demeter

The Farmer's Voice:

Drivers and Barriers to Technology Adoption

Discover what is driving and preventing farmers from adopting Smart Farming Technology (SFT).

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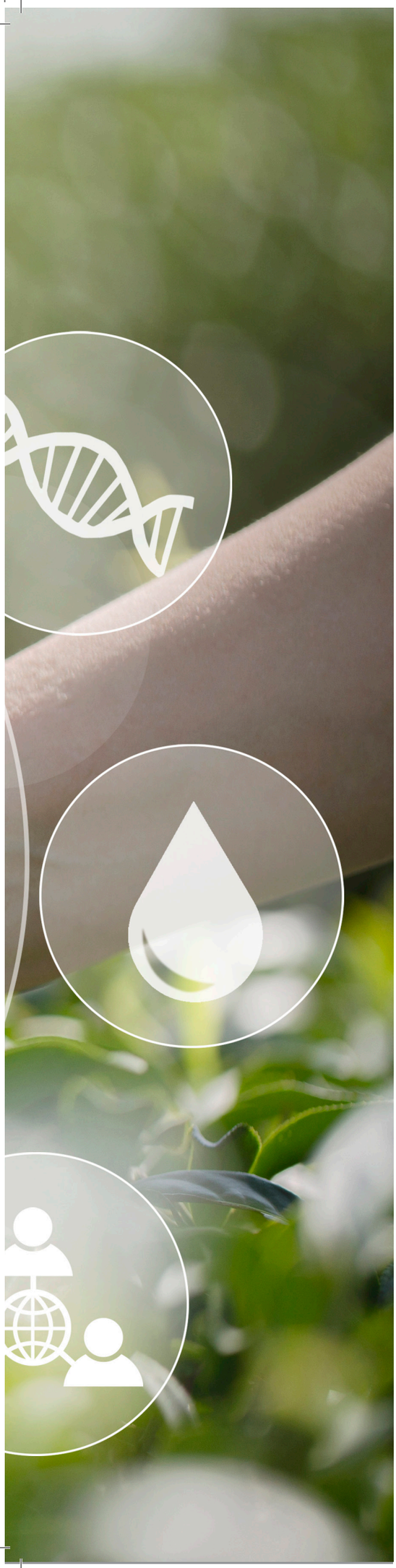

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EXECUTIVE **SUMMARY**

The challenges the agriculture sector faces are well documented. A growing population, the need to adapt to climate change, pandemic events, urbanisation, the loss of agricultural soil, biodiversity, and fertility, as well as the scarcity of water and other natural resources are driving the need for more sustainable agriculture methods.

Consequently, Smart Farming Technology (SFT) has been recognised as a potential solution to these identified challenges. SFT is defined as information and communication technology incorporated into farm machinery or on farm, creating large amounts of data which the farmer can use to optimise their operations. DEMETER is a Horizon 2020 project which aims to facilitate and speed-up the deployment of interoperable, data-driven, smart farming solutions providing decision support and control systems for the agricultural sector that empower farmers to make better decisions. This will allow them to harness the full value of their own data and knowledge as well as those shared with others.

DEMETER follows a Multi-Actor Approach (MAA) ensuring that newly developed technical solutions meet real-life needs. Farmers are a key stakeholder group within the DEMETER ecosystem. Understanding their needs, interests, and concerns regarding digital technologies is therefore central to a positive outcome for the project. With this in mind, DEMETER created an online survey to better understand the barriers and drivers to SFT adoption.

The research was conducted across November and December 2021 with farmers from 46 different countries responding to the survey. The results clearly indicate that farmers are looking for technical solutions that will provide them with better information to help manage their farm. Furthermore, they are looking for technology that will simplify their work and provide them with a better work-life balance. In addition, farmers want new technologies to help them increase their profitability and therefore deliver a significant return on investment.

On the other hand, cost is the biggest barrier to farmers adopting technology. Over half of the respondents indicated that most of the SFT that exists is too costly. In addition, data privacy and sovereignty concerns are seen as a barrier, with significant differences by country arising. Sustainability arose as a key issue for farmers. According to the results of the survey, the majority of farmers do not currently see clear environmental benefits associated with using SFT. However, they believe that such technologies can improve their environmental impact in the future and help them to cope with climate change, indicating an opportunity for technology providers.

Cost is the biggest barrier to farmers adopting technology. Over half of the respondents indicated that most of the Smart Farming Technology that exist are too costly.

Looking at the differences by country, farmers in Norway, Ireland, and Greece generally see higher barriers to adoption. Serbian, Georgian, and German farmers have the most positive attitudes towards SFT. Greek farmers are most concerned about the lack of educational support and training. Although it should be noted that response rates differed considerably by country. Internet connectivity was a key barrier for farmers outside the EU. In addition, farmers involved in crop production perceive fewer barriers to adoption, while cattle farmers perceive more barriers to adoption.

In conclusion, the DEMETER farmer survey provides us with a better understanding of the DEMETER target group and their attitudes towards, and perceptions of, SFT in line with the Multi-Actor Approach (MAA). In this way, we can sharpen DEMETER's value proposition both in terms of the DEMETER platform and the 20 established pilot projects. On the one hand, knowledge about drivers and barriers to SFT adoption can help to provide SFT developers within DEMETER with guidelines on which aspects to keep in mind when developing, demonstrating, and applying their solutions and how to set up the most viable business models.

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On the other hand, DEMETER not only aims to demonstrate current SFT implementations but also enable future ones. Therefore, the results of the survey inform the design of the DEMETER SOCS (Stakeholders Open Collaboration Space) platform and its co-creation application, which is currently under development, and aims to enable collaborations between SFT providers and farmers. Additionally, DEMETER explores the digital transformation in agriculture in general. The barriers to SFT adoption thereby help establish a cost-benefit analysis to provide recommendations of the most socially-profitable and sustainable alternatives for the improved management and governance of digital transformation in agriculture.

1. INTRODUCTION & BACKGROUND

1.1 ABOUT

The H2020 DEMETER project is a large-scale deployment of farmer-driven, interoperable, smart farming-IoT (Internet of Things) based platforms, delivered through a series of 20 pilot projects across 18 countries (15 EU countries). Our key objective is to empower farmers and farmer cooperatives to a) use their existing platforms and machinery to extract new knowledge to improve their decision making and b) ease the acquisition, evolution, and updating of their platforms, machinery, and sensors by focusing their investments where these are needed.

