**6**, +4) and prolonging maternal feeding in an efficient way (**12**, +4) were consistent with improving logistics to reduce the carbon footprint (**8**, +3). Overall this group preferred practical innovations that can improve the efficiency of a low-input supply chain.

3.3.2. Factor 2: Forage Advocacy

The Retailers & Processors represented by this factor were highly concerned about forage and forage quality (**5**, +4; **4**, +3; **7**, +3). This may go together with increasing the use of home-grown feed (**19**, +4) and improving on-farm recycling of nitrogen (**23**, +3). Strangely enough, traceability was not their main concern (**14**, -2).

4. Discussion

These data provide input for further reflection and discussion on innovations in dairy farming. The supply-chain members in the four countries investigated did not uniformly perceive the acceptability of innovations in the dairy farming system. Consensus across all of the participants within the supply chain was mainly on innovations that were deemed not to be acceptable in organic and low-input dairy systems. Supply-chain members strongly rejected innovations perceived as reducing the quality of agricultural input by including some sort of GM organisms or transgenic solution in the farming system. As all of the participants had primarily been individuals and dairy consumers before being supply-chain members, they negatively evaluated innovations that relate to the application of biotechnology or that can be perceived as conflicting with the ‘naturalness’ of the production. This is clearly the case for statements no. 18, 26 and 28, which never reached factor scores >-3 in the arrays. As highlighted in other studies, when individuals perceive food processing technologies as unfamiliar due to the possible presence of unacceptable uncertainty or unknown risks (Grunert et al., 2011), related innovations are rejected or at least considered suspicious.

Furthermore, rating some rather complex and technical innovations well-known to farmers, but somewhat unknown to consumers, accounts for some of the observed variability in Q sorts. Even if we accounted for the heteroglossia and used the least technical language, some consumers did not have full previous knowledge of all the concepts and innovations

presented. Consumers strongly disliked and rejected all innovations related to farming practices that moved away from ‘natural’ cycles and organic agriculture (statements no. 26, 28, 29, 32, 33).

The consensus on innovations that related to the quality of feed and new forage varieties specific for organic and low-input farming was also relatively high across the respondent categories, even though the supply-chain members associate these innovations with different benefits. Both factors two of the Consumers and the Retailers & Processors appeared to give great importance to feed quality – and especially forage – as a means to improve milk quality. The viewpoint that the cows (and us) “are what we eat” is apparently shared across these two groups. The role of forage quality and composition for improved milk quality is known to be highly relevant, and this represents a promising area of research (Dewhurst et al., 2006). Nevertheless, on the one hand, the Consumers and Retailers & Processors groups assigned great importance to innovations that related to the quality of feedstuff, and post-sorting interviews and discussions with the respondents clarified that this is positioned in relation to the quality of milk and dairy products. The type of feeding – animal-feed composition – and the presence of GM ingredients significantly affected the quality that they perceived for the product (Naspetti et al., 2012). On the other hand, farmers were centred on the development of new forage varieties and the use of home-grown feed.

In general, the Q scores did not differ that much across the respondent categories, nor between the factors. Near polarisation occurred in only two cases, both of which were related to animal welfare. Prolonging maternal feeding (statement no. 12) was seen as highly acceptable by both Consumer factors and by factor one of Retailers & Processors, although this was highly rejected by the other factor. Farmers were substantially neutral on this matter. Contrary with all other factors, only the first Consumer factor – highly concerned with animal welfare – deemed innovation in indoor housing (100% housed) for dairy systems as a highly acceptable innovation. In general, Consumers – not only for factor one – tended to prefer innovations that are aimed at improvements to animal welfare (e.g., maternal feeding, inside housing, herbs in pastures) and low levels of interference with any natural process (e.g., genetic manipulation, speeding-up of animal maturity). On one side, consumer concern regarding food processing in general has increased during the last few years in most European countries due to food scares. On the other side, conveying innovations that improve animal welfare can be difficult since the consumer perceives them as extrinsic quality cues that are not easily verifiable (credence attribute) and the costs associated with them might increase on-farm production costs. Nevertheless, a trade-off between the farmers and the needs of the

consumer is crucial (Olynk and Ortega, 2013). This should consider that the cost price per litre of milk at the farmer level in the EU is among the highest in the world due to the costs of milk quotas and animal welfare regulations, and the relatively high costs of inputs into the dairy-farming system. In the near future, competitors like New Zealand, Australia and South American, where the cost are lower, might benefit more from increasing world demand (Tacken et al., 2009).

