A Scoping Review on How Precision Farming Technology Affects Farmers' Mental Well-Being

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This paper will consist of an in-depth research study on the current state of the art technology used in farming and how they affect the farmers' mental health. To be more precise, this paper will encompass a scoping review on the impact that Precision Farming technologies have on farmers' stress levels, in an international perspective.

Within this scope, this study will cover pressing matters such as possible ways of improving these tools in order to reduce the stress that farmers have to endure, thus making their daily field work more manageable and boosting their mental health. The findings from this paper revealed that DSSs and smart glasses are essential tools for farmers, potentially alleviating work-related stress.

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Additional Key Words and Phrases: Precision Farming, Farmers, Mental Health, Stress, Augmented Reality, Farming, Technology, DSS, Smart Farming, HCI, Smart Glasses.

1 INTRODUCTION

For millennia farming has been a critical asset for every civilisation and it still is to this day. As the global population increased exponentially over the last few centuries, the demand for farming produce has skyrocketed thus intensifying the pressure on the farmers. Life without this essential pillar would be unimaginable as it would lead to social unrest, food scarcity and other catastrophic consequences which would change life as we know it. With this in mind, it is of utmost importance that we study and research the issues that the farmers are facing in these modern times.

Technology has also been exponentially growing in the past century which has lead to its implementation in many fields such as farming. Nowadays we can easily find different technologies in a conventional farm that vary from simple sensors [17] to highly sophisticated drones [19]. One of the most popular technological approaches currently used in farming is known as 'precision farming' or 'smart farming' [25]. This is defined as a management approach that focuses on (near real-time) observation, measurement, and responses to variability in crops, fields and animals. Farmers applying this concept commonly make use of tools such as sensors, Decision Support Systems (DSSs) [15], drones, smart glasses [5], Human-Robot Interaction technology [33], and many more tools (see Figure 1). The utilization of this technology has proven to relief and optimise the farmers' workload and administration [21].

While technology provides clear benefits for farmers, there are signs that due to modernisation and increase of demand, farmers also face new challenges. One of these new challenges concerns farmers' mental health [13]. In these modern times, the present farmer can be exposed to long hours of physically demanding and repetitive work, time pressure, unpredictable animals and machinery, climate change and many other factors that contribute to significant stress levels, detrimental to their mental wellness [13]. Poor mental health has proven to be an alarming concern in the farming community, leading to extreme cases such as depression and suicide [16]. Disregarding this problem could result in a fatal impact on the farming industry as mental distress could hinder the farmers to do their job adequately. A blow to the farming sector could therefore lead to the decline and deterioration of economic productivity, animal health, and human health worldwide.

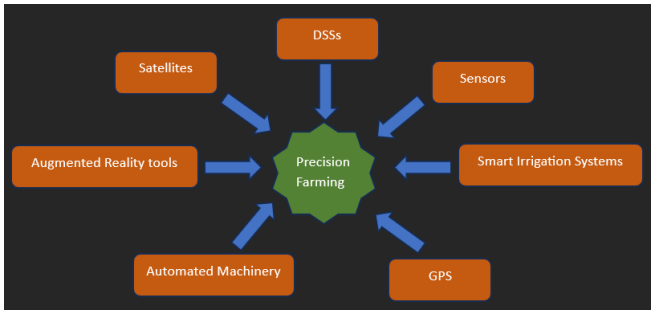

Fig. 1. Common Precision Farming tools

1.1 Objective and Goals

Due to the lack of literature linking both technology and factors affecting farmers' mental health, the objective of this paper is to make a scoping review of the current state of the art technologies in precision farming and how they affect the farmers' stress levels and mental wellness. This paper will aim to be to the first step on covering this gap and provide a foundation for future research on this topic.

Within this scope, this paper will analyse possible methods and modifications that could be applied to precision farming tools in order to ease the farmers' workload and stressful tasks, which could potentially contribute positively to their mental health. To be more precise, only DSSs and smart glasses will be reviewed in this paper since they are both common precision farming technologies studied in research papers and also to zoom in and not make this paper's theme too broad.

1.2 Research Questions

In order to achieve the proposed objective, the following main research question has been formulated:

TScIT 37, July 5, 2024, Enschede, The Netherlands

- How can DSSs and smart glasses have an impact on the farmer's mental well-being and stress levels regarding daily workload and stressful tasks?

