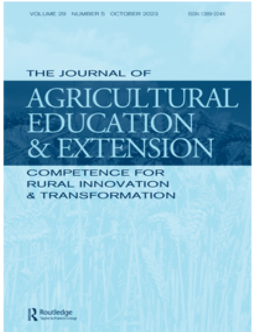

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Development and validation of an instrument to measure the vision of European agricultural advisors towards innovation

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ABSTRACT

Purpose: This article describes the development and validation of a survey designed to measure the vision of European agricultural advisors towards innovation.

Design/Methodology/Approach: The items of the instrument were developed based on the conceptual framework provided by the position paper for the Transformative Innovation Policy Consortium. The resulting instrument was completed by 656 advisors recruited through the network of the European Horizon 2020 i2connect project. The data was divided into two random subsets. The structure of the instrument was explored using an exploratory factor analysis (EFA) using one subset and convergent validity was tested by applying confirmatory factor analysis (CFA) to the second subset.

Findings: The EFA resulted in a three-factor solution. In accordance with the conceptual framework, these factors were labelled (a) linear innovation, (b) innovation systems and (c) transformative change. The CFA demonstrated an adequate fit and a satisfactory level of internal consistency.

Practical implications: The instrument can assist in eliciting advisors' views on innovation, which could be used in advisors' selection and recruitment.

Theoretical implications: Building on a strong conceptual basis, the paper presents a theoretically robust instrument for assessing advisors' views on different innovation models. Such assessments could in turn lead to further expand and elaborate concepts on this aspect.

Originality/Value: The survey is the first instrument to include the emerging policy paradigm of transformative change and as such allows measuring the degree to which European advisors are willing to support transformative innovation policy.

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Introduction

Our global society has been confronted with major social, economic and environmental challenges, called 'Grand Challenges'. These issues, such as climate change and sustainable and inclusive growth, require urgent attention but they do not occur in isolation; they are interconnected, complex and systemic (Mazzucato 2017). In the agricultural sector, for example, food security and climate-smart agriculture influence one another in a reciprocal fashion. These Grand Challenges have led to the formulation of ambitious goals, such as the 17 sustainable development goals (SDGs), formulated by the United Nations General Assembly in 2015 (United Nations Department of Economic and Social Affairs 2023). Since their initial formulation, the SDGs have been the foundation for many global policy aims, such as reducing greenhouse gas emissions to near zero by the end of the century (United Nations Environment Programme 2022). Reaching this target will inevitably require fundamental changes in our way of life, such as a transformation of our food and financial systems (United Nations Environment Programme 2022). The implementation of these changes must be guided by well-thought-out innovation policy (Fagerberg, Laestadius, and Martin 2016; Fagerberg 2018).

It is widely recognised that innovation processes are collective endeavours. These processes require all the actors with the potential to influence the direction of innovation to bring their strategic capacities to the table (Kanger 2020; Mazzucato 2017; Toillier et al. 2022). However, the formation of adequate innovation coalitions is not guaranteed, as ideological differences have been known to hinder the process (Klerkx, van Mierlo, and Leeuwis 2012). The alignment of several different views of innovation is paramount to the process.

Innovation intermediaries can influence transition processes. A growing body of literature recognises the importance of their work to link actors, activities, skills and resources (Kivimaa et al. 2019a, 2019b; Knickel et al. 2021; Tisenkopfs et al. 2015; Vilas-Boas, Klerkx, and Lie 2022; Wieczorek and Hekkert 2012). These intermediaries are also referred to as innovation brokers, boundary spanners, coalition builders and the like.

In the agricultural sector, agricultural advisors are increasingly seen as key actors in agricultural innovation systems (AIS) (Klerkx and Leeuwis 2009; Knierim et al. 2017). Where, historically, advisors were subject matter experts, they are now taking on more diverse roles, for example, acting as a sensemaker in the smart farming innovation system (Eastwood et al. 2019; Fielke, Taylor, and Jakku 2020), facilitating learning (Labarthe and Laurent. 2013), advisory organisations acting as intermediary to facilitate coordinated action (Compagnone and Simon 2018), etc. This is also reflected in recent literature focussing on new competencies for advisors (Lybaert et al. 2022; Seitz et al. 2022) and studies focused on advisors' understanding of their own role (Turner et al. 2023). Agricultural policy is also keeping up with this trend. For example, in Europe, a growing number of initiatives, funded under the Horizon 2020 and Horizon Europe frameworks, are being set up with the aim of empowering advisors to act as an innovation broker by linking research, industry and farmer communities (Smart-AKIS 2022), a process coined 'interactive innovation' (European Commission 2020). However, these policy instruments typically target what are referred to as 'impartial advisors', which appears to be conflicting with current reality (Fieldsend et al. 2021; Sutherland and

Labarthe 2022). In recent times, many nations have witnessed a surge in the privatisation of their agricultural advisory sector. This shift is a consequence of reduced government involvement and a growing dependence on the private sector to provide advisory services (Nettle, Crawford, and Brightling 2018). Consequently, a diverse array of advisory service providers has emerged (Knierim et al. 2017), some of which also offer various commercial services. This diversity raises questions about the impartiality and independence of the advice they provide. It is worth noting that many farmers maintain trust-based relationships with these partial advisors, such as input suppliers and retailers. Furthermore, the presence of truly 'impartial' advisors who exclusively offer advice is often a rarity in many contexts (Sutherland and Labarthe 2022). Given the significant role these advisors play for farmers, we recognised the importance of including them in this study. This study, therefore, outlines the design and development of an instrument aimed at assessing the perspectives of agricultural advisors on innovation, irrespective of the level of independence of the advice providers.

As advisors are expected to be the driving force behind innovation processes, we feel it is important to discern their actual views on this matter. This need is also demonstrated by the results of the European funded LIAISON project, which state the term 'interactive innovation', a central concept in many European policy instruments, is not well understood by key actors in the agricultural knowledge and innovation system (AKIS) (Fieldsend et al. 2021). Furthermore, the topic of transformation is receiving increased attention in academic literature and the use of this instrument could contribute to the discourse on how advisory services can support the transformation of our agri-food system and define the role of individual advisors (Klerkx 2020).

Thus, the purpose of this paper is to create and validate a tool for gauging the agreement of agricultural advisors with the three most prevailing innovation models. With the aim of reaching a large population, an appropriate quantitative instrument (a survey) was developed. Agricultural innovation policy is often established at a broad scale (e.g. European or even global level), covering diverse cultural and linguistic contexts. Therefore the instrument needs to be applicable to these diverse contexts. We begin this article with background information on how views towards innovation have changed over the past century (Section 1). Section 2 introduces the conceptual basis for the design of the instrument, that is, the position paper for the Transformative Innovation Policy Consortium[1] (Schot and Steinmueller 2018). Our instrument was built on the three prevailing innovation policy paradigms and their underlying innovation models, mentioned in that paper. In Section 3 we present the methodology used to design and validate the structure and items of the instrument. The results are then presented (Section 4), and we conclude with a discussion of the results and perspectives for future research (section 5).

Changing views on innovation policy

Over the last century, innovation policy scholars have changed their discourse from a focus on innovation for growth to a systems perspective on innovation and finally to the current focus on the paradigm of transformative change (Boon, Edler, and Robinson 2022; Borrás and Edler 2020; Diercks, Larsen, and Steward 2019; Köhler et al. 2019; Kuhlmann and Rip 2018; Schot and Steinmueller 2018; Steward 2012).

After the Second World War, the innovation for growth policy paradigm became dominant, especially in the United States and in Europe. Within this view of innovation, science and technology are valued for their potential to increase wealth by steering the economy towards mass production and consumption (Arrow 1962; Nelson 1959). In the 1980s, this linear view of innovation was criticised as being too simplistic, giving rise to a more systemic and holistic view on innovation, often called 'systems thinking' (Fagerberg, Mowery, and Nelson 2006; Jarrett 1985; Nelson 1993). Whereas the first paradigm emphasised knowledge development, the systems perspective on innovation strives to create an environment that stimulates innovation (Diercks, Larsen, and Steward 2019). Within the last decade, scholars have questioned whether this innovation systems policy paradigm can cope with current societal challenges. In response, scholars have put forward the paradigm of transformative change (Borrás and Edler 2020; Boon, Edler, and Robinson 2022; Diercks, Larsen, and Steward 2019; Köhler et al. 2019; Kuhlmann and Rip 2018; Schot and Steinmueller 2018; Steward 2012). Transformative innovation policy prioritises social and environmental objectives over competitiveness and economic growth and is inclusive and experimental by nature (Diercks, Larsen, and Steward 2019).

