Examining the Effect of Innovative Groundwater Management Methods on Farmers' Performance and Revenues: A Case Study of the United Arab Emirates

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ABSTRACT

Background: Water scarcity is a critical issue in the agricultural industry, especially in the United Arab Emirates (UAE), where groundwater is the primary source of freshwater. Innovative groundwater management methods have been developed to solve this problem and increase productivity, but their impact on farmers' performance and revenues remains unclear. ***Methods***: This study employs a qualitative research approach to explore the connection between innovative groundwater systems and farmers' performance and revenues. The study aimed to determine the impact of innovative methods on agricultural workers and raise awareness about their importance. ***Results***: Twenty farmers were interviewed, and content analysis was used to analyze their responses. The findings **indicate** a positive correlation between the use of innovative groundwater management methods and farmers' performance, resulting in increased revenues and productivity. The adoption of innovative methods by farms has contributed to the improvement of agricultural projects, profitability, and productivity. ***Conclusions***: Greater awareness of innovative ways to use water is essential for improving farmers' performance and increasing profits while conserving water and preventing waste. This study highlights the need for specialists, farmers, and individuals interested in the agricultural industry to seek accurate information and contribute to positive changes in the field by adopting innovative methods. The innovative groundwater management methods have a positive impact on the agricultural industry in terms of productivity and profitability.

Keywords: Groundwater scarcity, Irrigation Resources, Smart groundwater management, Farmers performance.

INTRODUCTION

The United Arab Emirates (UAE) is one of the desert countries that is experiencing a freshwater scarcity crisis. As a result, it must rely on alternative methods such as desalination and wastewater treatment to meet the freshwater needs of its residents. It should be noted that the climate has a significant impact on freshwater scarcity, particularly groundwater, which is the UAE's sole source of freshwater. However, as the country's population and structural growth have increased, as have other developments in the private and public sectors, demand for fresh groundwater has increased. States, particularly in arid regions, have sought solutions to ensure the long-term viability of freshwater productivity. The UAE is one of the leading producers of seawater desalination technology.

Sea water desalination is a technology that has been adopted in the UAE since 1976 when the first desalination plant was established in Abu Dhabi due to the scarcity of fresh water. As the demand for fresh water grew, the number of desalination plants increased, with 36 factories established in 2006 to meet the requirements of various sectors and the population.

There are several desalination plants in the Emirate of Abu Dhabi, each with a capacity of 4,364 liters per day. It also has a capacity for emergency desalinated water storage in case the freshwater level needs to be raised. The main cause of groundwater scarcity in arid countries such as the UAE is a lack of rain.

In recent years, the state has undertaken extensive well-digging initiatives to extract water and allocate it across all sectors, with a special emphasis on enhancing agricultural productivity. In order to address the burgeoning demand for water across diverse sectors, especially agriculture, the state has adopted an innovative approach that includes novel irrigation techniques like fog and bubble irrigation, the use of desalinated water, and the deployment of advanced devices for groundwater extraction, quantity measurement, salinity assessment, and well detection.
The UAE faces multiple challenges related to water losses and overconsumption in agriculture, primarily due to the inaccurate determination of appropriate water levels for crops and agricultural projects. The misuse of groundwater is a significant contributor to this issue. To address this challenge, the state's agricultural centers have prioritized education, training, and awareness-raising efforts among farmers regarding alternative, sustainable methods for water use that are both cost-effective and efficient. These initiatives aim to promote responsible water consumption practices among farmers, thereby reducing water losses and promoting sustainable agricultural practices. Although irrigated agriculture is recognized as a modern method of production due to its reduced reliance on rainfall, it is also an ancient and traditional practice. Historically, various civilizations, such as the Egyptians, Arabs, Assyrians, Babylonians, Chinese, and Hindus, have used successful irrigation systems, including those that involve groundwater.
Water constitutes 70% of the earth’s surface, but only 3% of it is usable for human purposes (Lean & Hinrichsen, 1994). Groundwater is the world's largest freshwater reservoir, and many people depend on it. Extraction and scarcity in arid regions like deserts are problematic, and countries are looking for sustainable strategies to protect and meet all sectors' needs (Bhattacharya et al., 2012). According to Parry (2012), energy and water demand are expected to rise globally.
Decision-makers face a major challenge in managing groundwater resources, as nearly half of the world's drinking water and almost half of the irrigation water for agriculture comes from groundwater. As the world population increases and economic development continues to expand, there is a growing demand for freshwater, making the need for innovative groundwater management methods more pressing (Brunner, 2017, Aljaradin et al.,2017). Unfortunately, human activities such as industrialization, urbanization, and climate change have negatively impacted water quality, affecting human health, the environment, and agriculture. In developing countries, river bodies have become polluted due to the discharge of wastewater containing harmful sediments such as heavy metals and industrial wastes is a growing problem threatening both the environment and the health of populations (Kamal, 2009). Water scarcity is a critical challenge for farmers in developing countries, as the availability of water often falls short of the actual crop requirements. This mismatch between water availability and crop needs poses a significant problem for farmers, leading to water scarcity in many regions. As a result, farmers often face challenges in growing crops and struggle to maintain their livelihoods. To address this issue, it is crucial to adopt sustainable