To answer this question, three research sub questions were formulated.

Visualisation tools are a key central aspect of DSSs that are responsible in displaying important information to the user, which is why it is addressed in the sub-question below:

- To what extent do the visualisation tools from current DSSs aid in the relieving of stressful tasks performed by the farmer?

Similar to DSSs, smart glasses are also a highly capable precision farming tool that could help farmers achieve higher autonomy and relief from stressful tasks. Therefore, this begs the question:

- How can the use of smart glasses reduce the impact that tedious and laborious tasks have on the farmer?

For clarity, the sub-question below means to dive into literature reporting complaints/issues regarding machines within this technology as well as improvements to be made in their design.

- How can we improve the current existing DSSs and smart glasses in order to make farmers feel that they have more control over their work environment?

2 RELATED WORK

While there are no articles that directly look into how precision farming technologies affect farmers' stress, some articles have been found related to the research (sub) questions.

For instance, a study [15] about the different types of visualisation techniques used in DSSs in order to improve the understanding of different data that farmers are given by the dashboards. Additionally a review analysing the current state of DSSs in the farming industry [26]. These are both interesting and valuable studies for this paper as it provides a systematic insight on the use of visualisation techniques in the field of agriculture. Additionally they conclude on suggested design guidelines for future DSSs that actively involve farmers in the development process. Another paper [5] studies the potential impact of using smart glasses for Precision Livestock Farming. The previously mentioned studies provide valuable insight for this paper on the different precision farming tools and how are they are put into practice by the farmers.

Additionally, research papers about the farmers' mental health [13] [9] [14] [7] should also be taken into account regarding the perspective of this study. Identifying farmers' mental health stressors is crucial to deduct how precision farming tools could aim to reduce stress from the farmer.

3 METHODOLOGY

As previously mentioned, there is very limited literature on how current farming technology has an impact on farmers' mental health. Many papers either discuss the technology itself or the mental aspects, but do not lay a connection between the two. Due to this, this paper will be a scoping review on literature covering the specific topics of "farmers' stress", "DSSs" and "smart glasses".

Table 1. Used keywords to extract results for each of the themes

Themes	Keywords
4.1 DSSs in Precision Farming	"Farming DSS"
4.2 Smart Glasses in Precision Farming	"Smart Glasses Farming", "Smart Glasses Farmer", "Smart Glasses impact farming", "Smart Glasses agriculture"
4.3 Improvement on DSSs and Smart Glasses	"improvement DSS farming", "improvement Smart Glasses farming"
4.4 Stress factors for farmers	"farmers mental health", "farmer stress"

To ensure that the literature is applicable and relevant regarding to the research questions, four themes were defined. For each theme, a set of keywords were used to find relevant literature in Google Scholar. These keywords can be found in Table 1. The first step in processing the results was to examine the title and abstract for each paper. Papers would be included if they provided relevant information for the four themes. Specially, for each theme some sub-themes of specific interest were defined to further explain each theme in more detail. The list of accounted sub-themes is as follows: Tasks supported by DSSs; Characteristics of DSSs; Design Methods used in DSSs; Impact of Smart Glasses in farming; Characteristics of Smart Glasses; Improvement on DSSs and Improvement of Smart Glasses. The literature derived from this selection has been read in depth, the relevant information extracted and included in the appropriate sections. More specifically, when interesting data is identified, it is annotated and finally connected with the rest of the work in this paper.

4 RESULTS

4.1 DSSs in Precision Farming

Currently, DSSs are a crucial component of the backbone of precision farming. These systems exhibit diverse designs and characteristics depending on the specific tasks they are intended to perform. Thus, in the following subsections, the reader will first find the information gathered by this study on the tasks supported by DSSs, then their characteristics and finally knowledge about their current designs. The collected knowledge will help us answer the first research sub-question in the discussion section.

4.1.1 Tasks supported by DSSs. One crucial task that DSSs support is water irrigation support, which helps remedy the issue of efficient use of water. Overcoming this agricultural challenge is a priority for sustainable and economically profitable crops [20].

The variability of climate change often poses a threat in the irrigation of crops, thus special DSSs have been developed like the

one from the project "An advanced low cost system for farm irrigation support – LCIS" (a joint Italian-Israeli R&D project). This LCIS-DSS is able to visualize different spatial scales at specific areas in the field, farm and district under different pedo-climatic conditions, and with different crop management under different water nutrient resources availability[4].