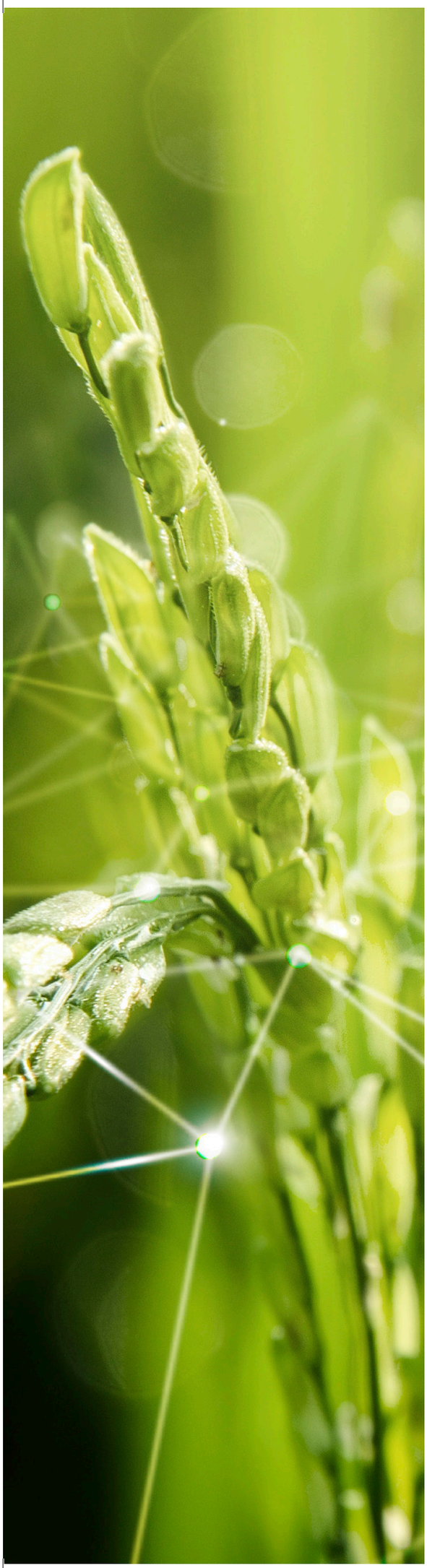
DEMETER will transform the technology ecosystem for agriculture by reinforcing and establishing agreed standards, an agreed common information model, an interoperability space combined with our online/physical networked ecosystem and a set of interoperability components, which will make the use of IoT technology effective and easy. DEMETER will make available a set of business models together with the associated analysis of opportunities/challenges that will enable a range of new enterprises across the agri-food and IoT technology sectors to emerge.

1.2 THE DEMETER FARMER SURVEY

As outlined, DEMETER follows a Multi-Actor Approach (MAA) that ensures that newly developed technical solutions meet real-life needs. A clear understanding of problems and expectations of all relevant stakeholders leads to the development of a solution that addresses a real need. Farmers are a key stakeholder group within the DEMETER ecosystem. Understanding their needs, interests, and concerns regarding digital technologies is central to a positive outcome for the project. With this in mind, we created a survey to share with farmers to better understand the barriers and drivers to Smart Farming Technology (SFT) adoption.

The main focus was to:

- Understand the current usage of SFT.
- Identify the key barriers and drivers to SFT adoption.
- Highlight the main information sources farmers use to learn more about SFT.
- Understand what training and support farmers want from SFT providers.



1.3 RESEARCH SURVEY METHODOLOGY

The research was conducted across November and December 2021 following a series of consultation meetings with members of the DEMETER consortium who have direct experience of working with farmers. These included the World Farmers' Organisation (WFO), the Irish Farmers' Association (IFA), Coldiretti, Georgian Farmers' Association (GFA), and the Romanian Maize Growers' Association (APPR). Farmers were also involved in the survey creation particularly in terms of the language used and question flow. The survey was translated into English, Spanish, French, Italian, Norwegian, Portuguese, and Romanian. A series of open-ended and closed-ended questions were asked. In particular, many Likert scale questions were asked to measure beliefs, attitudes and opinions.

The farmers' organisations involved in DEMETER as mentioned above, contributed to the research through their direct experience of working with farmers, by ensuring questions developed in the survey were fit for purpose, understandable, and suited to farmers and farms of all sizes, sectors and locations. Leveraging their network, the farmers' organisations were directly involved in the distribution of the survey to their members, both in and outside Europe, thanks to the global outreach of the WFO.

DEMETER also teamed up with THRIVE by SVG Ventures, the leading global agrifood investment and innovation platform. The main vision of THRIVE is to advance the future of food and agriculture through innovation. Partnering with THRIVE allowed us to share the survey with a wider network of contacts.

Quotes providing further insight into the drivers and barriers to SFT adoption were also provided by farmers participating in DEMETER and by farmers who spoke at the DEMETER webinar in March 2022, during which the results of the survey were shared.

IN TOTAL

484

RESPONDENTS COMPLETED THE SURVEY.

1.4 RESPONDENTS OVERVIEW

COUNTRY OF RESIDENCE

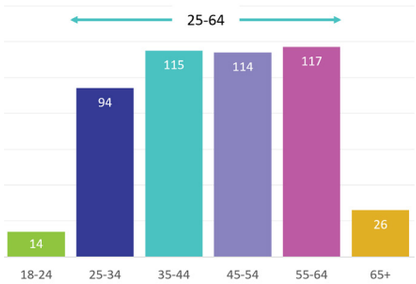
484 responses were received from farmers across 46 different countries. The countries with the most responses are illustrated below:

Ireland	Romania	Norway	Italy	South Africa
19.83%	16.12%	16.12%	9.09%	6.40%

Furthermore, 5% of respondents were from Serbia, 4% from Greece, 3.5% from Slovenia, 3.5% from Georgia, 2.5% from Spain, 2% from Germany, and 1.5% from Czech Republic. The remaining countries accounted for 1% of responses each.

