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Farmers' futures: an application of the Delphi method in the context of Finnish agriculture

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Abstract

In Finland, agriculture is practiced in variable growing conditions that are further challenged by climate change and under external pressure caused by international competition, changing consumer preferences and demands, and the renewal of the European Union Common Agriculture Policy and Paris Agreement climate targets. Futures studies in agriculture have focused on scenario building with expert panels, though usually without farmers' involvement. This study focuses on farmers' views of shaping the future of Finnish agriculture. It builds on the disaggregative Delphi method and combines interviews and a representative survey of Finnish farmers. The study is based on a bottom-up process in which a farmer panel of 20 farms defined their views of the future in a semi-structured thematic interview. The views were turned into statements in a structured survey sent to the second panel, which comprised all Finnish farmers who had received agricultural subsidies in 2016, with 4401 respondents. The results were analyzed using quantitative factor analysis, which produced five future images for Finnish agriculture. The images were shown to the original farmer panel for reflection. They considered the probability of each future image and their own role in it. *Technology solves* as a future image was most favored by farmers, followed by *Ecological and specializing small-scale production* image. *Business-as-usual* was the least likely future images according to the interviewed farmers. This paper describes the process and discusses both methodological benefits and pitfalls, as well as farmers' future views of the forthcoming decades.

Keywords Future images, Delphi, Agriculture, Farmer, Mixed methods, Factor analysis, Interview

Introduction

The farming of the future probably faces rapid changes in its operational environment. This may initiate many changes in agriculture, and some transformations are likely to be beyond farmers' potential influence: for example, the European Union's (EU) changing Common Agriculture Policy (CAP), obligations based on the Paris Agreement's climate targets, changes in consumer preferences, and new challenges caused by climate change to the agriculture in Finland.

Finland joined the EU in 1995, and the CAP therefore plays the central role in agricultural policies and subsidies available for Finnish farmers. Since 1995, the structural change in agriculture has been striking: the number of farms in Finland has declined from c. 100,000 in 1995 to c. 47,000 in 2019 [1], while the average farm size has more than doubled from 22 ha in 1995 to 49 ha in 2019. Farm size in Finland is therefore bigger than the average farm size in all EU member countries, i.e., 15 ha in 2016, similar to Sweden (48 ha), but lower than in Denmark (75 ha) [2]. Some 86% of Finnish farms were family-run, and the average age of the Finnish farmer was 53 in 2019. About 70% were crop production farms, and their land use has changed substantially away from traditional crops such as oats, barley and potato

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towards faba beans, peas, caraway, and spring oilseed rape in the 2000s, mainly driven by climate warming [3]. The remaining 30% were livestock farms, a high proportion of them dairy farms [1]. Some 11% of farms were organic producers in 2019 [4]. The average entrepreneurial income was 17,500 euros per year in 2018 [5], which is low compared to the average annual income wage earner's income of more than 41,000 euros [6]. Still with many structural barriers and changes together with unexpected rapid transformations in the agricultural production chain, such as the one caused by Russian war against Ukraine, farmers are the ones making the practical farm-level choices that influence the future of agriculture.

The Delphi method was originally developed in the 1960s as a tool for finding a consensus among experts regarding the future development of issues that were difficult to model [7, 8]. The method is often used to construct visions of the future, future images, and/or scenarios [9–11]. Usually, the Delphi method relies on expert views, but here, we rely on a more fluid definition of expertise where also practitioners, such as farmers, are experts on their own field [12]. Thus, in this research, the role of the expert is given to the farmers. Applying a Delphi-based mixed methods approach, Finnish farmers' future views on agriculture are being studied. The Delphi application consists of both qualitative and quantitative steps. The methodological approach of the applied Delphi is also evaluated, using evaluation criteria based on the Delphi literature.

The research questions for the study are as follows:

1) What kind of future views do the Finnish farmers have?
2) How well is the Delphi-based, mixed-methods application suited to study of practitioner based future views?

In "Delphi and the mixed-method approach" section, the materials and methods used are presented in detail. "Delphi method and its variants" section presents the results of the different steps of the Delphi-based process and the farmers' future views on Finnish agriculture. In "Overview of the mixed-method process" section, the farmers' future views and their implications are discussed, and the strengths and weaknesses of the Delphi-based method are evaluated. In the last section, conclusions are drawn of the future applications of the Delphi method together with future research needs.

Delphi and the mixed-method approach

Delphi method and its variants

Since the development of the Delphi method, it has been used in many applications that retain only the most important core elements of Delphi (Table 1). These include anonymity, iteration, and controlled feedback between rounds [8]. Later, many Delphi applications have abandoned the search for a consensus and use disaggregative methods to produce scenarios from a variety of expert views [29–32]. However, there are studies in which consensus-seeking is seen as a feasible goal for constructing scenarios [19].

Future scenarios are often used to address long-term challenges characterized by uncertainty and complexity, as they can help explore different alternative future pathways [33]. Images of the future are more static future states, i.e., "snapshots of the major features of interest at various points in time" [34, 35]. Images of the future do not necessarily contain an account of the flow of events leading to such future conditions, this temporal perspective would turn a future image into a future scenario.

Delphi represents a method that relies on experts and their expertise. However, the definitions of expertise can be fluid. For example, it can be argued that the practitioners of a field are lay experts, regardless of their

Table 1 Diverse ways of using the Delphi method

Approaches	Weight on	
1. Quantitative large panel survey *vs.* qualitative participatory process	Quantitative, survey-based Delphi [13]	Qualitative participatory Delphi process [14]
2. Laypeople vs. expert opinion	Laypeople [15, 16]	Experts [9, 17]
3. Consensus vs. dissensus	Building consensus (von [18, 19]	Dissensus as a source of alternative scenarios [11, 20]
4. Anonymity vs. known participants	Anonymity [7]	Known expertise and experts [21, 22]
5. Roundless vs. several rounds	Roundless, almost real-time Delphi method [23, 24]	Several rounds of the Delphi process [11]
6. Forecasting vs. foresight (alternative scenario construction)	Forecast (Experimental forecasting Delphi) [25]	Foresight (scenario construction of energy futures on farms) [26]
7. The accuracy in forecasting vs. surprising and extreme future views	Forecasting accuracy [27]	Surprising and extreme futures [28]

educational degrees or official positions. Farmers, for example, have a great deal of expertise in agriculture and its development. The line between an expert and a knowledgeable layperson can be blurred [12]. Many expert-based studies fail to take such expertise into account in considering the future of the field. Recent Finnish future studies in agriculture have mainly employed expert panels [10, 36]. Although expert views are valuable, it is also important to study how the farmers themselves view the challenges and opportunities they are going to face in the future. It can also be argued that it is democratic to ask the practitioners themselves what the future of their field looks like—especially the desirable future—not least because farmers are those who implement virtually all farm-scale transformations [37, 38].

Overview of the mixed-method process

This study is based on a bottom-up process based on farmers' views. A three-round Delphi approach was developed, which included both qualitative and quantitative elements (Fig. 1). In 2016, the first panel consisting of 20 farmers defined their future views in semi-structured thematic interviews. The views were turned into statements in a structured survey which was sent to the second farmer panel, comprised of all Finnish farmers, in 2018. The results were returned to the first farmer panel for discussion.

The first round: farmer interviews to build the survey

In April 2016, 20 farmers representing various farm types (i.e. crop, pig, dairy, and beef production) and geographical areas of Finland were interviewed. The participating farmers were sought from four prime, partly distinguishable agricultural areas of Finland (Fig. 2) through newspaper advertisements, as well as oral presentations or stands at various events focused on the farmer community. Approximately 50 farmers expressed their willingness to participate, and 20 farms were selected. Farm size, farm type, geographical location, soil type, and other relevant criteria produced a group of farms in four prime production regions that represented a combination of very typical and somewhat atypical farms for each area.

