Greek farmers' perceptions of precision agriculture technologies*

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Abstract

How do farmers view precision agriculture technologies and evaluate their impacts on farming and agrifood systems? Our study aims to answer this question using qualitative data from a sample of Greek livestock farmers. The results indicate that farmers have a positive attitude toward these technologies. Nevertheless, they cannot clearly define precision agriculture, while they express several concerns about the adoption cost and the potential negative social and cultural impacts of precision technologies. These findings reveal the many different angles through which farmers view precision agriculture technologies.

Keywords

Precision agriculture, farmers, impacts, digital technologies, smart farming

1. Introduction

Precision agriculture refers to a set of management strategies that support farmers' agronomic decisions by exploiting information technologies and the data on spatial and temporal variability that these technological tools collect [1]. Technologies that enable precision agriculture involve geographic information systems, global positioning systems, wireless sensor networks, remote sensing, and decision support systems [2]. Notably, although several studies focus on the impacts of precision agriculture on farms' technical efficiency [3], productivity [4], economic performance [5] or the environment [6-9], only a few studies have focused on farmers' perceptions of these technologies.

Researchers have mainly examined perception of precision agriculture as a determinant of the farmers' decision to adopt relevant technologies. For example, Adrian et al. [10] found that perceived ease of using these technological tools is associated with adoption intention. Researching adoption from a different angle, D'Antoni et al. [11] discovered that farmers' perceptions of the benefits that precision agriculture technologies may have and their potential importance for the future of farming positively influence the adoption decision. Others [12, 13] have also focused on the advantages of precision agriculture at the farm level, such as yield and income increase, convenience, and cost reduction.

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Several studies uncover a series of negative perceptions toward precision agriculture. For instance, Moretti et al. [14] found that farmers believe that the adoption of precision agriculture technologies will lead them to economic losses. The high investment needed to buy these technologies creates questions about the degree to which precision agriculture is suitable for small farms [15]. In addition, a study in the U.S.A. revealed that farmers are skeptical toward the reliability of precision agriculture technologies [16]. The same research uncovered that farmers can see a positive potential in these technologies, confirming their mixed perception of precision agriculture. Kendall et al. [17] also arrived at similar findings, showing that Chinese farmers view precision agriculture technologies as tools that can decrease inputs, enhance productivity and improve quality while, simultaneously, feel unsure about the capacity of such technologies to deliver the expected benefits. Nevertheless, a recent study indicates that not all farmers are aware of precision agriculture and its potential benefits [18].

However, a question not answered by these studies is how farmers conceive the very nature of precision agriculture technologies. Beyond benefits and potential risks associated with adoption, these technologies can alter the nature of being a farmer [19], the daily farming life [20] and how farming is executed [21, 22]. In this study, we aim to uncover how Greek farmers view precision agriculture technologies and the impacts they have on farming and agrifood systems.

2. Method

Data for this study were collected through semi-structured interviews. An interview guide was designed to elicit information on participants' perceptions of the benefits and potential negative impacts of precision agriculture technologies, the meaning attributed to precision agriculture by farmers, and their perceptions of the future of farming and the role of precision agriculture technologies in it.

The participants were eight livestock farmers from Northern Greece. Among them, seven were men. Their mean age was 42.1 years, and most of them noted that they continued their education after high school, either by attending post-secondary vocational education classes (50%) or by graduating from a tertiary institute (37.5%). Their average experience in farming was 16.7 years. Half of the participants manage mixed crop-livestock farms. The average number of productive animals per farm was 163, and the average size of cultivated land (for mixed farms) was 18.2 hectares.

Data were audio recorded and then transcribed, coded, and analyzed by conducting a content analysis. This procedure led to the generation of eight overarching codes. Combining them, we generated three main categories of content. Table 1 presents these categories, offering a description for each code. In the next section, we present our analysis per category, summarizing our key findings.

3. Results

3.1. Farmers' conceptions of precision agriculture

Farmers who participated in the study do not have a clear picture of what precision agriculture is. All of them tried to offer a definition based on their experiences. Two of them emphasized the information and data that precision farming offers, and five farmers focused on the technologies used in the farms and support farmers' work, i.e., drones, GPS, robots, meteorological sensors, etc. Finally, one farmer answered: "e-governance." It seems that all the farmers understand that the technological achievements are going together with precision agriculture, but none referred to the other aspects of precision farming.

3.2. Perceptions of precision agriculture: Benefits, difficulties, and social impacts

Although there were some gaps in farmers' understanding of precision agriculture, they were able to mention the benefits that precision agriculture provides to farmers, agrifood systems, farms, and society. Most of the farmers underlined the contribution of precision agriculture to the reduction of production cost and the improvement of products' quality. At the same time, three of them noted that precision agriculture technologies can facilitate the execution of everyday farm tasks. One participant stated: "*it can offer useful data to organize your next steps, while it is a kind of a tool that facilitates the entrance of changes in the enterprise*," showing farmers' great expectations from precision agriculture. Notably, only one participant stressed the importance of precision agriculture for society since he believes it can offer new job positions.