Another issue farmers face is land and soil degradation which interferes in the management of multi-functional roles of soil and landscape [31]. To address this problem, DSSs have been developed such as the Smart web-based DSS for land management and soil conservation from this study [31]. Other common tasks performed by DSSs in farming are namely: dairy farming [5], weed management [22], crop management [8], fish farming [35], livestock farming [27], and other applications for management control and strategic planning such as cotton [18] and soil management [10].

4.1.2 Characteristics of DSSs. DSSs in water irrigation support field, for example, are considered to be user-friendly and able to work with minimum data input which leads to lower costs and minimizes the need for professional consultancy [4]. A previously mentioned study [31] found out that most of the currently available DSSs with their standard Web-GIS systems already possess certain benefits for the farmers such as user-friendly interfaces, multi-scale, and easy updating of databases. In order for such systems to assist farmers making more effective decisions, they tend to use maps along with satellite imagery as their main visualisation tool. Additionally, they gather all sorts of information from sensors and other devices utilized in precision farming and display them through interactive dashboards. Please refer to Figure 2 and Figure 3 to observe examples of said dashboards.

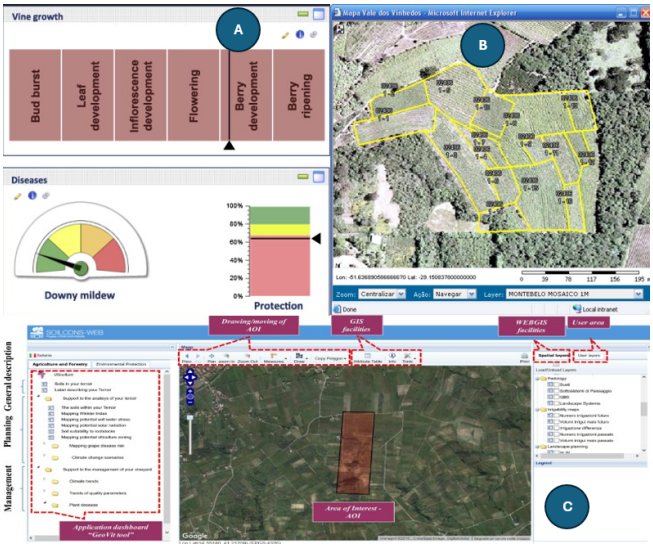

Fig. 2. Examples of visualisation tools from different DSS dashboards: a)Rossi et al.[28] b)Blauth and Ducati.,[3] c)Terribile et al.[32]

4.1.3 Design Methods used in DSSs. Decision support systems are still being worked on to improve and overcome their current limitations. Nowadays, agricultural DSSs (AgriDSSs) face a "problem of implementation" which in other words means that they are not used at their full potential since they have been developed based on what scientists and ICT specialists consider important for the farmer, when in reality they fail to satisfy the farmers' needs [23]. However, this does not count for all of the AgriDSSs and it must also be mentioned that there is an ongoing improvement in this area by utilizing User Centered Design (UCD) [29]. This is an approach where end-users, in this case farmers, actively participate during the design of DSSs which helps prioritize farmers along with capturing their needs and goals successfully.

Fig. 3. Dashboard from AgriDSS CropSAT [30] displaying the variation of vegetation index by satellite.

4.2 Smart Glasses in Precision Farming

It must be mentioned that augmented reality tools, such as smart glasses, are still at an early development stage in the agricultural and livestock fields hence the results in this section are based on the testing from different studies. The results of this section are vital to help us answer the second research sub-question in the discussion section.

Most of the identified papers have shown a clear trend on the testing of smart glasses in Precision Livestock Farming. Regardless of its clear popularity in studies regarding dairy and livestock farms, this AR tool has found its way to the arable sector with very limited but existing research such as the study by Huuskonen and Oksanen[19] where they evaluate the use of smart glasses and drones for soil sampling.

4.2.1 Impact of Smart Glasses in farming. Although this technology is still in early development and not implemented fully in the field, some studies can be found where smart glasses have been tested in Precision Livestock Farming. Caria et al.[5] found that this tool is

commonly tested and used in precise management for animal husbandry, animal identification, health status, productivity, diet, etc. Thus, they also stated that it provides additional support on tasks that the dairy farmer complete regularly such as feeding, milking and breeding [5].

