



Surveying the Awareness of Smart Agriculture Practices among Paddy Producers in Bafra Plain in Mid-Black Sea

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Abstract

Paddy fields in the northern part of Turkey are concentrated in the Bafra Plain in Mid-Black Sea region, where the highest wheat and leguminous production is performed. Turkey's longest river, Kızılırmak, flows into the Bafra plain. For this reason, it can be said that the most fertile lands in our country are in Bafra Plain and its surroundings. The aim of the present study is to determine the awareness of paddy producers located in the Bafra Plain about smart agriculture applications. A field survey has been conducted at the plain and the results were analyzed. Interviews were conducted in September 2024 with a total of 150 participants coming from different villages. 44% of farmers had more than 100 da paddy field each. At the end of the research some striking results were obtained. The level of awareness along with their reasons were determined. Awareness of smart agricultural tools was low at all. But, hopefully (3.3%) of farmers declared that the smart agriculture practices is and will keep on being important for the future in rice farming.

Orta Karadeniz Bafra Ovası'ndaki Çeltik Üreticilerinin Akıllı Tarım Uygulamalarına İlişkin Farkındalığının Araştırılması

Özet

Türkiye'nin kuzeyindeki çeltik tarlaları, en fazla buğday ve baklagil üretiminin yapıldığı Orta Karadeniz Bölgesi'ndeki Bafra Ovası'nda yoğunlaşmaktadır. Türkiye'nin en uzun nehri Kızılırmak Bafra Ovası'na akmaktadır. Bu nedenle ülkemizde en verimli toprakların Bafra Ovası ve çevresinde olduğu söylenebilir. Bu çalışmanın amacı Bafra Ovası'nda yer alan çeltik üreticilerinin akıllı tarım uygulamalarına ilişkin farkındalıklarının belirlenmesidir. Ovada arazi araştırması yapılmış ve sonuçları analiz edilmiştir. Eylül 2024'te farklı köylerden gelen toplam 150 katılımcıyla görüşmeler gerçekleştirildi. Çiftçilerin %44'ünün her birinin 100 dekardan fazla çeltik tarlası vardı. Araştırma sonunda çarpıcı sonuçlara ulaşıldı. Farkındalık düzeyleri ve nedenleri belirlendi. Akıllı tarım araçlarına yönelik farkındalık ise oldukça düşüktü. Ancak, umut verici bir şekilde çiftçilerin (%3.3) çeltik tarımında akıllı tarım uygulamalarının gelecek için önemli olduğunu ve önemli olmaya devam edeceğini ifade etmiştir.

1. INTRODUCTION

Smart agriculture has been accepted as one of the innovations that guide simpler and more efficient practices in the agricultural sector, and there has been increased investment in modern agriculture for economic, operational, and environmental reasons (Javaid et al.2022). Smart agriculture is an approach that aims to support, inform, and manage behavior in agricultural practices from production to consumption (Santiteerakul et al.2020). The concept of smart agriculture has gained great importance in recent years, given that the production of sufficient and nutritious food for all humans on earth depends on the effective and sustainable use of agricultural resources (Dhanaraju et al.2022). The use of modern technologies in farming practices will ensure that the agricultural economy works seamlessly and efficiently (Sarkar et al., 2020; Azadi et al., 2021). A study is needed to determine the awareness level of producers about smart agriculture applications in a district where paddy fields are mostly concentrated. In light of these situations, it is important to find out whether or not paddy producers are aware of the importance of applying smart agriculture in modern agricultural practices.

1.1. Background and Rationale

Worldwide, advanced programming technologies and high-tech solutions are used to transform the agriculture sector. This new approach, which addresses problems related to changing living conditions in line with evolving technologies, is referred to as smart agriculture. For paddy producers, who are involved in production activities in wetlands, the management system ensures higher and sustainable added value for producers and contributes to the state in terms of regional development, food safety and health, economic growth, and environmentally friendly agriculture. Bafra Plain in Türkiye is considered for this survey because rice production and wetland areas are very important. Paddy producers' decisions can affect the country and the region, and there is a possibility of easily offering an innovative practice. The need for the crucial importance of raising awareness among producers is emphasized. Since the success and contribution of the departments to the efficiency of the exploitation of enterprises directly lie in the decisions made by the producers, the quality, content, and accuracy of the decisions depend entirely on the level of knowledge of the enterprise. It is therefore imperative that public support is exploited effectively in order to make the right decisions and achieve the desired goals.

