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Impact of COVID-19 lockdown on small-scale farming in Northeastern Nile Delta of Egypt and learned lessons for water conservation potentials

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A B S T R A C T

The coronavirus disease-2019 (COVID-19) pandemic had a great impact on the agricultural sector, especially in developing countries. In particular, it caused exceptional challenges to small and local-scale farmers. Field questionnaires and interviews were used to investigate the effects of COVID-19 on small-scale farmers in the Northern Nile Delta of Egypt. Agricultural farms in Southern Port Said City represent emerging agricultural communities on newly reclaimed land, while those in Damietta are stable agricultural communities (old land of the Nile Delta). The questionnaire was divided into four questions groups to identify and analyze the different reasons that contributed to the disruption of farming systems and the agricultural sector. These groups were farmers' data, the effect of COVID-19 on agriculture inputs, infection rates and precautionary measures against COVID-19, and potential measures and governmental policies for controlling the negative impacts of COVID-19 and achieving agricultural sustainability. Results showed that the effect of lockdown was slightly lower in Damietta as compared to Port Said. Although fertilizers and labors costs, as well as water availability near Port Said, was not considerably affected during the lockdown, the total income of the small-scale farmers' notably decreased. The reluctance of major traders to buy crop production and keep the required balance of cash during the pandemic dramatically affected the crop production selling prices. Results showed that in the absence of agricultural extensions possibilities, there is a lack of awareness toward improving agricultural practices and switching to smart irrigation systems as a way of saving water and increasing crop productivity. The resistance against applying new agricultural practices and switching to smart irrigation systems depends mainly on farmers' financial capability and the nature of agricultural land either old or new. Activating the agricultural extensions roles is considered a keystone for enhancing agricultural sustainability in small-scale farming not only in developing regions of Egypt but also in other similar agricultural communities worldwide.

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1. Introduction

Coronavirus disease (COVID-19) is considered one of the most confrontational pandemics causing severe danger to humanity in the twenty-first century due to its progression, infection, spread, and mortality rate worldwide [28]. Till July 2021, the COVID-19 confirmed cases over the world were 190 million cases including 4.1 million deaths. The official confirmed cases in Egypt were 283,409 cases including 16,418 deaths [39]. The first detected case in Egypt was on 14th February 2020, which was the first confirmed case in Africa [18]. Disaster hazards (e.g., earthquakes, volcanoes, hurricanes, and spill of hazardous materials) are different from pandemics as they affect infrastructure and cause physical loss of structures and people while pandemics influence human resources and the entire society [5].

Agriculture is one of the most important economic sectors in Egypt, contributing to about 11.3% of GDP and employing about 28% of the working population [37]. Agriculture is especially important in Upper Egypt, located south of Cairo, where over 55% of employment is agriculture-related. Other important agricultural areas are the Nile Delta region [37,25]. The COVID-19 pandemic
The impact of COVID-19 on the food and agriculture sectors worldwide has already damaged the global economy, both directly and through restrictions taken by different countries to limit the spread of the virus. These impacts have cast their shadow on the food and agriculture sector. In addition, it affected national and global economic indicators (e.g., governmental expenditures, employment, GDP growth, poverty levels, and budget deficits).

Much research has been conducted to explore the potential effects of the COVID-19 pandemic on national and global economic indicators. Sumner et al. [34] assessed the potential effect of the COVID-19 pandemic on severity and poverty levels in developing countries. They concluded that COVID-19 will increase poverty in developing countries worldwide. People under the $1.90 poverty line will be increased by 400 million. Moreover, other 500 million people will live under the poverty lines of $3.20 and $5.50. They also predicted that global poverty would shift towards countries with middle-income as well as East and South Asia countries.

Kansiime et al. [16] evaluated the impact of COVID-19 on food security and household income in two East African countries (Uganda and Kenya). Their assessment was done based on analyzing data of 442 online questionnaires. They found that food security was considerably deteriorated due to the pandemic. The ratio of people suffering from food-insecure was increased by 44 and 38% in Uganda and Kenya, respectively. In addition, income shocks infected more than two-thirds of the respondents. Low-income households in both countries were more vulnerable to income shocks.