Even though innovations to improve animal welfare are important to Farmers and Retailers & Processors groups, these two groups prefer those innovations that are related to feed quality, efficiency and soil management. Especially for Farmers, the feeding quality and the efficiency of resources used appeared to be important in the evaluation of innovation priorities; they particularly valued those innovations that lead to minimising the use of purchased feed through better use of home-grown feed and new forage varieties, and the contemporary aims for improvements in the input quality. The post-sorting interviews and discussions showed that one group of Farmers (factor two) especially favoured innovations relating to sustainability only if they can also improve the economic viability of the farm. Organic and low-input dairy systems have received much attention as more sustainable methods of farming. There is evidence from the literature that farming and breeding practices that maintain the biodiversity are of the utmost importance for food production, health and the maintenance of ecosystems (Thrupp, 2000).

5. Conclusions

A wide range of factors influences the decision-making process of supply-chain members, and their willingness to make changes and adopt innovations. Economic theory would suggest that profit maximisation is the main driver, but other factors have significant roles as well as the relative profitability of the new systems, such as: personal attitudes towards the environment; social factors and professional relationships; agricultural policy; and the natural resources of the farm (Edwards-Jones, 2006). Participatory research processes and collaboration along the supply chain will enable all of these drivers to be taken into account and will facilitate the adoption of innovations (Naspetti et al., 2011).

This Q methodology study was aimed at obtaining an understanding of the viewpoints of organic and low-input dairy supply-chain members in relation to innovations aiming to more sustainable farming systems. According to Brown (1980), a central concept behind Q methodology is that there are only a limited number of distinctive viewpoints on any topic. A

well-thought-out Q sample and a well-designed Q methodology study that contains a wide range of existing opinions on the topic will indeed reveal these viewpoints. Although the results of any Q study cannot be enlarged to the population, as they are only related directly to the individuals who participate, the wide range of viewpoints included in the present study provide a statistically rigorous picture of the possible different supply-chain perspectives in the broader population.

The factors extracted identified synergies between various groups, showing that there is a consensus for non-GM solutions (among all of the respondent groups) and that especially the consumers and some of the farmers give importance to animal welfare. The efficiency of the supply chain and the better use of forage and feed appear to be an important concern, especially for farmers, retailers and processors, although forage quality is crucial also for a group of the consumers, as a means to improving milk quality.

These findings can contribute in the identification of pathways of changes and valuable opportunities for innovations to be introduced into the dairy system. The European dairy industry still accounts for 13% of the total food and drink turnover (CIAA, 2012), but this is now facing many challenges. The abolition of milk quotas and full liberalisation will affect the dairy industry competitiveness in the near future. The dairy business is still a leader in food innovation (7.8% for total food industry: CIAA, 2011), although innovations in dairy products have become a necessity now, given the rapidly changing environment in which the European agro-food industries operate.

Our study, based on the voicing of different stakeholders views, supports setting an agenda for innovations in the dairy sector, which is based on a relatively wide consensus. In other words, as pointed out by Brown and Ungs (1970) this appears to be a case in which "situations are more numerous and variable than persons", since crucial issues such as GMOs appear to be unanimously rejected. Further research should confirm these finding in a larger group of countries and stakeholders.

Finally, policy makers consider that the global evolution of market forces at the international level, and the European dairy sector reaction to this, will require new policy measures stimulating research in new products as well as in milk processing (DG agri, 2012).

A well-balanced policy should be informed by stakeholders' views and the logic of their respective beliefs. Asymmetries in stakeholders' power may be modified over time through the better identification and pursuit of shared values and goals. Our study shows that Q methodology – with its ability to account for heteroglossia in social discourses and to

operationalise salient beliefs and attitudes in Q Factors – may help to develop more democratic and effective policies, as postulated by Deignan (2012).