AGE

4% of respondents were aged 18-24, 20% were aged between 25-34, 24% were 35-44, 24% were 55-64 and finally 5% were aged 65+



EDUCATION

With regard to the highest education level attained by farmers, almost 57% of the respondents say they have a university degree (bachelor, master, PhD, or equivalent). It means that most of the respondents are highly qualified. The remainder of responses show that only 2.7% left their studies at Elementary/ Primary School level and 23.14% at Secondary School level. The rest of respondents (74.18%) continued studying, 17.4% at High School or Technical Schools.

GENDER

Male	Female	Other
82%	17%	1%
398	83	3

82% of respondents were male, 17% female and 1% other.

Primary	Secondary	Apprenticeship	University Degree
3%	23%	17%	57%
13	112	84	275

FARM TYPE

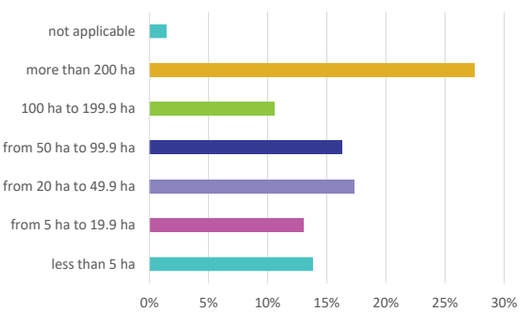
Respondents were from a variety of farm types as illustrated below with the majority from cattle farms (232 responses), followed by tillage (189 responses), vegetables (129 responses) and fruit (121 responses).

Livestock	Tillage	Vegetables	Fruit
232	189	129	121

FARM SIZE

27% of farmers that responded had a farm size greater than 200 ha, 17% indicated a farm size of 20ha-49ha, 16% had a farm size of 50-99ha. This was followed by smaller farm sizes with 14% having less than 5ha, while 13% indicated 5-19ha. Finally, 11% had 100-199ha.

47% of respondents reported having 2-5 employees on farm, 28% worked on farm by themselves, 9% had 6-10 employees, 9% had greater than 20 employees, whereas 7% had 11-20 employees.



POSITION ON FARM

79%

The majority of respondents were the farm owner (79%), followed by farm manager (30%) and farm worker (16%). 7% of respondents indicated 'Other' which mainly related to family farm positions.

SFT USAGE

48%

48% of farmers who responded were already using SFT on farm, with a further 37% indicating they would use SFT in the future; however, 15% doubted they would ever use the technology.

2. DRIVERS FOR **ADOPTION OF SFT**

The drivers for SFT adoption were measured via personal statements (e.g., “Smart farming technology would simplify my work”). The statements were combined with a 5-point Likert rating scale to assess the extent of respondents’ agreement, ranging from 1– “strongly disagree” to 5 – “strongly agree”. According to the survey’s results, the biggest drivers for Smart Farming Technology adoption are:

1. that the technology provides useful information to better manage the farm.
2. that it is expected to simplify work.

Notably, farmers tended to agree with all presented drivers; however, only slightly more than 50% agreed that coping with climate change impacts, improving work-life balance and making the farm future-proof are reasons for adoption.

Sustainability arose as a key issue for farmers. According to the results of the survey, the majority of farmers do not currently see clear environmental benefits associated with using SFT. However, they believe that such technologies can improve their environmental impact and help them to cope with climate change, indicating an opportunity for technology providers.

Further analysis of the results revealed small to moderate-sized relationships between the status of a farmer’s adoption of SFT (i.e., adopter vs non-adopter) and their view of the drivers. That means that farmers who doubt or disregard that they would adopt a SFT in the future see less benefits than those farmers who have already adopted technology. This is good news for technology providers as it demonstrates that the technology does indeed provide the benefits outlined. However, in terms of marketing, it becomes clear that efforts need to be undertaken to impart non-users of SFT with the products’ value proposition and clear demonstrations of the technology’s usefulness and ease of use. The same was true for farmers’ perceived benefits of SFT, as outlined in the Attitudes towards SFT section.

In terms of the expectation that SFT would help the farmer to better connect with other parts of the food value chain, there was no discernible differences in opinion between current adopters and non-adopters.

Moreover, education was significantly related to all the outlined drivers with small correlations. That means that the higher a farmer’s education, the more likely s/he considers one of the listed drivers as relevant reasons for his/her adoption

of SFT. It seems likely that less-educated farmers do not acquire the necessary information in order to be conscious of SFT's benefits. Again, the need for effective marketing and distribution of information becomes clear.

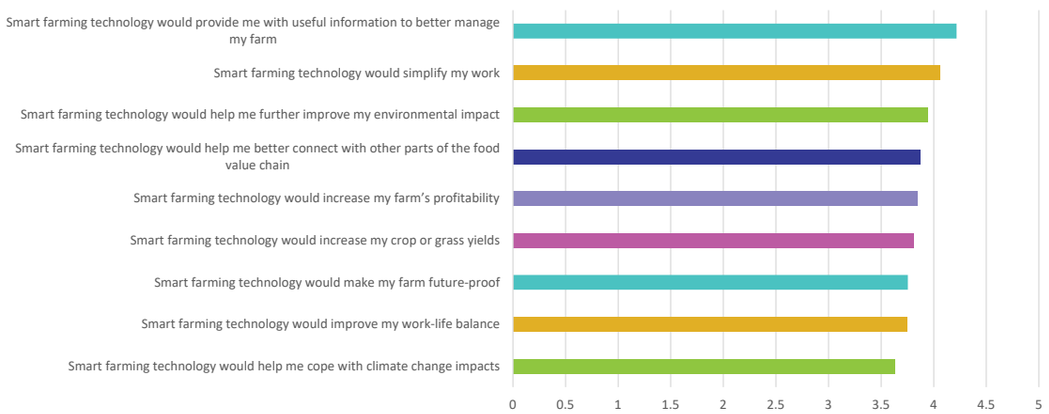
The size of respondents' farms positively correlated with some of the perceived drivers to SFT adoption. However, that relationship was only shown for the following drivers - SFT to simplify work, increase the farm's profitability, and increase crop and grass yield. Thus, for larger-sized farms, SFT's potential to simplify work and increase profits and yields is perceived as more relevant than in the case of smaller-sized farms. The correlation, that is the influence of farm size on those perceptions, however, was shown to be relatively small.