The interviews were semi-structured and focused on many topics ranging from the history of a farm to farmers' views of climate change. In several cases, both spouses running the farm participated in the interview. Regarding the future, the farmers were asked *what the Finnish agriculture would be like in 2030* and *what it would be like in 2050*. However, the interviewees had difficulties in distinguishing these two eras, and future views were therefore analyzed together, independently of the era. Furthermore, in the process's next steps, the future era was no longer specified. The interviewees were asked about both a probable future image and a preferred one. The questions regarding future views are given in Appendix 1. Although the data is now several years old, we are still far from the year 2030 and the society and farming conditions have not changed so radically as to render the material outdated.

The interviews were audiotaped, transcribed, and analyzed using qualitative content analysis [40] with analysis software ATLAS.ti. The descriptive coding method [41] was used when summarizing the basic topics arising from the data. The original coding is presented in Appendix 2.

The second round: nationwide quantitative survey

In January 2018, a nationwide survey was sent by email to all Finnish farmers who had received agricultural subsidies in 2016 ($N=38{,}091$). The survey was extensive, covering many topics. It therefore contained many types of questions and statements. Regarding the future of Finnish agriculture, the question's formulation was *How likely or unlikely do you consider the following future pathways for Finnish agriculture to be?* A five-step Likert-scale was

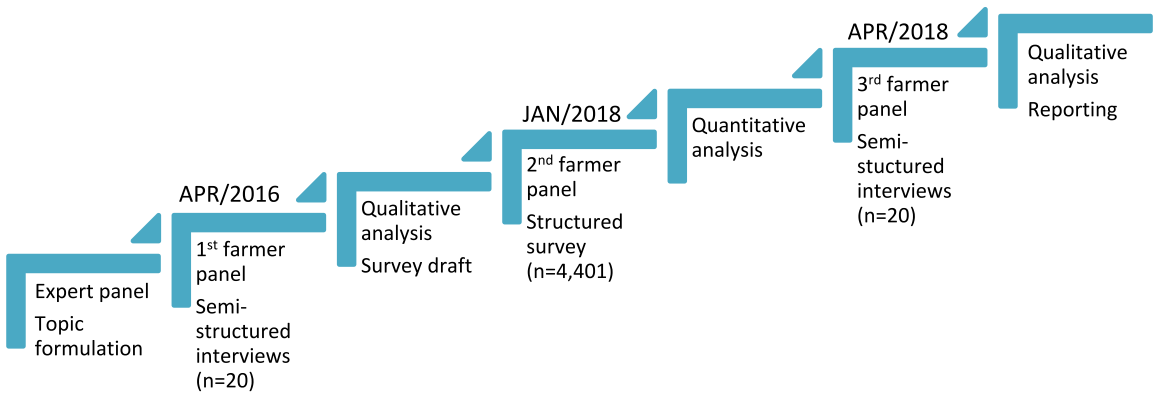

Fig. 1 The research process. The method consisted of three rounds of interaction with farmers: (1) semi-structured interviews with 20 farmers, followed by qualitative analysis of the data and drafting of the structured survey; (2) a structured survey answered by 4401 farmers, followed by quantitative analysis; and (3) semi-structured interviews with the 20 farmers interviewed in the first round followed by qualitative analysis and reporting of the results

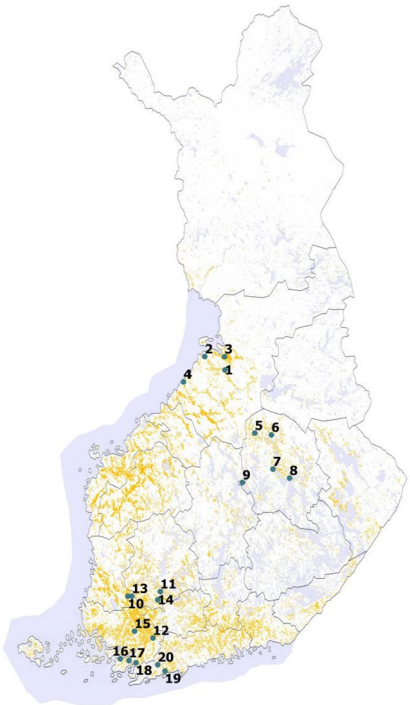

Fig. 2 Locations of the 20 farms that were interviewed in the first round. Yellow indicates agricultural land [39]

used, in which 1 = very likely, 2 = somewhat likely, 3 = neither likely nor unlikely, 4 = somewhat likely, and 5 = very likely. The questionnaire is in Appendix 3, with mean values and standard deviations. Altogether, 4401 farmers responded, making the response rate 12%. The respondents represented the Finnish farmer community well regarding age, education, geographical area, agricultural production line, and farm size. The panel is described in more detail in Appendix 4 and Sorvali et al. [38].

Exploratory factor analysis (EFA) with ordinal least squares (OLS) extraction was used to identify the number of latent constructs and the possible underlying factor structure of the claims about the future of Finnish agriculture. The OLS method, which is known to provide results similar to maximum likelihood (ML), was chosen because it does not assume multivariate normality of variables, which was found questionable. The Kaiser–Meyer–Olkin (KMO) test was used for assessing data suitability for factor analysis. Values over 0.50 can be considered acceptable, but a higher KMO value indicates that the variables share more common variance, increasing the likelihood of obtaining interpretable results. Orthogonal Varimax rotation was used to help the interpretation of factors. Non-orthogonal (oblique) Promax rotation was also tested, but the correlations between factors were relatively low. The internal consistency of the factors was measured using Cronbach's alpha. The values greater than 0.5 can be interpreted as acceptable. EFA was conducted using the FACTOR procedure in the SAS Enterprise Guide 7.15 (SAS Institute Inc., Cary, NC, USA).

The third round: farmer reflections on different farming futures

In April 2018, the results of the statistical analyses carried out based on the second-round nationwide survey were brought for reflection to the farmers, who were interviewed in the first round. A total of three rounds of deliberation was thus possible for the Delphi process. The factors originating from factor analyses were turned into future cards distinguished by their colors (Tables 3, 4, 5, 6, and 7). The *Business-as-usual* card was included to observe farmers' views of the need for a change from the current situation. The cards were presented to the interviewees, who were asked to rank the cards based on how probable they considered each future image. Furthermore, the interviewees were asked to reflect on what each future image would mean for them as a farmer (Appendix 6). The interviews were recorded, and interview transcripts were analyzed with qualitative content analysis, similar to the first round of interviews.

Results

From farmer views to survey statements

Based on the first-round farmers' interviews, a total of 126 codes were initiated, which were then grouped according to their analogies to form 53 themes (Appendix 2). *Climate change* as a descriptive code included the highest number of codes (12), followed by *larger farm size* (10) and *fewer farms* (9). In total, 30 out of the 53 themes had only one mention. The themes with more than one mention in the data were formulated into a total of 34 survey statements (Appendix 3), which were used to study how the larger Finnish farmer community considered the future of Finnish agriculture. The number of themes was intentionally kept quite large for the quantitative survey.

From future factors to farming futures

When the validity and reliability of the factors were tested with the EFA, the sampling adequacy was found to be meritorious (KMO = 0.88). Five factors were formed based on the screen test, the proportion of variation explained, and the interpretability of factors. The first two criteria preferred a four-factor model, but the fifth factor was included based on the last criterion. The standardized alphas for the first three factors were acceptable ($0.70 \leq \alpha < 0.80$), but poor for the fourth factor ($0.50 \leq \alpha = 0.54 < 0.60$), and unacceptable for the fifth ($\alpha < 0.5$) respectively. A low alpha value, especially for the fifth factor, may be attributable to the fact that there were insufficient questions in the test [42]. The correlation matrix of the 34 future variables is presented in Appendix 5.