water management practices that prioritize efficient water use and ensure that farmers have access to adequate water resources to meet their cropping needs (Bhatti et al., 2009, Aljaradin et al., 2016,2012 and 2011). Furthermore, there is an imbalance in water supply and demand across the globe, with varying degrees of impact on countries that rely on irrigation (Hanjra & Gichuki, 2008).

The use of advanced technology to extract and supply water is also an issue, with countries that possess such technology having an advantage in water supply over poor countries that lack these resources. Groundwater is a crucial freshwater source for communities globally, but its sustainability is threatened by pollution and overuse leading to water shortages. Access to water resources and innovative water technologies play a critical role in enhancing the productivity of farmers. However, the absence of such technologies restricts farmers from obtaining adequate water for irrigation and increases their expenses. In addition, factors such as population growth, and increasing water scarcity pose significant challenges for water systems worldwide. According to the World Health Organization (WHO) (2019), by 2025, half of the world's population will be living in areas facing water scarcity. According to the Food and Agriculture Organization (FAO) report from 1990, 18% of the cultivated land is irrigated, contributing to 30% of the world's food supply. Groundwater is a vital resource for agricultural irrigation, especially in small and medium-sized systems. Its continual supply and high quality make it ideal for irrigation, and its importance is becoming increasingly evident as demand for fresh water grows. However, the exact proportion of groundwater used in irrigation is not known due to a lack of reliable data. Therefore, access to groundwater resources is becoming increasingly essential. However, in the UAE, the use of groundwater in irrigated agriculture is still limited due to a lack of knowledge, traditional farming practices, and insufficient feasibility studies in the area. Nevertheless, the UAE has a vast infrastructure for desalination, providing an alternative source of freshwater. In UAE Groundwater in various regions requires desalination due to the high salinity. Groundwater remains the only source to meet the agricultural and population demands of the UAE (Al-Rashed, 2000). To effectively manage groundwater and utilize innovative methods, it is crucial to have a comprehensive understanding of the hydrogeology of the area and anticipate potential outcomes (Bhattacharya, 2012). The use of innovative methods, such as implementing a Geographic Information System (GIS) to identify areas that can be artificially replenished, can greatly benefit farmers, residents, and various industries (Aljaradin et al., 2016 and 2011.) It is essential to adopt innovative approaches to maximize its potential and improve management practices. Simple and effective methods for withdrawing and controlling groundwater intrusion must also be implemented. Given the increasing importance of groundwater, several regions in the UAE have made efforts to develop their groundwater resources in recent years (Sherif et al., 2011).

The importance of incorporating innovation into groundwater management practices is emphasized as this study examines the effects of cutting-edge groundwater management techniques on farmer productivity and income. It also aims to give farmers useful guidance on how to use cutting-edge water technologies to cut the cost of irrigation. The study will also highlight the significance of putting new groundwater extraction and management techniques into practice and explain how farmers can profit from doing so.