Currently, the paradigms of innovation for growth and innovation systems are already established in contemporary innovation policy discussions (Diercks, Larsen, and Steward 2019; Schot and Steinmueller 2018).

The literature on agricultural innovation shows a similar evolution in perspective (Klerkx, van Mierlo, and Leeuwis 2012) as the linear 'transfer of technology' paradigm has given way to a systems perspective on innovation (Knickel et al. 2009). For example, the transfer of technology model is characterised by 'one-way' knowledge flows but those have since been deemed inappropriate. In response to these criticisms, the AKIS concept was created. It describes knowledge exchange in a certain region and maps the actors and services that support such an exchange (Knierim et al. 2015; Rivera et al. 2006). However, it has recently faced criticism due to its predominantly national-level focus and its detachment from academic perspectives on innovation processes (Sutherland et al. 2023). Another significant example is the AIS concept, which sees innovation processes as multidimensional and complex interactions of new and interdependent practices implemented by a variety of actors (Hall et al. 2006; Toillier et al. 2022). Both the AKIS and the AIS concepts emerged in parallel, rather than building on each other; as the AKIS concept emerged from an advisory perspective, while the AIS concept was developed from a research perspective (Klerkx, van Mierlo, and Leeuwis 2012; Rivera et al. 2006). More recently, the importance of a mission-oriented view on AIS has becoming apparent in agricultural literature (Klerkx and Begemann 2020). Mission-oriented innovation policies respond to the Grand Challenges and thus coincide with transformative innovation policy (Mazzucato 2017).

An examination of recent agricultural policy strategies, such as the European Green Deal and the resulting Farm to Fork strategy, clearly reveals a transformative view on innovation. This emerging paradigm does not replace the established paradigms of innovation for growth and innovation systems, as paradigm shifts can be seen as evolutionary processes. New paradigms exist as a layer over and alongside established ones (Diercks, Larsen, and Steward 2019), as ideational paradigms never disappear completely (Skogstad 2011). This is reflected in concepts such as interactive innovation and its practical translation, the 'multi-actor approach' (i.e. the collaboration of farmers, farm advisors, scientists and other stakeholders to develop innovative solutions to practical problems European Commission 2020 [.]). These concepts are currently being applied in many initiatives under the Horizon Europe programme. For example, in the Horizon Europe Working programme 2023–2024 for Cluster 6 'Food, Bioeconomy, Natural Resources, Agriculture and Environment', 83 of the 176 topics require a multi-actor approach to be eligible for funding (European Commission 2022). It thus seems that the expectations set for agricultural advisors by the European Commission (i.e. to take up a facilitating role in multi-actor innovation projects) are rooted in innovation systems thinking. However, since the evolution in perspective is a continuous process and since the main policy strategies already reflect a transformative view on innovation, we assume that expectations towards advisors will also shift towards this vision of transformative change. This shift towards transformative innovation is also not merely a European phenomenon. The Transformative Innovation Policy Consortium is a global consortium of i.a. innovation policymakers and researchers, promoting transformative innovation to address the societal and environmental challenges on which the SDGs are founded, with consortium members in Columbia, South Africa, China, Panama, etc. (Transformative Innovation Policy Consortium 2023). Furthermore, the Global Forum on Agricultural Research and Innovation is advocating for transformative change in the global agrifood research and innovation system (Global Forum on Agricultural Research and Innovation 2023).

Conceptual background

The conceptual background for our instrument is the position paper for the Transformative Innovation Policy Consortium, 'Three Frames of Innovation Policy' by Schot and Steinmueller (2018). This article outlines the history and theory behind the three prevailing policy paradigms, set out in section 2 (innovation for growth, innovation systems and transformative change) and describes their respective underlying innovation models.

It is important to differentiate between the theory and practice of innovation policy (Fagerberg 2018). In Section 2, the three prevailing innovation paradigms are explained, but as advisors operate in a practical context, our instrument was built on the practical models of innovation and knowledge exchange that underlie these theoretical policy paradigms. The following paragraphs describe these innovation models according to the position paper of Schot and Steinmueller (2018) and a subsequent summary report (Schot et al. 2018).

Linear innovation model

According to Schot and Steinmueller (2018) and Schot et al. (2018), the innovation model underlying the innovation for growth paradigm has a linear view of innovation. Scientific discovery leads to innovation (i.e. the commercialisation of invention) which in turn leads to diffusion and adoption. The linear innovation model emphasises high-level technology and the creation of radical novelty. Its main strategy is to focus on knowledge creation by providing support for basic and applied science. The role of the private sector is to translate scientific discoveries into innovation, which are in turn expected to support economic growth. This linear model attaches great value to STEM (science, technology, engineering and mathematics) subjects. When applying this model to the context of agricultural advisors, their role can be described as transferring technological discoveries from a research context to the practical context of the farmer.

Innovation systems model

Schot and Steinmueller (2018) and Schot et al. (2018) state that the innovation model at the foundation of the innovation systems paradigm has moved away from a linear view of innovation towards an interactive and system-bound perspective (as exemplified by a chain-link model). Instead of seeing knowledge as flowing in a straight line from science to applied R&D to commercialisation, knowledge is created through interaction among diverse actors in national, sectoral, and regional information systems. These interactions require a process of interactive learning and the building of capabilities for the uptake and adaptation of knowledge, which is often influenced by physical and cognitive proximity. Therefore, it is necessary to align the actors, objectives, and capacities for interaction, in order to maximise the effectiveness of these processes. In the innovation systems model, knowledge is being increasingly produced in an application context, with an increasing diversity of actors being involved in knowledge production. This model identifies the users as possible sources of innovation. The strategy focusses less on funding of pre-competitive R&D and more on learning between the actors in the system, for example, by stimulating learning-by-doing or by constructing links between actors. The innovation systems model values both radical and incremental product and process innovations. As mentioned above the AIS and AKIS concepts can be considered as examples of innovation systems thinking (Klerkx, van Mierlo, and Leeuwis 2012; Rivera et al. 2006). The concept of interactive innovation and its practical translation, the 'multi-actor approach' also fit within the innovation systems perspective.

Transformative change model

According to Schot and Steinmueller (2018) and Schot et al. (2018), the innovation model underlying the transformative innovation paradigm considers an innovation process to be an exploratory process guided by social and environmental objectives. The paradigm of transformative innovation therefore assumes that there is no single best pathway to sustainability, equality or other socially desirable goals and thus considers innovation processes to be experimental in nature. Innovation involves multiple actors that all anticipate and negotiate alternative pathways with a potential for system change. Innovation should come with a willingness to revisit existing structures and arrangements to address societal challenges. An acceptable pathway for change will result from the accumulation of experience of a diverse set of actors with different motivations and priorities. Knowledge should thus be co-produced through dialogue in this collective search process. Innovation processes are likely to be effective in achieving their societal goals if they are inclusive, experimental, and aimed at changing the direction of socio-technical systems in all of their dimensions. In this view, innovation is considered primarily as a means to address social and environmental challenges, with economic growth seen as a bonus. The transformative vision on innovation is still in its infancy. One major issue highlighted in the literature is the lack of clarity about how experimentation can lead to transformative change (Kivimaa et al. 2017; Schot and Steinmueller 2018).

Methods

Development of the instrument

As mentioned above, the current study used the position paper 'Three frames for innovation policy' by Schot and Steinmueller (2018) as a conceptual basis (section 3) together with their respective innovation models, (a) linear innovation model, (b) innovation systems model and (c) transformative change model (Schot and Steinmueller 2018; Schot et al. 2018).

A survey was designed to gauge the view of EU agricultural advisors on each policy paradigm. Likert scale items were developed to measure the advisors' degree of agreement with the three innovation models mentioned above.

