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Information behaviour of farmers, foresters, and advisors in the context of digitalisation in the EU

This paper provides insights into the information behaviour of European farmers, foresters, and advisors in the context of the ongoing digital transformation. Data collection and analysis for this study were carried out as part of a substantial innovation project to create a new online knowledge platform, called EU FarmBook, for primary sector practitioners. Besides informing the design and development of this user-centred platform, this study also provides useful inputs to better understand the perceived information needs, preferences, and information behaviour of primary sector practitioners, which is an underexplored area of Agricultural Knowledge and Innovation Systems (AKIS) in Europe. This paper presents and draws on 40 semi-structured interviews conducted with farmers, foresters, and advisors from 20 different countries. The results reveal some of the major ways in which the rapid advancements in digital information and communication technologies have affected farmers, foresters, and advisors. The problem-solving strategies of primary sector practitioners now rely largely on online resources. Searches for photos and videos have become a particularly integral activity that reflects their practice-oriented and solve-it-yourself attitudes. This has implications for agricultural extension services, which must be prepared for the challenges and changes that the digital revolution will bring to extension work.

Keywords: Digitalisation, Interviews, EU FarmBook, AKIS, Extension Services.

JEL classifications: Q12, Q16

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Introduction

The context of primary sector production has never been more challenging than it is currently. There is a multi-dimensional set of concerns in relation to demographic change, climate change and globalisation. On top of that, the outbreak of the COVID-19 pandemic in early 2020 and the 2022 war in Ukraine brought additional and unprecedented (ongoing) challenges, emphasising the underlying weaknesses of food systems as well as the vulnerabilities of those working across agri-food value chains (Aday and Aday, 2020; Parks *et al.*, 2020).

This challenging context is driven by another factor: the advancement of information and communication technologies. In agricultural and food systems, digitalisation is one of the most trending transformations. The emergence of this transformation is well reflected in the growing interest expressed in various academic (Burg *et al.*, 2019; Bilali and Allahyari, 2018; Rolandi *et al.*, 2021; Rijswijk *et al.*, 2021; Rose *et al.*, 2016) and policy circles (European Commission 2020; Lajoie-O'Malley *et al.*, 2020; European Commission, 2016). With robotics, sensors, and big data analytics, producers' decision-making process can shift from relying on traditional or experimental knowledge to a management that is "highly optimized, individualized, real-time, hyper-connected, and data-driven" (Ingram and Maye, 2020, p2.). Digital technologies aim to increase agricultural productivity in a way that reduces environmental impacts and manual labour while still satisfying consumers' needs to improve the

way the food system works. Digitalisation is therefore also seen as a key contributor to the transition towards sustainable food production (Bilali and Allahyari, 2018).

Beyond the production-related applications of digital technologies, the rapid advancement of information and communication technologies has brought about fundamental changes in people's knowledge and information behaviour as well (Chowdhury and Chowdhury, 2011). These changes have been driven by a never-before-seen level of connectivity that characterises people's information environments (Eurostat, 2020). Connections have never been so easy to make and maintain due to the emergence of information communication technology (ICT) solutions. These include various digital platforms, social networking and content-sharing sites, search engines and easily accessible high-speed internet (European Commission, 2020). Within that perspective, there is relatively little known about the information behaviour of European farmers, foresters, and advisors. However, it has been evidenced that the ways of seeking, exchanging, and using information and knowledge in agriculture, forestry, and extension services play a major role in adapting to the major challenges that agricultural and food systems are currently facing (Klerkx *et al.*, 2019; Rijswijk *et al.*, 2021; Lajoie-O'Malley *et al.*, 2020; Klerkx, 2021; 2020). This research gap is particularly noteworthy given the enormous efforts that have been made to conceptualise and institutionalise formal and informal Agricultural Knowledge and Innovation Systems (AKISs) in EU member states (Knierim *et al.*, 2015).

The concept of AKIS is a good example of a systems-thinking approach involving the disciplines of sociology, agricultural extension, and information sciences to understand the process of knowledge production and exchange, learning, and innovation in agriculture. At the time of its inception, the ‘Agricultural Knowledge Systems’ (AKS) was understood as linear knowledge transfer structures coordinated at nation-state levels (Leeuwis, 2004). Later, this approach gradually evolved into a multi-stakeholder system that shifted the focus to collaborative research of knowledge and information structures and included farmers and other support services. Agricultural Knowledge and Innovation Systems today acknowledge that knowledge and innovation transfer is fragmented and characterised by pluralism and diversity due to the numerous types of networks and interactions through which information and knowledge flow (Sutherland *et al.*, 2017; Knierim *et al.*, 2015).

In the context of AKIS, information and communication technologies are now seen as pivotal tools with great potential for fostering innovation in agriculture and related sectors. The use of various platforms for communication and content sharing can further stimulate multi-actor innovation activities through informal and formal networks. Although ICTs clearly have the potential to contribute to the removal of barriers to innovation, they contain certain elements that may hinder this process. Areas of concern are evidenced by the lack of use of social media in agricultural context, the lack or prohibitive cost of a reliable broadband internet connection in poor or remote areas, the generational gap in use of these technologies, the risk of information overload and misinformation, and the lack of maintenance of collaborative networks beyond project periods. This array of difficulties must be overcome by joint research efforts (EU SCAR, 2015).