References

- Addams, H., Proops, J., 2000. *Social Discourse and Environmental Policy: an Application of Q Methodology*. Cheltenham: Edward Elgar.
- Augustin, M.A., Udabage, P., Juliano, P., Clarke, P.T., 2012. Towards a more sustainable dairy industry: integration across the farm–factory interface and the dairy factory of the future. *Intl. Dairy J.* 1–10.
- Barry, J., Proops, J., 1999. Seeking sustainability discourses with Q methodology. *Ecol. Econ.* 28, 337–345.
- Brislin, R.W., 1970. Back-translation for cross-cultural research. *J. Cross-Cult. Psychol.* 1, 185–216.
- Brodts, S., Klonsky, K., Tourte, L., 2006. Farmer goals and management styles: implications for advancing biologically based agriculture. *Agricult. Syst.* 89, 90–105.
- Brown, S.R., 1970. On the use of variance designs in Q methodology. *Psychol. Rec.* 20, 179–189.
- Brown, S.R., 1980. *Political Subjectivity, Applications of Q Methodology in Political Science*. New Haven, CT: Yale University Press.
- Brown, S.R., 1991. A Q methodological tutorial, <http://facstaff.uww.edu/cottlec/Qarchive/Primer1.html>.
- Brown, S.R., 1993. A primer on Q methodology. *Operant Subj.* 16, 91–138.
- Brown, S.R., 1996. Q methodology and qualitative research. *Qualit. Health Res.* 6, 561–567.
- Brown, S.R., Ungs, T.D., 1970. Representativeness and the study of political behavior. *Social Science Quarterly*, 51, 514–526.
- Capitanio, F., Coppola, A., Pascucci, S., 2009. Indications for drivers of innovation in the food sector. *Brit. Food J.* 111, 820–838.
- CIAA (2012). *Data & trends of the European food and drink industry*. Confederation of Food and Drink Industries of the EEC. Annual Report 2011, http://www.fooddrinkeurope.eu/uploads/publications_documents/1527_FoodDrinkEurope_AR11_12_FINAL_7.6.2012.pdf
- CIAA (2011). *Data & trends of the European food and drink industry*. Confederation of Food and Drink Industries of the EEC. Annual report 2011, <http://www.aijn.org/file.handler?f=juicy-news%2FCIAA%20Data%20and%20Trends%202011-27-05.pdf>

- Darnhofer, I., Schneeberger, W., Freyer, B., 2005. Converting or not converting to organic farming in Austria: farmer types and their rationale. *Agricult. Human Val.* 22, 39–52.
- Davies, B.B., Hodge, I.D., 2007. Exploring environmental perspectives in lowland agriculture: a Q methodology study in East Anglia, UK. *Ecol. Econ.* 61, 323–333.
- Deignan, T., 2009. Enquiry-based learning: Perspectives on practice. *Teaching in Higher Education*, 14(1):13-28
- Deignan, T., 2012. A Novel Approach to Policy and Practice, Operant Subjectivity: The International Journal of Q Methodology, 35(2): 102-128
- Dewhurst, R.J., Shingfield, K.J., Lee, M.R.F., Scollan, N.D., 2006. Increasing the concentrations of beneficial polyunsaturated fatty acids in milk produced by dairy cows in high-forage systems. *Anim. Feed Sci. Technol.* 131, 168–206.
- DG Agri, 2012. Prospects for Agricultural Markets and Income in the EU2012-2022, Commission's Directorate-General for Agriculture and Rural development, European Commission, Agriculture and Rural Development, December 2012
- Doan, A.R., Chambers, E., 2012. Predicting success for new flavours with information known pre-launch: a flavored snack food case study. *Food Qual. Pref.* 25, 116–120.
- Donaldson C, Baker R, et al., 2010. European Value of a Quality Adjusted Life Year. Final Publishable Report of the EUROVAQ project (SP5A-CT-2007-044172). Retrieved from: http://research.ncl.ac.uk/eurovaq/EuroVaQ_Final_Publishable_Report_and_Appendices.pdf
- Dryzek, J., Berejikian, J., 1993. Reconstructive democratic theory. *Am. Political Sci. Rev.* 87, 48–60.
- Eden, S., Bear, C., Walker, G., 2008. The sceptical consumer? Exploring views about food assurance. *Food Pol.* 33, 624–630.
- Edwards-Jones, G., 2006. Modelling farmer decision-making: concepts, progress and challenges. *Anim. Sci.* 82, 783–790.
- Estrada-Flores, S., 2008. Sustainable co-innovation: the food supply chain as a case study. Food chain intelligence, public report. http://www.dfat.gov.au/trade/export_review/submissions_received/FoodChainIntelligencePartA.pdf
- European Commission, 2012. The 2011 EU Industrial R&D Investment Scoreboard. European Commission available at <http://iri.jrc.ec.europa.eu/reports.htm>
- Falconer, K., 2000. Farm-level constraints on agri-environmental scheme participation: a transactional perspective. *J. Rural Stud.* 16, 379–394.

