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How could social media support farmers concerned with sustainability issues?

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Abstract

Purpose: This article aims to contribute to building an understanding of how social media may support farmers in transition to a more sustainable agriculture.

Methodology: we used a questionnaire survey and in-depth interviews with farmers concerned with sustainability issues to characterize the diversity of their social media (SM) uses and user profiles.

Findings: we show widespread but also very contrasting uses of SM by farmers concerned with sustainability issues, combining epistemic and socio-emotional dimensions.

Practical implications: we propose several implications for facilitators of online and in-person groups dedicated to supporting farmers engaged in sustainability transitions.

Theoretical implications: the use that farmers concerned with sustainability issues make of SM supports an integrated view of farmers' transitions to sustainability as processes that are

not only technical but also involve many variable dimensions. Our understanding would therefore benefit from further analyzing SM users as virtual communities of practice (COPv).

Originality: Rather than focusing on one SM, we start from farmers' uses of various SM, which provides an original perspective on SM in agriculture. It also contributes to filling in the gap in knowledge about digital tools' potential contribution to sustainability.

Keywords: sustainable agriculture, transition, farm, social media, digital agriculture, agroecology

1 Introduction

It is largely acknowledged that agriculture must become more sustainable to meet multiple challenges: feeding a growing world population, preserving natural resources, adapting to climate change, and improving the working conditions of farm workers. To do so, it has to transition to a more sustainable model. While its objectives actually vary from one continent, country and context to the next, this transition always comes with multiple issues: technical (e.g. which practices), cognitive (e.g. lack of knowledge), socio-economic (e.g. who to rely on), organizational (e.g. between all actors of the agricultural sector) and personal (e.g. commitment to values). It concerns not only farmers, but also all agricultural actors within agricultural innovation systems (advisors, processing industries, institutions, etc.) (Klerkx, Mierlo, and Leeuwis 2012). The – challenging – question is then: which skills, knowledge and resources will allow agricultural innovation systems to support the transition to a more sustainable agriculture?

There has actually been a significant increase in the use of digital technology in the agricultural world, analyzed in a fairly recent literature that is interested in understanding how such technology can support agricultural extension (e.g. Steinke et al. 2021). Much of this literature equates digital agriculture to smart farming or agriculture 4.0 (Klerkx, Jakku, and Labarthe

2019), which focuses on information and communication technologies and their ability to collect and analyze data, and thus to support efficient farming processes (e.g. Hrustek 2020; Bacco et al. 2019). Interestingly, few studies explore how these tools may improve the sustainability of agriculture (Maurel and Huyghe 2017; Basso and Antle 2020; Hrustek 2020; Schnebelin, Labarthe, and Touzard 2021; Kuch, Kearnes, and Gulson 2020; Ditzler and Driessen 2022; Schnebelin 2022). While there is a more or less implicit assumption that sharper data analysis will support more efficient and therefore more sustainable agricultural practices, much less emphasis is put on the role that digitalization may have in supporting knowledge exchange and knowledge production. Yet more sustainable forms of agriculture are repeatedly associated with non-prescriptive and knowledge-intensive processes (Leeuwis 2000; Röling and Jiggins 1994; Klerkx, Mierlo, and Leeuwis 2012; Duru et al. 2015; Timmermann and Félix 2015). In fact, to be less dependent on synthetic inputs and on standardized intensive agricultural practices, farmers need to adapt to their own dynamic local contexts. This implies dealing with short- and long-term uncertainties not only about climate, pests, and ecological processes in general, but also about prices, quality requirements, and policies (Darnhofer et al. 2016). Sustainable agriculture is thus knowledge-intensive, as is the transition to sustainability. Farmers need to re-learn and change their mindsets (Ingram 2008; Šūmane et al. 2018), mobilizing systemic, holistic, and experiential learning (Moschitz et al. 2015; Ingram, Fry, and Mathieu 2010; Coquil, Béguin, and Dedieu 2014; Lamine 2011), which calls into question the current agricultural and knowledge innovation system (AKIS). Transition to sustainability therefore needs multi-actor knowledge networks to support joint reflection, in which farmers have an ‘active role in knowledge generation and, in particular, in assuring its practical applicability’ (Šūmane et al. 2018: 235).

For this knowledge-exchange and knowledge-production, social media can have added value in connecting people and allowing them to exchange information on their practices,

experiences, opinions and values. We define social media (SM) in this article as web interfaces that allow participation in networks and professional knowledge groups, namely, social networks, forums, blogs and wikis. In agriculture, some research focuses on the potential of SM to share and produce knowledge but not necessarily with the idea of contributing to a more sustainable agriculture. Chowdhury has historically conducted research on this theme, with studies of SM uses among stakeholders in the agri-food and rural sectors (e.g. Chowdhury and Odame 2013). Materia and al (2015), Klerkx (2021) and Munthali and al (2021) have addressed the topic by examining the similarities and the combination of virtual and non-virtual interactions in innovation systems, particularly farmers' advice. Bentley and al (2019), Mills and al (2019), Phillips and al (Phillips, McEntee, and Klerkx 2021) and Riley and Robertson (2021) have explored diverse dimensions of knowledge exchange on SM. They respectively focus on: the role of farmer training videos to convey information; the different functions of Twitter (marketing and consumer engagement; lobbying and campaigning; networking and knowledge sharing; crisis communication); the characteristics of knowledge exchange in two Facebook and Twitter discussions; and farmers' use of SM to document and (re)present their working lives and practices. In none of these studies is the contribution of SM to develop sustainable agriculture a main object of research, beyond the fact that these tools could foster knowledge sharing. Precisely how SM may support farmers in transitioning to sustainability remains unknown. Moreover, studies describing farmers' actual uses of diverse SM (Roche et al. 2020) are very rare, even though they would be critical to understand how SM, and which of their functionalities, actually inform and support farmers in their diverse situations. We have therefore chosen in this article to contribute to this strand of research on the role of SM in agriculture, with two original approaches. First, rather than focusing on and analyzing the use, deployment and influence of a particular SM, we have chosen to look at farmers' uses of SM in their diversity. Second, we have focused on farmers concerned with sustainability issues, in