These issues have been widely explored in the literature. In the interpretation of Fielke *et al.*, (2020), the potential implications of digitalisation for agriculture and extension services are to make knowledge and knowledge networks more connected and transparent. This suggests that more technology-mediated interactions will be made between farmers, advisors, and consumers. Klerkx *et al.* (2019) pointed out that scientific literature on digital agriculture is focused on either technical, natural, or design aspects of the application of these technologies in primary production, and tends to neglect the equally important social science aspect. Their interpretation suggests that digitalisation is likely to affect farmers’ knowledge exchange through new modes of interaction. The concept of socio-cyber-physical takes this interpretation further when proposing an analytical approach to understand the interactions between social, cyber, and physical domains.

More specifically, interactions between cyber and social domains look at such an emerging issue that explores advisors’ changing role in extension services at times when a vast amount of information is largely available to a wide range of users (Rijswijk *et al.*, 2021). This is also related to the negative impacts of digitalisation that often appear in the social sustainability context when social, economic, racial, and skill inequities lead to more highly skilled agricultural professionals displacing those with less training and digital

skills (Rotz *et al.*, 2019; Carolan, 2020; Prause, 2021). This is expected to bring major changes and a resulting need for adaptation in the role of advisers as well. Eastwood *et al.* (2019) found that future advisors would rather spend their time helping farmers understand the value of data-driven farming technologies than promoting new technologies. The interface of social and cyber domains also encompasses the longstanding discourse on the so-called “digital divide”. Several comprehensive studies highlight that poor ICT infrastructure, scarce skills in digital communication technologies, and certain determining sociodemographic factors present cumulative causalities that hinder rural development initiatives (Philip *et al.*, 2017; Farrington *et al.*, 2015; Trendov *et al.*, 2019; Salemink *et al.*, 2017; Cowie *et al.*, 2020; Haefner and Sternberg, 2020).

Agricultural Knowledge and Innovation Systems involve dynamic interactions between multiple actors that communicate, exchange knowledge, co-create innovations, and share best practices for farmers, foresters, and other rural businesses. In this complex ecosystem, the means of interactions constantly evolve, which inevitably affects the activities and information-seeking behaviour of farmers, foresters, and advisors. Adapting to this constant evolution is both a challenge for individuals with various backgrounds and a prerequisite to being an efficient professional in the digital era. A good understanding of practitioners’ information needs and information retrieval is seen as an essential element in the development of AKIS that enhance users’ access to reliable sources of knowledge and innovations. Although attempts to understand subfields of information behaviour have been made, such as in relation to internet use (Janc *et al.*, 2019), on-farm demonstrations (Sutherland and Marchand, 2021), use of mobile technologies (Baumüller, 2018; Bonke *et al.*, 2018; Michels *et al.*, 2020; Inwood and Dale, 2019), farm advisory services (Eastwood *et al.*, 2019; Rust *et al.*, 2022), and social media use (Mills *et al.*, 2019), exploring practitioners’ information and knowledge journeys using the analytical framework provided by the information behaviour discipline has not yet been part of the AKIS literature.

The scope of this study

This paper aims to provide explorative insights into the information-seeking behaviour of European farmers, foresters, and advisors in the context of digital transformation. The framework of this study is provided by a Horizon 2020 Research and Innovation Action project. This EU-funded project aimed to assess the feasibility of and further develop the EU FarmBook digital knowledge platform. This interactive knowledge reservoir acts as an open-source e-platform, aiming to accelerate knowledge exchange and sharing of results generated by multi-actor projects and Operational Groups under the past H2020 and current/future Horizon Europe work programmes and the Rural Development Programme. Therefore, this digital initiative is strongly linked to the evolution of the AKIS ecosystem.

Building such an e-platform requires combined expertise and complex methodology. To ensure that the EU FarmBook

digital knowledge platform is fit for purpose, the platform was developed using a service design thinking approach. Through this approach, the EUREKA project thoroughly studied potential users' information needs, preferred channels of communication, as well as challenges faced in finding the most useful knowledge or information (Bull *et al.*, 2022). EUREKA provided a unique opportunity to engage diverse groups of professionals to gain a first-hand understanding of how they perceive their activities in the digital information environment. These examinations provided essential inputs into the development of the EU FarmBook in the first place, but they also produced rich empirical findings on how these professionals seek and use information in their day-to-day lives.

This paper presents explorative insights into European farmers, foresters and advisors' information seeking behaviour and consumption practices in the context of digital transformation. In the following sections of this paper, we first provide the theoretical framework of this study, including a description of information behaviour as a scientific discipline and exploration of information seeking behaviour through users' problem-solving practices. The theoretical framework is followed by the methodological framework, where we explain how this framework was operationalised in the EUREKA project and how the data collected has been analysed for the research described in this paper. This is followed by a presentation of the findings of 40 semi-structured interviews conducted with farmers, foresters, and advisors from 20 different countries. Findings highlight that the problem-solving strategies of primary sector practitioners now rely largely on online resources. Finally, we discuss the key implications for developing future mechanisms and instruments for knowledge transfer, specifically the design of the EU FarmBook.