During a study made by Caria et al.[5], the researchers used a GlassUp F4 Smart Glasses (F4SG) to evaluate its performance in a Precision Livestock Farming environment. They mentioned that already other studies have proven how the implementation of precision farming technologies in livestock farms improved farm profits, environmental sustainability and animal welfare and management. In order to prove the same point for specifically these smart glasses, they carried out some tests where the farmer would scan QR codes with the F4SG. Such QR codes were placed in different places of the farm, providing different types of useful information such as feed data on the bale silage, as well as sheep identification and productivity (Figure 4). Additionally video-calls with the glasses were also tested during field work so the farmer could work on different tasks while talking hands-free. According to their results, lag-time of these glasses during video-calls has proven to be steady which makes them comfortable for the user to utilise for a long period and while moving to different locations.

Moreover, the results of a study made by Caria et al.[6] discovered that graphic-based information (vs text-based) provided by the F4SG glasses to the milkers led to a decrease of 21.1% in mental demand (amount of mental effort), 19.7% for temporal demand and 6.4% for physical demand. They also found that participants strongly agreed that the smart glasses are relatively easy to learn and use, achieving the high score of 4.69 ± 0.48 in an IBM Computer System Usability Questionnaire (CSUQ).

Now in the arable perspective, a study by Huuskonen and Oksanen[19] put into practice the novel concept of automatically determining the locations for soil samples based on a soil map created from drone imaging after ploughing, and using the ODG R-7 smart glasses to guide the user to the generated sample points. The results of this experiment confirmed that although there were some issues with the magnetometer and GNSS of the smart glasses, the amounts of collected sample points were helpful for the farmer to track all sorts of information about the soil such as its type, pH, contained minerals and other properties.

Fig. 4. Scanning QR codes positioned on the sheep's tail in self-locking yokes at the milking parlour [5].

4.2.2 Characteristics of Smart Glasses. The literature review carried out for this paper has shown that smart glasses used in other studies to experiment with them in precision farming are usually commercial ones such as the F4SG [5] and ODG R-7 [19] smart glasses. These tools have several different integrated features such as a camera for image capturing, sensors (gyroscope, GPS, accelerometer, magnetometer, etc.), microphone, operating system (Android, Windows, Linux), a tangible interface, Bluetooth and WiFi connectivity.

During the experimentation and development in precision farming, participants have underlined the good visual and audio quality of the augmented reality devices [5][6]. As a result of their embedded capabilities, SG provide the farmer with the ability to receive real-time assistance through video calls as well as many other features such as real time file consulting, data collection, data sharing and all of this while working hands-free[5].

4.3 Improvement on DSSs and Smart Glasses

Gathering information on reported possible improvements to be made in DSSs and smart glasses is vital in order to answer the third research sub-question in the discussion section.

4.3.1 Improvement on DSSs. During the literature review, many papers such as the one by Lindblom et al.[23] agreed that one of the main obstacles that DSSs have in the agricultural world is the "problem of implementation" . Lindblom et al.[23]underline that this issue is due to the lack of user participation during DSS design and production. Having the end-users, in this case farmers, engaging during the design process would provide direct feedback. Such a change at an early stage like this which would be crucial to better understand user goals thus designing more applicable and effective DSSs. The same study found that another impediment farmers face is the lack of DSS availability since most DSSs have been developed and applied only locally without being publicly available. To solve this, a more extensive sharing and increased public availability (either free or commercial) would improve the farmers' awareness of this technology as well as its uptake [2].

Moreover, Lindblom et al.[23] discovered that current DSSs fail

to provide uncertainty in output variables. It would be important to showcase uncertainty in the data to the users since it would showcase the farmer vital information such as possible variability associated with climatic and economic factors. Apart from said improvement, another key factor that would enhance DSS adoption and continued implementation by farmers would be to increase its flexibility for its system to be adaptable for different farm-specific situations [2]. They also mentioned that future DSSs must also be easily maintained with the capacity to be adapted with new information so that outdated software does not shorten their longevity in agricultural work and future use.