Table 2 Future variables, established factors, and loadings as an outcome of the Varimax-rotated exploratory factor analysis

Future variable	Factors and loadings				
	Ecological & specialized small-scale production	Tightening policy and impoverishing production	Technology solves	Corporate agribusiness	Business-as-usual
Domestic production considered highly sanitary will become a driver of exports	0.68				
The valuation of domestic food will increase	0.68				
Local food will become popular	0.68				
Finnish food will be exported	0.54		0.32		
Small farms will maintain their vitality through specialization	0.47				
Organic farming will expand substantially	0.43				
Special crops will be cultivated more than currently	0.43				
Migration to the countryside will increase	0.33	-0.33			
Costs of agricultural production will increase		0.64			
Laws on agriculture will be stricter		0.52			
The number of farms will decrease		0.51	0.31		
Political decisions will have a significant impact on agricultural production		0.47			
Agricultural subsidies will decrease		0.45			
Finland's self-sufficiency in agricultural products will decrease		0.43			
Unproductive farming depending only on subsidies will increase		0.31			
Farmers' workload will become lighter		-0.4			
Innovations will be introduced in agriculture			0.6		
Automation will increase in agriculture			0.58		
Yields will increase from the current level			0.52		
Farm sizes will continue to grow			0.51		
Technological development will solve problems in agriculture			0.47		
Renewable energy will increasingly be used in agriculture	0.31		0.45		
Nutrient recycling will increase in agriculture	0.38		0.43		

Table 2 (continued)

Future variable	Factors and loadings				
	Ecological & specialized small-scale production	Tightening policy and impoverishing production	Technology solves	Corporate agribusiness	Business-as-usual
Large corporations will buy and cultivate farmland				0.51	
Farmland ownership will separate from labor				0.43	
Corporations and cooperatives will replace traditional family-run farms				0.43	
Agricultural subsidies will be discontinued				0.41	
Finnish production will decrease substantially		0.35		0.38	
Agriculture will remain as it is					0.37
Cultivated areas for barley and oats will remain as they are					0.36
Climate change will have a significant effect on agriculture in Finland					
Farm operations will be highly optimized					
Agricultural land will be more easily available					
Part-time farming will increase					
Eigenvalue	2.99	2.6	2.52	1.44	0.63
Variance explained	0.09	0.08	0.07	0.04	0.02
Squared multiple correlation	0.79	0.75	0.73	0.62	0.43
Cronbach's alpha	0.78	0.71	0.76	0.54	0.31

The eigenvalues of the factors, Cronbach's *α* values, and the squared multiple correlation (SMC) values are presented in the bottom rows, above which are the four scattered statements without loadings for any factors

Table 3 Card presented to the interviewed farmers describing "Technology solves" farming future (translated from Finnish)

Technology solves
• Farm sizes will continue to grow
• Technological development will solve problems in agriculture
• Automation will increase in agriculture
• Nutrient recycling will increase in agriculture
• Renewable energy will increasingly be used in agriculture
• Innovations will be introduced in agriculture
• Yields will increase from the current level

Table 4 Card presented to the interviewed farmers describing *Ecological and specialized small-scale production* farming future (translated from Finnish)

Ecological and specialized small-scale production
• Special crops will be cultivated more than currently
• Organic farming will expand substantially
• Migration to the countryside will increase
• Small farms will maintain their vitality through specialization
• The valuation of domestic food will increase
• Domestic production considered highly sanitary will become a driver of exports
• Finnish food will be exported
• Local food will become popular

Table 5 Card presented to the interviewed farmers describing *Tightening policy and impoverishing production* farming future (translated from Finnish)

Tightening policy and impoverishing production
• Finland's self-sufficiency in agricultural products will decrease
• Unproductive farming depending only on subsidies will increase
• Costs of agricultural production will increase
• Agricultural subsidies will decrease
• The number of farms will decrease
• Laws on agriculture will be stricter
• Farmers' workload will become lighter (-)
• Political decisions will have a significant impact on agricultural production

Table 6 Card presented to the interviewed farmers describing *Corporate agribusiness* farming future (translated from Finnish)

Corporate agribusiness
• Corporations and cooperatives will replace traditional family-driven farms
• Finnish production will decrease substantially
• Agricultural subsidies will be discontinued
• Large corporations will buy and cultivate farmland
• Farmland ownership will separate from labor

Table 7 Card presented to the interviewed farmers describing the *Business-as-usual* farming future (translated from Finnish)

Business-as-usual
• Cultivated areas for barley and oats will remain as they are
• Agriculture will remain as it is

The factors were given names that best characterized the combination of variables loaded to each factor (Table 2). The factor name and the variables loaded on it were written as cards that were shown to the interviewees (Table 3, 4, 5, 6, and 7) in the next phase of the process.

Farmers' reflection on farming futures

Views concerning the probability of the various farming futures differed significantly, and sometimes two or three different futures were considered equally probable by a farmer.

Technology solves

"Technology solves" was considered the most probable future image among the interviewed farmers (Table 3). Many stated that it was already going ahead, as farm size had increased in Finland as automation had developed. Remotely operated tractors and other farm machines were mentioned as examples. Nobody doubted the technological development per se, but some farmers had reservations about the pace of the change and its significance in shaping future agricultural practices. The farmer's presence was considered important particularly in animal husbandry, whatever the level of technology was.

Increasing yields provoked discussion, e.g., around topics like the unpredictable impacts of climate change, the contribution of new crop species and cultivars, and the role of precision agriculture in improving yields. Benefiting from robotic technology in weeding was mentioned as useful in organic farming, with impacts on yields. However, some respondents had doubts whether significantly higher yields could ever be produced in Finnish conditions. Nutrient recycling was considered important but to require more development work. Precise fertilizer application within a field was seen as a means of bringing both environmental and economic benefits, as were solar energy and on-farm manure-based biogas production.

In the future image in which technology largely solves the challenges of agriculture, the farmers envisaged that an increased need of knowledge and leadership would be the biggest change. Bigger farms would require either more advanced technology or more employees, and both would call for new competences. One respondent thought cooperation between farmers might increase, giving a jointly owned biogas plant as an example. It was characteristic of this future image that it did not present many threats but rather opportunities for farmers in

terms of a reduced workload and improved productivity. Although the unreliability of technology and the need for better competences could be seen as threats, farmers seemed confident in facing such a future image.

Ecological and specialized small-scale production

The topics included in the card named *Ecological and specialized small-scale production* (Table 4) were mostly considered desirable by farmers. On average, this was the future image that was considered most likely after *Technology solves*. On the other hand, several interviewees said that while they preferred this type of future image, they found it difficult to believe it could become a reality.

The statement considered least probable within this future image was that migration to the countryside would increase. Urbanization was expected to continue, but some positive signs of increase in appreciation of rural life, its tranquillity, and farming were observed. Specialization might lead to higher labor demand, which means that more people would move to the countryside. Demand for local food might increase, but in most cases, the shift was not expected to be significant.

Ecological farming and specialization in general were thought of as means to increase the competitiveness of small farms, but they were not seen as primary directions of Finnish farming. Some small farms may remain viable through specialization and dedication to the products and their marketing, but this would not be a large-scale solution. Small-scale farmers were often thought to need additional income by producing different types of services (snow removal, road maintenance, etc.). Ecological farming can bring some savings in terms of equipment, fertilizers, and pesticides, but large-scale ecological farming was occasionally seen as a threat to national self-sufficiency due to lower yields.

An export potential was considered quite real, but not necessarily if marketed by their exceptional sanitary standards. International food scandals might, however, strengthen the value of such argumentation. Instead, developing specialized niche products for international markets was found to be essential. Some examples were caraway, "clean oats" for celiacs (i.e., no contamination of other cereals) and ethical animal products (e.g., from pigs with tails and chicken with beaks).

This type of future image was seen as requiring considerable expertise from a farmer. Producing non-traditional niche crops and coping with the challenges of ecological farming required expertise. In addition, marketing specialized products and increasing the appreciation of local or domestic food were seen to require special expertise and close contacts between consumers and farmers. The bureaucracy, workload, and logistics related to selling food products directly to customers were seen as reducing profitability. Some specialized production systems such as those for berries also required a significant labor force, leadership, and management skills.