Awareness policies on innovative practices may change from time to time, as may the modern techniques of agricultural decision-making (Albats et al., 2020). It is impossible for producers to make the right decisions without updating and continuing education under changing production and commercial conditions in the international market (Smit & Hessels,

2021). The knowledge and physical factors of the producers, which have important roles in the competitiveness, development, and economic policy of the countries, are shaped according to the cultures that they live over time (Dewi et al., 2021; Roos et al., 2022). In many of the less developed and developing countries, decision-making processes in agriculture depend on cultural accumulation. These attitudes on production are based on tradition and experience. Therefore, producers should be informed by research units, consultants, and universities. It has been shown that rational evidence-based decisions made with the knowledge of smart agriculture by farmers are more beneficial and productive. Consequently, projecting important strategies is a very valuable topic. Therefore, ensuring the accuracy and reliability of the data is very important (Hopkins et al., 2021). The survey questions must be precise and easy to understand. The wording, style, tone, and length of the questions could influence the respondents' knowledge. Therefore, the feedback to be provided will be crucial (Hayes et al., 2024).

2. MATERIAL AND METHOD

2.1 Objectives and Significance of the Study

The main objective of this study was to determine the level of awareness of paddy producers regarding innovations in agriculture, known as smart agriculture, which takes advantage of advanced technology, and to reveal the factors influencing awareness. To achieve this aim, first of all, the implications arising from the concept of smart agriculture in the 21st century were revealed. The factors claimed to determine the level of knowledge regarding smart agriculture are the level of education and individual characteristics such as age, income, agricultural equipment, and information sources. To this end, the previous studies in the literature were reviewed. As a result of the review, it was observed that there were no unanimous ideas among the existing studies about the level of awareness and adoption, which can be considered as the first stage of the decision to use smart agricultural technologies. A field survey among the paddy producers in Bafra plain was done.

As part of this research, it tried to address both the gap identified in the literature in this regard and the failure to capture flawless ownership. In addition, it aimed to be a guide on this issue for policymakers, who are the practitioners of the idea of introducing innovations in various agricultural activities, mainly the agriculture sector.

The significance of the study is noteworthy in terms of both practices to be conducted in agricultural fields and outcomes of various studies to be conducted globally. In particular, paddy producers are important in today's world agriculture, and in our country, their relevance is increasing due to their ability to respond to the questions of smart agriculture and circular agriculture. For this reason, they are essential elements of the knowledge of the policymakers who advise the

paddy producers and provide them with interviews at a variety of events. Therefore, the work to be undertaken for the paddy producers is crucial. In addition, the research findings can also be a resource for other researchers. In this sense, the results will make scientific or academic contributions to the literature. At the same time, the level of awareness they have has specific contributions in terms of agricultural applications. In fact, there is an increase in the productivity, profitability, economic, and ecological resource efficiency cooperation of the businesses that lack technology and awareness. This kind of study has not been conducted regarding the paddy producers in the Bafra Plain, where the emphasis is placed on the transformation of rural society to smart agriculture, where the rural areas of the future are emphasized, which will gain additional income for the rural community after its protection. The main objectives of the idea of rural development that has now entered our lives with smart agriculture are to present the necessary information on how to contribute to sustainable rural development and agricultural planning under the requirements of many alternative practices.

2.2 Literature Review

In modern farming, many applications that have broad applications have emerged. With the expansion of places where technology is used in every field, the farming sector has also started to benefit from technological developments. When smart agriculture applications are examined, it is seen that they are used in many studies (Chuang et al., 2020).

There is a frequency of awareness among producers about smart farming practices and their use in studies conducted in different countries, with various percentages used to reveal these differences (Autio et al., 2021). These differences can be evaluated on a country and regional basis (Adamides et al., 2020). There is no sufficient information about the awareness of producers regarding smart farming practices or their use in the Free Zone and its surroundings, as well as in the region called Bafra Plain. In the present study, while determining the awareness level of producers in the 'Bafra Plain' about smart farming practices, the mentioned methods will also be discussed and compared in terms of percentage. Determining the socio-economic factors of the producers will also contribute to the literature and future studies in this area.