First, elements characterising the innovation models were inventoried and tabulated. Next, the elements were translated into statements (items) relating to these models. Inspiration for the formulation of the items was found in the validated instrument created by Landini and Beramendi (2019). Their instrument was designed to assess the beliefs of extension agents in Argentina regarding extension services and innovation. Statements from Landini and Beramendi (2019) were reformulated to be consistent with the characteristics described in the article by Schot and Steinmueller (2018) and supplemented with items gauging the paradigm of transformative change. For each of the innovation models, seven items were formulated and discussed thoroughly with all co-authors and other experts in the field to assure that all seven items clearly and accurately characterised the model in question. The first version of this instrument thus comprised 21 items divided across three scales measuring the level of agreement with the linear innovation, innovation systems and transformative change models. All items (see Annex 1) were rated on a 7-point Likert scale ranging from 1 for 'strongly disagree' to 7 for 'strongly agree'.

The resulting instrument was translated from English to Croatian, Dutch, French, German, Greek, Hungarian, Italian, Polish, Slovenian and Spanish. The initial translation was made by the research team with help from machine translation programmes DeepL and Google Translate. The machine-generated translations were then checked, adjusted, and corrected where needed by native speakers of the aforementioned languages.

Data collection

A variety of participants were reached by disseminating the survey through the network of advisors of the EU-funded Horizon 2020 i2connect project.[2] The i2connect consortium is composed of 42 organisations from 21 European countries, which allowed us to obtain responses from respondents working in 24 different countries. An invitation e-mail was drafted and translated into the above languages using the same approach. The survey was disseminated using a snowball sampling approach, where i2connect consortium members were asked to forward the email to their local network of advisors. The survey was administered between February 2022 and April 2022 using the online Limesurvey platform. Participation in the survey was voluntary and included an informed consent outlining the purpose of the study and confidentiality of individual responses. The participants had a choice of 11 languages (see above) in which they could complete the survey. In addition to the newly developed instrument, we also collected information on the background characteristics of the participants (i.e. age, gender, location, education level, agricultural background, work experience as an advisor, organisation for which they work, role in the organisation and job description).

The study was approved by the Ethics Commission of the Flanders Research Institute for Agriculture, Fisheries and Food (ILVO).

Data cleaning

The snowball sampling approach to survey dissemination made it impossible to know exactly how many advisors received the email, thus the response rate cannot be calculated. After closing the survey, the data ($N = 2672$) was exported to a csv file format and imported into R (version 2022.02.2). The data was restructured to comply with the tidy data format, using the Tidyverse package (Wickham and Grolemund 2017; Wickham et al. 2019). Next, the data were cleaned from unreliable observations such as incomplete responses, doubles, respondents that were not agricultural advisors, speeders (i.e. respondents who completed the survey in less than 2% of the average response time) and flatliners (i.e. respondents who selected the same answer to every multiple-choice question). Respondents from outside the EU were also excluded as they were not part of our target population.

Sample

After data cleaning, the sample consisted of 656 responses. Respondents were predominantly male (61.43% male, 37.65% female, 0.91% declined to answer). Among the respondents, the vast majority (97.14%) had completed higher education (Bachelor, Master, PhD). Only a small number of participants reported another degree as the highest educational degree (secondary school = 0.61%, technical school and/or apprenticeship = 1.98%). The age of participants ranged from 19 to 65+, with an average of 47 (SD = 12). The distribution according to the country of residence was skewed. Some countries, such as Belgium, Hungary, and Ireland, were overrepresented. The type of organisation the respondents worked for was also relatively diverse, 43.60% were active in the public sector (public advisory service and chamber of agriculture), 39.79% were active in the private sector (bank, legal counsel, accountancy firm, farmers' union, local farmers group, private sector advisory service, self-employed advisors). A minority of respondents (6.71%) were working for agri-input suppliers and agri-tech providers. Detailed characteristics of the sample are presented in Table 1.

Table 1. Sample characteristics.

	Total		First half sample		Second half sample	
	N	Percentage	N	Percentage	N	Percentage
Total	656	100	328	100	328	100
Age						
19–25	16	2.44	10	3.05	6	1.83
26–30	63	9.60	40	12.20	23	7.01
31–35	43	6.55	18	5.49	25	7.62
36–40	85	12.96	38	11.59	47	14.33
41–45	83	12.65	44	13.41	39	11.89
46–50	109	16.62	55	16.77	54	16.46
51–55	90	13.72	46	14.02	44	13.41
56–60	73	11.13	32	9.76	41	12.50
61–65	57	8.69	29	8.84	28	8.54
65+	37	5.64	16	4.88	21	6.40
Location						
Austria	22	3.35	13	3.96	9	2.74
Belgium	184	28.05	88	26.83	96	29.27
Bulgaria	2	0.30	1	0.30	1	0.30
Croatia	3	0.46	2	0.61	1	0.30
Cyprus	7	1.07	2	0.61	5	1.52
Finland	1	0.15	0	0.00	1	0.30
France	32	4.88	21	6.40	11	3.35
Germany	28	4.27	11	3.35	17	5.18
Greece	18	2.74	8	2.44	10	3.05
Hungary	96	14.63	46	14.02	50	15.24
Ireland	87	13.26	46	14.02	41	12.50
Italy	17	2.59	8	2.44	9	2.74
Latvia	1	0.15	1	0.30	0	0.00
Luxembourg	2	0.30	0	0.00	2	0.61
Netherlands	3	0.46	2	0.61	1	0.30
Poland	32	4.88	16	4.88	16	4.88
Portugal	4	0.61	3	0.91	1	0.30
Romania	1	0.15	1	0.30		0.00
Serbia	2	0.30	1	0.30	1	0.30
Slovakia	1	0.15	0	0.00	1	0.30
Slovenia	35	5.34	21	6.40	14	4.27
Spain	73	11.13	35	10.67	38	11.59
Switzerland	4	0.61	2	0.61	2	0.61
Other EU	1	0.15	0	0.00	1	0.30
Work experience as an advisor in years						
<2	47	7.16	25	7.62	22	6.71
2–5	120	18.29	69	21.04	51	15.55
6–10	97	14.79	49	14.94	48	14.63
11–15	70	10.67	32	9.76	38	11.59
16–20	91	13.87	47	14.33	44	13.41
21–25	68	10.37	34	10.37	34	10.37
26–30	77	11.74	34	10.37	43	13.11
31–35	38	5.79	18	5.49	20	6.10
36–40	30	4.57	12	3.66	18	5.49
40+	18	2.74	8	2.44	10	3.05
Language						
nl	126	19.21	55	16.77	71	21.65
fr	71	10.82	41	12.50	30	9.15
en	176	26.83	94	28.66	82	25.00
el	11	1.68	3	0.91	8	2.44
pl	31	4.73	16	4.88	15	4.57
de	53	8.08	25	7.62	28	8.54
hr	3	0.46	1	0.30	2	0.61
sl	34	5.18	21	6.40	13	3.96
it	11	1.68	6	1.83	5	1.52
hu	95	14.48	46	14.02	49	14.94

(*Continued*)

Table 1. Continued.

	Total		First half sample		Second half sample	
	N	Percentage	*N*	Percentage	*N*	Percentage
es	45	6.86	20	6.10	25	7.62
Organisation type						
Agri-input supplier	29	4.42	11	3.35	18	5.49
Agri-tech provider	15	2.29	10	3.05	5	1.52
Bank, legal counsel, accountancy firm, etc.	9	1.37	3	0.91	6	1.83
Chamber of agriculture	63	9.60	38	11.59	25	7.62
Farmers' association/ Farmers' union	67	10.21	38	11.59	29	8.84
Local farmers' group	17	2.59	7	2.13	10	3.05
Private sector advisory services	86	13.11	41	12.50	45	13.72
Public sector advisory services	223	33.99	108	32.93	115	35.06
Self-employed farm advisor	82	12.50	40	12.20	42	12.80
Other	65	9.91	32	9.76	33	10.06

Analysis

To establish the structure of the instrument, the sample ($N = 656$) was split into two random equally sized subsets, one for the exploratory and one for the confirmatory factor analysis. The structure of the instrument was examined using exploratory factor analysis (EFA) performed on the first random subset ($n = 328$), using a Maximum Likelihood extraction method with oblique rotation. The EFA was used to check whether a set of latent structures underlying the 21 items could be identified that corresponded to the conceptual basis of Schot and Steinmueller (2018), Fabrigar et al. (1999) and Goretzko et al. (2021). The sample size was sufficiently high, as a minimum of 300 subjects is deemed acceptable for EFA (Rouquette and Falissard 2011).