4.3.2 Improvement on Smart Glasses. With regards to the smart glasses, in the study by Caria et al.[6], they discovered that indoor and outdoor lighting posed a difficulty for farmers to quickly scan the QR codes and obtain relevant information while working hands-free, thus an improvement on the scanner readability should be worked on to prevent any delays in day-to-day field work for the farmer. Another challenge they faced during the experiments was that with all the different animals and machinery in the farm, it became less optimal for the farmer to make use of the vocal command feature from the SGs, although this could be solved in the future by switching directly to manual commands or implementing a noise-cancelling element in order to reduce background noise. Although most farmers work than 8 hours per day, these researchers found out that the 7 hours of battery life of the F4SG were just enough for the farmer to complete their tasks successfully since these SGs would not be used for most of those working hours.

In addition, during the soil sampling drone study mentioned earlier made by Huuskonen and Oksanen[19], the ODG R-7 smart glasses they used presented navigation issues for the farmer which were caused by the magnetometer. This was fixed after calibrating the magnetometer several times. Another issue with these SG was its integrated GNSS (Global Navigation Satellite System), which kept shifting while a sample point was being collected, resulting in the farmer losing their way to the next sample point. Thus, improvement on the GNSS and magnetometer should be encouraged in order to use this AR tool efficiently for agricultural tasks that require navigation,such as soil sampling. It must also be mentioned that other studies are required to provide more findings for future development and application of specific software for smart glasses in the agricultural context [5].

4.4 Stress factors for farmers

A few of the most cited stress-related factors from the reviewed literature are time pressure, economics, climatic variability, overwork and government regulations [9]. In the following paragraphs we will go deeper into some of these.

According to the results by Daghagh Yazd et al.[9], one of most mentioned key risk factor on farmers' stress that was found on their literature review was "Finances in general (input prices/ income/ profit/ market condition)". This study mentions that during the 1980s farm financial crisis in the US, farmers were faced with a decrease in demand, higher input costs and low commodity prices which caused farmers to experience psychological distress, depression, lower life satisfaction, alcoholism and even suicide. Moreover, the study also found that even in the present day farm financial problems also affect other family members from the farmers, which has been positively associated to farmers' stress perceptions. It was also stated that there has been a positive relationship between high farm profit, greater well-being and a decrease in distress amongst farmers.

Another critical stressor is the variability and unpredictability of the weather. The same study found that unfavorable climate conditions and their unpredictability have been the key stress factors of 75% of the farmers interviewed by Walker et al.[34]. Droughts are a typical disaster that is commonly found in literature when reading about climate variability. Daghagh Yazd et al.[9] also found that the agricultural sector is hit the hardest by drought, with farmers experiencing declined production, crop loss, and livestock failure. The financial hardship produced by these droughts has been identified as its major stress amongst farmers by studies like the one by Edwards et al.[12].

The results of a study by Marja Kallioniemi and Kymäläinen[24] showed that two of the most common key factors affecting stress on farmers were the "amount of work" and "administration of the farm". Overwork was found to be a common issue amongst farmer workers, with this study identifying all the dairy farmers that participated (N=265) as having slight burnout symptoms and one tenth (9%) of them experiencing severe burnout symptoms, making it a critical stressor to consider. The study results showed a rise in stress and burnout symptoms, potentially leading to negative impacts on farm productivity, development, animal welfare, and the sustainability of food production.

Deary et al.[11] reported that mixed-type and dairy farmers showed to have the highest levels of stress from time pressure, while cereals farmers the lowest levels of stress. During their interviews, when answering "How severe is the stress caused by this?", the mean score of 3.1 and standard deviation of 1.2 placed the answer "Too much to do and too little time to do it" as one of the highest mean scores in response to the previous question. In another study by Alpass et al.[1] the highest levels of stress were reported for time pressures (along with machinery breakdown, weather and government policies) as an answer to the question "Over a typical farming year, rate the stress you feel for each of the following events". Furthermore, this factor was not only rated highest in severity but also high in frequency occurrence.

5 DISCUSSION

To get insight into how DSSs and smart glasses can have an impact on the farmer's mental well-being and stress levels regarding daily field work and stressful tasks, we have reviewed the existing literature. In the following subsections, we will first discuss our research sub-questions. Following that we will discuss our main research question, this study's strengths and limitations, and the implications for future work.

5.1 The effects of visualisation tools from DSSs on stressful tasks

The aim of this subsection is to address the first research sub-question, which was: To what extent do the visualisation tools from current DSSs aid in the relieving of stressful tasks performed by the farmer?