McKibbin and Fernando [24] used a global intertemporal general equilibrium model with heterogeneous agents to investigate the effect of seven rational scenarios of COVID-19 on the Chinese macroeconomic outcomes. These scenarios were built and classified according to different percentages of people who were infected, those infected who die, and the total population who die. Based on the model results, they concluded that the COVID-19 outbreak notably affected the global economy in the short run. By investment in public health systems especially in less developed countries with high populations, economic costs could be significantly avoided, and the global economy can be improved.

Kumar et al. [17] explored different consequences of the COVID-19 lockdown on Indian farming systems. By combining qualitative and quantitative sources of data, they analyzed the causes of the cruel disruption of farming systems and the Indian agricultural sector after the lockdown. They concluded that the availability of migrant labors greatly affected the agricultural produce. The lack of migrant labor in some regions caused critical losses of products. Moreover, the partial lock of rural markets led to deficiencies of food supplies and dramatically augment prices.

In Egypt, the government has enforced several restrictions to control the COVID-19 spread within the country’s borders. These restrictions comprise borders closure, quarantine, partial lockdown, movement restrictions, social distancing, and reducing employees in non-essential services. Although these restrictions may have disrupted the supply of agro-food products to markets and consumers, the supply of food has held up well to date. Moreover, food supply chains are affected by the pandemic as shocks resulting in food gluts or shortages due to the spoil of agricultural commodities [33,26,16]. It is worth mentioning that the Egyptian government tried to alleviate the negative economic impact of COVID-19, especially for daily workers by paying a subsidy to them.

The impact of COVID-19 on the food and agriculture sectors worldwide has been highlighted in some reports (e.g., UNESCO-IHE, Delft [19], WAGENINGEN University & Research [20], OECD–Better Policies for Better Lives [21]). Moreover, some governmental actions for COVID-19 socio-economic responsibilities, recovery plans, and mitigating scenarios were emphasized (e.g., United Nations, Egypt [22]) and non-governmental solutions were presented (e.g., Techno Serve – Business Solutions to Poverty [23]). Nevertheless, from the literature review of previous studies, authors found that the multi-level impacts of the COVID-19 pandemic on small-scale agriculture were not fully addressed so far at least in the Northeastern Nile Delta of Egypt. Therefore, the objective of this study was to investigate the effect of COVID-19 lockdown on small-scale farming in the Northeastern Nile Delta of Egypt, near Port Said and Damietta Cities, and explore the potentially applicable water conservation techniques.

2. Materials and methods

This study explores the challenges and effects of the COVID-19 pandemic on the agricultural sector in Egypt, specifically small-scale farms. These farms are usually around one to ten acres and often use very little to no expensive technologies. Different qualitative and quantitative sources of information were used to describe and analyze various factors that influenced Egyptian farming systems during the COVID-19 pandemic. In this context, questionnaire-based field interviews containing four questions groups were carried out with farmers of small-scale farms in Northeastern Nile Delta of Egypt, near Port Said and Damietta Cities. The four questions groups related to farmers’ personal data, the effect of COVID-19 on agriculture inputs, precautionary measures against COVID-19, and potential measures and governmental policies for controlling the negative impacts of COVID-19 and achieving agricultural sustainability. The study relied on the social survey method in which random samples were chosen. Governmental actions taken during the pandemic and the lockdown policies were considered during designing the questionnaire. The questionnaire was designed to recognize the struggling of farmers during the COVID-19 pandemic. Fig. 1 shows a schematic of the applied research methodology.

![Fig. 1. Schematic of applied research methodology.](image-url)
2.1. Study areas

The two study areas, southern Port Said City and Damietta City, are representative of the Northeastern Nile Delta of Egypt (Fig. 2a–c) in terms of farming activities where the five northeastern governorates of the Nile Delta have the same nature of agricultural lands. The farms in the study areas were selected for performing farmers’ interviews based on the possibility to have contact with the local farmers there and the data availability. Southern Port Said is located between 32°15’2” E – 32°16’55” E and 31°11’8” N – 31°10’16” N and Damietta between 31°46’5” E – 31°47’51” E and 31°28’5” N – 31°25’15” N. Nile water is the only irrigation source for the study areas and surface irrigation (i.e., flood and furrow) is the commonly used irrigation method [7]. Wheat, sugar beet, and alfalfa are the summer cultivated crops in southern Port Said while rice and maize are winter crops. In Damietta cereals, vegetables, fruits, and trees are cultivated during both the summer and winter seasons.