Theoretical framework

Information behaviour research is founded on the fact that seeking information is one of the most fundamental human activities. Information behaviour research offers a holistic approach that aims to explore people's relationships with information and knowledge while focusing on mediums, sources, and circumstances of encountering (Case, 2007). Following from this, Ford (2015) presents information behaviour as Wilson's (1999) nested concept: The core activity is a search for information using a certain tool (e.g. search engine, social networks); this search, along with other activities such as browsing or monitoring, forms a personal info-seeking strategy. This strategy is the foundation of information behaviour (Ford, 2015).

Information behaviour research started with studies on library use and scientists' information sources (Wilson, 2000). Later, the interest shifted towards what types of information sources are used by individuals, groups, organisations, and communities, and what constitutes their information behaviour (Ford, 2015). Most recent enquiries acknowledge that information behaviour activities are in a constant state of change, partly because of the rapidly changing technologies and the very diverse circumstances of individual users (Bawden and

Robinson, 2011). Referring to the extent of change in the focus of recent enquiries towards the advancement of digital and online solutions, Chowdhury and Chowdhury call for a paradigm shift in information behaviour (Chowdhury and Chowdhury, 2011).

This consequential shift is explored in various recent statistics and findings. In 2019, accessing the internet on a daily basis was an ordinary activity for more than three-quarters of individuals in the EU (Eurostat, 2020). Going online is not just a routine step for most people due to the advancement of mobile and portable devices, but these technologies also keep users in continuous contact with information sources, essentially making information seeking a continuous activity (Burford and Park, 2014; Nicholas *et al.*, 2004). Smart applications can help filter online information by letting in information only from selected domains that fulfil individuals' information needs (Burford and Park, 2014). Today, a substantial fraction of information that is shared flows through social media sites thanks to the 3.5 billion people who use these platforms as part of their communication, news acquisition, cultural consumption, socialisation, and professional activities (Muhlmeyer and Agarwal, 2021). The constant flow of information has accelerated information consumption, which has significantly reduced users' tolerable waiting duration when seeking information (Nah, 2004). 'Information overload' has been described as a phenomenon in which a user receives too much uncontrolled or unfiltered information that essentially leads to a sense of frustration, stress, and in some cases depression (Muhlmeyer and Agarwal, 2021; Fuchs, 2014; Matthes *et al.*, 2020; Bright *et al.*, 2015; Dijck, 2013). This has clear implications for most work in today's economy as well, as a large amount of available information increases the complexity of information-seeking activities (Chowdhury and Chowdhury, 2011). Another important consequence of multiple digital sources, tools, and applications is the complication of users making sound credibility judgements about online information. In addition to the established authority and expertise of the creator, users consider accuracy, recency, reliability, trustworthiness, and truthfulness to underlie credibility judgements (Rieh *et al.*, 2010). However, detecting when online content is fake and/or intended to mislead has never been more challenging due to the sheer growth of information shared and communicated online (Zhang *et al.*, 2020).

The theoretical framework used in this work is rooted in two concepts. First, it relies on Ford's (Ford, 2015) conception of information behaviour that identifies five constituent activities. As a starting point, (i) *perceiving some information-related needs* involves thinking of needed and not needed information; (ii) *coming into contact with information potentially relevant to some needs* covers activities such as searching, browsing, and monitoring information, as long as the information encountered carries some relevance to the person; (iii) *assessing the suitability of information in relation to some information-related needs* includes key steps in information behaviour such as judging intelligibility, relevance, trustworthiness, and usefulness; (iv) *using information* covers recalling, applying, sharing, or communicating information; finally, (v) *organising information for one's own access and use* is related to individuals' classification

and cataloguing of information (Ford, 2015). This approach has provided points of reference for identifying the aspects of respondents' information behaviour.

A second key element of the theoretical framework was the inclusion of an empirical approach centred on the problem-solving practises of users. In the EUREKA project, a key objective was to gain a sufficient understanding of the information needs, preferred channels, and challenges of potential users of the EU FarmBook to ensure that the platform is designed to satisfy their needs. The problem-solving approach was chosen based on the generally held view that problems and problem-solving are primary reasons for individuals to engage in information-seeking activities. This problem-specific aspect has been discussed thoroughly in information behaviour literature. According to Belkin, "*When people engage in information-seeking behavior, it's usually because they are hoping to resolve some problem, or achieve some goal, for which their current state of knowledge is inadequate*" (Belkin, 2000, p58). The problem-resolution chain model proposed by Wilson (1999) became influential in information behaviour research. The starting point for his model is a problem or situation that presents a certain state of uncertainty. The model identifies problem identification, problem definition, problem resolution, and solution statement as key stages in information seeking and suggests that uncertainty decreases the further the information seeker moves along the chain. However, it was later acknowledged that moving to a solution statement may require successive searching behaviour that is identified as a fundamental aspect of information-seeking behaviour (Spink *et al.*, 2002).