The second random subset ($n = 328$) was used to perform a Confirmatory Factor Analysis (CFA) to validate the structure of the instrument derived from the EFA. The CFA was also conducted using the Maximum Likelihood method and was performed in R (version 2022.02.2), using the Lavaan package (Rosseel 2012). Model fit was improved by adding covariances between items within factors if modification indices were 10 or higher (Byrne 2016). To determine the adequacy of the model fit several fit indices were analysed, that is, Normed Chi-Square Index ($\chi 2/\mathrm{df}$), Comparative Fit Index (CFI), Tucker Lewis Index (TLI), Standardized Root Mean Square Residual (SRMR), Root Mean Square Error of Approximation (RMSEA) (Kyndt and Onghena 2014). Model fit is considered adequate when ($\chi 2/\mathrm{df}) < 3$, CFI > 0.90, TLI > 0.90, SRMS < 0.08 and RMSEA < 0.08 (Kyndt and Onghena 2014).

Subsequently, the reliability of each scale was assessed by computing Cronbach's alpha coefficients, which measure the internal consistency of the items within each scale (Song et al. 2015).

Finally, the measurement invariance across groups was assessed, as the instrument was developed for widespread use across Europe. To compare the view on innovation across groups (e.g. advisors from different nationalities) it is important to determine whether the instrument measures the same structures across these groups. Because the number of responses in the different languages was highly variable (Table 1), and most groups were too small, invariance was tested for the two groups with the highest number of responses (i.e. Dutch and English) to give an initial indication of potential problems regarding interpretation of the items across different language groups.

Table 2. Results of the exploratory factor analysis.

Item code	Factor 1	Factor 2	Factor 3
I1	0.57	0.17	−0.07
I8	0.51	0.15	0.03
I9	0.69	−0.07	0.04
I13	0.87	0.29	−0.31
I7	0.12	0.64	0.04
I11	0.14	0.55	0.05
I15	0.14	0.55	0.04
I14	0.17	0.72	−0.12
I5	−0.06	0.81	0.09
I12	0.08	0.65	0.11
I4	−0.11	0.14	0.71
I10	0.01	−0.07	0.60
I6	0.08	0.08	0.54
I2	−0.10	0.16	0.41
I3	−0.25	0.27	0.64

Results

Exploratory factor analysis

First the appropriateness for factor analysis of the first subset was evaluated using the Kaiser–Meyer–Olkin test for sampling adequacy and the Bartlett's Test of Sphericity. The results of the KMO and Bartlett's test of sphericity were adequate (0.909) and significant ($\chi 2 = 3029.35$, df = 210, $p < .001$), respectively, meaning that the data were deemed appropriate for factor analysis. Next, the number of factors was determined. Theoretical considerations indicated a three-factor solution. This was confirmed by the scree plot (Figure 1), as it contained three factors before the first point of inflexion, and the Hull method, as the higher boundary of the convex hull of the plotted data indicated three factors to retain (Goretzko, Pham, and Bühner 2021).

The total variance explained by the model was 45.74% (Factor 1: 19.90%, Factor 2: 11.85%, Factor 3: 14.00%).

Consequently, a three-factor EFA was conducted using a Maximum Likelihood extraction method with oblique rotation (Promax). The Promax rotation was chosen because it allows factors to be correlated. This makes sense from a theoretical point of view, as each factor should refer to a type of innovation model. Another reason for choosing the Promax rotation is its suitability for large data sets due to its fast processing time (Field 2017). The EFA was performed in R (version 2022.02.2), using the psych package (Revelle 2016). Based on the rotated factor matrix, six of 21 items were excluded due to factor loadings less than 0.40 or between factor cross-loadings smaller than 0.2. The factor loadings can be found in Table 2 and the list of items is provided in Annex 1.[3]

Factor interpretation

A content analysis revealed that the remaining items were structured in line with the conceptual framework of Schot and Steinmueller (2018).

Factor 1 (items I1, I8, I9, I13) is composed of items belonging to the linear innovation model and is labelled as such. This factor accounted for 11.85% of the variance. The items refer to the two main characteristics of the linear innovation model. The first is a focus on scientific and technological knowledge production. The second is a linear, top-down

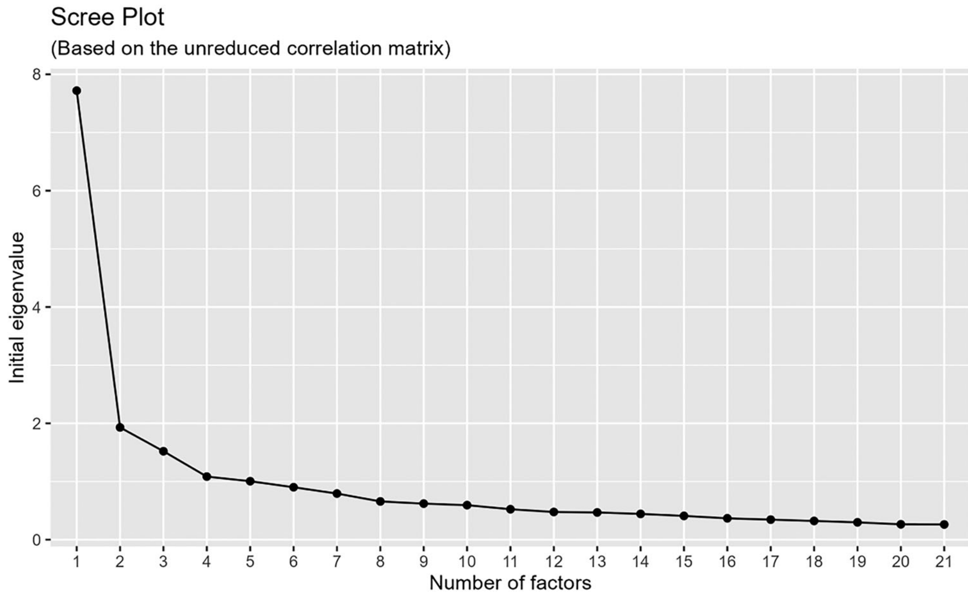

Figure 1. Scree plot.

system of knowledge creation and transfer, where research institutions are responsible for knowledge creation and the advisor then transfers that knowledge.

Factor 2 (items I5, I7, I11, I12, I14, I15) was labelled 'innovation systems' as it comprised six items that were all based on the innovation systems model as described by Schot and Steinmueller (2018). This explained 19.90% of the variance. Overall, the factor focusses on interactive innovation as defined by the European Commission, as the items all refer to situations in which multiple stakeholders collaborate to produce knowledge (European Commission 2020). Three items focus on the interaction between different types of actors in the context of knowledge creation as well as knowledge transfer. Two items focus on communication and interaction in learning processes. One item stresses the importance of creating knowledge in the context of application.

Factor 3 (items I2, I3, I4, I6, I10) was labelled 'transformative change' because it is composed of items that refer to the innovation model underlying the transformative innovation policy paradigm (Schot et al. 2018; Schot and Steinmueller 2018). Two items prioritise social and environmental objectives over economic growth. Two items emphasise the need for a fundamental transformation of existing structures and systems. One item stresses the need for innovation processes to be inclusive and experimental.

Confirmatory factor analysis

A CFA was carried out on the second subsample (n = 328) to confirm the structure identified with the EFA. The result of the three-factor model demonstrated adequate fit on standard indices: ($\chi 2/\text{df}$) = 1.90, CFI = 0.951, TLI = 0.936, SRMR = 0.045, and RMSEA 0.052 CI 90%, [0.040, 0.065]. Figure 2 presents the resulting model.