order to explore the type of support they need to move towards more sustainable agricultural practices. Our objective here is to explore how these SM seem to be useful to farmers transitioning to a more sustainable agriculture, with the idea that this will contribute to a broader understanding of how agricultural innovation can support farmers in this transition. Thus, based on a questionnaire survey and in-depth interviews with farmers concerned with sustainability issues, as detailed in the Material & Methods section, we present an overview of their uses of SM. We then propose a characterization of different types of use and user profiles. The discussion links our findings to the needs of farmers concerned with sustainability issues. In this way we hope to contribute to an understanding of the best ways to support transition to sustainable agriculture, and of the need for AKIS to renew their approaches in that respect.

2 Material & Methods

2.1 Collection of data on the use of social media (SM)

The study presented in this article is part of Agor@gri, a Casdar project funded by the French Ministry of Agriculture and Food, which focuses on the use of SM for sustainable agriculture. Data were collected in two stages: an online questionnaire survey targeting a large number of farmers, and then, to gain a deeper understanding, interviews with volunteer farmers who had answered the survey questionnaire. All of the participants in the survey and interviews stated that they were concerned with sustainability issues and with specific associated farming practices. The issue of sustainability, seen through the concerns and farming practices of the interviewees, was a criterion for inclusion in the study.

2.1.1 Questionnaire survey

The online survey was designed by two researchers taking part in Agor@gri. The target was French farmers concerned with sustainability issues, to better understand the contexts of SM uses and the farmers' profiles. We released the survey on an online platform for 2 months in

autumn 2019, and the project members disseminated it within their respective professional networks. It consisted of six themes addressed with closed and open questions. As specific paths were proposed, not all the themes had the same number of respondents. 112 usable responses were collected: 1/ identity of the respondent (112 responses); 2/ farming system and practices (108 responses); 3/ use of digital tools in work (99 responses); 4/ use of SM (68 responses); 5/ integration in in-person groups of farmers (50 responses); 6/ farmer and sustainable agriculture (71 responses).

The main characteristics of the participants in the online survey are summarized in Figure 1.