Chowdhury *et al.* (2011) claim that the complexity of the digital information environment may further increase individuals' sense of uncertainty at any stage of the search process. E.g., choosing channels and sources, trying to remain up-to-date in the field, formulating a search expression, information overload or out-of-date search results (Nicholas *et al.*, 2004). Belkin (2000) looks at information-seeking behaviour from an information system perspective by drawing attention to the importance of query formulation as the primary representation of an individuals' information problem. Savolainen's (2008) study uses the critical incident interview technique to assess source preferences in the context of seeking problem-specific information for non-work purposes. It was revealed that problem-specific information is sought through human and networked sources in the first place, while printed sources came as sources of supplementary information in the process of information-seeking. In terms of criteria for the selection of sources, availability and accessibility were prioritised over usability, which may refer to the element of urgency in problem-specific information seeking. However, Case (2007) argues that because information seeking involves a series of situations, motivations, and surroundings, it implies the influence of various factors that do not necessarily lead to rational or uniform information-seeking behaviour. This is a characteristic of human information behaviour that any research undertaking to explore this subject must consider when methodological approaches are being developed.

The above examples have illustrated the diversity that characterises information behaviour research from a problem-specific perspective. In the context of this study,

this problem-oriented approach was adopted to explore and identify the typical elements and patterns that constitute the information-seeking behaviour of primary sector practitioners. The next section will present how this approach was applied as part of the methodological framework of the EUREKA project.

Material and methods

As indicated above, this paper presents the information-seeking behaviour of European farmers, foresters and advisors by drawing on a specific segment of the mixed methodology designed to categorise potential users of the EU FarmBook knowledge platform into user personas'. The categorisation of these agricultural personas was an essential element in the development of the FarmBook because it supported the integration of the user perspective in the design of the platform (Bull *et al.*, 2022). The mixed methodology used to provide a sufficient grounding for the development of these user personas included an initial user-profiling workshop, four EU macro-region workshops, one quantitative survey, qualitative interviews, and a final validation workshop. The 40 semi-structured interviews made with farmers, foresters and advisors from 20 different European countries comprise the data presented and analysed in this study.

Semi-structured interviews are an often-used tool for qualitative data collection in social science because this type of interview can be easily adapted for various study purposes (Brinkmann, 2014). Semi-structured interviews were particularly suited in this case because the target group of this study represented a diverse community, and an approach allowing flexibility came as a great advantage when interviewing professionals with different backgrounds (King *et al.*, 2019). This advantage was multiplied when social-distancing rules and lockdowns were implemented across Europe and the rest of the world due to the COVID-19 pandemic. Following these interventions, the interviews had to take place in online environments using various communication platforms.

The interview guideline¹ was centred around four major themes. The identification and definition of these themes were based on, online regional workshops with potential users, and the incorporation of concepts from information behaviour research. The first theme covered fundamental aspects of users' information behaviour by addressing their *routinely used information sources, tools, and information retrieval pathways*. The second theme on the *use of digital tools or sources for professional purposes* was covered by users' narratives in which they recall an occurrence when professional problems were solved by using knowledge or information found through a digital tool or source. The theme of *an ideal online platform for users* directly served the development of the EU FarmBook with essential user perspectives on the desired features of an ideal digital information system. The fourth theme concentrated on specific *socio-demographic information* because these factors have been shown to play an explanatory role in users' information behaviour.

¹ The interview guide is available on request from the authors (kiralay.gabor@aki.gov.hu).

Interviewing was supported project-wide to ensure that interviewers carried out the interviews in a uniform way. This support included a one-day online training for interviewers with specific emphasis on preparation (sampling, invitation and collecting consent), interviewing, post-production (transcription and translation), and a follow-up workshop to share experiences and feedback in relation to the ongoing interviews. The sampling of interviewees was subject to non-probability purposive expert sampling, meaning that there are no probability-related preconditions involved. However, sampling is based on deliberate choices due to knowledge, experience, and proficiency associated with potential participants willing to provide information (Etikan *et al.*, 2016). In that sense, interviews were selected and asked for participation based on the project partners' judgement.

The interviews were conducted over a period of five weeks from the end of April to the beginning of June 2020. Due to COVID-19 restrictions, each interview was conducted either by phone, Skype or Zoom. In the majority of cases, the interviews were conducted in the mother tongue of the interviewee, which ensured that they could express themselves as freely as possible and without language constraints. All participants were informed about the research prior to giving their free written consent to participate. Each interview was recorded, transcribed, and translated into English.

Verbatim English transcriptions of the interviews were thoroughly analysed using a qualitative content analysis facilitated by the software QDA Miner Lite® (Silverman, 2020). Qualitative content analysis is a flexible method for analysing text data. Hsieh and Shannon define qualitative content analysis as “a research method for the subjective interpretation of the content of text data through systematic classification process of coding and identifying themes or patterns” (Hsieh and Shannon, 2005, p1278). The key element of qualitative content analysis is the coding process. The aim of this highly iterative, intuitive, and reflexive process is to expand and interpret the meaning of the raw textual data in the framework of careful and consecutive examinations (Silverman, 2020; King *et al.*, 2019). The coding process defined codes inductively, meaning that there was no pre-defined coding scheme used. Codes were defined purely based on empirical materials. This step was followed by the iterative course of categorisation, re-coding, and interpretation (Corbin and Strauss, 2015).