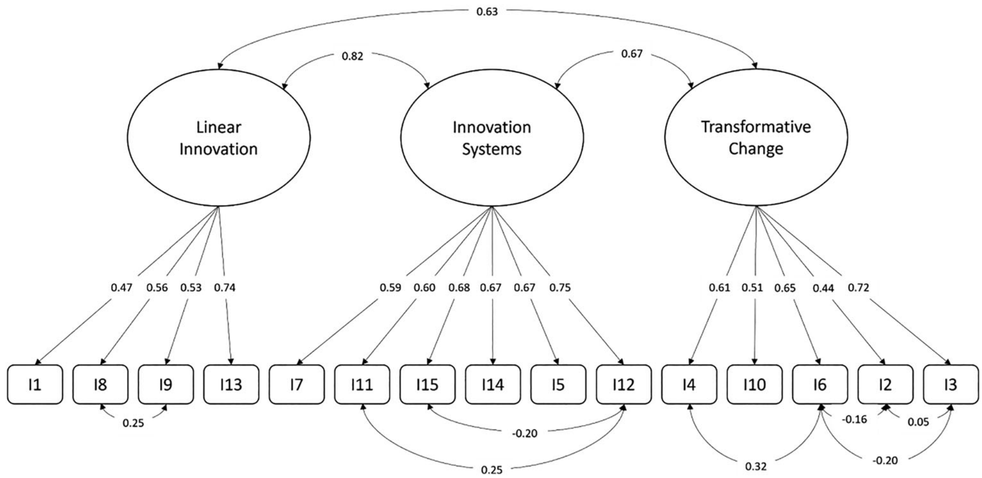

Figure 2. Diagram of CFA with standardised factor loadings.

Internal consistency

To assess the internal consistency of the scale, Crohnbach's alphas were calculated using the entire sample ($N = 656$). The results were satisfactory for all three factors. Crohnbach's alpha equalled 0.74 for the factor 'linear innovation', 0.85 for the factor 'innovation systems' and 0.73 for the factor 'transformative change' .

Measurement invariance

Different levels of measurement invariance can be taken into account: (a) configural invariance indicates whether the basic model structure is invariant across the groups, (b) metric invariance refers to the fact that different groups interpret the items in a similar way, (c) scalar invariance indicates whether differences in means of the observed items are a consequence of the differences in means of the latent constructs (Kyndt and Onghena 2014). To test for metric invariance, the configural model can be compared to a model in which the factor loadings are constrained. Metric invariance is achieved when constraining the factor loadings does not result in a significantly worse fit of the model (i.e. when the difference between the CFIs of both models is smaller than 0.01) (Kyndt and Onghena 2014).

The results as shown in Table 3 indicate that configural, metric and scalar invariance were achieved, meaning that the instrument is invariant across participants who completed the survey in either Dutch or English.

Table 3. Measurement invariance.

	Cfi	rmsea	Δcfi	Δrmsea
fit.configural	0.902	0.078	–	–
fit.loadings	0.904	0.074	0.002	0.003
fit.intercepts	0.897	0.074	0.007	0.000
fit.means	0.883	0.078	0.014	0.004

Discussion and conclusion

Addressing the Grand Challenges will require insights from many perspectives due to the complex and interconnected nature of the problems at hand (Mazzucato 2017). A number of scholars deem the established policy paradigms (innovation for growth and innovation systems) to be insufficient in light of the Grand Challenges (Schot and Steinmueller 2018; Weber and Rohracher 2012). In a global transition process, actors belonging to different languages and cultures will have to cooperate. The success of these collaborations rests on their ability to find common ground and mutual understanding (Klerkx, van Mierlo, and Leeuwis 2012). Innovation intermediaries can facilitate such collaborations by strengthening linkages and enhancing alignment of the multi-actor network (Klerkx and Leeuwis 2008) through communication, translation and mediation (Vilas-Boas, Klerkx, and Lie 2022). They are therefore viewed as essential catalysts for transition policies (Bäumle, Hirschmann, and Feser 2022; Kivimaa et al. 2019a). In the agricultural sector, advisors are considered good candidates to take up this role. The crucial nature of that role underscores the importance of understanding how they view innovation processes .

Before this study, only one instrument (Landini and Beramendi, 2019) was available to gauge how advisors view innovation. However, this instrument did not assess the innovation model of transformative change (Landini and Beramendi 2019; Landini, Beramendi, and Rojas-Andrade 2021). This rendered it unfit for the European context with its increasing focus on transformative innovation. In response, an instrument was designed to measure the level of agreement with each of the innovation models underlying the three prevailing innovation policy paradigms (i.e. innovation for growth, innovation systems and transformative innovation) (see above). The factor 'linear innovation' refers to the model underlying the innovation for growth policy paradigm (Schot and Steinmueller 2018). Within that model, which involves a top-down understanding of knowledge generation and transfer, new knowledge is created by universities and research institutes, with a focus on STEM subjects. The role of the advisor is to transfer this knowledge to the practical context of the farmer. This is consistent with the categorisation of Diercks, Larsen, and Steward (2019), who characterised the innovation for growth policy paradigm as having a narrow understanding of the innovation process. The factor 'innovation systems' is the model underlying the innovation systems policy paradigm (Schot and Steinmueller 2018). Within this innovation systems model, knowledge is co-created and transferred in the context of application by different types of actors. Communication and interaction in learning processes are considered essential features of an innovation process. In contrast to the first linear model, this model holds a broader, more holistic view of the innovation process (Diercks, Larsen, and Steward 2019). Last, the factor 'transformative change' represents the model underlying the transformative innovation policy paradigm (Schot and Steinmueller 2018). This model prioritises social and environmental objectives over economic growth and requires the innovation process to be inclusive and experimental. Existing structures and systems need to be fundamentally transformed to obtain a sustainable future. In contrast to the first two factors, the transformative change model does not include a clear understanding of the practicality of the innovation process. Diercks, Larsen, and Steward (2019) revealed the conceptual diversity present within the transformative innovation paradigm, indicating that different understandings of the innovation process are possible within this view on innovation. Nevertheless, these different articulations of the transformative innovation paradigm all share a common policy agenda (Diercks, Larsen, and Steward 2019).

What follows is a discussion of the main contributions of this study, as well as some limitations and recommendations for further research. The main contribution of this article is the development and validation of an instrument to assess the view on innovation of European agricultural advisors. To our knowledge, this instrument is unique; it can be applied for research as well as for practical purposes.

From a research perspective, the instrument could be used to perform quantitative comparisons of the view of advisors on innovation throughout different European regions, countries, or AKIS. The survey has been translated into 11 languages, which gives it great potential to survey a diverse set of agricultural advisors. Gathering data from advisors across Europe regarding their view on innovation could help to reveal where a paradigm shift has not yet occurred, which in turn informs policy choices. Upon examination of initiatives funded by the Horizon 2020 and Horizon Europe programmes, it seems the advisor is currently expected to take on a facilitating role in multi-actor projects. They are expected to connect different actors within the sector and create an enabling environment in which knowledge can be co-produced. This view of interactive innovation is in accordance with the innovation systems model. The survey could show to what extent advisors have either embraced this role, prefer a linear form of knowledge exchange, or see value in both visions on innovation. In addition, the survey could indicate whether European advisors are likely to embrace the emergent transformative change innovation model. As a mission-oriented perspective on AIS gains increasing significance (Klerkx and Begemann 2020), it is crucial to engage all stakeholders who can potentially impact the food system transformation (Mazzucato 2017). Advisors, who often share a trusted relationship with farmers, are in an ideal position to facilitate the implementation of such transformative innovation policies. Recent research in Argentina has shed light on advisors' perspectives on innovation, yielding intriguing findings that highlight key considerations for effective innovation policy implementation (Landini 2015; Landini and Beramendi 2019; Landini, Beramendi, and Rojas-Andrade 2021; Turner et al. 2023). For instance, these studies reveal that advisors in the context of Argentina may endorse multiple, sometimes conflicting, views on innovation, depending on the specific context they operate (Landini and Beramendi 2019). Furthermore, researchers have identified two distinct mindsets regarding innovation support, neither of which aligns perfectly with the goals of the country's leading extension institution (Landini 2015). Lastly, it becomes evident that the objectives of advisors or advisory organisations (i.e. the concrete goals they aim to achieve) are often influenced by the type of funding they receive (Turner et al. 2023).