The results gathered in section 4.1.1 show that DSSs in farming are an essential tool to gather information about the farm and its produce. Having all this information centralised and easily manageable from the interactive dashboards provided by DSSs could be an improvement over having all the raw data in physical paper, which could lead to more stress for the farmer when it comes to keeping track of all the crucial information. Said dashboards have shown to be user-friendly for the farmers to help them visualise better the information by utilizing graphs[30] and other visualisation tools such as detailed maps from satellite imagery [3]. These features have shown to assist farmers making more effective decisions that could otherwise pose substantial amounts of stress if such visualisation tools were not available to inform the farmer with the most up-to-date information about their assets.

Furthermore, this precision farming tool is commonly employed in labour-intensive agricultural operations such as soil management [19] and water irrigation support [4]. The latter currently faces the significant challenge of efficient use of water, for which DSSs have shown to be a noteworthy tool to overcome this agricultural issue [4]. Handling this threat is currently a priority among farmers in order for sustainable and economically profitable crops. According to the results gathered regarding key stress factors for farmers internationally, financial problems contribute as one of the most frequent stressors for farmers. Hence we can safely assume that since the visualisation tools provided by DSSs facilitate the management of efficient water irrigation, a positive impact on profit and sustainability is made which could lead to a significant loss of financial stress for the farmers.

Another considerable stress agent is the unpredictability of the weather due to climate change. While most DSSs struggle to tackle this dilemma accurately, there have been some DSS projects deployed (such as the LCIS as mentioned earlier in the results section 4.1.1) that account for the visualisation of specific areas in the field, farm and district under different pedo-climatic conditions, which provide an effective solution to remedy this stress element for farmers.

5.2 Impact of Smart Glasses in tedious and laborious farming tasks

The contents of this subsection will help answer the second research sub-question: How can the use of smart glasses reduce the impact that tedious and laborious tasks have on the farmer?

As a result of the recent introduction of smart glasses in the agricultural world, their impact on farmers regarding laborious tasks has not gone unnoticed. This AR tool has proven its use in livestock management in daily activities such as animal identification, diet, health and husbandry [5], which normally takes a significant amount of time for the farmers to oversee, while with smart glasses the workers can do all of this while working hands-free by taking advantage of its scanning capabilities. Similarly, they have also been researched in arable activities that would manually be highly time-consuming such as determining soil properties or identifying different soil divisions in the field [19]. This precise and automated support easily allows farm workers to multitask which facilitates saving time and reducing the amount of physical work they have to do. Increasing the amount of work done in a lower amount of time without any extra physical effort by using smart glasses could be the key to remedy the stress induced by the different time pressures that farmers repeatedly experience.

With high workload being one of the factors that stress farmers the most, the observations by this study have made it clear that smart glasses could potentially relief this stress by providing its services in the agricultural industry. Their implementation in farms could likely reduce overwork cases as well as burnout symptoms on farmers, which have shown to be seriously frequent and ordinary.

Superb audio quality, lasting battery life and steady lag-time are all important features provided by the studied smart glasses that ensure the possibility for the farmer to video-call while working in the field at the same time. These features make it possible to consult other stakeholders regarding farm administration [5], which is another prevalent stressor among the farming community. Another noteworthy possibility that this feature could present is the contacting of specialists for periodic maintenance checks on the device.

5.3 Improvement on current DSSs and Smart Glasses to make farmers perceive higher control over their work

The information stated in this subsection will aid in the answering of the third research sub-question: How can we improve the current existing DSSs and smart glasses in order to make farmers feel that they have more control over their work environment?

Based on the results collected, DSSs' design methods have been facing a major flaw that has been identified and is currently being handled to remedy this matter. As stated in section 4.1.3, this issue consists of the "problem of implementation". The literature review on this subject has demonstrated that solving this problem would ensure DSSs to be more specific and accurate regarding the accomplishment of the goals sought by farmers. The implementation of the User Centered Design method has been the preferred solution amongst all research papers encountered in this study, as it encourages active participation of farmers in the design process of these systems, fulfilling their objectives and needs.