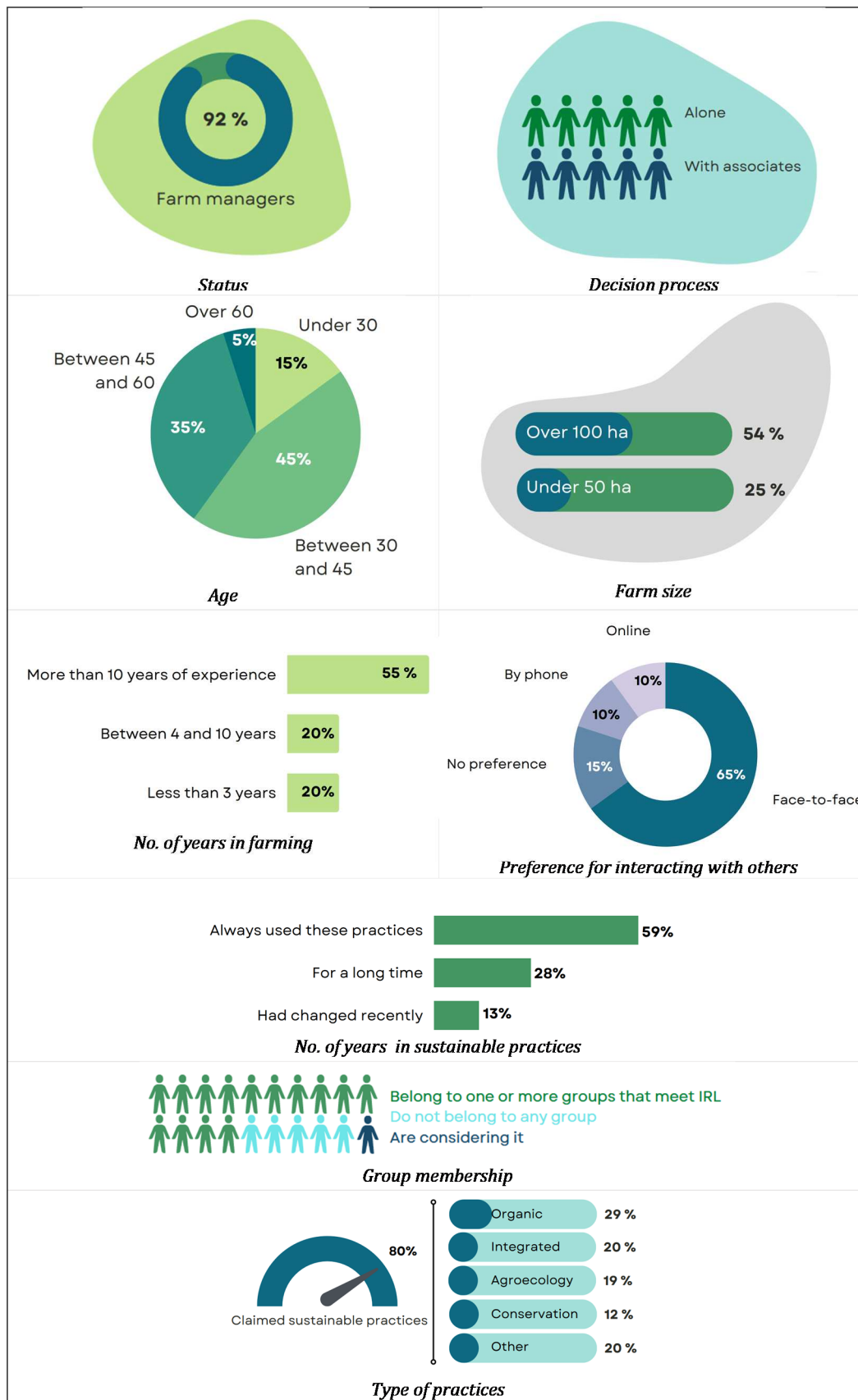


Figure 1: Main characteristics of the participants in the online survey

Most of the 112 farmers who answered had practices that indicated a strong focus on sustainability issues in agriculture, since about 80% of them claimed to practice integrated farm management, and organic, agroecological or conservation agriculture. They covered a wide range of ages, production systems and geographic locations. They stated that they had several sources of advice (3 on average), including SM, which did not replace other sources but complemented them.

2.1.2 Interviews to extend the survey

Interviews were conducted with some respondents of the online survey, to further investigate its results. We wished to clarify the links the farmers made between the different themes of the survey, particularly between the uses and needs expressed on SM and their position with regard to sustainability issues in agriculture.

The sampling was designed to reflect diversity: women and men; diverse degrees of commitment to sustainability; membership or not of a farmers' group; diversity of roles played in the SM (animation, contribution, consultation); and various levels of ease with digital tools (see Table 1). 16 semi-structured interviews were conducted following the online survey, lasting between 1h15 and 2h. The interview guide was composed of 3 parts: 1/ the interviewee, their farm (strategy), the history of the farm, their professional network, their resources; 2/ use of SM; 3/ expectations and needs regarding SM in the context of their professional practice.

	Gender	Age group	Type of production	Type of agriculture	Working situation	Link with non-virtual advice	Social media literacy	No. of years of farming
Sylvie	F	45-60	orchards	organic	alone on her farm	isolated	Weak	20 years
Alain	M	30-45	crop-livestock	low till then organic	alone on his farm	very strongly integrated with a particular group	Very strong	10 yeras
Roger	M	45-60	crops	low till then organic	family work	very strongly integrated with a particular group	Very strong	more than 30 years
Bernard	M	45-60	crops	low till then organic	farming group	very strongly integrated with a particular group	Very strong	more than 30 years
Stéphane	M	30-45	crop-livestock	conventional	family work	belongs to several groups	Weak	less than 5 years
Rachida	F	30-45	vegetable	organic	alone on her farm	belongs to several groups	Very strong	less than 5 years
Sabine	F	20-30	vegetable, orchard, vineyard	partly organic	runs the farm of an agricultural high school (with staff)	isolated	Very strong	less than 5 years
Laurence	F	30-45	vegetable	organic	has an employee	husband-adviser	Strong	5 to 10 years
Corinne	F	30-45	crop-livestock	integrated	runs the farm of an agricultural high school (with staff)	belongs to several groups	Strong	less than 5 years
Ludovic	M	45-60	crop-livestock	organic	farming group	belongs to several groups	Strong	15 years
Chloé	F	20-30	goats	organic	family work	belongs to one group	Very strong	less than 5 years
Ludvine	F	30-45	crop-livestock	organic	family work	belongs to one group	Strong	less than 5 years
Arnaud	M	30-45	crop-livestock	organic	family work	belongs to one group	Very strong	10 years

Table 1 – Presentation of the interviewed farmers

2.2 Data analysis

2.2.1 Survey analysis

The results of the closed-ended questions in the online survey were flat-sorted and the responses were transformed into a question-by-question statistical measure. Cross-tabulations between some of the data were then performed to provide trends (e.g. is there a relationship between the type of SM activity and perceived benefits?). However, the numbers were not large enough to perform further statistical treatments.

2.2.2 Inductive thematic analysis approach

Inductive thematic analysis was used on all the qualitative data collected through interviews. A monograph and a typology of social media use and user profiles were thus produced from the

interviews. The Strauss and Corbin (1998) and Braun and Clarke (2006) approaches were adopted.

Two coders, authors of the article who were familiar with content analysis, worked on the data set. The steps followed were: 1) several readings of the corpus to become familiar with the data set; 2) coding: identification and coding of relevant features (labels) of the data; 3) generation of initial themes: the different codes generated were classified into potential themes and all relevant data of each potential theme were collected; 4) revision of themes: the data were systematically reviewed for coherence; 5) definition of themes: each theme was labelled and defined; 6) the two coders separately categorized the themes according to the previously established coding scheme.

2.2.3 Monograph analysis

The same grid, with the principal themes of the interview guide, was applied to all the monographs built from the interviews:

(i) Social media use: media used; material, frequency, contexts; type of participation; type of professional use; place of emotions and identity dimension in interactions and needs.

(ii) Place and role of SM in professional activity: in the farmer's relationship to technical information; in the logic of technical decisions and/or action; credibility given to the information found on SM; impacts of SM on sustainable agricultural practices.

(iii) Barriers, expectations and needs expressed: barriers to SM use; needs in terms of SM.

Verbatims were collected to illustrate the subject.

2.2.4 Typology of social media use and user profiles

Once the results of the survey and interviews were analyzed, we proceeded with a new analysis, to highlight a typology of SM uses and of user profiles.

To establish the typology of SM uses, we identified in the monographs the elements relating to the farmers' intentions in their use of SM. Once this work was completed on all the monographs,

we cross-checked them by thematic analysis (see the Introduction of 2.2.2), which enabled us to highlight four types of SM use.

To establish profiles, we identified the intensity of the uses identified in the first step (absent, weak, strong) for each interviewee, and specified when one of the uses was exclusively linked to another. We then categorized them according to the combinations between the types of use and their intensity.