2.3 . Smart Agriculture and Its Importance

Smart agriculture refers to the use of new and existing technologies for in-line processes, measurement, and data-driven decision-making for crop farming, inevitably helping farmers control the processes in the best possible way (Gürdil et al., 2024). It attaches advanced technology and data utilization for dispensing knowledge to farmers that ultimately

raise awareness about working farmlands more effectively and efficiently. Expansion in population and the industrial revolution from the late 18th century has developed an exponentially increasing population globally, which is the root prompting the need to grow more food than was produced in the past. Acceptance of smart agriculture practices will be the top priority in the coming years where agricultural trends must change from various perspectives. It is essential to produce more agricultural products with limited labor and natural resources, reduce nutrient emissions, increase farm profits, give top priority to consumer interest, use information to manage the farm, and use the latest technologies to create a more sustainable way of living (Rani et al., 2023; Kwaghtyo & Eke, 2023).

Currently, these advanced smart practices are making agricultural systems more efficient in resource use because of climate change, which urges farmers to use critical inputs like water, fertilizer, and pesticides more responsibly, conserving biodiversity, and protecting the environment (Gupta and Nahar, 2023). Over the past two decades, there has been rapid advancement and revolution in various fields of information technology, communication technology, and sensor technology in very high proportions. Precision farming technology for specific applications was not widely available until the 1990s. Smart agriculture depends on soil test values, crop types, sensor observations, topography of land, weather forecasts, and techno-economically optimizing the precision agricultural scheduled practice to meet annual yield production (Adesipo et al., 2020). Automated monitoring associated with farmland monitoring tools and machinery using single or multiple force shafts, auto-planters, and harvesting tools is an efficient course of action and could transform the agricultural world toward the smart era (Yin et al., 2021; Javaid et al., 2022). The responsibility for transferring smart farming technology to farmers is carried out by extending training programs for farmers, setting up demo plots in association with the state or central government, and by providing honest information with the help of agricultural scientists through booklets and pictorial literature.

2.4 Previous Studies on Smart Agriculture Awareness

There have been previous studies regarding the awareness of paddy producers, either on their use of smart agriculture practices or their acceptance of technology (Alfred et al., 2021). Studies examined the readiness and willingness of paddy producers in the Tanjung Karang region and Southern Aceh, Indonesia, to use smart agriculture practices (Nguyen et al., 2024). A survey was conducted in the Tengku Burhanuddin District in South Sumatra Province on the level of adoption of smart agriculture practices by

farmers. A survey was also used to assess the intention of paddy farmers in Mulya Sari village, Indonesia, to adopt agricultural machinery. The current status, expenditure, willingness to pay, and demand for future technologies were assessed. The perception and sharing of environmental information among Danish pig farmers were studied. In Australia, a survey of beneficial management practices among landowners and their adoption of smart farming techniques in Queensland was conducted. Given that the literature shows differences in awareness based on demographic variables such as age, education, and geographic location, targeting the appropriate awareness message to the appropriate population is crucial (Chuang et al., 2020; Oo & Usami, 2020). Survey-based studies were selected as the optimal method to address this subject because of the relative absence of related research in Europe and the environmental meaningfulness of the issue for which we are searching for a potential solution. In today's rapidly changing world, there is a need for continuous research into new demanding aspects of stakeholder awareness (Onyeneke et al., 2021).

2.5 Material and Method

A field survey consisting of 15 questions and defining the general structure of the farmers was conducted. First the general situation in the region has tried to be understood then the farmer action and reaction to the smart agriculture concept tried to be understood. Some interesting and striking results were obtained. In the qualitative dimension of the research, a semi-structured questionnaire with open-ended questions was used. Subsequently, with the methodological policy analysis model, it can be used both in real and online settings as a source of collection in the quantitative field. Interviews were used in the qualitative dimension to collect data from paddy producers in the region. The main headings in the bibliography were the focus of the research, and the issue of smart agriculture was evaluated under each of their main headings, including three discussions and suggestions regarding smart agriculture. Qualitative data was collected through structured interviews. The data were analyzed through content analysis. In the quantitative direction, a survey form was developed for the paddy producers of the field research and this study. Data collected from the instrumentation have been scanned for data analysis and interpretation.