A higher availability of DSSs to the public would naturally provide the farmers with a greater variety of DSS options which could aid them in choosing a more appropriate system for the desired

task. This possibility has been confirmed in literature to be an incentive to increase DSS uptake and awareness [2]. By utilizing a highly relevant system for the task at hand, farmers may perceive greater control over decisions within the specific field where the DSS is applied. Another important improvement discovered by the results of this study is the much desired development of showcasing uncertainty in the data shown by DSSs to the farmers [23]. Such uncertainty covers crucial information about economic variability and climate change. Results in section 4.4 made clear that the latter conforms a major worry in the farming community as it makes farmers feel less in control of their work environment. An enhanced flexibility of DSSs by being able to be adapted with new information could also provide farmers with support regarding a higher extensive set of tasks to improve the management and administration of the farm.

Regarding smart glasses, the processed studies indicate that an improvement must be made in the tweaking and calibration of the different sophisticated sensors that the device possesses (such as magnetometer) in order to boost their applicability for specific tasks to support the farmer effectively. Upgrading scanner readability would count as a remedy to the different lighting issues experienced in the different experiments carried out in farms [5]. Noise cancelling would also be a great enhancement for farmers to be able to comfortably use the voice command feature regardless of the background noise occurring in the farm, which could make them perceive to have a higher command of their work environment due to the lack of any hindrance. Finally, future improvement in the precision of the GNSS (Global Navigation Satellite System) is also necessary to provide accurate navigation for the farmer in the field, which could be vital in this line of work.

5.4 Influence of DSSs and Smart Glasses on farmers' stress levels

The objective of this subsection is to resolve the main research question: How can DSSs and smart glasses have an impact on the farmer's mental well-being and stress levels regarding daily workload and stressful tasks?

As a consequence of the answers stated above for each of the three sub-questions that shape the main research question, it is undoubtedly substantial to urge the continued usage of precision farming tools such as DSSs and smart glasses in order to equip farmers with the best possible tools to assist them in their arduous and stressful workload.

Future continuation of DSSs would support farmers by enhancing their decision making process which could lead to more effective choices. An advantage like this could strongly increase the financial gain and sustainability of their farms and produce. A reduction of economic problems has proven to relief farmers from the financial stress that they face regularly. Moreover, Decision Support Systems offer additional information through dashboards, ensuring the soundness and security of critical decisions made by farmers. This plethora of information reduces stress by facilitating informed decision-making.

As described earlier in the discussion, the implementation of smart glasses could also weaken the stress levels of farmers by offering multitasking capabilities which could lead to shorter work shifts, more work done and a potential reduction of burnout symptoms and overwork. A shrinkage in workforce could also be a likely outcome from the support provided by AR tool, which would also contribute to more financial benefits. Alleviating burnout symptoms could lead to increased farm productivity, animal welfare and sustainability of food production, which again tackles financial stress. The video-calling feature also grants them the opportunity to seek professional assistance during the job which could culminate in less stressful work.

5.5 Strengths and limitations of this study

One of the strongest points of this scoping review is the thoroughness and accuracy of the information extracted from the included studies. A notable amount of time and effort were required to inspect each of the research studies and subtract relevant knowledge that would be included as an asset for this study. Another strength to be considered is the identification of this new topic which could persuade other researchers for further investigation.

On the contrary, the main limitation of this research study has been the lack of researchers participating in this study. The involvement of additional students in gathering information and improving the paper could have significantly enhanced its quality.

5.6 Future Work

In terms of improvement, a higher number of studies should have been examined to boost the validity of the results achieved from this research project. By studying and analysing more papers on the subject could have potentially identified a deeper linkage between precision farming tools and farmers' stress, yet the time constraint for this project hindered this possibility. Now that this paper serves as a starting point for this new topic, more extensive research must be done in this field possibly including direct farmer participation

6 CONCLUSIONS

In this paper, we performed a literature study to gain insight into the effects of DSS and smart glasses technology on stress levels and mental well-being of farmers. We have found that existing studies do not connect farmer stress and the utilization of precision farming machinery, but conclude on the helpfulness and suitability of this technology in the different ambits of the farming profession. Being, to our understanding, the first study to analyse this connection, we hope that this paper can be a valuable asset for future studies to build upon on the much required research for this particular field. This study concluded that DSSs and smart glasses do have a positive impact on farmer stress and mental well-being by supporting them in the tackling of financial struggles, time constraints, overwork and farm management. A promising direction for future work would be the investigation and report of the effects on farmer stress from other precision farming technology not mentioned in this study

in order to provide future design and production improvement on these devices. In this way, we can ensure that these technologies are developed in such a way that they assist farmers in what matters most.

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