> *"Before <the technology> we were not able to check the soil moisture and our intention to irrigate was just not based on any data. But now we are able to see the chart when it is needed to irrigate. It saves our time and our money related to irrigation cost." (Farmer G)*

> *"I think a big driver (of new technology) is if you see that it makes your work easier." (Farmer T)*

Drivers for SFT adoption

If you were to adopt SFT, what would be the main reason?



> *"We want to go in the direction of precision farming because it's the way we were taught – the way of sustainable farming." (Farmer C)*

3. BARRIERS TO **ADOPTION OF SFT**

To understand the barriers to farmers' adoption of SFT, the survey included multiple question types including scale questions (ranging from strongly agree to strongly disagree) on certain topics, multiple choice questions and single choice questions. The range of question types was used to better gauge attitudes and perceptions to adoption.

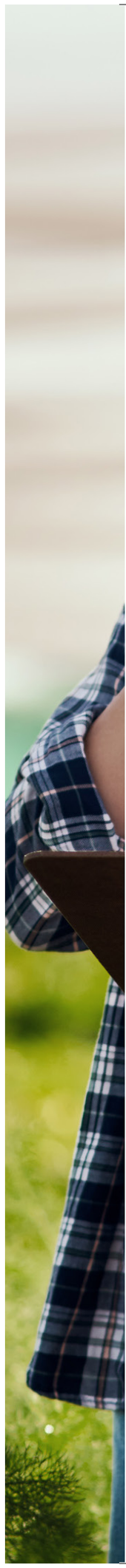
The key findings are:

The biggest barrier to farmers' adopting SFT is cost, with over 53% of respondents indicating that the price of the technologies is too prohibitive for them. In terms of how much farmers were willing to invest in a SFT, 51% of respondents indicated €1-€10k, 30% would invest less than €1k, while 19% of respondents would invest more than €10k.

"Cost (coupled with the resounding difficulty in accessing financial aid) has been a significant barrier for the implementation and use of Smart Technology on my farm. We must tackle the plaguing factor of cost and financial assistance together in order to maintain constant food production."

Shalini Seaton, FarmerChic Supplies Ltd (Jamaica)

The next biggest barrier preventing farmers from adopting SFT was that 3rd parties would gain ownership of their private data, as outlined by 23% of respondents. In addition, 18% of respondents agreed that they were concerned that the value of their data would not be returned. This highlights the need for technology providers to provide clear and transparent policies on how the data is being managed and used.



“With increasing automation and mechanisation of agriculture, we farmers collect more and more data about our farming practices. These data are for the most part internal key figures which are to be treated as strictly confidential. When implementing Smart Farming Technology, the risk of data losses increases and we as farmers have to be able to choose whatever happens with our data.“

Hannes Bumann, Farmer Germany

“All our members are enabled to use data from 13 deployed weather stations and 6 smart traps for insects. They all agreed to share their data in order to improve the software and prediction of the diseases, which primarily benefits them. They are aware that the data they provide in return is important for the accuracy of the portal and mobile application."

Slobodan Spasovski, Association of Producers of Grape and Wine with Protected Designation of Origin “Srem-Fruška gora"

Next, access to financial resources was highlighted as a problem, with 22% of respondents indicating it was barrier to adoption. Along these lines, 22% of farmers also outlined that they lacked the resources needed for SFT, while 18% lacked access to relevant support and training.

Finally, access to a stable Internet connection was a key concern for 19% of farmers.

"In our country, Internet coverage in rural areas is still a problem in most areas. For our farm specifically we have been in a position to erect a mobile network tower which provides us with access to Internet. However, the tower is only accessible near the radius of the home stead as our farm is 2,000 ha. As we farm with cattle, we have been piloting a device which is a sensor tied to the collar for the cattle. However, the device is not 100% accessible to the wifi radius, as the grazing camps do not have access to wifi."

Nono Sekhoto, Farmer Africa

To better understand the barriers, all answers were evaluated against differing demographics (location, farm size, farm type, etc.).

LOCATION

Taking the countries with the highest level of respondents, an analysis was conducted to identify any key differences in their perception of the barriers to adoption. It should be noted however that the response level differed considerably by country.

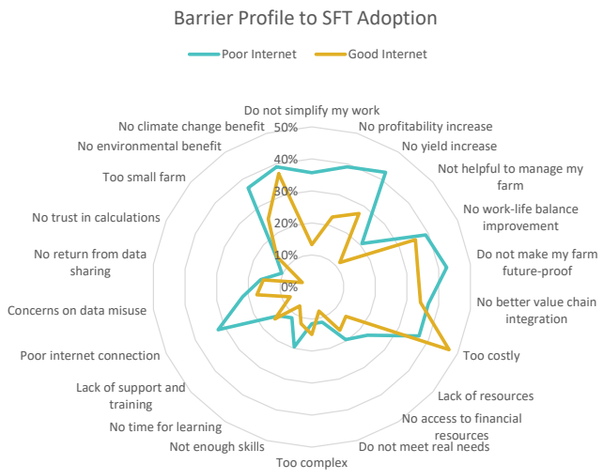
In Norway, 22% of respondents doubt they will use SFT with the main reasons being no clear cost-benefit associated with adoption, followed by not having the necessary skills.
In South Africa, only 1 in 5 respondents is currently using SFT. However, 50% of respondents believe they will adopt the technology in the future. Currently, Internet connectivity is a key concern, followed by cost. Internet connectivity was rated as 4.5 out of 10.

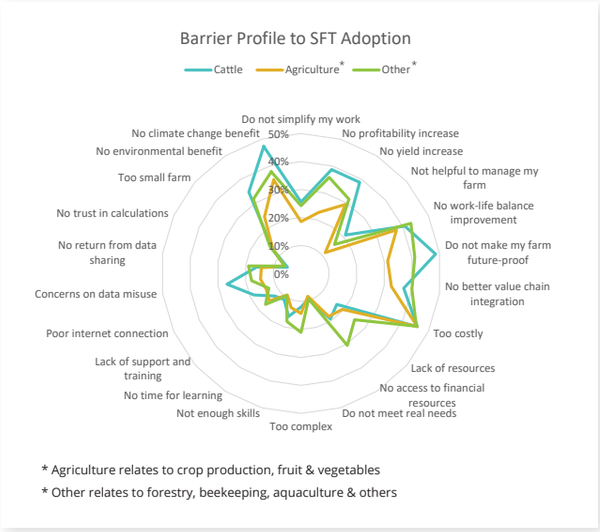
In Italy, 39% of respondents are using some form of SFT with 47% planning to in the future. Lack of skills and cost are the main barriers to adoption. Usability and ease of use are important decision-making factors when choosing SFT.
In Ireland, there is a high rate of adoption (53%) with a further 34% planning on using SFT in the future. 50% of respondents claim data ownership is a key concern to adoption as they do not feel that SFT keeps data secure and private. However, the majority of farmers believe that SFT can simplify work and give useful information.