Based on farmers' responses, precision agriculture technologies can positively or negatively impact farms and agrifood systems. As participants mentioned during the interviews, precision agriculture technologies lead to the limited use of pesticides, agrochemicals, and fertilizers, thus reducing agriculture's environmental footprint. In addition, these technologies can offer a detailed picture of farm enterprise elements. The cost of the technologies and the time and effort that farmers must spend to understand how precision agriculture tools work are the pivotal negative impacts of technologies mentioned by farmers.

Table 1
Categories and codes used in the analysis

Category	Code	Description
Vague understanding of precision agriculture	Inability to define precision agriculture	Farmers cannot offer an explicit definition of precision agriculture
	Misperceptions about precision agriculture technologies	Farmers cannot distinguish which tools belong to the group of precision agriculture technologies
Mixed perceptions of precision agriculture	Benefits of precision agriculture	Farmers believe that precision agriculture has environmental, economic, and managerial benefits
	Difficulties in implementing precision agriculture	Limited adaptability of precision agriculture technologies to the Greek farming conditions
	Social impacts of precision agriculture	Precision agriculture entails risks for some categories of people
Precision agriculture and the future of farming	Greening the agrifood sector	Farmers consider precision agriculture technologies tools that can reduce the environmental footprint of agriculture
	Farming restructuring	Precision agriculture is expected to alter the way of doing farming
	Improving farmers' lives	Precision agriculture technologies are expected to improve farmers' working and living conditions

The lack of fit with the conditions that characterize the Greek agrifood sector is another source of concern for producers. One farmer expressed his doubt about precision agriculture technologies, stating that: "*these technologies are not helpful in Greek agriculture due to fragmented land.*" Interestingly, other factors that might reduce the suitability of these technologies for Greek farming – like the absence of basic technological infrastructure in many farms, the relatively small size of herds which puts at question the feasibility of investing in precision agriculture technologies, the lack of advisory support, or skill shortages on the part of farmers and farm workers – were not mentioned.

Two respondents seem biased towards precision agriculture technologies since they mentioned only positive impacts on farms and agrifood systems. This positivity bias can be attributed to the ways technology providers promote these technologies to the farming population and the expectations about the future of precision agriculture that popular media cultivate.

To further discuss the negative and positive impacts of precision agriculture technologies on farms and agrifood systems, farmers were asked to provide some examples of technologies that have positive or negative effects on agrifood systems. Some farmers mentioned spraying with drones and precision irrigation systems as technological solutions that are able to improve farm productivity. Others referred to more general concepts, like "soil analysis," as good practices that can benefit farm production and product quality without directly linking them with specific precision agriculture tools.

However, one participant expressed his worries about using farm robots, highlighting the social impacts of such a technology: "*The entrance of farm robots can reduce production cost, but this change will also reduce the number of farm workers.*" This comment shows farmers' fear of technology and uncertainty towards it, despite their beliefs concerning the positive effects of precision agriculture technologies on the agrifood system.

3.3. Envisioning how precision agriculture will determine the future of farming

Remarkably, farmers envision farming along with technologies. As one participant said, "*Digitalization of agriculture is the next step. Big data will facilitate farmers' work and their everyday life.*" Farmers believe that, in the future, they can rely on technology since it can lead to improve farm performance. Based on farmers' interviews, precision agriculture technologies can shape a better future for the environment since they can mitigate the environmental footprint of agriculture.

One intriguing finding was that farmers believe precision agriculture technologies will restructure the country's farming sector, as highlighted in the following comment: "*In the future, farmers will be fewer, and the enterprises will be bigger.*" Nevertheless, participants were not able to classify this evolution as positive or negative.

4. Discussion and conclusion

Our study sought to uncover Greek livestock farmers' perceptions of precision agriculture technologies. The results revealed that precision agriculture is viewed as a positive development that can reduce the environmental externalities of agriculture, and has a highly transformative potential for farming and the agrifood sector. In parallel, a notable finding was that farmers could not define precision agriculture.

A plausible explanation for farmers' inability to fully understand the meaning of precision agriculture while they view it as an evolution with a highly positive potential can be the persuasive nature of the techniques used to promote digital technologies, which overemphasize the promises of digitalization [23, 24] thus cultivating public trust toward precision technologies [25]. Although more work is needed to examine this contention, farmers in our sample seem confident that precision agriculture technologies can improve the economic performance of farms and assist in effectively managing farms without fully understanding what precision agriculture is. Hence, despite producers' concerns about the negative social impacts of precision technologies, their misfit with the specific characteristics of the Greek agricultural sector, the high cost of technology purchase, and the cultural and structural disruptions they can cause, farmers' general attitude toward these technologies continues to be positive.

Despite the fact that we based our analysis on data derived from a small sample, our work offers some evidence for understanding how livestock farmers conceive of precision agriculture. However, since the distance between expectations and the reality of practicing precision agriculture can be vast [26], future research could explore if adopters of such technologies share the same views with potential adopters and how the new socio-technical architectures and relational contexts that emerge after adoption [27] affect farmers' perceptions of precision agriculture.

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Declaration on Generative AI

The author(s) have not employed any Generative AI tools.

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