Tightening policy and impoverishing production

Contrary to the quite positive future image of ecological production and specialization, the *Tightening policy and impoverishing production* (Table 5) was a dystopic image. Nevertheless, the two were considered equally probable by farmers, perhaps reflecting the possible segmentation of future agriculture in Finland. In many answers, this image was thought to reflect a continuation of the current situation. For example, the declining trend in the number of farms was expected to continue. Production costs were expected to increase. In particular, older farmers without a successor were seen as being in difficulties. They therefore just tried to get along until retirement without significant investments or improvements, even if they would have been necessary to avoid the farm's decline in profitability.

Some consensus was found among farmers that the subsidies would decrease in the future. Some farms would continue to flourish even in more difficult conditions, but in general, subsidies were considered necessary for Finnish agriculture. One farmer hoped all subsidies would be abolished so that the market price for food would reflect its real production costs. Others considered that global food prices might rise, which would justify the reduction in subsidies. This would make farming more meaningful, as the income would come from markets rather than subsidies. However, this type of change was considered to be quite slow.

Unambitious and unproductive farming mainly aimed to receive subsidies, which annoyed many interviewees. Such farming was said to eat into subsidies from the farmers who tried their best as producers but still could not manage without subsidies in the current market situation. Some interviewees argued that the "greening" policies with biodiversity targets contributed to unproductive farming. Focusing on environmental matters might also increase dependency on imported food. One interviewee noted that this type of unproductive farming could not coexist with the diminishing subsidies, as envisioned in this future image. Changes in agricultural policy, particularly the CAP, might hinder unproductive farming, e.g., through a harvesting obligation.

Farmers' workload was expected to increase. One interviewee specifically believed that the mental load would increase due to the impoverishing conditions. If subsidies were decreased, farmers would need to find work beyond the farm, as many already did.

Corporate agribusiness

The interviewed farmers did not consider corporate agribusiness a probable future image of agriculture (Table 6). In particular, the idea of international corporations

buying land was thought to be unrealistic. The rationales for such a view were that climate conditions did not make agriculture very lucrative in Finland compared to more southern countries, and the lots remained small and dispersed. Only in the longer term, if agricultural land was valued significantly more highly than today, could this become reality in Finland. On the other hand, the shift to company-owned farms or to a lesser extent, to cooperative farms, was thought possible—with larger farms even probable. However, the ownership was still expected to stay within a family or a couple of partners. This type of change in ownership could reduce farmers' financial risks.

Although it was thought possible that total agricultural production would decline in Finland, most farmers envisioned that production would change instead. For example, the crops grown would change. In general, there was a clear belief in continuing agriculture in Finland. Some reduction of agricultural subsidies was anticipated but not the abolition of subsidies, as they were necessary for maintaining Finnish production, and they were also seen as a global practice.

Larger farms would need to hire external workers. Certain production systems such as berries and cattle were rather labor-intensive, and contract workers were often necessary, even on family-owned farms. Growing farm sizes meant that farmers increasingly needed leadership and management skills. According to one respondent, if ownership and work on a farm became separate, there was a risk of mismanagement. An absent landlord might not be sufficiently familiar with the farm and its needs. As farmers were now entrepreneurs, work as a salaried worker could be more financially secure, even if less independent. On the other hand, bad harvests might result in the termination of the work contract.

Business-as-usual

Most interviewees considered the *Business-as-usual* future image (Table 7) the least probable. They argued that the world was constantly changing, and agriculture could not stay unchanged. Regarding the specific statement on the production of barley and oats, it was noted that these spring cereals were currently largely used for feed, and their future demand depended on the volume of animal production. However, some remarked that oats were "booming," and novel food products were being processed from it. Those who were farmers as their secondary occupation and obtained their main income from salaried work might continue as monotonous cereal producers, while many farmers expected to switch to more competitive crops.

Discussion

In this study, we used an applied Delphi process with an extensive farmer panel, thereby developing five alternative futures based on farmers' views. Views of stakeholders other than farmers are often used in sketching the future of agriculture, even though farmers are those who put farm-scale changes into practice [37, 38].

Farmers' future views

The process pinpointed four alternative farming futures with a business-as-usual view as an additional fixed future image. The *Technology solves* as a future image for agriculture means further increases in farm size, technological advances, and innovations, i.e., further automatization, more nutrient recycling, more renewable energy, and elevated yields. Hence, farmers considered technology as a means to solve current challenges. This was the most likely future among the farmers according to the third round of the applied Delphi process based on farmers' interviews. Faith in technological solutions solving challenges has also been strong in expert-based Delphi results [10, 11, 43]. Many farmers stated that such a transformation was already happening. Indeed, farms have become larger [1], and the management of larger areas evidently requires modern technology with improved capacity, not least as the window for the optimal timing of field operations like sowing and harvesting is limited by the short growing season and weather constraints typical of high latitudes [44].

This technology-oriented future view seemed to offer many opportunities. However, this study also entailed uncertainties like how climate change would alter growing conditios and what the impacts on agriculture per se in Finland would eventually be. However, some recent studies have highlighted that Finnish farmers are used to coping with challenging climatic conditions: They smoothly switch from early to late maturing crops and cultivars after experiencing a favorable growing season but reverse after a cool and rainy season [45]. Yet, change in agricultural practices and farmer's role as the change agent will require more knowledge and better leadership skills, as envisaged by farmers.

The *Ecological and specializing export agriculture* future entailed expanded cultivation of special crops and an increase in organic production. Finnish farmers highlighted the value of domestic and local food, and furthermore, the opportunities for exports driven by the lack of sanitary problems with the Finnish products. This originates in the low use of pesticides but also salmonella-free animal production systems [46, 47]. Interestingly, farmers did not foresee this type of reputation partly vanishing in the future, even though climate change is anticipated to increase abiotic risks in crop production according to a farmer survey [37], which may increase future dependence on pesticides [48]. In this future image, specialization also makes it possible for smaller farm units to cope with, despite the increasing pressure. Indeed, small farms (< 30 ha) have already managed to tack against the challenges of low volumes and competitiveness by specializing in the cultivation of horticultural crops and starting

sheep raising [49]. The *Ecological and specializing export agriculture* type of future view of Finnish agriculture was the second most likely according to the interviewed farmers. Some farmers commented that some of the elements in this future image would be attractive as such but were unlikely to be realized on a large scale. Farmers considered that this future would force most farmers to have additional income sources outside agriculture. Farmers' work would also consist more heavily of marketing activities besides the actual agricultural practices.

Farmers opposed both the *tightening policy* and the *corporate agribusiness* future images of agriculture. *Tightening policy* future image portrayed Finnish agriculture as regressive, struggling financially, and politically even more strictly regulated than currently. This future was actually seen to resemble the current situation of Finnish agriculture, when investments and improvements have been minimized because of the pressure of poor farm profitability. As this future view was often selected alongside *Ecological and specializing export agriculture*, they might be considered as "either-or" alternatives for future agriculture. Compared to the expert-based Delphi studies, farmers consider policy development more uncertain and consisting mainly of threats, whereas experts' views are more divided, supporting either strong and effective policies for agricultural development or allowing the markets to operate more freely without strong policies as safety nets [10, 11, 43].

Corporate agribusiness meant that in such a future image there would be a shift from traditional family-owned farm units to large-scale agro-businesses that would separate the everyday operational actions on a farm from the ownership. This was a very unlikely future image according to our farmer panel, but the expert panels see it as more likely [10].

Most farmers considered "Business-as-usual" an absurd idea for future farming in Finland. The main rationale was that agriculture could not stagnate but had to transform alongside other societal changes. Since the data was collected, Finland (and the rest of Europe and the world) has faced crises such as the COVID-19 pandemic and the war in Ukraine. The former reduced the available labor force in agriculture, and the war has affected energy and fertilizer prices as well as food export. Even with less radical events, society is constantly changing, which seem to validate the farmers' views.

The Delphi method and practitioner-based future views

In this article, we studied farmers' future views with a mixed method Delphi application. The Delphi method has been used in various ways during its existence. Experiences of the applied method in this study and reflections to earlier method use are presented in Table 8 and discussed below.