In Romania, two-thirds of farmers are already using SFT, which was the highest adoption rate per country. 28% are planning to adopt some form of SFT in the future. Farmers strongly agree that SFT simplifies work, and increases profitability and yield. They also tend to disagree that SFT complicates work or excludes them from the wider community. Interestingly, the farm size in Romania is the highest (over 200ha) overall and farmers perceive the Internet connectivity as high (8/10) facilitating adoption.

Overall, Norway, Ireland and Greece perceive the barriers to adoption to be higher than other countries. Serbia, Georgia, and Germany have a more positive opinion and strongly agree that SFT simplifies work, and increases profitability and yield. Greek farmers are most concerned about the lack of educational support and training.

Outside of Europe poor Internet connectivity is a big barrier to SFT adoption. In general, farmers' perceptions of the barriers to adoption are greater for those who perceive their Internet connection as poor, except for cost. Overall, better Internet connectivity increases the likelihood of adoption.





* Agriculture relates to crop production, fruit & vegetables

* Other relates to forestry, beekeeping, aquaculture & others

FARMING TYPE

Breaking down the results based on farm type shows that crop production farmers perceive fewer barriers to adoption in general. Results indicated that cattle farmers perceive the barriers to be higher than other farm types. Other sectors including beekeeping and forestry etc. have a negative view of the support and training available.

Dairy Farmers

- 18% of dairy farmers say they would never use SFT.
- Price and data security are the main reasons.
- Technology providers rarely approach them to collaborate on ideas.

Tillage Farmers

- 60% are already using SFT with almost 30% saying they will in the future.
- They strongly believe that SFT provides useful information and will future proof the farm.
- Aside from cost, difficulty in usage is the main concern when adopting.

Livestock Farmers

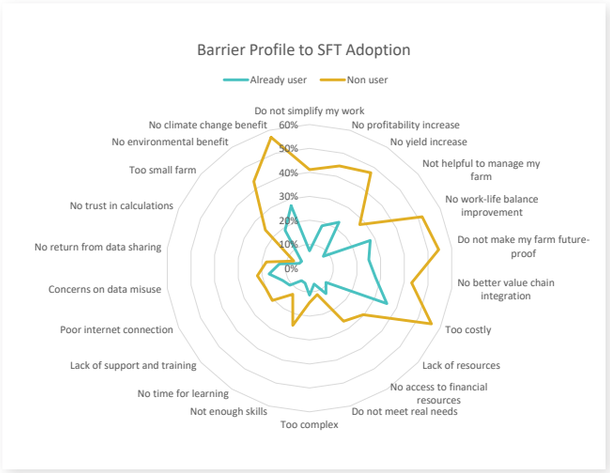
- Only 45% are using SFT.
- A further 35% are planning to use it in the future.
- Usability and ease of use are rated highly.

GENDER

As outlined, 82% of respondents were male, whereas 17% were female. Of the female farmers that responded, 28% are already using SFT with a further 51% planning to use SFT in the future. This is lower than their male counterparts whereby 51% are already using SFT but less are planning to use it in the future. Female respondents were generally younger. Notably, there were no general differences in opinion between male and female farmers regarding the drivers and barriers to adoption.

USERS VS NON-USERS OF SFT

The perceived barriers to adoption are much higher for farmers who do not use SFT. This means that farmers are not seeing the proposed benefits of adoption (see Drivers for SFT Adoption section) from technology providers or their peers but rather perceive possible downsides.



AGE

In general, the older the farmer the more likely they are to perceive the barriers to SFT adoption as higher. Those aged 55+ perceive the barriers as higher than farmers aged 35-54 and those aged under 35. The only exception is in the instance of SFT not delivering any climate change benefit and SFT being too costly, which were the biggest barriers for 35-54s.

4. ATTITUDES **TOWARDS SFT**

Besides questions relating to the drivers of SFT adoption, a set of questions also focused on general attitudes and perceptions of SFT. Farmers' attitudes towards using a technology is one of the most influential factors impacting their behaviour. Furthermore, other studies demonstrate that farmers' decisions to adopt a technology is directly related to their attitude and anticipation of its impact in economic benefit, farm performance, and usefulness terms.

Again, attitudes towards SFT were measured via personal statements (e.g., "Smart farming technologies make me feel more capable at what I do in my work.") combined with a 5-point Likert scale from 1– "strongly disagree" to 5 – "strongly agree". The previously discussed two main drivers for adopting a SFT, 1) providing useful information and 2) simplifying work scored the highest when ascertaining farmers' attitudes to SFT. This suggests that farmers in general have a positive attitude towards SFT.

Half of the respondents agreed that SFT makes them feel capable and in control, while providing greater freedom and choice. They also tend to agree that SFT helps to reduce costs and to connect with other farmers. All this suggests that the perceived capacity or expectation of SFT is to satisfy psychological needs like autonomy, competence, relatedness, and (financial) security.