GROUNDWATER, IRRIGATION, AND WATER MANAGEMENT

Around three-quarters of fresh water used by humans is for agriculture (FAO, 2008), and irrigated land accounts for 25% of cultivated land but produces 40% of the world's food (FAO, 2020). Groundwater is critical to small and medium-sized systems, and 74% of global irrigation water comes from underground sources. Water for urban supply is more costly than water for agriculture, despite the agricultural sector consuming over 80% of water (UNEP, 2017). In Saudi Arabia, the government is turning to existing and new wastewater collection systems, especially in urban areas, to use wastewater as an alternative to freshwater, such as groundwater (Al-Sefry, Şen, 2006). In the water scarcity is a significant issue, therefore, monitoring, managing, using, and preserving groundwater innovatively is necessary (Batarseh et al., 2021). In 2011, Irmak et al. conducted a study on the effectiveness of irrigation methods for crops. The authors assumed that irrigation is directly related to the water needs of the crops. Micro-irrigation was found to be the best method for achieving a 90% uniformity goal. Poor uniformity in irrigation can be attributed to factors such as inadequate system design, poor maintenance, and pressure fluctuations. The on-farm efficiency of micro-irrigation was reported to be between 0.7 to 0.95. In areas where water scarcity is a concern, water management in irrigation must be supported by organized information about crops, their water needs, and how irrigators tend to use water.

A systematic database of this information is necessary, and when the data has a spatial distribution, a GIS is the most appropriate tool for organizing it (Aillery et al., 2001). Huffaker and Whittlesey (2000) developed a pan-European irrigation map that utilizes regional statistics, a land use map, and a global irrigation map. These maps provide information about the spatial distribution of irrigated areas by crop type, which allows for determining irrigated areas on a spatial modeling unit level. This tool is required for assessing the impacts of irrigated agriculture on water resources at a European scale. According to these authors, irrigation practices vary significantly in Europe, with agriculture largely relying on rainfall, and irrigation being temporarily used to overcome water shortages during the summer for optimized crop yields. However, areas with highly industrialized agriculture are often equipped with irrigation facilities, even if they are not used on a permanent basis. Southern Europe heavily relies on irrigation to maintain vegetable production due to a lack of rainfall during the growing season.

QUALITATIVE DATA COLLECTION AND ANALYSIS METHODS

The research methodology used evaluated the value of water resources and discussed how cutting-edge technology has a significant impact on increasing farmers' productivity and income. Case studies, interviews, and secondary and primary data analysis are just a few of the qualitative research methods used in this study. The two dependent variables of the research, namely, farmers' productivity and income, and the independent variable, namely, innovative groundwater technology, are analyzed using in-depth interviews with prominent figures in the UAE's water resources sector. Non-probability convenience sampling and open-ended questions covering the study's variables are both used in the data collection procedure.

In this study, the Nvivo qualitative data analysis software was used. The software enhances the quality of analysis by grouping, contrasting, and filing data into a specific format. It provides a platform to organize, manage, and analyze large amounts of qualitative data such as interviews, focus groups, and surveys. The software allows to code and categorize the data, conduct thematic analysis, and visualize the findings (Hilal & Alabri, 2013).

RESULTS

Seven interview questions formed the backbone of our data collection, prompting participants to share their experiences with the research topic. As theories began to emerge from this rich qualitative data, coding became a valuable tool for understanding their perspectives and analyzing their lived experiences. This technique facilitated not only data categorization and sorting pertinent to the research theme, but also established a structured platform for interpreting and constructing meaning. Importantly, coding allowed us to engage in a negotiation of meaning, ultimately enabling its presentation and textualization - a crucial step in qualitative research. Such detailed data analysis empowers researchers to follow a clear path towards achieving their research objectives (Williams & Moser, 2019).

Three sets of codes were identified from interviews: the importance of smarter water systems, the impact of innovative methods on performance, and the impact of innovative methods on profit. Participants emphasized the role of technology in solving groundwater problems, knowledge of the amount of water, depth, and irrigation cost, as shown in table 1,2,3,4,5,6 and 7. They also highlighted the importance of reducing water consumption, conserving water for future generations, and using suitable methods for the UAE's climate. Innovative devices such as bubble and fog irrigation systems were found to be effective in the agricultural field, and technology such as well detectors were used to solve drilling problems in places where there is no groundwater.