Large panel and mixed methods

A key feature of the used method is that it collects views from a large panel. Japan was a forerunner in large Delphi studies, starting at the end of 1960s and continuing through decades [13]. The objective of these large studies was not to produce a prognosis, but an instrument to systematically investigate the longer-term future with the aim of identifying the areas of strategic research and the emergence of generic technologies likely to yield the greatest economic and social benefits. The Japanese conducted large national Delphi studies systemically, which was argued to be very useful for Japan's technology development [13]. It would be costly to conduct similar exercises continuously within Finnish agriculture, but this would certainly bring value added to national decision making concerning farmers' views of future agriculture, food security, and the resilience of the food system.

The mixed methods use (e.g., combining a large survey and in-depth interviews) ensures that the data is both extensive (i.e., a large survey) and intensive (i.e., in-depth interviews). It enables a rich data analysis through quantitative and qualitative perspectives. However, the process is both long and labor-intensive. Resources must be dedicated to the interviews, transcription, and an analysis of the interviews. Here, we balance between the value of reflection and reasoning on one hand and resources on the other.

Laypeople as experts

It is usually the expert community that is asked their views considering the future of the food system [10, 36]. Using laypeople as participants in Delphi processes is less usual. Delphi applications that use laypeople to promote public hearing have been applied especially when it concerns citizens' future views of their own living environment (representative democracy as Hilbert et al. [15] describes). In these kinds of opinions, gathering participation, fostering transparency, and the accountability of public decision making is highlighted [15]. In the case of agriculture, it can be argued that farmers as practitioners are themselves experts. Expertise is both a cognitive property and a social construction [12], and not everyone who has gained knowledge and expertise has gained the social status of an expert. The latter is often based on education and social position. In some cases, it may be more important to consider who the relevant stakeholders are [50]. After all, who has more at stake in agriculture than the farmers themselves? Changes in farming very directly affect their own living environment and livelihood. It can be argued that it is democratic to ask the practitioners themselves what the future of their field would (and should) look like.

Table 8 Strengths and weaknesses of the Delphi method (see also Table 1)

Approaches	Strengths	Weaknesses
1. Combining quantitative large panel survey with qualitative interviews	The number of consulted experts increases, meaning the future **information base widens** Also enables **in-depth analysis** through targeted interviews	**Cost** of conducting this kind of combination is **quite high** **Time-consuming** to realize and analyze Feedback loop of results between rounds more **challenging** concerning survey panel
2. Using laypeople as experts	Possible **new insights** that might not come up in other expert groups Farmers as **real experts in producing food** can bring a valuable source of future information Wide consultation with farmers ensures the **extensive root level information** and future views on agriculture's future development	The capture of an extensive **variety of future views** becomes more challenging and calls for an understanding of mixed methods use **Knowledge is very subjective**, based on people's own experiences in a limited geographical area There may be a **lack of a holistic view** of future development in agriculture that could be obtained from other agricultural stakeholders Personal **life stories or feelings** may prevent different futures being seen
3. Large survey data do not force a consensus but can hide weak signals	**Extensive coverage** of future viewpoints Also, when combined with in-depth interviews, alternative future views can be **analyzed and understood in detail**	The amount of survey data can **blur important messages** from a single farmer or a small opinion poll of farmers **Weak signals or wild cards may not be revealed**
4. Full anonymity was not maintained during the Delphi process (in 2nd interviews, participants knew each other, but not each other's views)	Ensures that **power relations** do not show in results Every answer and observation are **treated equally**, especially in statistical analysis of survey data	In some cases, the reflection from **where the future view comes from** can be beneficial for informant to **evaluate their own viewpoint** and arguments for seeing future as they see it
5. Several clearly defined rounds with varying methods	Ensures the **depth of data** **Analysis and feedback** of results for the next round is **clearer**	If the time between rounds is long, the panelists may be unable to **absorb the results** from earlier rounds
6. Using Delphi in alternative scenario construction instead of forecasting	Wide consultation of farmers ensures that the **base of information is extensive** for scenario construction	The weight of analyzing the **most probable future** remains weaker The scope of the study **may highlight paths that are irrelevant** for decision making
7. Seeking surprising and extreme future views with extensive farmers' consultation	The mixed methods use (large survey, in-depth interview) ensures that the **data base is extensive** Enables a **rich data analysis** from a quantitative and qualitative perspective	The panel of farmers lacks **all the relevant knowledge** when evaluating the future of agriculture Difficulties **rising above the current situation** (imagine futures not yet present)

Weak signals

Large surveys and aggregating results may hide individual weak signals. Interviews and forums to continuously discuss data analysis extensively may therefore help identify them. It is also useful to organize a policy dialog processes which can be used as forums to primarily test the results of the Delphi processes [11]. It is usual that these dialogs concentrate more on the relevance of results to the strategic planning of agriculture, but outside-in thinking may also reveal something that is not recognized within the research group.

Anonymity

Anonymity has been an important part of Delphi principles. It prevents the authority, personality, or reputation of participants dominating others in the process. Over the years and in its applications, this principle has been changing, and participatory Delphi processes especially have given up on it. The key issues to recognize in using anonymous panels, and therefore future views, are gaining the full competencies of participants and the information policies of experts [51]. It has been argued that the best possible information is gained through anonymity as the bases for strategy preparation and subsequent strategic decisions.

Several rounds with varying methods

The data collection process takes time—in this study, 3 years. Some drastic changes may take place during the process, making the initial thoughts from the first qualitative round obsolete. For future applications, the timespan could be shorter. Nevertheless, the process might still take at least two years, at least with farmers, because the possible interview windows exist only outside the growing season.

Using Delphi for scenario building

Although Delphi results are traditionally reported using median and interquartiles, Delphi data can also be used for scenario construction. There are several techniques for developing the final scenarios of the Delphi data [10, 30]. The Disaggregative Policy Delphi is based on quantitative cluster and qualitative content analysis, and fits Delphi processes well, which gather data through interviews and surveys. The reason for using a scenario approach is that it can widen the future paths in Delphi studies by not just giving the future state but also opening future paths [10]. A scenario approach can therefore benefit the achievement of deeper and more consistent answers for strategic planning purposes.

Surprising and extreme future views

We conducted the interviews in the context of a large data inquiry in which farmers answered many questions about different themes in the same interview lasting approximately 3 h. This was cost-effective but exhausting for the farmers. The future outlook was only one of the themes of the interviews. Covering many themes may have divided the attention of the interviewees, and if future views had been the only focus, there might have been more unforeseen responses.

For many of the farmers interviewed, it was difficult to think into the very distant future. This was apparent in the first round of interviews (Appendix 1), when they were first asked to reflect on their thoughts about Finnish agriculture in 2030 and then in 2050. The near future was relatively easy to imagine, but the future in 2050 was impossible to imagine for many. As farmers, the interviewees were so close to agriculture that in many instances, they tried to imagine the future through their own personal life story. This limited their imaginative power, when the first thing to come to mind when thinking about 2050 was "I will already be dead by then." Some then found it difficult to continue thinking about the future.

The second interviews, in which farmers were asked to reflect on future factors and put them in order according to probability (Table 2), also revealed some difficulty in imagining futures that were very distant from the current situation. The likely futures tended to be those already on the horizon, e.g., technological advances and specialized production. Farmers' roles also seemed quite similar to the already existing ones.

Conclusion

The results of a Delphi study can be used in policymaking, in other development activities of the field, and in improving our understanding of the field in general. Giving voice to the practitioners at the grassroot level can both improve the Delphi results and make the results seem more authentic, inclusive, and even just. The inclusiveness can be a significant benefit on its own, but some changes also emerged when the results were discussed using recent expert-based studies. In the future, a separate study could more exactly study, how much the results differ from those made through traditional expert views.

Further research could also help in solving how to obtain more radical views or to encourage practitioners to envision further into the future. In this study, the initial future views were asked about very openly, and they therefore reflect the farmers' perspective very well. In other studies, it might be useful to ask for their views about specific drivers rather than the states of the future in specific years. This might help the respondents to consider why changes might be forthcoming.