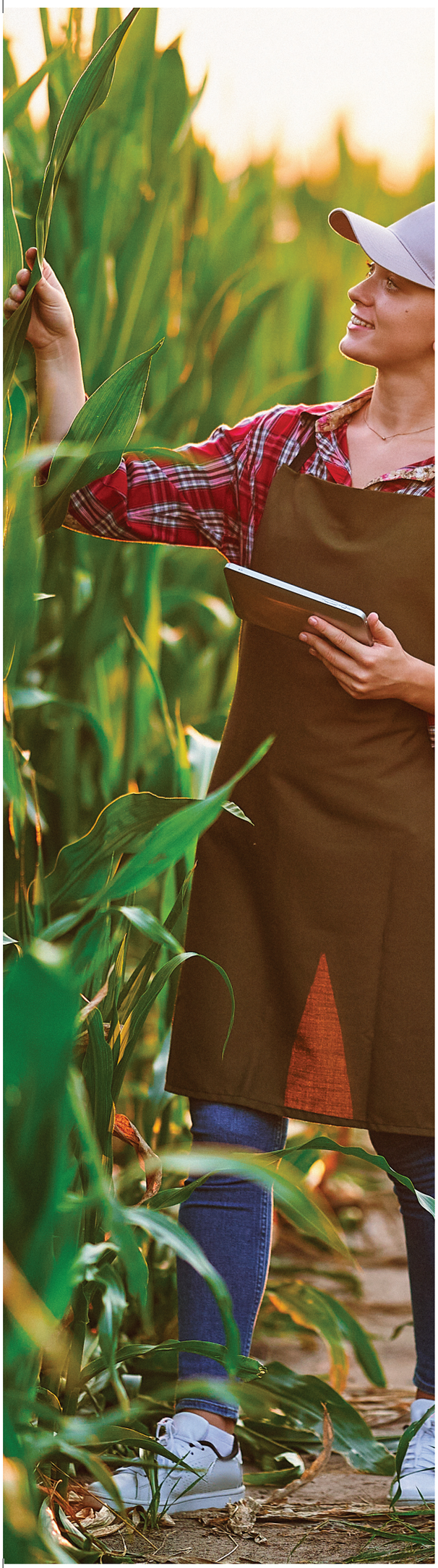
Moreover, farmers were rather undecided whether SFT increases expenses and keeps data secure and private, hinting at two main barriers to adoption: cost and lack of data security.

Respondents overall tended to deny that SFT is hard to understand and does not provide any benefits. This demonstrates that farmers' attitudes towards usability and ease of use is generally positive. In addition, farmers did not feel that using SFT made them feel excluded from the overall farming community. Contrary to this, the majority of farmers felt that SFT helps them to connect with other farmers.

Similar to the drivers for SFT, analyses revealed that farmers that had already adopted SFT or plan to adopt a smart farming technology, have a more positive attitude towards the technology than those farmers who doubt they ever will or even outright reject the notion of adopting SFT. This would suggest that users are seeing the real benefits of adoption and are therefore more positively disposed to SFT in general.

"A modern farm without digital technologies looks like a warrior without proper armour. Digital technology for farming is changing the farming concept - bringing novelties in management practices which guarantees sustainable development. In my case I am using an agro-meteorological station which helps me to plan irrigation properly as well as Integrated Pest Management practice."

Edvard Shermadini, Farmer Georgia



5. INFORMATION **SOURCES**

The survey also included questions on the sources farmers use to find out information about new technologies for their farms. Respondents could select more than one source of information in the survey. The Internet such as social media, blogs, forums, etc. was most popular with 72% of respondents selecting this option, followed secondly by agrimedia and publications (65%) and thirdly by attending trade fairs (40%). The Internet as a main source of information was consistent across all age groups.

Another source of information is peer farmers and farmers' association as indicated by 37% of farmers. A similar percentage (35%) indicated that farm advisors are a source of information about new technology. Word of mouth was also listed by several farmers (32%). Being approached by a sales representative only represented 17% of responses.

Many of the farmers' organisations involved in DEMETER represent a valuable resource for finding out information about new technologies and farming practices:

World Farmers' Organisation website
https://www.wfo-oma.org/

Irish Farmers' Organisation
https://www.ifa.ie/

Coldiretti
https://www.coldiretti.it/

APPR
http://apprs.ro/

Georgian Farmers Association
https://gfa.org.ge/en/

In addition, other useful resources include:

American Farm Bureau Foundation
Source Trace blog
Oliver Wyman website

6. TECHNOLOGY PROVIDER **SELECTION CRITERIA**

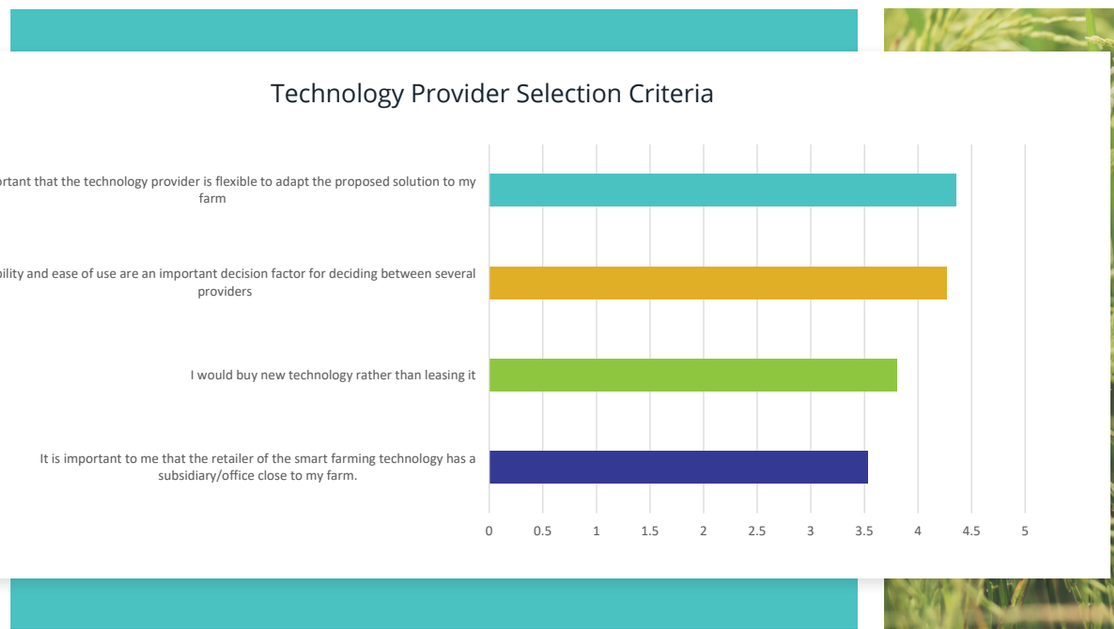
Another subset of questions focused on farmers' selection of technology providers for acquiring SFT. Like before, it was measured via personal statements for which farmers could rate the extent to which they agree or disagree on a 5-point Likert scale from 1– "strongly disagree" to 5 – "strongly agree".