- Fisher, R.A., 1960. *The Design of Experiments*. 7th ed. Oliver and Boyd, London.
- Glaser, B.G., Strauss, A.L., 1967. *The Discovery of Grounded Theory: Strategies for Qualitative Research*. Aldine the Gruyter, Hawthorne.
- Grunert, K.G, Bruce Traill W., 1997. *Products and Process Innovation in the Food Industry*. Springer.
- Grunert, K.G, Verbeke, W., Kügler, J.O., Saeed, F., Scholderer, J., 2011. Use of consumer insight in the new product development process in the meat sector. *Meat Sci.* 89, 251–258.
- Hall, C., 2008. Identifying farmer attitudes towards genetically modified (GM) crops in Scotland: are they pro- or anti-GM?. *Geoforum*, 39, 204–212.
- Jongen, W.M.F., Meulenberg, M.T.G., 2005. *Innovation in Agri-Food Systems*. Wageningen Academic Publishers. Wageningen.
- Kotler, P., 1994. *Marketing Management: Analysis, Planning, Implementation and Control*. 8th ed. Englewood Cliffs, N.J. Prentice-Hall.
- Kristensen, E., Enevoldsen, C., 2008. A mixed methods inquiry: how dairy farmers perceive the value(s) of their involvement in an intensive dairy herd health management program. *Acta Vet. Scand.* 50, 50–12.
- Kristensen, E., Jakobse, E.B., 2011. Danish dairy farmers' perception of biosecurity. *Prevent. Vet. Med.* 99, 122–129.
- McKeown, B., Thomas, D., 1988. *Q Methodology*. Newbury Park, CA: Sage Publications.
- Marquer, P., 2013. Milk and dairy production statistics. *Statistics in focus* 17/2013. http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Milk_and_dairy_production_statistics, download on 14.08.2013.
- Midmore, P., Padel, S., McCalman, H., Isherwood, J., Fowler, S., Lampkin, N., 2001. Attitudes towards Conversion to Organic Production Systems: A Study of Farmers in England. http://orgprints.org/8441/1/midmore_padel_Attitudes_conversion.pdf
- Naspetti, S., Alberti, F., Solfanelli, F., 2012. Quality determinants in the organic cheese supply chain: a quality function deployment approach. *New Medit*, XI (4), 61 – 64.
- Naspetti, S., Lampkin, N., Nicolas, P., Stolze, M., Zanolli, R., 2011. Organic supply chain collaboration: a case study in eight EU countries. *J. Food Prod. Market.* 17, 141–162.
- Neely, A., Hii, J., 1998. *Innovation and Business Performance: a Literature Review*. Government Office for the Eastern Region, Cambridge.