3 Results

3.1 Describing the uses of social media in our survey panel

3.1.1 Farmers largely use social media in their professional activity

The survey responses show a panel of farmers who have good access to digital tools (Fig. 2a) and are at ease with these tools (87% state they are completely or very much at ease with digital tools). Digital tools seem to be well integrated in their professional practices (Fig. 2b) and are used for diverse purposes (see Fig. 2c).



Figure 2 - Characteristics of the SM uses in our survey panel

A total of 90 farmers out of 112 reported using SM. For a majority of the respondents, SM are used from home, at the office, during a break, in the evening or at the weekend, as well as during farm work (Fig. 2h). 70% use them regularly throughout the year, and not only for specific problems or needs (e.g. a question, a difficulty); this use is a habit anchored in their professional practices. They are also relatively experienced users since the majority have been using SM for more than 3 years (Fig. 2e) and use multiple SM (Fig. 2g). The most widely used SM are Facebook, WhatsApp and, to a lesser extent, Twitter (Fig. 2f). Interestingly, the vast majority of SM mentioned are private (Fig. 2d), whether in social networks (private Facebook or WhatsApp groups) or private mailing lists. In other words, users do not access these groups automatically and anonymity is relative, insofar as users must be identified to participate. Another interesting point is that the SM mentioned are ‘non-specific’ that is, not specific to their professional practice.

The main types of contribution are consultation, then information sharing, followed by contribution, and lastly moderation (Fig. 2i). A large majority trusted the content either ‘all the time’ or ‘sometimes’. No one indicated that they never trusted it (Fig. 2j). The reasons for this trust vary widely (Fig. 2k), and the high level of trust in the content exchanged could be explained by the fact that farmers interact more with people who have identified themselves (little anonymity, see above).

3.1.2 Farmers have contrasting uses and expectations regarding social media

This section presents the elements showing the contrasting uses of SM among the surveyed farmers (see also Figure 3).

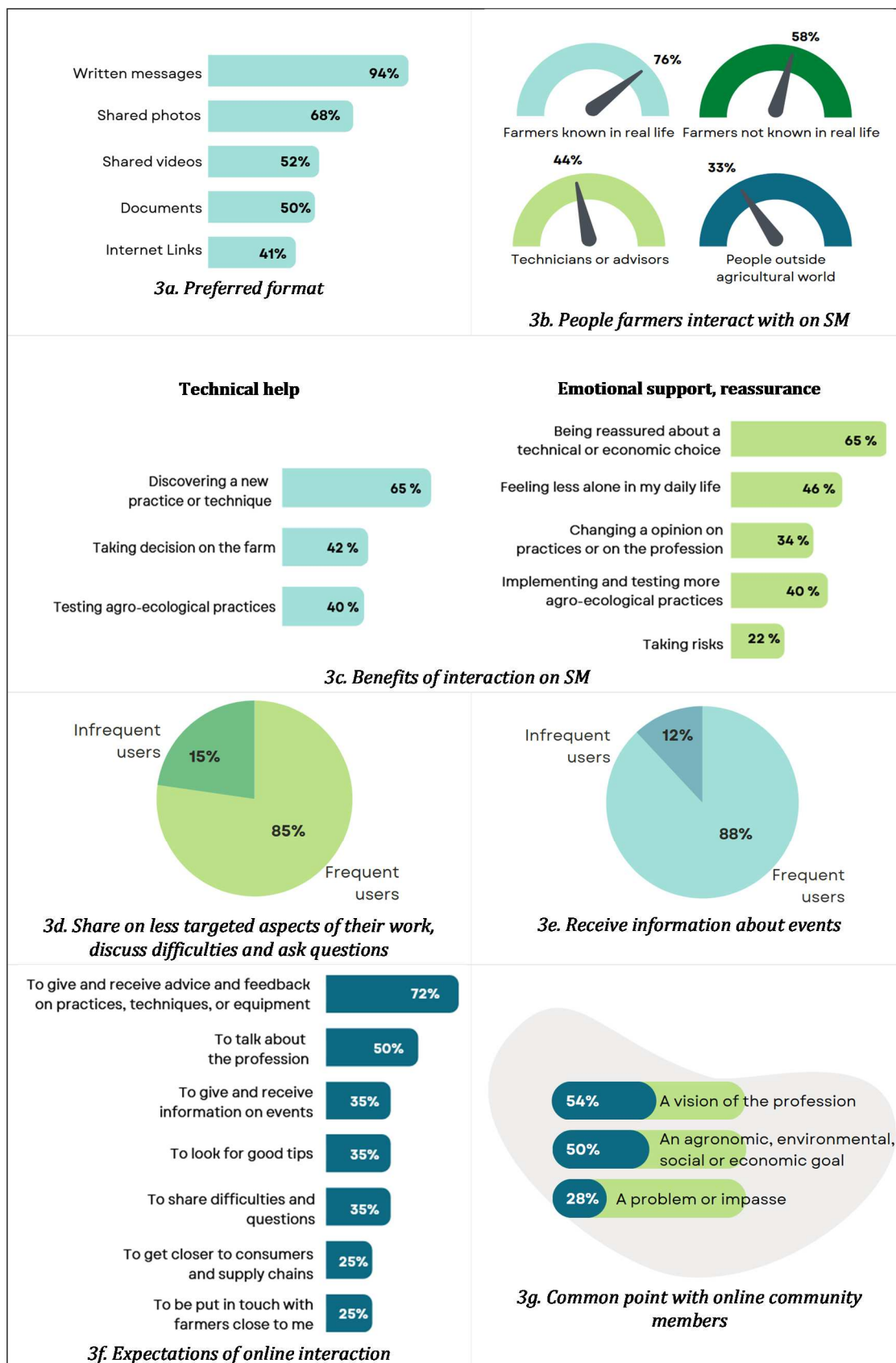


Figure 3: diversity of uses and expectations regarding SM

The first point of diversity is related to the contents exchanged, which vary widely: written messages, shared photos and videos, documents and URLs (Fig. 3a).