Table 1.1 Reliability test for the survey

Cases Processing Summary

		N	%
Cases	Valid	150	100
	Excluded	0	0
	Total	150	100

Reliability Statistics

Cronbach's Alpha	N of Items
0,954	15

The reliability of the survey appears to be 95%. The survey appears to be quite safe.

3. RESULTS AND DISCUSSION

This study used participatory rural appraisal techniques, and data were collected through interviews, surveys, and focus group discussions. Interviews were conducted in September 2024 with a total of 150 participants coming from different villages. Through these surveys, data on farmers' background, current farming practices and techniques, available resources, and knowledge of new agricultural practices were collected. The appropriateness of the data collection tools and methods was assessed beforehand to make them adequate for obtaining the necessary information on the awareness of farmers. Through careful item development and validation of the survey instrument, this study is well positioned to generate meaningful conclusions.

3.1. Statistical analysis

When the answers to the 15-question survey prepared to measure the awareness of paddy producers in the Bafra Plain about smart agricultural practices were examined statistically, the average scores of the answers to each question ranged from the lowest to 1.14 (I don't know at all) and the highest to 2.65 (I know a little). It seems to be between (I know at an intermediate level). While the majority of the producers answered the 12th Question (Do you know how smart agricultural practices can be used to determine the rice harvest time?) with answers close to "I don't know at all?", to the 5th Question (Do you know the benefits of using drone technology in rice farming?) they gave an answer close to the "I know" answer at a moderate level. The fact that drone technology has become popular in the plains in recent years, especially in paddy agriculture, and that the producer has personally seen the benefits of using drones, supports the answer given to the 5th Question with the highest score. In general, it is seen that the average is 1.60. We can interpret this result as paddy producers in the Bafra plain do not have enough information about smart agricultural practices.

The results of the survey are summarized below.

First the average area distribution was determined in the plain. The parcels were tried to be understood. 51 farmers among 150 had rice fields less than 50 da, which corresponds for 34%. 33 farmers had a field area of 5- to 100 da, that is 22%. 66/150 farmers had more than 100 da paddy field each, that is 44%. There is a significant difference in awareness of smart

agricultural practices between producers who cultivate paddy rice up to 50 da and those who cultivate over 100 da.

Demographic descriptive statistics of the respondents are like that. It is seen that 18.7% of the paddy producers are 18 – 35 years old, %59.3 (89/150) are 36 to 60 years old, and %22 (33/150) are older than 60. Concerning the level of education; 66% have graduated from primary school, 10.7% from secondary school, %13.3 gymnasium and the rest (%10) from university graduate.

As a result, there is a significant difference between primary school graduates and high school and

university graduates, and between secondary school graduates and high school and university graduates in terms of awareness of smart agricultural practices. A meaningful difference was found between the ages of the paddy producers in terms of whether they have received training in smart agriculture practices and also, a meaningful difference was found between the paddy producers in terms of their education levels and the area cultivated at a 95% confidence interval.

The questions and the answers given are analyzed, below.

Question 1. Do you know about smart agriculture technologies?

	Number of farmers	Proportion (%)
I don't know at all	27	18.0
I know a little	93	62.0
I know at intermediate level	28	18.7
I know very well	2	1.3
Total	150	100

It's seen from the answers that most of the paddy farmers (62%) know a little about, or didn't heard a little about smart agriculture technologies. After evaluating all, the level of awareness about smart agriculture tools among the paddy farmers is said to be low in the region.

Question 2. Do you have information about the applications of smart agriculture that can be used in paddy production?

	Number of farmers	Proportion (%)
I don't know at all	56	37.3
I know a little	53	35.3
I know at intermediate level	37	24.7
I know very well	4	2.7
Total	150	100

It shows us that they have again less information about the possible applications of smart agriculture tools in rice farming.

Question 3. Do you know the benefits of using sensor technologies (soil moisture, air temperature, etc.) in rice irrigation?