In the European context, it is already apparent that some central concepts in innovation policy are not universally understood by all stakeholders (Fieldsend et al. 2021). Therefore, it is reasonable to assume that there is also much to gain from research that offers insights into advisors' perspectives on innovation and innovation policy. For instance, using this instrument could help determine whether the views held by advisors or advisory organisations, who are the intended recipients of specific policy instruments, align with the intended objectives of those instruments.

From a practical perspective, the instrument could be used by advisory organisations as a tool in the selection of new advisors. The instrument would allow the organisation to find employees who share the values and vision of the organisation they would represent. We want to emphasise that the tool should not be interpreted as a value judgment, as one view on innovation is not inherently better or worse than another. As such the tool should not be used in a normative manner, nor should it be used as the only criterion in the selection of advisors. The instrument also has potential for use in different settings, such as in other sectors. For this, the items of the instrument will have to be modified, since they are now formulated from the point of view of an advisor.

This study also has limitations. The distribution of the survey was performed using a snowball sampling method starting with the i2connect project partners and extended through their networks. This resulted in responses from 24 nationalities. Although use of this network might imply bias from people sympathetic to the project and its vision, we see this as a minor risk, as each partner has its own extensive network and the respondents were not i2connect project partners, meaning that many of them had only limited or no contact with the project. Moreover, this method of distribution made it impossible to assess the response rate of the survey. Since participation was voluntary, our responses might be biased towards people with strong opinions on the topic. However, this should not affect our results, as this article aims to validate an instrument, which means the score levels of the participants are not important. What matters is the consistency of their responses. We conducted a level of measurement invariance analysis to verify if there is a systematic difference in how people answer, and our results suggest otherwise. Another weakness is related to the lower number of responses in languages other than Dutch and English, which meant that measurement invariance could only be determined for those two language groups. Future studies may establish measurement invariance in other languages. Depending on the objective of the research, achieving metric or scalar invariance is a precondition before using the instrument in languages other than English or Dutch (Kyndt and Onghena 2014). The survey 'vision of EU advisors towards innovation' is now ready for use in the European context (Annex 1), as it was applied and validated only in Europe. To use the instrument in other continents it should be translated both technically and culturally using the back-translation method. Additionally, it should be validated in those continents. For guidance on this process, the International Test Commission (Hambleton 1994) can provide valuable resources and support. The survey's internal consistency is satisfactory, as evidenced by the values of Crohnbach's alpha for each factor, particularly when measuring a complex construct with a limited number of items. It is worth noting that Likert himself acknowledged that increasing the number of items can improve reliability. Therefore, our initial suggestion to enhance reliability would be to include more items that measure each construct. However, we should also consider that including more items can lead to survey fatigue, limiting the usability and uptake of the research in the future. The results of the present study represent a foundation for further qualitative investigations, to gather additional information about how European advisors understand innovation processes as well as their vision of the future. Furthermore, by linking the results of the survey with local AKIS country reports[4], developed in the i2connect project, possible links might be explored between a certain understanding of the innovation process and local policy or AKIS characteristics.

Notes

1. https://www.tipconsortium.net/
2. https://i2connect-h2020.eu/
3. The items without item code are excluded from the instrument due to the results of factor analysis.
4. https://i2connect-h2020.eu/resources/akis-country-reports/

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References

Arrow, K. J. 1962. "Economic Welfare and the Allocation of Resources for Invention." In *The Rate and Direction of Inventive Activity: Economic and Social Factors*, edited by National Bureau of Economic, 609–626. Princeton University Press.

Bäumle, Philipp, Daniel Hirschmann, and Daniel Feser. 2022. "The Roles of Knowledge Intermediaries in Sustainability Transitions and Digitalization : Academia-Driven Fostering of Socio-Technical Transitions ?" Available at SSRN 4159600.

Boon, Wouter P.C., Jakob Edler, and Douglas K.R. Robinson. 2022. "Conceptualizing Market Formation for Transformative Policy." *Environmental Innovation and Societal Transitions* 42 (2022): 152–169. https://doi.org/10.1016/j.eist.2021.12.010.

Borrás, Susana, and Jakob Edler. 2020. "The Roles of the State in the Governance of Socio-Technical Systems' Transformation." *Research Policy* 49 (5): 103971. https://doi.org/10.1016/j.respol.2020.103971.

Byrne, Barbara M. 2016. "Structural Equation Modeling With AMOS." Third. Routledge, https://doi.org/10.4324/9781315757421

Compagnone, Claude, and Béatrice Simon. 2018. "Cooperation and Competition Among Agricultural Advisory Service Providers. The Case of Pesticides Use." *Journal of Rural Studies* 59 (January): 10–20. https://doi.org/10.1016/j.jrurstud.2018.01.006.

Diercks, Gijs, Henrik Larsen, and Fred Steward. 2019. "Transformative Innovation Policy: Addressing Variety in an Emerging Policy Paradigm." *Research Policy* 48 (4): 880–894. https://doi.org/10.1016/j.respol.2018.10.028.

Eastwood, Callum, Margaret Ayre, Ruth Nettle, and Brian Dela Rue. 2019. "Making Sense in the Cloud: Farm Advisory Services in a Smart Farming Future." *NJAS: Wageningen Journal of Life Sciences* 1–10 (1): 1–10. https://doi.org/10.1016/j.njas.2019.04.004.

European Commission. 2020. "Interactive Innovation and the EIP-AGRI." Accessed July 30. https://ec.europa.eu/info/research-and-innovation/research-area/agriculture-and-forestry/interactive-innovation-and-eip-agri_en.

European Commission. 2022. "Horizon Europe Work Programme 2023-2024 – 9." Food, Bioeconomy, Natural Resources, Agriculture and Environment.

Fabrigar, Leandre R., Duane T. Wegener, Robert C. MacCallum, and Erin J. Strahan. 1999. "Evaluating the Use of Exploratory Factor Analysis in Psychological Research." *Psychological Methods* 4 (3): 272–299. https://doi.org/10.1037/1082-989X.4.3.272.

Fagerberg, Jan. 2018. "Mobilizing Innovation for Sustainability Transitions: A Comment on Transformative Innovation Policy." *Research Policy* 47 (9): 1568–1576. https://doi.org/10.1016/j.respol.2018.08.012.

Fagerberg, Jan, Staffan Laestadius, and Ben R Martin. 2016. "The Triple Challenge for Europe: The Economy, Climate Change, and Governance." *Challenge* 59 (3): 178–204. https://doi.org/10.1080/05775132.2016.1171668.

Fagerberg, J., D. C. Mowery, and R. R. Nelson, eds. 2006. *The Oxford Handbook of Innovation*. Oxford: Oxford University Press.

Field, Andy. 2017. *Discovering Statistics Using IBM SPSS Statistics*. UK: SAGE Publications Ltd.

Fieldsend, Andrew F., Evelien Cronin, Eszter Varga, Szabolcs Biró, and Elke Rogge. 2021. "'Sharing the Space' in the Agricultural Knowledge and Innovation System: Multi-Actor Innovation Partnerships with Farmers and Foresters in Europe." *The Journal of Agricultural Education and Extension* 27 (4): 423–442. https://doi.org/10.1080/1389224X.2021.1873156.

Fielke, Simon, Bruce Taylor, and Emma Jakku. 2020. "Digitalisation of Agricultural Knowledge and Advice Networks: A State-of-the-Art Review." *Agricultural Systems* 180 (November 2019): 102763. https://doi.org/10.1016/j.agsy.2019.102763.

Global Forum on Agricultural Research and Innovation. 2023. "Global Forum on Agricultural Research and Innovation." Accessed April 21. https://www.gfar.net/.

Goretzko, David, Thien Trang, Huong Pham, and Markus Bühner. 2021. "Exploratory Factor Analysis: Current Use, Methodological Developments and Recommendations for Good Practice." *Current Psychology* 40 (7): 3510–3521. https://doi.org/10.1007/s12144-019-00300-2.