- Olynk N.J., Ortega D.L., 2013. Consumer preferences for verified dairy cattle management practices in processed dairy products. *Food Cont.* 30, 298–305.
- Omta, S.W.F., Folstar, P., 2005. Integration of innovation in the corporate strategy of agrifood companies. In: *Innovation in Agri-Food Systems*. Wageningen Academic Publishers. Wageningen.
- Padel, S., (2002). Conversion to organic milk production: the change process and farmers' information needs. Institute of Rural Studies. Aberystwyth, University of Wales, Aberystwyth.
- Previte, J., Pini, B., Haslam-McKenzie, F., 2007. Q methodology and rural research. *Sociol. Ruralis* , 47, 135–147.
- Regouin, E., 2003. To convert or not to convert to organic farming. *Organic Agriculture: Sustainability, Markets and Policies*. Organisation for Economic Cooperation and Development. Wallingford, CT: CAB International, 227-335.
- Rhoads, J.C., Brown, S.R., 2002. "Sex, lies, and videotape": Attitudes toward the Clinton impeachment. *Operant Subjectivity*, 25, 99-116.
- Ronteltap, A., van Trijp, J.C.M., Renes, R.J., Frewer, L.J., 2007. Consumer acceptance of technology-based food innovations: lessons for the future of nutrigenomics. *Appetite*, 1, 1–17.
- SCAR, 2008. Towards a coherent strategy for a European Agricultural Research Agenda, EU publication.
http://ec.europa.eu/research/agriculture/scar/pdf/comm_twds_coh_str_4_eara_en.pdf
- Schmolck, P., 2002. PQMethod Manual. Available at
<http://www.lrz.de/~schmolck/qmethod/pqmanual.htm>
- Smit, A.H., Driessen, P.J., Glasbergen, P., 2009. Conversion to organic dairy production in the Netherlands: opportunities and constraints. *Rural Soc.* 74, 383–411.
- Smith, E., Marsden, T., 2004. Exploring the “limits to growth” in UK organics: beyond the statistical image. *J. Rur. Stud.* 20, 345–57.
- Stephenson, W., 1935. Correlating persons instead of tests. *Charac. Personal.* 4, 17–24.
- Stephenson, W., 1936a. The inverted factor technique. *Brit. J. Psychol.* 26, 344–361.
- Stephenson, W., 1936b. The foundations of psychometry: Four factor systems. *Psychometrika* 1, 195–209.
- Stephenson, W., 1953. *The Study of Behaviour: Q Technique and its Methodology*. Chicago: University of Chicago Press.

- Tacken, G.M.L., Batowska, A., Gardebroek, C., Nisha, K., Turi, Banse, M., Wijnands, J.H.M., Poppe, K.J., 2009. Competitiveness of the EU Dairy Industry, The Hague, LEI, Report 2009-011.
- Thrupp, L.A, 2000. Linking agricultural biodiversity and food security: the valuable role of agrobiodiversity for sustainable agriculture. *Intl. Aff.* 76, 265–281.
- Van Exel, N.J.A., de Graaf, G. 2005. Q methodology: A sneak preview. [available from www.jobvanexel.nl]
- Watts, S., Stenner, P., 2012. *Doing Q Methodological Research: Theory, Method and Interpretation*. London: Sage.
- Webler, T., Tuler, S.P., 2006. Four perspectives on public participation process in environmental assessment and decision making: combined results from 10 case studies. *Policy Studies Journal*, 34 (4): 699-722.

Table 1. The structured sampling matrix

Dairy farming category	Breeds	Feed	Management practice on farm and supply chain
Organic	2	5	5
Low input	4	3	7
Conventional	3	3	2

+1	+2	+3	+4	+5	+6	+7	+8	+9
+1	+2	+3	+4	+5	+6	+7	+8	+9
	+2	+3	+4	+5	+6	+7	+8	
		+3	+4	+5	+6	+7		
			+4	+5	+6			
				+5				

Figure 1 Q sorting score sheet

Table 2. The P set composition

Country	Belgium	Italy	Finland	United Kingdom	Total
Consumers	9	8	9	10	36
Farmers	5	9	11	8	33
Retailer/Processor	7	7	8	8	30