Participating in the Delphi process was thought-provoking for the farmers. Many of them commented that they had not really thought so far into the future before. Connecting experts and laypeople with a common process could be beneficial. This would bring together the grassroots knowledge, obstacles, and even wishes for the future from the farmers and policy relevance and knowledge outside practice from the experts (such as researchers, politicians, civil servants).

Appendix 1

Questions regarding the future in first-round interviews (translated from Finnish).

The future of farming:
What will the situation of your farm be in 1 year?
What will the situation of your farm be in 5 years (2020)?
What will the situation of your farm be in 10 years (2025)?
What will Finnish agriculture be like in 15 years? (2030).
What will have changed?
What will Finnish agriculture be like in 35 years? (2050).
What has changed?

Appendix 2

Table 9 Original coding (code content), their frequency (codes), and themes (descriptive codes) from the first round of farmer interviews

Descriptive code	Codes	Code content
Climate change	12	Climate change Climate change continues—so does farming here Climate change a significant factor Feed producers in the future Like Central Europe (2 harvests) Sugar beet not cultivated More extreme weather Milder winters, longer falls Pests and weeds Discontinued production areas (sugar, rapeseed, malting barley) New crops No competition with cereal harvests—through cows
Larger farms	10	Larger units Large cattle farms Large farms like in Central Europe Fewer domestic animals (cows) Smaller farms discontinued Larger farms Larger farms Sizes of farms will increase Larger unit sizes Larger units
Fewer farms	9	Only a few active farms (approx. 20,000) Few estates Run by a handful of people Production centralized on larger farms Centralization Discontinued farms The number of farms will decrease Fewer farms Fewer active farmers
Automation	7	Automation Increased mechanical automation Mechanization Machines without people Satellite fields Industrial production Less oil and fewer people
Technological development	7	No large and heavy tractors Trust in technology will increase Electric tractors Technological development Advances in technological development Leaps in technological development Technologization
Companies and investors	7	Ownership separates from labor Attracted investors Large international companies do business Major corporations Centralized production employees Companies Owned by businesses
Value of domestic products increases	5	Valuation of domestic products will increase Purity and cleanliness will be valued more than now Hopefully, people will understand the value of food production Bright future Production hygiene
Energy taken into consideration	3	Energy issues will be taken into consideration Energy will be a key issue Cereals will be dried in another location
Emphasized impact of policies	3	Global policies and markets will have an impact Impact of policies (taxes, etc.) Policies as the deciding factor
End of production	3	No greenhouse production I wonder if there will be any agriculture left in Finland Discontinued dairy farms
Circular economy	3	The importance of carbon sequestering will be understood Closed cycles The use of water will change
Company-owned farms	3	No entrepreneur-driven farms Company-owned farms will grow Company-owned farms (thousands of hectares and animals)
Local production	3	Local production will increase Local production will grow More locally produced food
Increased use of recycled nutrients	3	Increased use of recycled nutrients Fewer extracted nutrients Nutrient recycling
Business-as-usual	2	Fields will remain cultivated Food will be produced as now
Fields freed for other purposes	2	Land will be available through bankruptcies Fields will be freed for other purposes (energy production)
Emergency supply	2	Emergency supply The nation should be self-sufficient
Higher yields	2	Higher yields Increased yields
More diverse crops	2	Versatility through crops Changes in crops—from cereals to others
More innovation	2	More ideas Crop factories
Optimization	2	Everything will be optimized Optimization will be needed—Will we have the money?

Descriptive code	Codes	Code content
Localization	2	Localization New migration to agricultural areas, small farms will be available for sale
Organic production	2	Organic production will grow Organic production will not grow as much as expected
No bureaucracy	1	No anxiety from bureaucracy
Time allocation	1	Time allocation under control
Specialization	1	Standing out from others
No subsidies	1	No dependence on subsidies
Fragmented field structure	1	Far from the farm estate
More attractive production	1	Attractiveness of production will increase
Local energy production	1	Local energy production
GMO	1	GMO questions
Higher production costs	1	Higher costs due to natural conditions
New products	1	Growth in other agricultural products (experiences, tourism, horses, fishing)
Ownership separated from labor	1	Working on the farm
Land value increases	1	Land value will increase
Steps back	1	Steps back will be necessary
Profitability	1	Major change in profitability
Higher prices	1	Costs of primary production will start to increase
Lower subsidies	1	Lower subsidies
Business model	1	Business-oriented
Stricter laws	1	Stricter legislation
Global undersupply of food	1	Global under-supply of food
Development	1	New wave of production development
Shortage of farmland	1	Basic 100-hectare parcels will not be available
Protection until ruination	1	The EU will be a playing field for idealists—agriculture will be protected until ruination
Field management based on leases	1	Field management based on leases
Smaller farms specialize	1	Smaller farms will specialize
Cleared farmland	1	Fields will be cleared once again
Finnish products in global markets	1	Global demand for Finnish products
Family-owned farms develop	1	Family-owned farms will grow and specialize
Carbon sequestering understood	1	The importance of carbon sequestering will be understood
No unproductive farming aiming to collect subsidies	1	No unproductive farming aiming to collect subsidies
More secondary occupations	1	Farming as a secondary occupation—jobs elsewhere

Appendix 3

Table 10 Future questions from survey questionnaire (translated from Finnish)

Variable number	How likely or unlikely do you consider the following future pathways about Finnish agriculture to be? (1 = very unlikely, 2 = somewhat unlikely, 3 = Neither likely nor unlikely, 4 = somewhat likely, 5 = very likely)	Mean	Std. Dev
Var1	Climate change will have a significant effect on agriculture in Finland	3.59	0.926
Var2	Farm size will continue to grow	4.23	0.797
Var3	Number of farms will decrease	4.46	0.792
Var4	Advances in technology will solve problems	3.20	1.047
Var5	Automatization will increase	4.10	0.781
Var6	Corporations will buy and farm agricultural land	2.90	1.157
Var7	Ownership of land and work will differentiate	3.39	0.995
Var8	Appreciation for Finnish food will increase	3.64	1.033
Var9	Domestic production considered highly sanitary will become a driver for exports	3.76	1.038
Var10	Finnish food will be exported	3.75	0.958
Var11	Politics will have a great influence on production	4.28	0.818
Var12	Nutrient recycling will become more common	3.90	0.788
Var13	Renewable energy will be used	3.99	0.764
Var14	Local food will become popular	3.79	0.906
Var15	Companies and cooperatives will replace family farms	3.25	1.029
Var16	Finnish production will decrease significantly	3.11	1.109
Var17	Farm activities will be highly optimized	3.36	0.923
Var18	Cultivated areas for barley and oats will remain as they are	3.17	0.921
Var19	Special crops will be cultivated more than currently	3.68	0.863
Var20	Organic farming will increase	3.29	1.022
Var21	Agriculture will remain as it is	2.28	0.999
Var22	Migration to the countryside will increase	2.32	1.057
Var23	Availability for agricultural land will get easier	2.61	1.098
Var24	Self-sufficiency of agricultural products in Finland will decrease	3.51	1.078
Var25	Innovations will be adopted	4.01	0.796
Var26	Yields will increase	3.38	0.913
Var27	Unproductive farming aiming to collect subsidies will increase	3.23	1.108
Var28	Part-time farming will increase	3.74	1.064
Var29	Costs of production will increase	4.25	0.777
Var30	Agricultural subsidies will become smaller	4.09	0.984
Var31	Agricultural subsidies will be brought to an end	2.78	1.169
Var32	Agricultural legislation will tighten	3.92	0.937
Var33	Small farms will preserve their vitality through specialization	3.11	1.162
Var34	Farmers' workload will get lighter	1.89	0.956

Appendix 4

Table 11 Basic characteristics of the respondents and the total Finnish farming population. Data for the total farming population in Finland is from 2017 because of the lack of comparable data from 2018. All data from [24] unless otherwise stated