Hall, Andrew, Willem Janssen, E. Pehu, and R. Rajalahti. 2006. "Enhancing Agricultural Innovation" *World Bank* January. https://doi.org/10.1596/978-0-8213-6741-4
Hambleton, R. K. 1994. "Guidelines for Adapting Educational and Psychological Tests: A Progress Report." *European Journal of Psychological Assessment* 10: 229–244.
Jarrett, F. G. 1985. "Sources and Models of Agricultural Innovation in Developed and Developing Countries." *Agricultural Administration* 18 (4): 217–234. https://doi.org/10.1016/0309-586X(85)90092-5.
Kanger, Laur. 2020. "Neglected Systems and Theorizing: A Comment on the Transitions Research Agenda." *Environmental Innovation and Societal Transitions* 34 (January): 352–354. https://doi.org/10.1016/j.eist.2020.01.001.
Kivimaa, Paula, Wouter Boon, Sampsa Hyysalo, and Laurens Klerkx. 2019a. "Towards a Typology of Intermediaries in Sustainability Transitions: A Systematic Review and a Research Agenda." *Research Policy* 48 (4): 1062–1075. https://doi.org/10.1016/j.respol.2018.10.006.
Kivimaa, Paula, Mikael Hildén, Dave Huitema, Andrew Jordan, and Jens Newig. 2017. "Experiments in Climate Governance – A Systematic Review of Research on Energy and Built Environment Transitions." *Journal of Cleaner Production* 169 (December): 17–29. https://doi.org/10.1016/j.jclepro.2017.01.027.
Kivimaa, Paula, Sampsa Hyysalo, Wouter Boon, Laurens Klerkx, Mari Martiskainen, and Johan Schot. 2019b. "Passing the Baton: How Intermediaries Advance Sustainability Transitions in Different Phases." *Environmental Innovation and Societal Transitions* 31 (January): 110–125. https://doi.org/10.1016/j.eist.2019.01.001.
Klerkx, Laurens. 2020. "Advisory Services and Transformation, Plurality and Disruption of Agriculture and Food Systems: Towards a New Research Agenda for Agricultural Education and Extension Studies." *The Journal of Agricultural Education and Extension* 26 (2): 131–140. https://doi.org/10.1080/1389224X.2020.1738046.
Klerkx, Laurens, and Stephanie Begemann. 2020. "Supporting Food Systems Transformation: The What, Why, Who, Where and How of Mission-Oriented Agricultural Innovation Systems." *Agricultural Systems* 184 (August): 102901. https://doi.org/10.1016/j.agsy.2020.102901.
Klerkx, Laurens, and Cees Leeuwis. 2008. "Matching Demand and Supply in the Agricultural Knowledge Infrastructure: Experiences with Innovation Intermediaries." *Food Policy* 33 (3): 260–276. https://doi.org/10.1016/j.foodpol.2007.10.001.
Klerkx, Laurens, and Cees Leeuwis. 2009. "Establishment and Embedding of Innovation Brokers at Different Innovation System Levels: Insights from the Dutch Agricultural Sector." *Technological Forecasting and Social Change* 76 (6): 849–860. https://doi.org/10.1016/j.techfore.2008.10.001.
Klerkx, Laurens, Barbara van Mierlo, and Cees Leeuwis. 2012. "Evolution of Systems Approaches to Agricultural Innovation: Concepts, Analysis and Interventions." In *Farming Systems Research Into the 21st Century: The New Dynamic*, edited by Ika Darnhofer, David Gibbon, and Benoît Dedieu, 457–483. Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-4503-2_20.
Knickel, Karlheinz, Gianluca Brunori, Sigrid Rand, and Jet Proost. 2009. "Towards a Better Conceptual Framework for Innovation Processes in Agriculture and Rural Development: From Linear Models to Systemic Approaches." *The Journal of Agricultural Education and Extension* 15 (2): 131–146. https://doi.org/10.1080/13892240902909064.
Knickel, Marina, Sabine Neuberger, Laurens Klerkx, Karlheinz Knickel, Gianluca Brunori, and Helmut Saatkamp. 2021. "Strengthening the Role of Academic Institutions and Innovation Brokers in Agri-Food Innovation: Towards Hybridisation in Cross-Border Cooperation." *Sustainability* 13 (9): 4899. https://doi.org/10.3390/su13094899.
Knierim, Andrea, K. Boenning, M. Caggiano, A. Cristóvão, V. Dirimanova, T. Koehnen, P. Labarthe, and K. Prager. 2015. "The AKIS Concept and Its Relevance in Selected EU Member States." *Outlook on Agriculture* 44 (1): 29–36. https://doi.org/10.5367/oa.2015.0194.
Knierim, Andrea, Pierre Labarthe, Catherine Laurent, Katrin Prager, Jozef Kania, Livia Madureira, and Tim Hycenth Ndah. 2017. "Pluralism of Agricultural Advisory Service Providers – Facts and Insights from Europe." *Journal of Rural Studies* 55: 45–58. https://doi.org/10.1016/j.jrurstud.2017.07.018.

Köhler, Jonathan, Frank W. Geels, Florian Kern, Jochen Markard, Elsie Onsongo, Anna Wieczorek, Floortje Alkemade, et al. 2019. "An Agenda for Sustainability Transitions Research: State of the Art and Future Directions." *Environmental Innovation and Societal Transitions* 31 (December 2018): 1–32. https://doi.org/10.1016/j.eist.2019.01.004.
Kuhlmann, Stefan, and Arie Rip. 2018. "Next-Generation Innovation Policy and Grand Challenges." *Science and Public Policy* 45 (4): 448–454. https://doi.org/10.1093/scipol/scy011.
Kyndt, Eva, and Patrick Onghena. 2014. "Professional and Practice-Based Learning." *In Professional and Practice-Based Learning* 9: 255–291. https://doi.org/10.1007/978-94-007-7012-6_14.
Labarthe, Pierre, and Laurent. 2013. "The Importance of the Back-Office for Farm Advisory Services." *EuroChoices* 12 (1): 21–26. https://doi.org/10.1111/1746-692X.12015.
Landini, Fernando. 2015. "Different Argentine Rural Extensionists' Mindsets and Their Practical Implications." *The Journal of Agricultural Education and Extension* 21 (3): 219–234. https://doi.org/10.1080/1389224X.2014.927375.
Landini, Fernando, and Maite Beramendi. 2019. "Construction and Validation of a Psychometric Scale to Assess Extension Agents' Beliefs About Extension and Innovation." *The Journal of Agricultural Education and Extension* 25 (5): 381–399. https://doi.org/10.1080/1389224X.2019.1643748.
Landini, Fernando, Maite Regina Beramendi, and Rodrigo Rojas-Andrade. 2021. "Transcultural Validation of a Scale in English, Portuguese and Spanish to Assess Rural Extension Agents' Beliefs About Extension and Innovation." *Journal of Rural Studies* 86 (March): 518–526. https://doi.org/10.1016/j.jrurstud.2021.07.012.
Lybaert, Charlotte, Lies Debruyne, Eva Kyndt, and Fleur Marchand. 2022. "Competencies for Agricultural Advisors in Innovation Support." *Sustainability* 14 (1): 182. https://doi.org/10.3390/su14010182.
Mazzucato, Mariana. 2017. *Mission-Oriented Innovation Policy – Challenges and Opportunities*. UCL Institute for Innovation and Pubic Purpose.
Nelson, Richard R. 1959. "The Simple Economics of Basic Scientific Research." *Journal of Political Economy* 67 (3): 297–306. https://doi.org/10.1086/258177.
Nelson, Richard R. 1993. *National Innovation Systems: A Comparative Analysis*. Oxford University Press on Demand.
Nettle, R., A. Crawford, and P. Brightling. 2018. "How Private-Sector Farm Advisors Change Their Practices: An Australian Case Study." *Journal of Rural Studies* 58 (December 2017): 20–27. https://doi.org/10.1016/j.jrurstud.2017.12.027.
Revelle, William. 2016. *Psych: Procedures for Psychological, Psychometric, and Personality Research.* Evanston, IL: Northwestern University. http://cran.r-project.org/package=psych.
Rivera, William M, Gary Alex, James Hanson, and Regina Birner. 2006. "Enabling Agriculture: The Evolution and Promise of Agricultural Knowledge Frameworks." Proceedings of the Association for International Agricultural and Extension Education 22nd Annual Conference, Clearwater Beach, Florida, 580–591. https://www.aiaee.org/attachments/article/847/580.pdf.
Rosseel, Yves. 2012. "Lavaan: An R-Package for Structural Equation Modeling." *Journal of Statistical Software* 48 (2): 1–93. https://doi.org/10.18637/jss.v048.i02.
Rouquette, Alexandra, and Bruno Falissard. 2011. "Sample Size Requirements for the Internal Validation of Psychiatric Scales." *International Journal of Methods in Psychiatric Research* 20 (4): 235–249. https://doi.org/10.1002/mpr.352.
Schot, Johan, and W. Edward Steinmueller. 2018. "Three Frames for Innovation Policy: R&D, Systems of Innovation and Transformative Change." *Research Policy* 47 (9): 1554–1567. https://doi.org/10.1016/j.respol.2018.08.011.
Schot, Johan, W. Edward Steinmueller, Laur Kanger, and Tuomo Alasoini. 2018. "Three Frames: A Comparison." http://www.tipconsortium.net/wp-content/uploads/2018/04/4173_TIPC_3frames.pdf.
Seitz, Paige, Robert Strong, Steve Hague, and Theresa P. Murphrey. 2022. "Evaluating Agricultural Extension Agent's Sustainable Cotton Land Production Competencies: Subject Matter