Table 3 Rotated factor loadings for Consumers

No. Q sort	ID Q sort	F1	F2
1	1-ITA	0.4141X	0.3285
2	2-ITA	0.4741	0.6046X
3	3-ITA	0.2897	0.6952X
4	4-ITA	0.4683X	0.3790
5	5-ITA	0.3469	0.6143X
6	6-ITA	0.6684X	0.3057
7	7-ITA	0.4771X	0.1602
8	8-ITA	0.4519X	0.3102
9	1-BE	0.7657X	0.2327
10	2-BE	0.6906X	0.3958
11	3-BE	0.5464X	0.2715
12	4-BE	0.7634X	0.3105
13	5-BE	0.5351X	0.2360
14	6-BE	0.5511X	0.4324
15	7-BE	0.4120	0.4333X
16	8-BE	0.6004X	0.1671
17	9-BE	0.3837	0.6050X
18	1-FIN	0.4832X	0.4445
19	2-FIN	0.6889X	0.2005
20	3-FIN	0.8538X	0.1865
21	4-FIN	0.7347X	0.2602
22	5-FIN	0.4173X	-0.3569
23	6-FIN	0.2104	0.3569X
24	7-FIN	0.7177X	0.3108
25	8-FIN	0.7420X	0.2754
26	9-FIN	0.6617X	0.3565
27	1-UK	0.3478	0.6674X
28	2-UK	0.3441	0.5091X
29	3-UK	0.4335	0.6752X
30	4-UK	0.0561	0.7462X
31	5-UK	-0.0533	-0.4403X
32	6-UK	0.2292	0.6252X
33	7-UK	0.1455	0.6464X
34	8-UK	0.3882	0.5025X
35	9-UK	0.3749	0.4260X
36	10-UK	0.3976	0.4670X
%expl. Var.		27	20

Table 4 Rotated factor loadings for Farmers

No. Q sort	ID Q sort	F1	F2
1	1-ITA	0.6412X	0.0155
2	2-ITA	0.6292X	0.1676
3	3-ITA	0.4669X	0.3882
4	4-ITA	0.5893X	0.1527
5	5-ITA	-0.1115	0.1766
6	6-ITA	0.7377X	0.0934
7	7-ITA	0.5793X	0.3391
8	8-ITA	0.3311	0.0449
9	9-ITA	0.5506X	0.5487
10	1-UK	0.0829	0.2103
11	2-UK	0.5035X	0.4121
12	3-UK	0.404	0.4685X
13	4-UK	0.0036	0.7672X
14	5-UK	0.4694	0.5982X
15	6-UK	0.2113	0.7594X
16	7-UK	0.3031	0.8197X
17	8-UK	0.3257	0.4215X
18	1-FIN	0.5348X	0.2981
19	2-FIN	0.5323	0.6241X
20	3-FIN	0.4472	0.6496X
21	4-FIN	0.5895X	0.5449
22	5-FIN	0.5826	0.5956X
23	6-FIN	0.5975X	0.3817
24	7-FIN	0.6489X	0.484
25	8-FIN	0.3036	0.7778X
26	9-FIN	0.5577X	0.4439
27	10-FIN	0.4139	0.5958X
28	11-FIN	0.4867X	0.4484
29	1F-BE	0.6464X	0.4761
30	2F-BE	0.6417X	0.4708
31	3F-BE	0.3907	0.6802X
32	4F-BE	0.5418X	0.466
33	5F-BE	0.6701X	0.3345
%expl. Var.		25	24

Table 5 Rotated factor loadings for Retailers & Processors

No. Q sort	ID Q sort	F1	F2
1	1-ITA	0.7763X	0.257
2	2-ITA	0.6597X	0.389
3	3-ITA	0.7712X	0.3352
4	4-ITA	0.4108	0.4258X
5	5-ITA	0.7886X	0.2444
6	6-ITA	0.7773X	0.2601
7	7-ITA	0.6647X	0.342
8	1-UK	0.7221X	0.3492
9	2-UK	0.1552	0.7940X
10	3-UK	0.2074	0.6131X
11	4-UK	0.2392	0.4371X
12	5-UK	0.5723X	0.5611
13	6-UK	0.3372	0.7733X
14	7-UK	0.4764X	0.2234
15	8-UK	0.4755	0.6471X
16	1-FIN	0.1951	0.5499X
17	2-FIN	0.7662X	0.1395
18	3-FIN	0.045	0.6856X
19	4-FIN	0.3279	0.4740X
20	5-FIN	0.433	0.4911X
21	6-FIN	0.5951X	0.0929
22	7-FIN	0.7083X	0.2267
23	8-FIN	0.0577	0.4644X
24	1-BE	0.3907	0.5666X
25	2-BE	0.6784X	0.3951
26	3-BE	0.4981X	0.3092
27	4-BE	0.5579	0.5697X
28	5-BE	0.6687X	0.1579
29	6-BE	0.4008	0.5631X
30	7-BE	0.6899X	0.222
%expl. Var.		30	21