	Number of farmers	Proportion (%)
I don't know at all	99	66.0
I know a little	41	27.3
I know at intermediate level	10	6.7
I know very well	-	-
Total	150	100

Most of the farmers don't even know how the benefits of using sensors could affect the irrigation on their fields.

Question 4. Do you know the effect of automatic irrigation systems on rice productivity?

	Number of farmers	Proportion (%)
I don't know at all	119	79.3
I know a little	22	14.7
I know at intermediate level	9	6.0
I know very well	-	-
Total	150	100

Main portion of the farmers haven't even heard about the benefits of automatic irrigation on yield or they saw it as an unnecessary investment.

Question 5. Do you know the benefits of using drone technology in paddy farming?

	Number of farmers	Proportion (%)
I don't know at all	6	4.0
I know a little	71	47.3
I know at intermediate level	46	30.7
I know well	23	15.3
I know very well	4	2.7
Total	150	100

The numbers show that they know a little about the possible benefits of using drones in rice farming. But, hopefully a small percentage (2.7%) knows it very well. That is at least it's a nice consolation.

Question 6. Do you know the potential of using data analysis and artificial intelligence in paddy production?

	Number of farmers	Proportion (%)
I don't know at all	118	78.7
I know a little	28	18.7
I know at intermediate level	4	2.7
I know very well	-	-
Total	150	100

It's again the same concerning the results. Most of the farmers don't know nothing about the potential usage of data analysis in their farming process.

Question 7. Do you know the potential of smart farming practices to reduce water and fertilizer use in rice production?

	Number of farmers	Proportion (%)
I don't know at all	106	70.7
I know a little	32	21.3
I know at intermediate level	12	8.0
I know very well	-	-
Total	150	100

The results show that unfortunately nobody knows very well about the possible positive effects of smart farming tools on water and fertilizer consumption.

Question 8. Do you know the potential of smart farming practices to increase efficiency in rice production?

	Number of farmers	Proportion (%)
I don't know at all	73	48.7
I know a little	57	38.0
I know at intermediate level	20	13.3
I know very well	-	-

Total	150	100
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They know nothing or a little about the possible effects of smart farming on yield of rice.

Question 9. Do you know how smart farming practices affect costs?

	Number of farmers	Proportion (%)
I don't know at all	82	54.7
I know a little	45	30.0
I know at intermediate level	19	12.7
I know very well	4	2.7
Total	150	100

2.7% of the farmers know or think that smart farming will positively affect the costs, and it's totally same for the positive effect of smart tools on time management.

Question 10. Do you know how smart farming practices can affect time management in rice production?

	Number of farmers	Proportion (%)
I don't know at all	68	45.3
I know a little	57	38.0
I know at intermediate level	21	14.0
I know very well	4	2.7
Total	150	100

Question 11. Do you know how smart agricultural practices can be used to combat rice diseases and pests?

	Number of farmers	Proportion (%)
I don't know at all	96	64.0
I know a little	35	23.3
I know at intermediate level	11	7.3
I know very well	8	5.3
Total	150	100

Most of the farmers (64%) don't have any idea about the possible positive effect of smart agricultural tools against diseases in rice. But, promisingly at least 5.3% knows about it.

Question 12. Do you know how smart agriculture applications can be used to determine rice harvest time?

	Number of farmers	Proportion (%)
I don't know at all	130	86.7
I know a little	18	12.0
I know at intermediate level	2	1.3
I know very well	-	-
Total	150	100

Interestingly that no farmers have an idea about the time reducing effect of smart tools on rice farming.

Question 13. Do you know the importance of using smart agricultural applications for data collection and analysis in paddy production?

	Number of farmers	Proportion (%)
I don't know at all	119	79.3
I know a little	23	15.3
I know at intermediate level	8	5.3
I know very well	-	-
Total	150	100

Main percentage of the farmers don't know anything about the importance of smart tools for data collection and analysis. That's a very sad situation, of course. But, the main reason for that is most of the

paddy farmers do conventional farming, so called old style farming.

Question 14. Do you know the importance of using smart agricultural practices in paddy production in terms of environmental sustainability?