Table 1. Importance of having smarter water systems

Codes	Frequency
Automating irrigation and sustaining production	5
Sole water problems and crises	5
Provision of large amounts of water	4
Improves efficiency	3
increase production and profit	3
Developing and sustaining agriculture	2
Control water quantities and preserving water	2
Reducing water salinity	1

Table 2. The impact of new ideas in solving groundwater problems

Codes	Frequency
Raise the community awareness regarding agricultural projects	4
Educate farmers and increase their awareness towards economic schedule of irrigation	4
Exchange views between experts and farmers to the betterment of water use	2
Contribute to schedule plans for crops and for irrigation	2
Develop well-thought-out plans	1
Use modern irrigation plans	1

Table 3. Importance of technological intervention in solving the problem of groundwater scarcity

Codes	Frequency
Reduce water consumption and preserve water for future generation	5
Treatment of salinity water and desalinization of sea water	4
Modern methods in irrigation	2
Increase water management efficiency and control of irrigation	2
Solve the problem of water scarcity	2
Increase productivity by detecting new water reservoirs	2

Table 4. The spread awareness of new ways of using or extracting water to all beneficiaries

Codes	Frequency
Communicating through social media and websites	14
Conducting awareness raising workshops, seminars by experts	4
Conducting experiments and showing results	2

Table 5. Impact of innovative methods on the performance of farmers

Codes	Frequency
Improves performance in terms of accuracy, better results of workers and income, reduction of cost	10
Training and education	2
Improved self-efficiency and reduce losses	2

Overcome sanitary problems	2

Table 6. Improvements that could occur if new innovative methods were applied

Codes	Frequency
Increase in profits, productivity and benefits	13
Improve the quality of water, quality of crops and reduce challenges	2
Replace flood irrigation with modern sustainable irrigation	1
Reduce sanitary of water	1

Table 7. impact of innovative methods of using or extracting groundwater on farmers' profits

Codes	Frequency
Increase in profits, productivity, benefits and financial returns	15
Extract water at lower cost and least effort	2

Based on qualitative data and content analysis, this discussion on smarter water systems in the UAE highlights their effectiveness in preserving groundwater, preventing waste and improper use, and increasing water productivity and efficiency for irrigation. The results showed that using smarter water systems preserves groundwater and prevents its waste and improper use, as well as the development and implementation of automated irrigation systems and alternative methods such as desalination and sewage treatment.

The use of innovative methods such as fog irrigation and bubble irrigation, as well as other methods, has effectively contributed to the resolution of the main issue, which is related to water equivalency and water quantity. The results also showed that smarter water systems improved water productivity and efficiency, as well as increased water production for irrigation, thus improving farmers' performance and facilitating the cultivation process, as well as monitoring the process using unconventional methods such as well detectors and other devices that determine the appropriate water level for each crop, and as a result, costs, manpower, and profits increased. Smarter water systems have improved water quantity control and conservation while also assisting farmers in reducing water sterilization.

The impact of new methods and ideas in solving groundwater problems and scarcity is clear, as evidenced by increased productivity and profits. According to the findings, new ideas contribute to the improvement of agricultural projects, but there is a lack of social awareness about the innovative methods. They also noted that the use of these methods, which increased the availability of fresh water such as groundwater, resulted in crop diversification, increased productivity, and lower costs for farm owners. New ideas also play a catalytic role in educating farmers and increasing their awareness of the irrigation schedule. It also provided new ideas to farmers, experts, and entrepreneurs who were exchanging ideas on how to better use water. Thus, ideas can play a role in developing well-thought-out plans that can improve water use for irrigation, and these ideas will maximize water use efficiency by using scheduled irrigation plans. A hydrology-based approach, according to Mukherjee and Shah (2005), focuses on the behavior and properties of groundwater. Within this framework, technology can be used to provide supply-side solutions to groundwater issues.

The study found that there are many factors that contribute to solving the problem of groundwater scarcity, including reducing water consumption, protecting water for future generations, treating saline water, desalinating seawater, and modern irrigation methods like fog irrigation, which was implemented in some UAE farms as part of a live experiment, as well as bubble irrigation. Additionally, it has been found that using technology helps farmers learn

how much water is needed for each project, how much irrigation will cost, and whether there will be enough water to complete each project.

The benefits of adopting groundwater technologies were examined by Burt (2004). The author claims that farmers can use composite technology to enhance their abilities in crop pattern design and soil and water management. According to Burt (2004), the use of water technologies lowers water demand, improves farmers' water management skills, and takes advantage of the potential advantages of groundwater. The study placed a strong emphasis on the use of communication through social media and websites in relation to the participants' perceptions of how knowledge of new uses or extraction methods for all beneficiaries will spread. Educate communities and farm owners by disseminating information and advancements about novel agricultural techniques through the media and social networking sites, holding awareness workshops and seminars, and finally conducting and publishing experiments in articles across the Emirates.