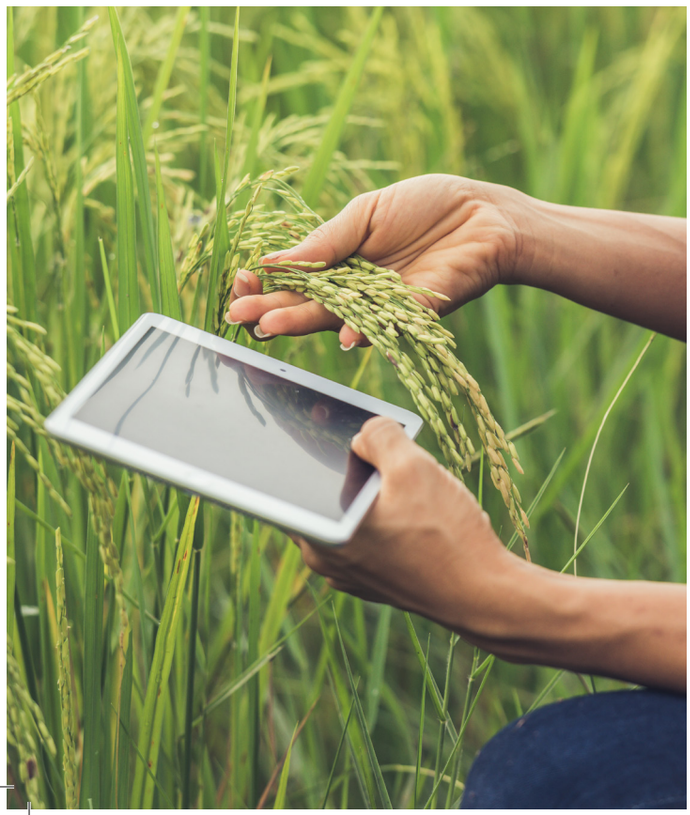
Farmers clearly agree that technology providers should be flexible in order to adapt proposed solutions to their farm (mean = 4.36). In that regard, usability and ease of use are clearly important factors when deciding which technology provider to consult (mean = 4.27), which is in line with the perceived drivers and benefits of SFT described above.

According to the survey results, farmers have a slight preference to buy technology rather than leasing it (mean = 3.80).

Moreover, they tend to agree that retailers should have a subsidiary rather close to them (mean = 3.52). Hereby, again half of the respondents (50.9%) agreed with the statement, whereas 34.7% were neutral.

Farmers clearly agree that technology providers should be flexible in order to adapt proposed solutions to their farm.





7. EDUCATION **& TRAINING**

This section summarises the results from the survey considering farmers' training and support needs. The survey included a question to ascertain whether SFT is hard to understand, and another one to uncover which are the most significant barriers for adoption, as analysed previously. The respondents generally do not feel that SFT is extremely hard to understand (mean=2.74). However, the majority of farmers that responded had a university degree, which could influence the response.

In addition, 18% of the respondents reported that a lack of access to support and training is one of the reasons that prevents them from adopting SFT, while 11% mentioned that a lack of time to learn is also another barrier. Thus, even though SFT is not considered as difficult to learn or operate, the respondents are aware that they need training to better profit from their investment and to improve their daily activities on the farm.

The results from the survey also establish that usability and ease of use of SFT products have a significance of 4.27 out of 5 when selecting providers. The importance for respondents that technology providers offer training and support services also ranked high with a score of 4.47 out of 5. SFTs should have a low learning curve and using them on-farm for daily tasks should not take longer than the previous way of doing things. Respondents also point out that it is important that technology providers generally support them in their adoption of SFT and offer training courses.

The survey also included a question to identify the respondents' preferred way of learning. 50.26% of the respondents prefer a blended learning approach mixing online training, training in the field using real products in real environments close to the respondents' daily environment, and traditional training in a classroom. This is aligned with previous results, as a blending learning approach lets users better organise their time for their daily tasks on farm and their learning activities. A significant number of respondents (34.21%) selected an in-field training approach, much more similar to their daily life on farm.

8. COLLABORATION WITH **TECHNOLOGY PROVIDERS**

Three final questions in the survey served to assess farmers' attitudes towards collaboration with technology providers, as this is a central tenet of the DEMETER project and also the focus of the platform developed in DEMETER, the Stakeholders Open Collaboration Space (SOCS). The SOCS is an online platform dedicated to all stakeholders (farmers, advisors, and suppliers) where they can collaborate, share best practices, and participate in the co-creation processes.

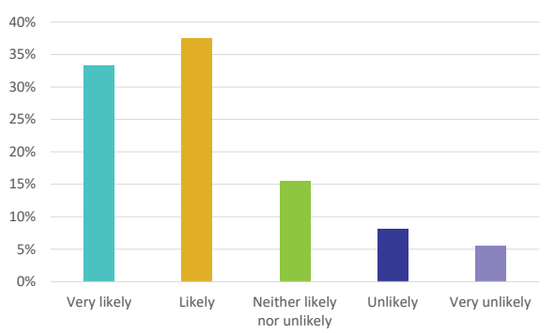
The measurement used for the first two questions was again a rating scale from 1– "strongly disagree" to 5 – "strongly agree" referring to personal statements.

According to the results, farmers in general are rather undecided regarding if technology providers should approach them and/or if farmers should actively seek out technology providers. Notably, the results were independent of whether respondents had already adopted SFT or not, highlighting the need of collaboration structures and processes that enable initiatives from both sides.

Another question specifically asked, how likely they were to use an online platform to collaborate with other farmers and SFT providers. Responses were measured from 1 – "very likely" to 5 – "very unlikely", with lower values indicating more agreement. The results showed that farmers are very interested in using an online platform to collaborate with other farmers and technology providers. 33% of farmers are very likely to use such an online platform with a further 38% likely to use it.

This is good news for the development and population of the DEMETER SOCS platform. The SOCS includes a so-called Co-Creation Application, which allows farmers and technology providers to form collaborations for the development and deployment of SFT based on farmers' specific needs.

How likely are you to use an online platform to collaborate with other farmers & smart farming technology providers?