Diversity is also reflected in the different profiles of the people they interact with: farmers they know in real life or not, technicians, advisors, and people outside the agricultural world (Fig. 3b). There is also wide diversity when it comes to what farmers expect and get out of online interactions: for example, sharing, giving and obtaining information, advice and feedback; contributing to debates about the profession; and fostering relations with other farmers or consumers (Fig. 3f). While the technical dimensions are important in these interactions, so are the dimensions of reassurance and emotional support. The participants clearly have varied expectations concerning SM, as the average number of answers ticked by the same respondent is 3. To the question ‘Have these interactions [on SM] ever helped you to... [multiple choice answers]’, the answers again show a balance between technical help and support that is essentially emotional, providing reassurance (Fig. 3c). This balance seems to depend on the intensity and ease of use of the SM. Those who use SM less frequently and are less comfortable with digital tools seek answers to more targeted and often more technical questions. Those who use them more frequently share on less targeted aspects of their work, discuss difficulties, and ask questions or receive information about events (Fig. 3d, 3e). Another element related to this balance is that when asked: ‘What do you have in common with other community members or people you interact with online? [multiple choice answers]’, the most frequently cited answer is ‘a vision of the profession’, just ahead of ‘an agronomic, environmental, social or economic goal’, followed by ‘a problem or impasse’ (Fig. 3g). The diversity of expectations and benefits of interactions finally appeared in the answers to the open-ended question: ‘Describe an example of the contribution of interactions on SM in the context of work’. They show the importance of SM not only for tactical decision-making (e.g. using a tine stubble cultivator instead of a cover crop, choosing a variety, managing the watering of zucchini), but also for

more strategic choices (e.g. artificial insemination for the dairy herd, plowing with pigs, use of lablab in combination with corn). They also show that the content exchanged is used to organize collective actions (e.g. discussion to build a network, group purchase, organization of meetings) and with the objective of joint experimentation and production of references (e.g. participation in seed trials; plant cover trials; situating one's system in the group).

3.2 The analysis of the monographs shows different user profiles

The interviews allow us to define farmer profiles by highlighting the characteristics of four different uses of social media and by showing how they are intertwined. These four uses are not mutually exclusive, and their interrelatedness highlights the variety and richness of SM user profiles.

3.2.1 Four uses of social media

Four uses of SM by the 16 farmers interviewed can be distinguished: 1) use oriented towards self-training (hereinafter “self-training”, 15 farmers); 2) use for emotional or identity reassurance (“reassurance”, 11 farmers); 3) the SM extend an existing in-person group (“extending”, 7 farmers); and 4) use oriented by a wish to transmit knowledge (“transmission”, 8 farmers).

Use 1. Self-training: farmers see SM as a source of information enabling them to obtain technical, economic, commercial or organizational knowledge, especially when their farming systems are not up and running.

‘On the pig enterprise [organic, specific local breed with a small population], we’re in WhatsApp groups waiting for data, since we’re still at the beginning. We’re not at all comfortable with the technique. We’re just starting out’, Ludivine.

This use is significant for 9 farmers interviewed, weak for 4 and absent for 1. SM can be a means to explore a question used very early in decision making (Corinne) or, on the contrary, to validate a decision (Bernard):

'Internet can allow me to rough out things a bit'; 'It's a gateway to bibliography. I study the subjects, I look for documentation. For instance, I wanted to work on soil biological fertility',

Corinne.

'We share the information on the private FB group, to check our choices', Pierre; 'we wanted to buy a XXX seeder [for direct drilling]. We posted about it on the WA group. That allowed us to have the opinion of 30 people very quickly', Bernard.

The information is picked up passively (Marie) or actively (Chloé):

'I'm here to learn [about homeopathy, naturopathy and essential oils for pigs]. There are files available, I download them and then I look at them', Marie.

'I have this mold on my cheese, I ask what we can do. A sick animal, I post a photo', Chloé.

The more closed the group (i.e. restricted to identified participants, such as WhatsApp groups), the better the farmers assess the reliability of the shared information and the more likely they are to ask for advice that they will follow.

Use 2. Reassurance: farmers use SM to get together as a group for sharing their feelings and for reassurance, construction or reinforcement of a professional identity and/or a sense of community. This use is significant for 11 of the farmers interviewed but it is firmly rejected by the other 5:

'We don't talk about doing well or badly. We don't put ourselves forward, especially when we screw up', Stéphane;

'we don't even say hello to each other', Chloé.

For 7 of the 11 farmers who have this social use, social interaction takes place in online groups with participants with whom they are unacquainted in real life. This sharing is an opportunity for some to maintain a social life (Rachida) or even to break out of their isolation (Marie):

'It's very important. When you settle down, you don't get off the farm much, and I have three children, so I don't have much time to get out and about...', Rachida.

'I have the impression of being cut off from the world. The farm is isolated. It's 20 km to go shopping...', Marie.

For the other 4, this interaction takes place with colleagues from existing groups in real life, so the SM is an extension of groups frequented elsewhere (see use 3, 'extending'). All 11 farmers who have this social use share emotional experiences: positive feelings (Sabine1) as well as negative ones (Sabine2):

'Having people wish you good luck cheers you up (...) it's important', Sabine1

'When my plots are destroyed by slugs, we see all our work screwed up... The fact of being able to share this does a lot of good', Sabine2.

These interactions enhance a sense of community:

'It's like in life, you have to fool around, you have to have a drink together, conviviality is necessary', Bernard.

This emotional closeness strengthens relations and ensures the presence of help in case of need:

'If the guy calls for help, there are people who'll respond, that's for sure', Roger.