Agricultural areas located in southern Port Said represent emerging agricultural communities as these areas are on newly reclaimed land. These are, however, suffering from salinity problems [8] and most farmers who currently are settled here moved from Nile Delta and Nile Valley Governorates (i.e., Upper Egypt). Farmers’ desire to increase their agricultural area is the reason for moving to the newly reclaimed land where the cost of land is much cheaper than in Upper Egypt. The relationship between the cost of one acre with moderate fertility in Upper Egypt may correspond to 3:1 as compared to the newly reclaimed land. Two main obstacles are facing the farmers in southern Port Said. First is the lack of experience in dealing with salt-affected soils as they are accustomed to employing conventional practices in the Nile Valley and Nile Delta [11]. The second is dealing with new markets for selling produced crops. Contrary to this, Damietta represents a stable agricultural community. The land here is fertile and farming practices are well established. Moreover, produced crops can be easily sold. The selection of the only two studied areas was restricted by the transportation difficulty and accessibility and contacts to more private farms in other Northeastern Nile Delta governorates. Although readers may argue this as a limitation of the study, authors believe that these study areas are quite enough for representing the Northeastern Nile Delta where their topographic and agriculture conditions are similar to other Northeastern Nile Delta governorates (Sharqia, Dakahlia, and Ismailia) [25].

2.2. Questionnaire design

The questionnaire was divided into four questions groups. These groups were: (i) farmers’ personal data, (ii) effect of COVID-19 on agriculture inputs, (iii) infection rates and precautionary measures against COVID-19, and (iv) measures and policies for sustainable small-scale agriculture against other potential risks. The questionnaire’s main four groups were designed from the
implications of the COVID-19 on agriculture, food, and rural America which is supported by the USDA [38], and the recommendations of the World Bank regarding food security and COVID-19 [41]. The groups’ items were selected from the questionnaire of Kumar et al. [17] study of the multi-level impacts of the COVID-19 lockdown in India and were revised according to the country profile report of Egypt provided by FAO [9]. The first group included questions about farmer’s age that was classified into five groups: less than 20, 21 to 29, 30 to 40, 41 to 60, and 61 to 75 years, the qualification which was quantified regarding literacy, average, above average, and higher education, holder kind of agricultural tenure, area of agricultural tenure (acres) that classified into five segments: less than one acre, one to three acres, three to five acres, five to ten acres, and greater than ten acres, and ability of the agricultural tenure holder to deal with technology (e.g., smartphones). Farmers’ ability to deal with smartphones was identified through a direct question about their knowledge of this technology. Three levels were used to indicate farmers’ technological level of knowledge as poor, moderate, and perfect. The second group involved questions about water, fertilizers, and part-time worker availability during the pandemic due to lockdown, change in seed and fertilizer prices, wages of part-time workers, effect of the pandemic on cultivation cost, crop yield, crop selling price, local agricultural industry, total farmer’s income, and role of the agricultural extension during the pandemic.

The third group contained questions about infection rates, precautionary measures applied by the farmers such as social distance, wearing face masks, using sanitizer, and the desire to get a vaccination and its availability. The fourth group included questions about farmers’ awareness on modern irrigation management, remote irrigation, and its effects on saving water and increasing crop production, farmers’ resistance toward changing to field automation, willingness to attend even off or on-line training regarding smart irrigation systems, and their financial capacity to switch to remotely managed irrigation. At the end of the questionnaire, water-saving techniques-related questions were presented. All questions are shown in Table S1 in the supplements.

2.3. Farmer interviews

To evaluate the impacts of the COVID-19 pandemic on representative Egyptian farms and to assess the macro-economic situation, field surveys were carried out with forty farms that exemplify southern Port Said. Thirty private farms were randomly selected to represent Damietta. Some of the questionnaires were answered during direct interviews with the farmers and others were done through mobile phones. Field visits and interviews were performed from 15th May to 15th June 2021. Farmers were asked to describe how the COVID-19 pandemic had affected their farm operations, as well as their investment, and the profitability of major crops.