The participants emphasized the significance of sending a team of specialized centers to train and educate farmers about cutting-edge technologies like fog irrigation, which was trialed in the Al Ain region of the Emirate of Abu Dhabi, to raise awareness among farmers and individuals about the use of innovative methods. Fog irrigation was used to irrigate the crops, which produced impressive results in terms of crop quality. It also enhances the farmer's performance by making it easier to grow crops, calculating the amount of water needed, determining the right salinity ratio for the crop, and unquestionably preventing groundwater waste. Spreading knowledge among all state farm employees about the significance of creating new concepts and techniques for extracting groundwater and using it to support the agricultural sector, which heavily depends on groundwater (Tate, 2021). The participants emphasized the significance of raising awareness of communication channels to present novel ideas, educate farm owners, and facilitate communication between farm owners and specialized institutions across the nation.

Innovative approaches are also closely related to enhancing farmers' performance in terms of accuracy and use of contemporary agricultural equipment, saving time, money, and water, improving production and income, and lowering cost. Participants discussed ways to improve farmers' performance by reducing losses, addressing sanitation issues, and providing self-efficacy training and education. According to the FAO, about 75% of the exports from Middle Eastern nations were a result of the use of new technologies and groundwater management systems. The spread of new methods and creative techniques in agriculture and irrigation, along with the publication of illustrations showing how to use and benefit from them, were also addressed as variables that were enhanced. spreading knowledge about the various uses for groundwater and fresh water, as well as giving farmers the knowledge they require regarding the salinity of the water and the amount of water required per crop.

Also, the study found that the most beneficial improvements are the low cost of innovative methods compared to traditional methods in terms of the need for a lot of labor, agricultural materials, and freshwater resources and their extraction by traditional methods, but the innovative methods cut a lot of hard work by using well detection devices to determine the adequate water level, as well as a number of other benefits. As an alternative to groundwater conservation, flood irrigation could be replaced with contemporary sustainable irrigation. According to the study, implementing new approaches and technologies improves the quality of water. Crop quality is another desired outcome brought about by technology. This technology is high tech and heavily depends on non-conventional resources, claim Sharif et al. (2021). Participants are also aware of how cutting-edge groundwater extraction

techniques affect farmers' productivity and profitability. The study discovered that new technologies enable the extraction of groundwater at the lowest possible cost and with the least amount of effort, increasing profits, productivity, and benefits.

CONCLUSION

Despite the importance of water technology for farmers, the study reveals a gap in knowledge and awareness of innovative water methods that could potentially improve irrigation practices and increase profits for farmers. Bridging this knowledge gap and promoting the use of innovative water technologies will not only enhance farmers' performance but also aid in meeting the increasing demand for water in the face of growing challenges. The groundwater scarcity crisis poses a major problem in agriculture and most sectors in the country. The importance of devising ways to extract and manage groundwater lies in solving a large part of the main problem, which is the scarcity of groundwater.

The current study examined the effects of cutting-edge groundwater management techniques on the productivity and income of farmers in the United Arab Emirates. The study used the qualitative research methodology to better understand the perspectives of 20 participants who were interviewed and worked on agricultural projects in the United Arab Emirates. The interview questions were analyzed using a content analysis by the study. According to the study's findings up to this point, new technologies are widely used in the United Arab Emirates, and they improve underground water production, performance, and monetary earnings.

New technologies have a significant impact on performance in terms of raising output, timed irrigation plans, water detection and extraction, and reasonable water consumption. Communication was seen as a way to exchange concepts and inform people about how to use underground water responsibly. Additionally, the study found a correlation between new technologies and higher production, so revenues are also likely to rise, particularly in light of the clear perception that farmers are trained to make plans, use scheduled crops, and use underground water sensibly. Modern technology will undoubtedly improve the quality of agricultural products, according to farmers, and will also make farming easier. More importantly, though, it will ensure that water is used as efficiently as possible. However, the initial investment required to use these high-tech products is substantial. Although there are restrictions on using underground water in the UAE, as we have already mentioned, it does not make sense to do so without providing a substitute.