The final sample provided a unique opportunity to gain insights into elements of information behaviour in European agricultural society. In total, 40 interviews were conducted,

of which 37.5% (15) were with farmers, 32.5% (13) with farm advisors, 17.5% (7) with foresters, and 12.5% (5) with forestry advisors. The interviews covered 20 different countries in four predefined regions. The vast majority of interviews were conducted with male participants. No female participants from the Atlantic-North Sea region were involved in the interviewing. In terms of age distribution, most participants were aged 55 or younger, with less than 18% of participants in the oldest age group. Table 1 shows the detailed distribution of the sample.

Results

The most essential findings of this study are the identification of activities that are understood in this context as core constituents of information behaviour based on Ford's (Ford, 2015) analytical framework. This section gives a brief description of these findings in the form of descriptive statistics derived from incidences and representative quotations (See Table 2).

Searching online was one of the most common activities described by participants, with 83% (n=33) reporting that web search is part of their problem-solving approach. However, there was a difference in distribution between the three target groups, with 95% of the advisors (n=18) reporting this activity but only 36% (n=4) of the foresters mentioning web search as part of their information-seeking practices. In the farmers' group, nearly 80% (n=15) of participants mentioned this activity. Web searches can be distinguished into three groups. These are navigational, informational, and transactional searches. The navigational search usually targets one particular website. The purpose of an informational search is to satisfy information needs by learning about target content. In transactional search, the aim is to interact with the target content, for instance through online shopping, accessing datasets, or downloading content (Broder, 2002; Jansen *et al.*, 2008). This classification was clearly reflected during the analysis of the participants' interviews. Participants' navigational searches often target websites that are visited on a routine basis. These sites are usually official channels, that either collect and share information relevant to a specific sector or locality or generate information. These sites are operated by EU or national bodies, universities, and scientific organisations. Newsletters are also considered a navigational search as subscribing is a deliberate user decision for which participants expect in return regular updates concerning a chosen activity from a source of interest.

Table 1: Composition of sample for interviews.

Region	Countries represented	Profile			Gender		Age		
		farmer	forester	advisor	male	female	-35	35-55	55-
Danube - Balkan	HU, SK, BG, RO	5	1	4	9	1	3	6	1
Atlantic - North Sea	BE, FR, UK, NL, DE	4	2	4	10	0	4	3	3
Nordic - Baltic	EE, FI, LV, LT, PL, SE	2	4	4	6	4	2	7	1
Mediterranean	IT, EL, MT, PT, ES	4	0	6	9	1	3	5	2
TOTAL	20	15	7	18	34	6	12	21	7

Source: Own composition

Table 2: Constituent activities in participants' information behaviour.

Information behaviour activity	Frequency	Representative quotation
web search	83% (n=33)	"There is no longer something that cannot be found on the digital interface, whatever cannot be found. The question is more about how to navigate." (58 years old farmer from Slovakia)
searching for pictures, images, photos online	45% (n=18)	"When I get pictures from the field to identify something, I use online images to provide an answer. Look, I recognise weeds, but farmers, for example, very often do not know weeds in the stages of the germ leaves or in the first stages of the native leaves. They don't even recognise rye flowers, which are quite different than blooming." (47 years old farmer advisor from Estonia)
searching for video-based online information	58% (n=23)	"Sometimes it's good when you when you see things. So if you can get a clear video of what they are doing and what is happening, that's quite useful. But that's not always available. So you always have to always have to go and look for some written text." (29 years old farmer advisor, from the Netherlands)
engaging in social media	65% (n=23)	"Coming back to Facebook, it depends on the nature of the group. Does the group have a good host? For example, there is a group for young farmers, it has 7000 members and I know the guy who created it and is patronising it. There is relevant information coming and going and relevant information being exchanged. (...) If there is moderation, from someone who knows what they are doing and people who might be able to steer it even outside the moderator, then it can work." (35 years old farmer from Hungary)
smart applications	70% (n=28)	"Well, from my experience, there is a quite numerous of inspiring applications that have been introduced over the recent years in the primary sectors. Let's say from precision farming to precision irrigation to application for weather forecasts" (40 years old farmer advisor from Italy)
peer-to-peer information flow	85% (n=34)	"Sometimes it's easier to call a colleague than search for a solution on the Internet, especially in the situation which is very critical." (50 years old farmer advisor from Lithuania)
accessing printed materials	80% (n=32)	"Books, I used to, but no, I don't get the time now to read the new books. Maybe the latest one was about agroecology. But I have to refresh some knowledge that I've had before. No if we talk about offline, it is mainly newspapers and magazines. But then I get often some bit of information here and there. And then I complete it with more online actual information." (45 years old advisor from Romania)

Source: Own composition

Informational searches follow consecutive click-throughs, keyword-based searches, or a combination of these. Participants' search intents are linked to learning more about specific topics such as pests, diseases, equipment, or nutrients. Market price information is also often sought by farmers and foresters to make sure they are well informed before making any deals that involve selling their products. Another typical reason for informational searching is tender or proposal writing for funds and development support. This is mostly related to advisors. Transactional searches usually target equipment shopping, use of satellite map images, and weather databases.