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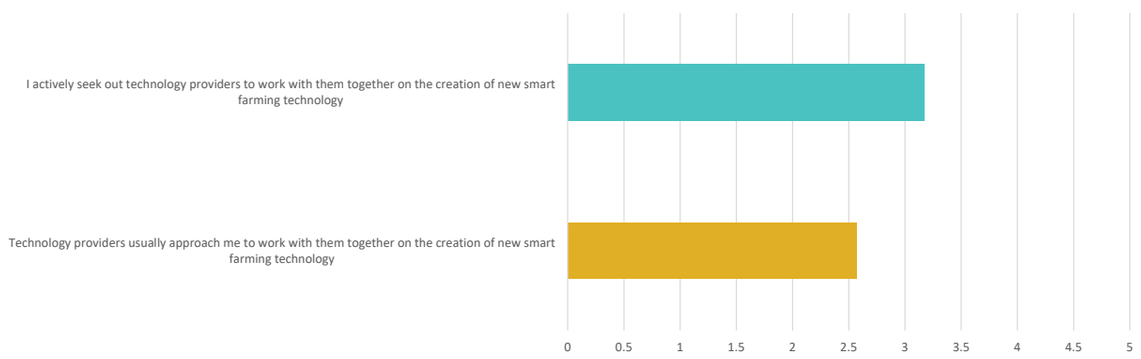
Attitudes towards collaboration with technology providers



9. CONCLUSION

In conclusion, the results of the survey indicate that cost constitutes the biggest barrier to the adoption of SFT, followed by data privacy issues and concerns. However, in general farmers have a positive attitude towards SFT and are driven to consider adopting such technologies based on the need to have more information to better manage the farm, to simplify work, and to increase profitability. Farmers are also interested in technology that can help them improve their environmental impact but, at the moment, do not see clear environmental benefits associated with SFT. Technology providers should take the environmental impact of the farming business into account and help the farmers they are collaborating with to fulfil their sustainability goals.

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The farmers' survey results make very clear that non-adopters of SFT see more barriers and less benefits to SFT adoption than adopters do. Clear measures and data to demonstrate benefits and alleviate doubts regarding SFT would be helpful to drive adoption. In this way, there is a need for better showcases and demonstrations. The creation of marketing materials clearly demonstrating the cost-benefit analysis of adoption, the improvements in the work life balance and increased profitability would be welcome. These materials should include case-studies representing farmers from a diverse range of farm size and farm type. Furthermore, farmers need first-hand experience, which is why technology providers should provide opportunities for the farmers to test and talk to those who have already adopted SFT. In addition, farmer-to-farmer peer learning should be fostered by creating a space where farmers currently using SFT can share their experience with other farmers and leverage their network of farmers' organisations and farm advisors to learn more about the benefits of using such technology. Although the results demonstrate that farmers would prefer to buy the technology rather than leasing it, more leasing opportunities are becoming available and could represent an opportunity for farmers struggling to access capital.

Importantly, SFT providers need to demonstrate and actually ensure that their solutions are usable and useful. The survey has shown that ease of use and usefulness should be prioritised. This puts emphasis on the Multi-Actor Approach, advocated by DEMETER, during development, through which developers engage all stakeholders, including farmers, in order to elicit and fulfil their needs and requirements. Farmers should be fully involved in the whole development process to co-create solutions. In other words, SFT providers should approach farmers before they develop technology for them, making development demand-driven instead of technology-driven. This is demonstrated in DEMETER, where there are 20 pilot projects from across Europe. Moreover, the SOCS platform developed in DEMETER is going to support and initiate such collaborations between technology providers and farmers.

With regard to data, it seems that farmers who have already adopted technology are particularly concerned about their data and privacy since many solutions rely on the farm's data to provide accurate predictions and support. Data privacy is something SFT providers should prioritise. Therefore, guarantees and policies should be established that provide transparency and enhance trust among farmers.

When it comes to connectivity of devices, it is important for technology providers to allow users to have the option to

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use a solution in low or no coverage areas through offline mode integration. This would alleviate some of the concerns when it comes to connectivity, especially for areas that have low Internet coverage. According to this survey, this would be an important feature outside of Europe where Internet connectivity was rated lower than European counterparts.

Investment in education and training is important so that farmers, regardless of their current education level, have access to specialised SFT training.

Most of the respondents in the survey have a university degree, and we can therefore conclude that they are highly qualified. This is positive; demonstrating that education will foster the adoption of new approaches, new technologies, and so forth. As such, investment in education and training is important so that farmers, regardless of their current education level, have access to specialised SFT training. We also see that older farmers are more likely to see the barriers to adoption as being higher. Specialised training based on their concerns could result in increased engagement.

In general, the respondents do not consider that SFT is difficult to understand but they are aware that they will require support and training to get the most out of these technologies. Thus, the lack of access to training courses or the lack of time to attend them can be a significant barrier for the adoption of SFT. Moreover, the results indicate that farmers take into account the training support of a technology provider as well as the usability and ease of use of their products when making the final decision to purchase new technology. Finally, respondents prefer a blended learning methodology approach, as it fits better with their daily routine on-farm, followed by in-field training, where the users can get a more real experience, much more similar to their daily life. Technology providers should therefore ensure they offer such a blended learning approach to facilitate the farmer's needs.

Undoubtedly, there is a key role to play by policy makers at all levels to ensure a conducive innovation framework. Political support for agricultural development and innovation, catalysing States' capacity to drive agriculture transformation is crucial. In particular, public and private investments should be channelled in both basic and digital infrastructures to support innovation, particularly technological and digitalisation, where needed.

This DEMETER farmer survey provides us with a better understanding of farmers' perceptions, attitudes and concerns towards SFT, in line with the Multi-Actor Approach (MAA). The findings are being used to sharpen DEMETER's value proposition for those participating in the project and for a wider network of farmers and technology providers. For example, the results inform the design of the DEMETER SOCS platform and co-creation application that is being developed, and serves the vision to enable collaborations between SFT providers and farmers. Furthermore, DEMETER aims to not only demonstrate the benefit of current SFT implementations but also enable future ones. These results will help to inform technology providers on how they can engage farmers in the development process of SFT to create technologies that address real-life needs.

FOR MORE INFORMATION

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