	Finnish farmers, total		Survey sample	
	N	***%***	***N***	***%***
Number of farms	48,562		4401	
Gender[a]				
Female	5900	*12*	569	*13*
Male	43,820	*88*	3831	*87*
Age				
30 and under	1376	*3*	137	*3*
31–50	15,214	*36*	1844	*42*
51–70	23,343	*56*	2289	*52*
71 and over	1945	*5*	129	*3*
Education[b]				
Comprehensive	8741	*18*	325	*7*
Vocational	27,195	*56*	2871	*65*
University	12,626	*26*	1119	*25*
Other			84	*2*
Farming system				
Organic[c]	4665	*10*	657	*15*
Conventional	43,897	*90*	3743	*85*
Farm size (ha)				
Less than 50	33,238	*69*	2751	*63*
50–99	9917	*20*	1069	*25*
100–149	3262	*7*	327	*8*
More than 150	2145	*4*	191	*4*
Revenue (euros)[d]				
Less than 20 000	23,592	*50*	886	*20*
20 000–50 000	9359	*20*	1111	*25*
50 000–100 000	5939	*13*	914	*21*
100 000–300 000	6385	*13*	1032	*23*
300 000—500 000	1101	*2*	280	*6*
500 000—1 000 000	676	*1*	176	*4*
More than 1 000 000	636	*1*	51	*1*
Farm type				
Family farm	41,878	*86*	3707	*84*
Agricultural alliance	4178	*9*	433	*10*
Limited liability company	931	*2*	84	*2*
Death estate	1227	*2*	93	*2*
Other	348	*1*	82	*2*
Production line				
Cereals and other field crop	30,619	*63*	2248	*51*
Dairy production	6704	*14*	804	*18*
Beef production	3485	*7*	287	*7*
Outdoor production	1477	*3*	130	*3*
Pig production	607	*1*	165	*4*
Poultry production	436	*1*	65	*1*
Other	5234	*11*	497	*11*
Not known	0	*0*	205	*5*
Region				
Southern Finland	***14,809***	***31***	***1471***	***35***
Uusimaa	3173	*7*	313	*7*
Southwest Finland	5175	*11*	537	*13*
Southeast Finland	2957	*6*	277	*7*
Häme	3504	*7*	344	*8*
Western Finland	***19,298***	***39***	***1627***	***38***
Satakunta	2976	*6*	334	*8*
Pirkanmaa	3782	*8*	405	*10*
Central Finland	2576	*5*	238	*6*
South Ostrobothnia	5411	*11*	364	*9*
Ostrobothnia	4553	*9*	286	*7*
Eastern Finland	***8443***	***17***	***698***	***17***
South Savo	2339	*5*	193	*5*
North Savo	3448	*7*	295	*7*
North Karelia	2009	*4*	151	*4*
Kainuu	647	*1*	59	*1*
Northern Finland	***5609***	***12***	***399***	***9***
North Ostrobothnia	4273	*9*	314	*7*
Lapland	1336	*3*	85	*2*
Åland (i.e., archipelago)	***403***	***1***	***30***	***1***

[a] Eurostat, 2019 [52]

[b] Numbers for education are indicative due to limited data availability and differences in classification

[c] Finnish Food Authority, 2019

[d] Data for total of Finnish farmers from 2018

Appendix 5

Table 12 Spearman correlation matrix of 34 future variables. Statements corresponding to each variable are presented in Appendix 3. Significance is indicated as follows: $*p < .05$, $**p < .01$, $***p < .001$

	Var1	Var2	Var3	Var4	Var5	Var6	Var7	Var8	Var9	Var10	Var11	Var12	Var13	Var14	Var15	Var16	Var17	Var18
Var1	1	***	***	***	***	***	***	***	***	***	***	***	***	***	***	*	***	***
Var2	0.21	1	***	***	***	**	***	***	***	***	***	***	***	***	***	0.85	***	0.29
Var3	0.20	0.52	1	0.13	***	**	***	0.89	*	***	***	***	***	***	***	***	***	0.10
Var4	0.11	0.13	0.02	1	***	**	**	***	***	***	0.67	***	***	***	***	***	***	0.76
Var5	0.22	0.40	0.33	0.28	1	***	***	***	***	***	***	***	***	***	***	***	***	0.36
Var6	0.09	0.04	0.04	0.04	0.05	1	***	1.00	0.29	0.68	***	***	*	0.28	***	***	***	**
Var7	0.14	0.19	0.18	0.05	0.13	0.30	1	0.31	0.52	*	***	***	***	0.46	***	***	***	0.69
Var8	0.15	0.07	0.00	0.20	0.14	0.00	−0.02	1	***	***	0.48	***	***	***	0.75	***	***	***
Var9	0.16	0.09	0.04	0.22	0.16	0.02	0.01	0.57	1	***	*	***	***	***	0.14	***	***	***
Var10	0.18	0.16	0.09	0.24	0.25	0.01	0.03	0.42	0.51	1	***	***	***	***	0.11	***	***	***
Var11	0.16	0.26	0.31	−0.01	0.21	0.07	0.13	−0.01	0.03	0.08	1	***	***	*	***	***	***	0.30
Var12	0.25	0.25	0.18	0.26	0.33	0.08	0.11	0.25	0.27	0.31	0.18	1	***	***	***	***	***	**
Var13	0.22	0.26	0.21	0.24	0.36	0.03	0.10	0.21	0.24	0.29	0.19	0.47	1	***	***	***	***	0.87
Var14	0.17	0.09	0.05	0.17	0.16	0.02	0.01	0.56	0.48	0.39	0.03	0.29	0.24	1	*	***	***	**
Var15	0.11	0.16	0.15	0.10	0.16	0.27	0.26	0.00	0.02	0.02	0.10	0.13	0.10	0.04	1	***	***	0.31
Var16	0.03	0.00	0.15	−0.19	−0.06	0.15	0.12	−0.22	−0.19	−0.23	0.14	−0.12	−0.11	−0.15	0.11	1	0.56	*
Var17	0.07	0.12	0.10	0.12	0.17	0.11	0.05	0.11	0.14	0.14	0.11	0.17	0.16	0.12	0.11	0.01	1	**
Var18	−0.06	0.02	−0.02	0.00	−0.01	−0.05	−0.01	0.06	0.07	0.05	0.02	−0.05	0.00	0.05	−0.02	−0.04	0.04	1
Var19	0.24	0.16	0.11	0.21	0.23	0.11	0.14	0.27	0.28	0.27	0.08	0.31	0.27	0.30	0.13	−0.06	0.12	−0.08
Var20	0.21	0.10	0.05	0.14	0.11	0.09	0.07	0.25	0.24	0.21	0.02	0.26	0.19	0.32	0.10	−0.03	0.06	−0.05
Var21	−0.16	−0.21	−0.24	0.01	−0.19	−0.06	−0.14	0.08	0.05	−0.02	−0.18	−0.13	−0.12	0.03	−0.09	−0.09	−0.02	0.17
Var22	−0.03	−0.21	−0.27	0.11	−0.08	0.05	−0.07	0.24	0.21	0.18	−0.15	0.05	0.02	0.17	−0.03	−0.15	0.04	0.02
Var23	−0.02	−0.02	−0.02	0.06	−0.02	−0.05	0.01	0.04	0.02	0.02	−0.08	0.02	−0.04	0.01	0.02	0.04	0.00	0.01
Var24	0.07	0.14	0.24	−0.15	0.04	0.11	0.16	−0.21	−0.16	−0.17	0.22	−0.02	−0.01	−0.12	0.12	0.45	0.03	−0.02
Var25	0.24	0.29	0.23	0.35	0.48	0.03	0.11	0.23	0.24	0.31	0.19	0.42	0.44	0.24	0.11	−0.18	0.18	−0.04
Var26	0.10	0.24	0.12	0.29	0.25	−0.03	0.05	0.18	0.18	0.28	0.01	0.24	0.23	0.14	0.05	−0.24	0.11	0.02
Var27	0.02	0.10	0.11	−0.10	0.04	0.08	0.14	−0.09	−0.08	−0.07	0.14	−0.06	−0.03	−0.08	0.07	0.26	−0.03	0.05
Var28	0.10	0.15	0.16	−0.01	0.11	0.07	0.13	0.01	0.03	0.05	0.17	0.09	0.10	0.05	0.05	0.13	0.02	0.06
Var29	0.14	0.28	0.34	−0.09	0.16	0.09	0.14	−0.03	0.01	0.02	0.37	0.09	0.13	0.02	0.08	0.24	0.09	0.04
Var30	0.14	0.27	0.36	−0.01	0.19	0.11	0.19	−0.05	0.00	0.02	0.28	0.14	0.15	0.01	0.13	0.22	0.09	−0.02
Var31	0.05	−0.03	0.04	−0.09	−0.03	0.21	0.13	−0.14	−0.11	−0.15	0.05	−0.05	−0.07	−0.10	0.16	0.26	0.04	−0.04
Var32	0.15	0.25	0.31	−0.04	0.17	0.14	0.17	−0.08	−0.05	−0.03	0.33	0.11	0.13	−0.01	0.15	0.23	0.10	0.03
Var33	0.09	−0.11	−0.13	0.19	0.07	0.00	−0.04	0.30	0.30	0.26	−0.05	0.19	0.15	0.31	−0.02	−0.16	0.07	0.02
Var34	−0.08	−0.18	−0.25	0.16	−0.08	0.03	−0.04	0.09	0.03	0.00	−0.27	−0.05	−0.07	0.02	−0.01	−0.12	−0.03	0.00