Image-based searches have also become a very important feature of online search activities. Many participants reported that they often search for photos and images specifically when they need to find information quickly. The significance of images in participants' information-seeking practices was strongly reflected in the interviews, with 45% (n=18) of the participants mentioning using this approach. These practices included several types of visual elements in various contexts: searching images, sending or posting images, learning from or demonstrating with illustrations, monitoring crops from satellite or aerial images, or detecting or assessing relevant characteristics of subjects of interest, such as weed detection.

Online videos were even more prominent in participants' information and knowledge seeking and consumption

behaviour, with 58% (n=23) sharing experiences of coming into contact with online videos. Participants shared that they searched for videos related to their interests on a regular basis. This was true across the three main potential user groups of the EU FarmBook (foresters, farmers, and advisors). These activities appeared in contexts related to learning about technologies or farming practices. A significant share of the participants, mostly advisors, said that they used this format as a tool for demonstration in their advisory work.

Social media use clearly has a growing influence on people's information behaviour. Social media-related activities were mentioned by 65% (n=23) of the participants. This includes Facebook, Twitter, LinkedIn, Instagram, and WhatsApp. However, individual views on social media presented a mixed picture, ranging from regular and willing users to those who completely reject use of these platforms.

The multi-functionality of smartphones drives the use of numerous smart applications that aim to serve the immediate needs of farmers, foresters, and advisors. Seventy percent (70%, n=28) of the participants mentioned that they regularly use smart applications in a professional context. Findings show that these apps serve a wide range of functions such as communication, weather forecasting, plant protection and pesticide control, farm management, mapping volume calculations, and access to satellite imagery. The importance of mapping applications can be further emphasised in the

context of forestry, wherein these tools appear to be must-have assets for forestry professionals with reliable data, navigation, and locating functions.

Interviewees also often reported information searching activities that do not take place online. Requesting information through peer-to-peer interactions was referred to as the most generic offline information-seeking activity. In-person interactions were part of the information behaviour of participants in many forms, including direct face-to-face interactions, various types of meetings, forums, presentations, and events where it is possible to meet physically. These encounters seem to be excellent opportunities for peer-to-peer information exchange, which the target group approached in the study view as particularly needed: 85% (n=34) participants mentioned that they needed this form of information.

Printed materials were identified as another major source of information for the participants. Although the declining importance of these formats has been a long-standing trend in information behaviour studies, the targeted professionals in this study showed a pronounced interest in printed materials such as professional magazines, journals, and periodicals, or books. These sources of information were mentioned in 80% (n=32) of the interviews. Despite the shrinking space for printed farming press, these sources seem to remain important reference points in participants' information behaviour. Many participants specifically named such sources, suggesting that they use them on a regular basis. In terms of access, subscriptions seemed to be a common solution. Subscriptions are typically associated with workplaces (institutions or organisations) or memberships, which ensure permanent access to these sources. Subscriptions, whether paid or free, often provide the latest issues of journals and magazines in electronic format. Although this delivery method makes these contents convenient to consume, it also links this activity to the internet, which inevitably leads to more online presence and web searches.

Discussion

The thematic content analysis resulted in the identification of several activities that constitute practitioners' information behaviour. Activities were assessed using Ford's conception of information behaviour (Ford, 2015) and a problem-solving approach. In that sense, respondents shared their typical procedure when confronted with a constant stream of information in problem-solving situations.

Although Ford's framework includes five components of information behaviour (see Theoretical Framework), this study did not identify all of these. Respondents provided in-depth descriptions of how they *come into contact with* various forms of information after *perceiving certain needs that relate to information*. In the methodological setting of this study, this need was artificially presented via concrete questions concerning their professional problem-solving experiences. Given the ease of access to what was often referred to as an "overloading stream of information", it is not surprising that interviewees frequently reflected on how they *assess the suitability of information*. According to Ford's interpretation, *using information* encompasses recalling, applying,

sharing, and communicating it. These types of activities were clearly demonstrated in multiple interview cases. However, *classification and cataloguing of information*, the fifth component of information behaviour in Ford's framework, was not discussed in the interviews, thus this area remains unexplored in this study.

From a general perspective, information behaviour activities are usually arranged into two basic information retrieval pathways that participants take in their everyday operations. An information pathway is an individual's journey of selecting various information sources over time to attempt to overcome a problem or a problematic situation (Savolainen, 2008). The first type of information search is one that is triggered by the need for a quick solution, response, or fix to smaller or less complex day-to-day questions or problem, typically implemented on the ground and on a single device (in the case of online searches). The second is a more complex process involving multiple searches and requiring more time, due to a question or issue of a more complex nature. These multi-step searches usually require the use of multiple resources and tools. Multi-step information retrievals can begin as quick searches that do not yield the desired answer or solution, and thus drive individuals to engage in multiple and successive information behaviour activities. These more complex problems and the associated multi-step, multi-source information retrieval pathways resonates with the general concept of AKIS, which builds on diversity and pluralism in information and knowledge transfers within primary sectors. The effectiveness of AKIS can be improved if the design of the related activities considers the findings of this study, principally that the information behaviours of primary sector practitioners involve a diverse combination of several equally important sources and tools.