Table 6. The Eigenvalues and variance explained for each category

	Factor arrays	
	Factor 1	Factor 2
Consumers		
Eigenvalues	14.4676	2.2626
% expl. Var.	27	20
Farmers		
Eigenvalues	14.6533	1.6781
% expl. Var.	25	24
Retailers & Processors		
Eigenvalues	13.2399	2.0849
% expl. Var.	30	21

Table 7. Factor arrays

N°	Distinguishing Statements	Consumers		Farmers		Retailers & Processors	
		F1	F2	F1	F2	F1	F2
1	Improve breed performance in different natural environments.	-1	1	-1	0	-1	1
2	Identify adapted breeds for organic and low input production systems	2	1	1	1	0	1
3	Reduce the risk of genetically modified organism (GMO) contamination in dairy feed by optimal use of protein alternative to soy.	1	2	1	2	0	2
4	Develop techniques to improve soil biodiversity to increase the feed value of forage.	1	3	2	4	1	3
5	Develop new forage varieties specific for organic and low-input farming.	2	2	4	3	0	4
6	Develop the use of herbs in pastures for their phytotherapeutic properties to reduce animal health problems.	2	4	3	0	4	0
7	Improve milk quality by better use of forage.	0	4	2	3	1	3
8	Improve the carbon footprint of dairy supply chains through improved logistics.	2	2	0	0	3	1
9	Develop an efficient network for the selling of biogas from livestock manure and slurry.	0	0	-2	-1	-1	0
10	Improve storage and processing methods for organic food products to maximise their nutritional quality.	-1	1	1	0	1	0
11	Innovation in automation and robotics in dairy management.	-1	-2	1	-2	-2	0
12	Increase animal welfare by prolonging maternal feeding in an efficient way.	4	3	0	1	4	-2
13	Develop organic dairy production systems free of antibiotics.	3	1	2	2	2	1
14	Innovation in milk analysis to enable traceability (e.g., access to pasture, place of rearing, quality of feed).	0	2	-1	-1	1	-2
15	Innovation in on-farm processing of raw milk.	-2	0	2	-2	1	-1
16	Innovation in housing aimed at improving animal	4	1	3	1	3	2

	welfare.						
17	Selection of breeds for higher levels of desirable fatty acids in milk to produce healthier milk products.	-2	0	0	1	-2	-1
18	Improve forage quality and yields in low-input dairy systems by GM plant breeding techniques.	-3	-3	-3	-4	-3	-3
19	Minimise the use of purchased feed through efficient use of home-grown feed.	1	0	3	4	2	4
20	Develop management systems that reduce the use of wormers to control parasites.	0	0	0	0	0	-2
21	Improve forage conservation techniques to improve feed quality.	-1	0	0	1	2	2
22	Develop systems for reducing water and fossil-fuel consumption on organic and low-input farms.	3	-1	1	2	3	2
23	Advances in crop and soil management to improve on-farm recycling of nitrogen from slurry and manure.	1	-1	0	3	-1	3
24	Reduce the nitrogen in slurry and manure through better management of the animal diet.	0	-1	-1	-1	-1	0
25	Develop approaches to manage health problems during the transition between gestation and lactation.	1	-1	-1	2	0	1
26	Develop designer dairy food from transgenic animals.	-4	-4	-4	-4	-4	-4
27	Improve the efficiency of reproductive techniques acceptable for organic dairying.	-1	-1	-1	-1	0	-1
28	Acceleration of genetic selection including recombination <i>in vitro</i> (e.g. semen sexing).	-3	-4	-4	-3	-3	-3
29	Innovation in dietary supplements to increase milk yield and quality.	-2	-2	-3	0	-2	-2
30	Develop feed additives to reduce greenhouse gas emissions without reducing milk yield or quality.	-2	-2	-2	-2	-1	-1
31	Innovative solutions to improve the efficiency and customer convenience of short supply chains in the dairy sector.	0	3	4	-1	2	0
32	Improving the digestibility of feeds via physical, chemical or other processing.	-3	-2	-2	-3	-2	-3
33	Innovations to speed-up calf development so that they can breed earlier.	-4	-3	-3	-2	-4	-4
34	Innovation in indoor (100% housed) dairy systems	3	-3	-2	-3	-3	-1

to improve animal welfare.