For two farmers, whose online contacts are customers, SM acts as a 'commercial and communication showcase' and as a means to talk about farm work or share some concerns:

'It also allows us to share difficult moments with clients and to talk about the business. They [the clients] have interesting feedback, they support us', Laurence.

Use 3 Extending: farmers use SM to extend peer groups that exist in real life. These groups are often led by agricultural advisors and facilitators from various organizations. The SM used for this purpose are mainly WhatsApp or closed Facebook groups. This is in addition to face-to-face meetings, to maintain the collective dynamics between 'real meetings'. The two main characteristics of the farmers concerned by this use are that: i) they know each other and meet regularly in real life, and ii) they share common concerns about certain agricultural practices (e.g. no-till organic farming). These characteristics give a specific tone to the interaction. There is very little anonymity; on the contrary, the farmers rely on mutual acquaintance between group members. In the most active groups (4 farmers with a strong 'extending' use), everyone knows

exactly who is behind each comment, and they know one another's farm, technical level, values, preferences, etc.

'it [WhatsApp group] is with my fellow farmers. We've known each other for a very long time',

Alain.

The use of SM can be intensive (Roger) with short questions/answers (Alain):

'In periods of intensive work, vegetation, there's something every day', Roger; 'One who sows, who posts photos, who asks questions', Alain.

'The WhatsApp group is lighter, it's more about adjusting a seeder for example, the depth of seeding, 2-3 answers and I adjust', Alain.

A high level of trust pervades these interactions, and technical conversations are intrinsically mixed with marks of conviviality:

'Our WA group [about Conservation Agriculture], it's high level, it's efficient. You don't have to explain everything over and over again', Roger.

When the in-person groups are less active, or are larger or more recent, the farmers rarely refer to interactions in the online groups as resources (weak use, 3 farmers in our panel). One mentioned the fact that there was not a common vision in his WhatsApp group (Stéphane 1) or that there were too many diverse viewpoints (Stéphane 2):

'I question our agricultural model. The majority of the others do not. We can't have the conversation', Stéphane1

'10 people, 10 different opinions', Stéphane2.

Finally, this use is totally absent for 7 farmers of our panel who do not belong to any in-person peer group. Of these, 3 participate in online groups. These are not necessarily isolated farmers, but rather farmers who are not attracted to existing groups:

'closed groups [...]aren't my thing, they're only for closed circles...', Laurence.

Use 4 Transmission: farmers are keen to transmit to their peers the knowledge, know-how and learning they consider interesting and useful from a sustainability perspective. This use is the

least prevalent of the 4 identified uses, even though 8 farmers mentioned it. Three have a transmission activity within the group in which they participate in real life (cf. previous use), 4 mention it with a low to medium intensity, and for the last one, this use is mentioned as a possibility. It comes with active participation in online interactions, practical answers to questions asked by farmers, a search for solutions for peers who share their difficulties, and proactive sharing of knowledge on a specific topic of interest to the farmer. The underlying motivations are diverse. They can be linked to a desire to widely disseminate specific practices to make them known.

'[I] post things connected to regaining decision-making autonomy [and I] see the result, who comments. [...] It's political. It's to share things that mean something to me', Ludovic.

Others are more interested in helping young farmers to avoid making mistakes:

'What scares me is when I see some young people... I'm thinking of one who's starting on an ultra-intensive system with huge investments [...] it's madness, he'll fail, he won't be able to keep it up', Pierre.

The posture here is similar to that of experts who accompany less experienced farmers. The same farmer also explains that he uses SM to establish dialogue with peers and with people outside the farming community (especially activist groups) to defend and argue his ideas:

'What we need to do is to engage in dialogue, to confront each other, to expose ourselves, and also to listen, both at the same time, it has to go both ways', Pierre.

3.2.2 The mix of uses creates a diversity of farmer profiles

Looking at the combination between the types of use and their intensity, we can characterize four different profiles that give us access to the way farmers concerned with sustainability issues rely on SM to develop more sustainable agricultural practices. These 4 profiles are not set; farmers can evolve over time in their use of SM, depending on their willingness to progress towards sustainable agriculture and their confidence in themselves and in their practices in this transition. Characteristics taken into account in the profiles are detailed in Table 2.

Profil	Name	Use 1 self-training	Use 2 reassurance	Use 3 extending	Use 4 transmission	Differentiated uses of social media
1	Sylvie	weak	-	wish	-	no (one use only)
	Stéphane	weak	-	weak	-	No
	Ludovic	weak	-	-	weak	yes
2	Laurence	-	strong (inside one group + with her clients)	-	weak	yes
	Corinne	weak	strong (inside one group-use 3)	weak	-	yes
	Mathieu	strong	-	-	-	yes
3	Sabine	strong	strong	weak	-	yes
	Chloé	strong	-	-	-	yes
	Ludivine	strong	strong (with her clients)	-	-	yes
	Marie	strong	strong	-	strong	yes
4	Alain	strong (inside his group-use 3)	strong (inside one group-use 3)	strong	strong (inside his group-use 3)	yes
	Roger	strong	strong (inside one group-use 3)	strong	weak (inside his group-use 3)	yes
	Bernard	strong (inside his group-use 3)	strong (inside one group-use 3)	strong	strong	yes
	Rachida	strong	strong	strong	perspective	yes
	Arnaud	strong	strong (inside one group-use 3)	strong	-	no
	Pierre	strong	strong	-	strong	yes

Table 2 – Profiles of the farmers interviewed (each use –columns 3 to 6– is defined by its intensity: absent, weak, strong)

Farmers of Profile 1 are very cautious about SM use (Sylvie, Stéphane, Ludovic). They want technical information and customized advice in real life but are not satisfied with the offer available locally. They turn to SM to get ideas and answers to their numerous technical questions, and then cross-compare the information with that on the websites of ‘recognized’ institutions, reference books, magazines, and so on. They have difficulty drawing parallels with their own situations, and regret that the contexts in which certain solutions shared on SM are implemented are not identical to their own (advice not appropriate to their farms). There is a lot of wariness, even mistrust, of the information found online and especially of the people who post it (doubts as to professional competence and fear of commercial objectives and agribashing). It is under this profile that we find most of the farmers who strictly reject Use 2 of SM; they are not looking for conviviality, on the contrary. These farmers are generally uncomfortable with SM. Their transition to sustainable agriculture is implemented in varying stages (started 20 years ago by Sylvie and Ludovic, and very recently by Stéphane). They are all looking for adaptable solutions to progress in their transition, and express the feeling of still having a lot of progress to make.