An important finding of this study is that image-based searches have become an important part of practitioners' information-seeking approaches, particularly among advisors, thanks to the powerful internet search engines that make this functionality readily accessible. Recent studies have shown that the characteristics of online image searches differ from general online searches. Image search is usually driven by exploratory motivations and conducted with shorter queries (Xie *et al.*, 2018). Participants prefer images over text-based results because images enable visual information processing that leads to quicker information acquisition. Additionally, an image search often serves as the entry point for a subsequent web search if finding the appropriate image generates a click-through to the host website.

Although no comprehensive theory has yet been developed to understand people's intentions and behaviour concerning viewing of online videos, it seems likely that the magnitude of online video consumption for learning, development, and information has caught up with videos made for entertainment. This is evidenced by the fact that so-called "how-to" videos have become one of the most widely viewed online video types (Purcariu, 2019). Many participants reported that they routinely turn to YouTube – the largest and most popular video-sharing site – for information. The motivation or intent of these video searches is to seek information on technologies, practices, or innovations of interest. Interviews suggest that participants seek both professional

and amateur content. Searching for images and videos also points to the fact that participants' work is highly practice-oriented. An important consequence of this is that they often try to solve problems and issues themselves, and visual materials can undoubtedly be very helpful in this respect.

The prominence of social media in participants' information behaviour is not surprising given the role that these platforms have had in everyday life. Participants' reflections on social media use fully supported Klerkx's statement claiming that farmers and advisors actively use social media platforms (Klerkx, 2021). Themes related to farmers' and advisors' use of social media are beginning to be explored in other studies. However, various topics have been recommended to be on the research agenda of agricultural and extension services (Klerkx, 2020). What has been found thus far is that practitioners are actively using these networks, mostly for knowledge sharing and learning, and more rarely for knowledge generation (Rust *et al.*, 2022; Klerkx, 2021; Mills *et al.*, 2019). However, there is a growing number of examples of content and influence generation in the context of agriculture and food facilitated by various social media platforms (Klerkx, 2021).

Reports made in the interviews were in line with these findings, emphasising that social media platforms are now a primary source in practitioners' information behaviour, including among farmers. These platforms have become useful virtual spaces for professional socialisation, including through the formation of groups centred around certain topics, themes, or interests. However, if such groups lack professional moderation, there is higher risk of the disseminating and trending of misleading information that may discourage people from further use of these forums.

Social media platforms provide an easy and reliable way to maintain client contacts even in times when social distancing measures are in place. Many participants identified Facebook as an important source of information, which is most likely due to the News Feed feature and its customisable preferences. Most of the negative remarks made by interviewees on social media mentioned its time-consuming nature and frustration resulting from encountering misleading or false information.

Many studies have investigated farmers' use of smartphone applications (Bonke *et al.*, 2018; Inwood and Dale, 2019; Michels *et al.*, 2019; Rose *et al.*, 2016; Baumüller, 2018). The interviews showed, in line with these previous studies, that more and more applications are becoming available for agricultural and forestry purposes. However, there is still great potential for growth in their adoption. These decision-support tools are particularly useful in *ad hoc* problem situations that often occur on the ground. Quick access to information, provided a network is available, is a highly valuable feature in remote forest areas. For foresters, maps are a very important form of information, which is traditionally used in paper form, and older generations seem reluctant to change this. However, the younger generation shows openness to digital maps accessed on a smartphone or a tablet. The future role of paper maps has been questioned due to the increasing availability of mapping applications, but it seems that paper maps still have qualities that make this format relevant in the digital age (Hurst and Clough, 2013).

Despite all the advancements in communication and access to information made possible in the digital age, peer-

to-peer information flow is still an integral part of primary sector practitioners' information behaviour. This activity was reported so frequently by participants that it clearly supports the often-evidenced finding that farmers' number one source of information is other farmers (Garforth *et al.*, 2003; Kilpatrick and Johns, 2003; Šūmane *et al.*, 2018). Philips *et al.* (2018) explain this behaviour with the principle of homophily, claiming that farmers prefer farmers over other sources. Such peer-to-peer interactions usually involve information exchange or requesting advice. The latter was reported to be most common in cases when an information search was driven by encountering or considering a previously non-experienced practice, technology, or disease. The existence of trust in these information exchanges is based on three main factors: a long-standing acquaintance or partnership, knowledge of having experience in the issue, and being in a position of authority, such as an advisor or veterinarian. These findings related to personal contacts support the importance of understanding the socio-organisational context of farming (Klerkx *et al.*, 2019; Rijswijk *et al.*, 2021).

Alongside peer-to-peer information flows, the interviews demonstrated that printed materials still constitute a major information source, which is in line with those studies that highlighted the importance of access to explicit knowledge in printed materials. Collectively, these results show that printed materials still have the capacity to support routine professional activities such as solving problems, staying up-to-date on the latest news, or spreading sector-specific information, despite the rise of the Internet (Gava *et al.*, 2017; Klerkx and Proctor, 2013; Kutter *et al.*, 2011). However, this capacity has been on a downward trend in terms of their share in participants' information behaviour, which makes their role in the future uncertain (Rust *et al.*, 2022).