According to the results, we must persuade farmers that these systems will be advantageous to them both in the short and long term if we want to educate them about the advantages of using modern technologies, which is necessary given that the country has underground water reservoirs. As this study's findings demonstrated, farmers will initially benefit from using high-tech systems, making it simple to inform and persuade them to adopt them. On the other hand, implementing such systems will be advantageous for the government as well, as they will be able to rely on agricultural products for both domestic consumption and exports without endangering underground resources. To lessen the financial burden of deploying such systems on farmers, we recommend that the government passes legislation and implement a policy. The government can encourage farmers to upgrade their irrigation system by offering low-interest loans.

As some farmers have noted, the main foundation of new technologies is high-tech systems that require professionals and experts to operate. To put it another way, an infrastructure built on modern technologies like IT and computer programming is required for the renovation of farm systems. Consider a farmer who wants to use an irrigation system that is entirely automated. Understanding fundamental technologies, such as how to use the software created for this system, is one requirement for using the system. The technology company must provide training for this, as well as the necessary infrastructure to put such systems in place. A system that needs to inform farmers online about the percentage of soil moisture, for instance. This system requires access to the Internet network, which can be obtained through WiFi or career networks. The farmer must also have access to this system via a computer or mobile device. This necessitates an IT infrastructure for the technology company as well as the farmer, which could be costly for farmers. In light of this, the study's limitation can be seen in the absence of IT underground water companies from the study. To better understand how these technologies contribute to the production of underground water, organizations that deal with underground water should be included in future studies.

Also based on the result, we were able to show that countries, especially those in arid regions like the Middle East, must use high-tech irrigation systems. The use of these systems is advantageous both in the short term—especially for farmers who will produce goods of higher quality with less water waste—and in the long term, which benefits the nation by supplying infrastructure for the export of agricultural products and by reserving water for future generations.

RECOMMENDITIONS

The development of sound and sophisticated strategic and development plans regarding the sustainability of groundwater flow and its availability for development in agricultural fields is suggested as a focus for future academic studies in order to meet farmer satisfaction in agricultural fields and to profit from cutting-edge technological devices. However, with regard to the primary issue that creates a crisis in the UAE—the lack of fresh water—we recommend allocating extension teams made up of specialists, agricultural engineers, and extension workers to help farmers, train them, and introduce them to new ideas in order to achieve the best results in terms of crop productivity and an increase in profits. In order to spread knowledge about contemporary techniques and technologies that influence the agricultural sector and its growth, it is also advised that the educational component of future academic studies be given careful consideration.

The importance of educating farmers, farm owners, and anyone else interested in the agricultural industry was also covered in the study's findings. To improve communication between farmers and extension centers, it is proposed to educate farmers on everything new in the agricultural field through an app or website that informs them about the best irrigation and water-saving techniques, such as irrigation through automatic drip, which controls the water level. Future research should concentrate on modern irrigation theories and hypotheses, particularly how it works in arid desert regions and how water levels are controlled, as well as the value of having communication programs that make complex information about modern mechanisms and everything related to agriculture clear. One of the suggestions for future research is to make farms more aware of strategic plans by making them into specialized farms, which entails allocating a specific area of the farm to grow one type of crop and concentrating on it. Palm, fruit, vegetable, wheat, weed, and fish farms are a few examples of these specialized farms.

The process of assigning farms aims to concentrate on each category of crops and to guide farm owners to fully understand the varieties designated for cultivation and the best strategic plans that must be followed in terms of water conservation and supplying sufficient water to plants, so that the farm owner reaps at the end of the season to the best possible production that can reach it from continuous guidance. There are a few barriers to implementing such technologies: Farmers ought to be encouraged to use these systems, be able to invest in them, and have access to experts to run and maintain them. We have the following ideas for overcoming these barriers:

1- Farmers need to be informed and aware of the advantages that these systems will provide, such as improved product quality, lower labor costs, and the preservation of underground water.

2. The government ought to offer farmers low-interest loans so they can upgrade their irrigation systems. Farmers will be encouraged by this, which will eventually help the government.

3- Foreign businesses should be allowed to open branches in the UAE, and the government should support them by offering them benefits like low taxes on sales. Farmers will benefit from having domestic product guarantees thanks to this, and system maintenance will be quick and simple.

We attempted to demonstrate the significance of having a modern irrigation system in this study. This could be seen as the start of a reformation of the agricultural system. Both the government and farmers must be willing to implement this reform to have a modern system. The farmers will be seen as the most important component, as they will use these systems to improve the quality of their products, and the government can aid this reform by offering infrastructure and low-interest loans.

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