SM are much more integrated into the professional practices of the other three profiles identified. Differences are reflected in the number of uses and in the farmers' representations of the potential of SM in the different spheres of their professional life (technical, socio-affective, identity, political, commercial, transmission, etc.).

Profile 2 groups together farmers who use SM intensively but for only one of the four uses identified above (Laurence, Mathieu, Corinne). In this profile, the expectations linked to the use of the SM can be diametrically opposed: farmers can expect conviviality only (Laurence) or, on the contrary, want to limit interactions strictly to technical points (Mathieu). In all cases, they have a very specific and circumscribed use of the SM. They are at ease with it and know what they are looking for, unlike those in Profile 1. Their level of sustainable practices is relatively high, and although they want to evolve, this does not generate tension for them.

In Profile 3, the use of SM is intensive but uses are highly segmented (Chloé, Ludivine, Sabine, Marie). Some uses are excluded, or the farmers use different SM for different purposes, as in the following two contrasting examples. Sabine has many technical and friendly interactions with two other farmers on Twitter, and she uses Facebook as a showcase for her agricultural high school farm; Marie uses different Facebook groups, first to learn about homeopathy for her farm, on the technical side, and second to be involved in a 'women farmers in crisis' group, on the social side. Their level of transition to sustainable agriculture is roughly the same as for Profiles 1 and 2 (some advanced and others less so) and they intend to evolve further. What clearly distinguishes them from Profile 2 is their high level of SM proficiency, which allows them to find their way through the different SM offers and to use several SM for very different purposes.

Profile 4 encompasses farmers who have a highly expert and differentiated use of SM (Alain, Roger, Bernard, Rachida, Arnaud, Pierre). They have sound knowledge of the Web sphere, and they see the potential advantages of SM for each of the uses identified above. These uses are

fully integrated into all aspects of professional practice and each use is often associated with a particular type of SM or group. They have trusting friendly and technical interactions in well-identified arenas (closed groups for instance). While they do consume information on open SM, they know how to assess and cross-reference it, and can contribute to political or identity-based interactions in other arenas. They are both readers and contributors, but here again, this depends on the arena (contribution in closed arenas identified as trusted; reading only in others). SM sometimes help to compensate for isolation at work, as in the case of Rachida who is mostly present on her farm with three young children, and for whom SM are indispensable at all levels: acquisition of knowledge about sustainable agriculture, strategic thinking, tactical choices on a daily basis, and an important role in the quality of her daily life (relational and identity-related aspects, professional isolation). These farmers are far advanced in their transition to sustainable agriculture and are distinguished from the other profiles by the stability of their practices; they are no longer looking for major changes in their system.

4 Discussion

4.1 Towards an understanding of the needs of farmers engaged in sustainability transitions

From what farmers concerned with sustainability issues tell us about their use of SM, some of their needs – expressed more or less explicitly – can be identified. As the literature largely recognizes, the issue of knowledge is decisive. Sutherland and al (2012), for instance, speak of knowledge lock-in to underline the fact that both practical experience and formal training are inadequate when farmers try to renew their farm management approach. Our study similarly shows that there are farmers who identify many gaps in their knowledge and much progress to be made in their ways of farming, and who try to access as many resources as possible to support their professional activity. As their use of SM shows, these resources are provided not only by

usual AKIS players but also, to a large extent, by peer interactions. As Šūmane and al (2018: 233) explain, *'farmers seeking to follow a more sustainable path rely more on alternative support and learning networks and knowledge sources than on the formal [AKIS] which is still strongly focused on the production-oriented model of agriculture and does not adequately address the knowledge and learning needs of this type of farmer'*. Our results nevertheless show that for farmers less accustomed to SM, having information from a classical AKIS actor can be reassuring. Others cross-compare and combine information found on SM with that given by their advisors, thus demonstrating a form of hybridization of knowledge and not a substitution as suggested by Šūmane and al (ibid). The interviews also show that the farmers most accustomed to SM and most advanced in their transition to sustainability have a differentiated use of the sources of advice. While SM are used to ask occasional tactical questions, to get ideas, and to explore new ways of doing things, the IRL groups and/or the advisor remain very present when it comes to taking more strategic decisions.

Apart from this issue of knowledge, we have also underlined an issue of reassurance, which goes beyond technical aspects. In our study, farmers expressed a need to reassure themselves when facing all the uncertainties that their exploration of new paths generated, and peer interactions are key in that respect. This resonates with what we know about the processes of transition to a more sustainable agriculture. As mentioned above, such fundamentally open-ended processes (Lamine et al 2021) are knowledge-intensive and exploratory (Sutherland et al. 2012), which raises questions about recognizing, sharing, and co-creating knowledge to support farmers' transitions (Gliessman 2022). Yet while these transitions are mostly professional (Slimi et al. 2021), they also involve many social elements, values and emotions (e.g. Dessein and Nevens 2007; Coquil, Dedieu, and Beguin 2017; Chizallet, Prost, and Barcellini 2020; Perrin et al. 2020; Bouttes, Darnhofer, and Martin 2019), and these personal, subjective elements are often not emphasized or are even ignored and not made visible. For

instance, the agricultural press hardly reports on them (Chupin and Mayance 2021) and the farmers themselves as well as their advisors are not necessarily at ease (or used to) sharing such information (Lucas 2021, Bezner Kerr et al. 2022). Our study shows the extent to which farmers in transition are willing to interact on each of these two dimensions, sometimes both at the same time, depending on their profile.