The thematic content analysis also revealed some overarching themes that point to the changing nature of agricultural and forestry advisory work in the context of emerging digital information technologies in these sectors. One of these themes is that participants are increasingly concerned about the reliability of the information they find online. According to Ford (2015), this information activity assesses or judges the suitability of the information, which is in essence a judgement of how intelligible, relevant, trustworthy or useful the information the individual comes into contact with is. This was expressed frequently in the interviews, making this issue a common ground for participants regardless of their personal or professional background. Participants shared their experiences of situations when they found it difficult to decide what was reliable, trustworthy, or validated versus what was not among the wealth of information available. Questioning the reliability of these sources is usually driven by the perception of non-professional content, underlying marketing or advertising objectives, or out-of-date information. Some participants reported that they cope with this issue by examining two things: the structure or appearance of websites and the references (or lack thereof). These factors are in line with those findings from information technology research that have shown links between website-related factors and online trust (Kim and Lee, 2020).

Another interesting overarching theme is related to the changing nature of extension services. Traditionally, extension

services are inherently based on in-person encounters and meetings in agriculture and forestry (Klerkx *et al.*, 2019). Eastwood (2019) explored advisors' sensemaking role in assisting farmers in the use of data-driven technologies, while Ayre (2019) demonstrated the challenges and possible solutions for advisors to develop their services to meet the growing information and knowledge needs of farmers. Such a challenge is explored by Rijswijk (2019), who demonstrates that digitalisation responses of agricultural knowledge providers are often *ad hoc* in nature, highlighting the lack of a strategic approach as well as suggesting uncertainty towards digital transition in agriculture. Based on Ingram and Maye's review (2020), this may lead advisory and extension services to face the emergence of demands for developing new capabilities, practices and skills. In particular, the latter statement was reflected in the interviews: advisors in the sample of this study seemed to agree that one of the essential features of advisory work is the possession of thorough and up-to-date knowledge of their field. In their information behaviour, sources included online, printed, and in-person contacts. Trustworthiness of information was an issue of particular importance to advisors, which can be explained by the fact that they are accountable for the knowledge they pass on to their clients. It is therefore worth noting that the free flow of information available online may lead to a situation where advisors will need to compete with the numerous online information sources, further questioning the traditional linear extension models. This might become particularly important as farmers become even more keen to follow online opinion leaders or influencers (Rust *et al.*, 2022).

References to the importance of communication were also a common element in the interviews. These statements clearly indicated the fundamental role of communication in advisors' activities. These reports also revealed that a form of hybrid online-physical communication has started to appear in advisors' communication toolbox. Social distancing measures induced by the pandemic clearly contributed to this trend, as they necessitated staying in touch and continuing advisory work virtually with the use of the various ICT tools.

Conclusions

This study revealed explorative insights into the information-seeking behaviour of European farmers, foresters and advisors, drawing on 40 semi-structured interviews practitioners from 20 different countries. Data collection and analysis for this study were carried out as part of a large Horizon 2020 innovation project to create a new online knowledge platform for primary sector practitioners. In the development of this 'EU FarmBook', the categorisation of agricultural personas and future potential users of the platform was an essential element.

This task of the development work was specifically designed to assess how farmers, foresters, and advisors search for, use, or exchange information in their everyday operations. In addition to being a particularly useful element of the platform development, this task provided highly useful input to better understanding a less explored area of Agricultural Knowledge and Innovation Systems in Europe. The rapid advancements in digital information and

communication technologies directly and indirectly affect farmers, foresters, and advisors. A digitalised, empowered, and smart European agriculture can be built on a strong foundation of understanding these practitioners' information needs and how they can be met.

Clearly, the use of various ICTs forms a substantial part of the participants' work-related activities. The study showed that a significant proportion of online searches are now image-based as opposed to text-based. Photos and videos can often convey information faster and more efficiently, which is a key aspect both in a quick problem-specific search or a multi-step search. Farmers, foresters, and advisors are specifically practice-oriented. Therefore, there is a growing demand for high-quality images of farming practices, technology demonstrations, and video tutorials.

It is important to point out that practitioners' access to an almost unlimited amount of online information poses new challenges for advisors working in the field. They should be prepared to be able to use the latest ICT technologies in their advisory or demonstration activities and to expertly react to practitioners' information retrieval themselves. In that sense, the traditional linear extension model can no longer be maintained because there are many other sources, tools, platforms, and applications that will likely make future extension models more diverse and complex, like the information environment itself. This factor should be considered when developing future instruments for sharing and dissemination of knowledge and innovations. This study and the underlying exploratory work have not only contributed to the development of the EU FarmBook agriculture and forestry knowledge platform, but will also provide useful insights for the next phase of research on the information behaviour of European farmers, foresters and advisors.

The current study has some limitations that the authors wish to acknowledge. The most obvious limitation is the consequence of the purposive expert sampling procedure of the research. The sample used in the research does not statistically reflect the composition of the farmers, foresters and advisors in the countries concerned. However, Etikan *et al.* (2016) claims that studies adopting purposive sampling concentrate more on particular characteristics and expertise to be involved, rather than a cross section of various socio-demographic variables of the population.

Although the interviews conducted in mother tongues were seen as a technique that supported data collection for this study, the quality of English translations varied widely due to the use of online translation tools. Translated transcriptions in uneven stylistic qualities required considerable post-editing efforts and inevitably reduced the efficacy of content analysis.

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