Discrepancies Restricting Farmers' Information Adoption." *Land* 11 (11): 2075. https://doi.org/10.3390/land11112075.
Skogstad, Grace Darlene, ed. 2011. *Policy Paradigms, Transnationalism, and Domestic Politics*. Vol. 35. Toronto: University of Toronto Press.
Smart-AKIS. 2022. "Innovation Broker." Accessed July 5. https://www.smart-akis.com/index.php/i-am-a/innovation-brokers/.
Song, Hummy, Alyna T. Chien, Josephine Fisher, Julia Martin, Antoinette S. Peters, Karen Hacker, Meredith B. Rosenthal, and Sara J. Singer. 2015. "Development and Validation of the Primary Care Team Dynamics Survey." *Health Services Research* 50 (3): 897–921. https://doi.org/10.1111/1475-6773.12257.
Steward, Fred. 2012. "Transformative Innovation Policy to Meet the Challenge of Climate Change: Sociotechnical Networks Aligned with Consumption and End-Use as New Transition Arenas for a Low-Carbon Society or Green Economy." *Technology Analysis & Strategic Management* 24 (4): 331–343. https://doi.org/10.1080/09537325.2012.663959.
Sutherland, Lee-Ann, Anda Adamsone-Fiskovica, Boelie Elzen, Alexandros Koutsouris, Catherine Laurent, Egil Petter Stræte, and Pierre Labarthe. 2023. "Advancing AKIS with Assemblage Thinking." *Journal of Rural Studies* 97 (2023): 57–69. https://doi.org/10.1016/j.jrurstud.2022.11.005.
Sutherland, Lee-Ann, and Pierre Labarthe. 2022. "Should 'Impartial' Advice Be a Priority of European Agricultural and Rural Policies?" *EuroChoices* 21 (1): 15–22. https://doi.org/10.1111/1746-692X.12348.
Tisenkopfs, Talis, Ilona Kunda, Sandra Šūmane, Gianluca Brunori, Laurens Klerkx, and Heidrun Moschitz. 2015. "Learning and Innovation in Agriculture and Rural Development: The Use of the Concepts of Boundary Work and Boundary Objects." *The Journal of Agricultural Education and Extension* 21 (1): 13–33. https://doi.org/10.1080/1389224X.2014.991115.
Toillier, Aurélie, Syndhia Mathé, Abdoulaye Saley Moussa, and Guy Faure. 2022. "How to Assess Agricultural Innovation Systems in a Transformation Perspective: A Delphi Consensus Study." *The Journal of Agricultural Education and Extension* 28 (2): 163–185. https://doi.org/10.1080/1389224X.2021.1953548.
Transformative Innovation Policy Consortium. 2023. "Transformative Innovation Policy Consortium." https://www.tipconsortium.net/.
Turner, James A., Fernando Landini, Helen Percy, and Marcos Roberto Pires Gregolin. 2023. "Advisor Understanding of Their Roles in the Advisory System: A Comparison of Governance Structures in Argentina, Australia, Brazil, and New Zealand." *The Journal of Agricultural Education and Extension* 29 (1): 3–28. https://doi.org/10.1080/1389224X.2021.1944233.
United Nations Department of Economic and Social Affairs. 2023. "Sustainable Development Goals." Accessed April 18. https://sdgs.un.org/goals.
United Nations Environment Programme. 2022. "Emissions Gap Report 2022: The Closing Window – Climate Crisis Calls for Rapid Transformation of Societies." Nairobi. https://www.unep.org/emissions-gap-report-2022.
Vilas-Boas, Jean, Laurens Klerkx, and Rico Lie. 2022. "Connecting Science, Policy, and Practice in Agri-Food System Transformation: The Role of Boundary Infrastructures in the Evolution of Brazilian Pig Production." *Journal of Rural Studies* 89 (December): 171–185. https://doi.org/10.1016/j.jrurstud.2021.11.025.
Weber, K. Matthias, and Harald Rohracher. 2012. "Legitimizing Research, Technology and Innovation Policies for Transformative Change." *Research Policy* 41 (6): 1037–1047. https://doi.org/10.1016/j.respol.2011.10.015.
Wickham, Hadley, Mara Averick, Jennifer Bryan, Winston Chang, Lucy McGowan, Romain François, Garrett Grolemund, et al. 2019. "Welcome to the Tidyverse." *Journal of Open Source Software* 4 (43): 1686. https://doi.org/10.21105/joss.01686.
Wickham, Hadley, and Garrett Grolemund. 2017. "R for Data Science." O'Reilly Media, Inc. https://r4ds.had.co.nz/.

Wieczorek, Anna J., and Marko P. Hekkert. 2012. "Systemic Instruments for Systemic Innovation Problems: A Framework for Policy Makers and Innovation Scholars." *Science and Public Policy* 39 (1): 74–87. https://doi.org/10.1093/scipol/scr008.

Anne 1. Items of the 'vision of EU advisors towards innovation' survey.

Item code	Innovation model	Question
I1	LI	To bring about innovation, the fields of science, technology, engineering and math are essential.
	LI	It is the role of the private sector to transform scientific discoveries into innovations which will support sustained long-term economic growth.
I2	TC	To address social challenges, existing structures and arrangements need to be changed.
	IS	Striving for inter-institutional cooperation and coordination is fundamental to advisory work.
I3	TC	To be effective, innovation processes should be inclusive, experimental and aimed at changing the direction of socio-technical systems in all its dimensions.
	TC	Innovation processes should be proactive and anticipate alternative futures, associated with certain technological choices.
I4	TC	Solving social and environmental problems should lie at the base of an innovation process.
	TC	An acceptable pathway for change needs to be discovered and pursued through the accumulation of experience by a variety of actors with different motivations and priorities.
	LI	Innovation involves the commercialisation of scientific discovery.
I5	IS	Coordination and communication between different actors form a central component of an innovation processes.
I6	TC	The focus of an innovation process should be to address environmental and social challenges, which can lead to economic growth as a bonus.
I7	IS	User-producer relations are a key source of information in an innovation process.
I8	LI	Conveying results stemming from scientific and technological research is the advisor's main task.
I9	LI	The knowledge provided by universities and research institutes offers the best answers to the sustainability challenges, which the agricultural sector faces.
	LI	The purpose of innovation is to create a radical novelty.
I10	TC	A sustainable future can be achieved by fundamentally transforming the architecture of the agricultural system.
I11	IS	To reach their objectives, advisors have to work in conjunction with the actors and institutions situated in their territory.
I12	IS	To be effective, innovation processes should focus on learning, interaction and dialogue.
I13	LI	Research and scientific advancements are a central component of an innovation process.
I14	IS	The most important innovations arise from the joint experience of different actors (farmers, advisors, researchers, etc.).
I15	IS	To be effective, knowledge should be produced in the context of application.

Innovation models: LI (Linear innovation model), IS (Innovation Systems model), TC (transformative Change Model). Items without item code are excluded from the instrument due to the results of factor analysis.