4.2 Expressing the potentialities of SM to support farmers engaged in sustainability transitions: what are the challenges?

In respect of the elements described in the preceding paragraph, SM are interesting because of their ability to (diversely) mix epistemic and socio-emotional dimensions. They allow farmers not only to exchange knowledge and to renew their interactions with AKIS players, but also to exchange socio-emotional support. In fact, SM allow conviviality and sharing of usually hidden aspects of their activity, as Riley and Robertson have shown for Twitter (Riley and Robertson 2021). Ultimately, the interaction allowed by SM can help farmers to give meaning to their transition and to build a professional project in accordance with their objectives and values, which become clearer through the interactions. These contrasting combinations of epistemic and socio-emotional dimensions are found in virtual communities of practice for professionals (see Prost, Cahour and Détienne, 2014, who studied communities of education professionals). When experiencing a problematic work situation, the professionals who take part in communities of practice do so not only to improve their practice but also to share their emotions related to this problematic work situation. Several of our findings suggest that farmers concerned with sustainability issues would like SM that offer virtual communities of practice. The advantages of communities of practice in agriculture have already been discussed (e.g. (Oreszczyn, Lane, and Carr 2010; Morgan 2011). As Wenger (1999) argued, communities of practice allow individuals with similar practices and concerns to share personal experiences from which they build, create, and innovate in their practice. Our results have shown that the

most expert users have differentiated uses of the CoPs. This is an advantage compared to IRL communities of practice where geographical proximity is often the determining factor (Compagnone and Hellec 2015).

Our findings have certain limitations that will have to be addressed by other studies. As we relied on declarative data, at a given point in time, we cannot analyze in detail how SM actually support pathways of change. We built on what the farmers said they found useful in SM and from the potentialities of such tools. How to exploit such potentialities has become a central question. The answer may not be an issue of technical support: when considering the SM used by the farmers of our panel, the main SM seem to offer functionalities that mostly meet farmers' needs. It is the contents exchanged and the tones set by those who contribute to the groups that will matter. Our data show that tools as simple as WhatsApp groups can have extremely varied tones. In that respect, the role of SM facilitators in combining knowledge management and facilitation of interaction is a key research issue that challenges the usual roles and perimeter of AKIS players. The literature about communities of practice may provide some interesting and original contributions to that debate. By definition, a community of practice is self-organized (Bootz and Dupouët, 2019). The facilitators therefore have a complex and multifaceted role. They must manage to 'stimulate without stifling' the activities of the community (Josserand, 2004). Our data show the need for these facilitators to be able to identify user profiles and to offer support adapted to these profiles, by mixing social and technical aspects at different intensities. For instance, Profile 1 needs facilitators who objectify information, provide technical content and resources, and avoid taking extreme positions that block debates. The other user profiles rather need someone who prevents the debates from diverging from the objectives set by the group (without putting aside the identity or socio-identity aspects if the group values them). Facilitators also have a key role in building trust within the online community (Probst and Borzillo 2008). This could be done in our context by

requesting information that identifies the farmer's situation (practices, logic and objectives; information on farms, enterprises on the farm, etc.). This issue of the role of SM facilitators can be linked to the overall issue of supporting transition to sustainable agriculture and the need for advisory systems to renew their approaches: less top-down approaches with more consideration for experiential, systemic and local knowledge (e.g. Coquil et al 2018; Charatsari et al 2022). In any case, there is a challenge for the advisors to connect to SM to better engage and communicate with farmers to support transition to sustainable agriculture (Klerkx, Jakku, and Labarthe 2019; Klerkx and Begemann 2020; Phillips, McEntee, and Klerkx 2021; Klerkx 2020; 2021). A promising way may be support services for the agroecological transition that mobilize SM along with other means to integrate both dimensions of community facilitation and knowledge exchange.

5 Conclusion

Based on a survey and in-depth interviews on the use of SM with farmers committed to a more sustainable agriculture and concerned by sustainability challenges, our work shows that regardless of their age or farm characteristics, they are highly connected via SM. Their use of SM is widespread, with farmers who seem to be less anonymized and more active than other audiences on these SM (Nonnecke and Preece 2000). Above all, our study of this use shows that it is widely diverse: SM can be used for self-training, social and identity reassurance, extension of existing in-person groups, or transmission of a representation of rural activities to others. Our work highlights four different profiles that enable us to map out the ways in which farmers concerned with sustainability issues rely on SM to develop more sustainable farming practices. These profiles combine the uses identified. One of the original findings of our study is that both dimensions, epistemic and socio-emotional, combine in contrasting ways in farmers' needs regarding sustainability. Some farmers see these epistemic and socio-emotional dimensions as mutually exclusive; others, particularly the most expert users of SM, see them as

deeply connected. Our study shows the extent to which these two dimensions are important for farmers in transition and that depending on their profile, they interact in each of them, sometimes both at the same time. These results align with the characteristics of virtual communities of practice. An interesting step forward would be to make use of the potentialities of SM to organize virtual communities of practice for farmers who are transitioning to a more sustainable agriculture. The variety of SM allows farmers and facilitators to choose the community or communities of practice that suit them.

To conclude, a promising approach may consist in creating support services for the agroecological transition that mobilize SM along with other means, to integrate both dimensions of community facilitation and knowledge exchange.

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7 Disclosure statement

The authors report there are no competing interests to declare.

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