	Number of farmers	Proportion (%)
I don't know at all	113	75.3
I know a little	18	12.0
I know at intermediate level	17	11.3
I know very well	2	1.3
Total	150	100

Luckily, 1.3% of the farmers, that could be also a good indicator, know the positive effect of smart farming on environment and on sustainability.

Question 15. Do you think that the use of smart agricultural practices in paddy production is important for future agricultural trends?

	Number of farmers	Proportion (%)
I have no idea at all	60	40.0
I have a little idea	61	40.7
I have an intermediate idea	24	16.0
Yes, I do	5	3.3
Total	150	100

Finally, and hopefully (3.3%) at the last question they declared that the smart agriculture practices is and will keep on being important for the future in rice farming.

technological innovations to paddy farmers. For this purpose, the responses of 150 paddy producers from the district of Samsun in Bafra plain were evaluated through a survey. The study revealed that the awareness of paddy producers regarding smart agriculture practices was still low in the Bafra Plain, but most of the results seem to be promising.

3. CONCLUSION AND RECOMMENDATIONS

It is more important than ever that farmers implement measures that will improve the productivity, efficiency, and sustainability of agricultural ecosystems. Smart agriculture practices provide an opportunity to achieve this aim by holding the potential to create digitally connected agroecosystems that will enable more controlled agricultural production. It is also important to appropriately utilize resources in the face of changing climate requirements and the negative consequences that are present in the agricultural sector. This study focused on identifying the level of awareness regarding knowledge of smart agriculture practices and the broadcast of

The results obtained showed that the mean level of awareness about smart agriculture practices was found to be medium with sociodemographic variables such as age, education, landowner status, extension in service, number of beneficiaries of social security, and income impacting awareness levels. It was concluded that raising the awareness levels of paddy producers will bring about a positive change in the maintenance and permanence of the agriculture sector and in increasing productivity. Therefore, relevant people must be aware of this situation. Policymakers,

practitioners, academics, researchers, and the media should recognize the potential of increasing awareness and encourage the development and application of innovations that can inspire innovation in communities.

Agriculture has large potential for decreasing its carbon footprint through efficient resource use, which requires empirical evidence for the design of policy measures. The results of this study show a need for policies in the near future to focus on enhancing the unawareness of paddy producers about smart agriculture. Therefore, extension services and empowerment programs should integrate, build on, or transform awareness gaps into sustainable smart paddy producer systems in existing paddy frameworks. Promoted policies can support extension services and the sustainability of communities by increasing their willingness to initiate people-to-people-based programs that enhance community and workplace socialization, but it also supports extensions for creating a smart paddy producer promotion officer in charge of staffing and coordinating community-based awareness programs. Those pathways require the close coordination of agriculture, water, and related policies and strategies, and finally, the existing agreements that affect water quality distribute responsibility for actions needed to reduce emissions among different spatial scales and national entities and laws reform.

3.1 Recommendations

While this study provides diverse findings about the awareness of smart agriculture among rice producers, it has several limitations: it is limited to a single time period, and thus does not clearly reveal the growing level of awareness of smart agriculture applications among producers. Therefore, subsequent studies may be executed to observe the progress of producers' awareness of smart farming practices over time and to more precisely determine the time needed by the unsophisticated producers who participated in queries relating to smart agriculture applications to begin to benefit systematically from the situation. Furthermore, future questions could concentrate on the role of these components, revealing the advanced level of awareness of smart agriculture implications during pronounced purchases and market fluctuations. It is also probable to expand the research to other areas to see the comparison in the attention of producers. Furthermore, it might concentrate on learning how to boost awareness through teaching approaches such as

courses, seminars, and options connected with modern media. This research had some limitations because it considers the cognitive aspect of appreciation about smart agriculture and does not explore deep experiential, attitudinal, and behavioral methods. Furthermore, attention is mainly placed on general intelligence, rather than organizing it around a product. Since individuals often link a product and its value propositions rather than technological knowledge, analysis can be concentrated on a particular device of smart agriculture, for instance, high productivity organs. Identifying the essence of the stated limitations is the first step toward progress. Given these limitations, future research can take into account the current research and disclose repercussions that may have practical and academic implications. To this end, further analysis can be proposed in this area.

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