	Var19	Var20	Var21	Var22	Var23	Var24	Var25	Var26	Var27	Var28	Var29	Var30	Var31	Var32	Var33	Var34
Var1	***	***	***	*	0.14	***	***	***	0.12	***	***	***	***	***	***	***
Var2	***	***	***	***	0.25	***	***	***	***	***	***	***	*	***	***	***
Var3	***	***	***	***	0.18	***	***	***	***	***	***	***	**	***	***	***
Var4	***	***	0.59	***	***	***	***	***	***	0.63	***	0.45	***	*	***	***
Var5	***	***	***	***	0.19	**	***	***	**	***	***	***	*	***	***	***
Var6	***	***	***	***	***	***	*	*	***	***	***	***	***	***	1.00	*
Var7	***	***	***	***	0.47	***	***	***	***	***	***	***	***	***	**	*
Var8	***	***	***	***	**	***	***	***	***	0.63	0.09	***	***	***	***	***
Var9	***	***	***	***	0.14	***	***	***	***	*	0.34	0.80	***	***	***	0.06
Var10	***	***	0.26	***	0.23	***	***	***	***	**	0.16	0.13	***	*	***	0.77
Var11	***	0.22	***	***	***	***	***	0.72	***	***	***	***	***	***	***	***
Var12	***	***	***	**	0.15	0.25	***	***	***	***	***	***	**	***	***	**
Var13	***	***	***	0.25	*	0.55	***	***	*	***	***	***	***	***	***	***
Var14	***	***	0.09	***	0.47	***	***	***	***	***	0.10	0.35	***	0.61	***	0.26
Var15	***	***	***	*	0.10	***	***	***	***	***	***	***	***	***	0.12	0.58
Var16	***	*	***	***	*	***	***	***	***	***	***	***	***	***	***	***
Var17	***	***	0.11	*	0.99	0.05	***	***	0.05	0.18	***	***	**	***	***	*
Var18	***	***	***	0.26	0.33	0.10	**	0.12	**	***	**	0.21	*	0.06	0.15	0.89
Var19	1	***	***	***	0.38	**	***	***	0.59	***	***	***	0.46	***	***	*
Var20	0.28	1	0.54	***	**	***	***	***	0.21	***	0.77	0.06	0.38	0.31	***	***
Var21	−0.08	0.01	1	***	***	***	***	*	0.06	***	***	***	**	***	***	***
Var22	0.08	0.10	0.18	1	***	***	0.14	**	***	***	***	***	0.06	***	***	***
Var23	0.01	0.05	0.08	0.09	1	*	0.54	***	0.75	**	***	***	0.77	***	0.74	***
Var24	−0.04	−0.07	−0.12	−0.21	−0.03	1	***	***	***	***	***	***	***	***	***	***
Var25	0.29	0.18	−0.17	0.02	−0.01	−0.07	1	***	***	***	***	***	***	***	***	**
Var26	0.21	0.06	−0.04	0.05	0.07	−0.13	0.30	1	***	*	**	**	***	*	***	***
Var27	−0.01	−0.02	−0.03	−0.10	0.00	0.26	−0.07	−0.06	1.00	***	***	***	***	***	***	***
Var28	0.12	0.06	−0.06	−0.07	−0.05	0.19	0.09	0.04	0.25	1.00	***	***	***	***	*	***
Var29	0.07	0.00	−0.13	−0.22	−0.13	0.31	0.09	−0.05	0.21	0.23	1.00	***	***	***	***	***
Var30	0.11	0.03	−0.19	−0.21	−0.06	0.28	0.12	0.04	0.16	0.20	0.35	1.00	***	***	***	***
Var31	−0.01	−0.01	−0.04	−0.03	0.00	0.18	−0.12	−0.15	0.16	0.06	0.14	0.30	1.00	***	***	**
Var32	0.08	0.02	−0.16	−0.21	−0.09	0.29	0.06	−0.03	0.21	0.23	0.43	0.40	0.21	1.00	***	***
Var33	0.24	0.24	0.11	0.25	0.00	−0.16	0.15	0.12	−0.10	0.03	−0.09	−0.06	−0.09	−0.10	1.00	***
Var34	0.03	0.06	0.19	0.23	0.15	−0.20	−0.04	0.07	−0.10	−0.09	−0.35	−0.22	−0.04	−0.22	0.14	1.00

Appendix 6

Questions regarding the future in second-round interviews (translated from Finnish).

What do you think about the probable future images? (Placing future image cards on a table).

Which do you consider the most probable? And which the most improbable?

(Can you rank the future images based on probability?).

Why?

What kind of changes would need to take place for the future images to become reality?

How do you see your own role as a farmer in these future images?

When could the future images become reality?

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Authors' contributions
Conceptualization: Jaana Sorvali, Vilja Varho and Pasi Rikkonen; Methodology: Jaana Sorvali; Formal analysis and investigation: Janne Kaseva, Jaana Sorvali, Vilja Varho; Writing—original draft preparation: Jaana Sorvali; Writing—review and editing: Jaana Sorvali, Vilja Varho, Pasi Rikkonen, Janne Kaseva, and Pirjo Peltonen-Sainio; Funding acquisition: Pirjo Peltonen-Sainio and Jaana Sorvali; Resources: Jaana Sorvali; Supervision: Pirjo Peltonen-Sainio.

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Availability of data and materials
The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Declarations

Ethics approval and consent to participate
Natural Resources Institute Finland is committed to comply the guidelines of Finnish National Board on Research Integrity (TENK) on ethical principles of research with human participants. The guidelines state, that no prior ethics approval in necessary, when the below-mentioned conditions in the research design do not apply: (1) Participation in the research deviates from the principle of informed consent. (2) The research involves intervening in the physical integrity of research participants. (3) Research that exposes participants to exceptionally strong stimuli. (4) Research that involves a risk of causing mental harm that exceeds the limits of normal daily life to the research participants or their family members or others close to them. (5) Conducting the research could involve a threat to the safety of participants or researchers or their family members or others close to them.
The interview and survey data used in this research was collected with the informed consent of the participants. None of the research design elements mentioned above (1–5) was applicable for this research and therefore further ethical evaluation was not needed.
The ethical principles of research with human participants and ethical review in the human sciences in Finland:
https://tenk.fi/sites/default/files/2021-01/Ethical_review_in_human_sciences_2020.pdf
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The authors have declare that they have no competing interests.

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