Economic indicators collected during the interviews included farmer investment in different inputs, labor wages, transportation, bagging, and the total cost of production, as well as value return regarding yield, the market price of the produce, gross return, net return, and benefit-cost ratio. Changes in comparison with normal conditions were subsequently quantified by comparing indicators drawn from the results of the interviews representing the initial lockdown period and normal daily life before the pandemic. A difficulty experienced by the authors during data collection was the ignorance of farmers regarding the importance of these kinds of questionnaire-based studies. One reason for this ignorance is the absence of agricultural extension role and low level of education. Answers acquisition of such questionnaires is particularly difficult for rural small communities where low educational awareness and poverty is widespread which greatly affects the sample size although ours is still expressive.

2.4. Statistical analysis

Statistical data analyses of questionnaires were assessed using the descriptive analysis tool of the Statistical Package of the Social Sciences (SPSS) 24.0 software (IBM Corporation, New York, NY, USA). Comparison of the collected data from the survey was performed for the situation before and during the lockdown.

3. Results and discussion

3.1. Analysis of farmers’ personal data

3.1.1. Farmers’ age

In southern Port Said, 5% of farmers are 21 to 29, and 20% are 30 to 40 years old. About 60 and 15% of the farmers’ ages range from 41 to 60 and 61 to 75, respectively. The survey did not include farmers with an age less than 20. On the other hand, farmers’ age in Damietta was 20, 60, and 20% for 30 to 40, 41 to 60, and 61 to 75 years, respectively. The survey in Port Said and Damietta gives insights regarding the demographic distribution of farmers in these regions.

3.1.2. Farmers’ education level

Education levels of farmers in Port Said and Damietta are shown in Fig. 3. Results showed that the literacy level is much higher in Port Said than in Damietta and the average education level of farmers is the same in both governorates.

The higher percentage of illiteracy of Port Said farmers as compared to Damietta can be directly related to literacy distribution in Egypt. The literacy rates in Upper Egypt are approximately three times of Lower Egypt [35]. As previously mentioned, most farmers settled in southern Port Said were shifted from Nile Delta and Nile Valley Governorates (i.e., Upper Egypt) as a desire to increase their agricultural tenure.

3.1.3. Area of agricultural tenure

Fig. 4 shows the percentage of farmers for each of these areas. Most farmers in Damietta (40%) have more than ten acres while 30, 20, and 10% of farmers have an agricultural area from 5 to 10, 3 to 5, and 1 to 3 acres, respectively. The situation in Port Said is quite different where the least farmers (15%) have an agricultural area of more than 10 acres. About 25, 40, and 20% of farmers have an area between 1 and 3, 3 and 5, and 5 and 10 acres, respectively. The higher and lower percentages of farmers in southern Port Said that have an agricultural tenure of less than five and more than five acres, respectively, compared with those in Damietta can be attributed to the financial capability of farmers.

3.1.4. Technological knowledge

Results showed that only 20% of farmers in Port Said do not have smartphones and do not use this technology, 45% of farmers
have average knowledge regarding smartphones, and 35% are advanced knowledge of smartphones (Fig. 5 a). In Damietta, 40% of farmers have poor knowledge about using this technology and 40% are using smartphones perfectly. Only 20% of farmers have moderate knowledge about this technology (Fig. 5 b). Although the education level for farmers in Damietta is higher than in Port Said, most farmers have poor knowledge of using smartphones. Farmers' technological knowledge can be linked to education level and age. The percentage of old farmers is higher in Damietta than in southern Port Said. Therefore, the poor technical knowledge of farmers is higher in Damietta than in southern Port Said. The reason for this can be attributed to the farmers' awareness level and social communication networks.

The percentage of old farmers is higher in Damietta than in southern Port Said. Therefore, the poor technical knowledge of farmers in Damietta as compared to southern Port Said can be attributed to age and not to education level. Results of farmers' gender, holder kind of the agricultural tenure, the place of residence of the tenure holder, and the social communication availability are summarized in Table 1 for the study areas in Port Said and Damietta.

### 3.2. Effect of lockdown on agriculture inputs

Farmers' opinion on the effects of the lockdown on agricultural inputs is shown in Fig. 6a and 6b for Port Said and Damietta, respectively. Among the five selected inputs, water and fertilizer availability were most affected during the lockdown in Port Said where 30% of farmers were more affected due to the lockdown. Farmers' opinions regarding water availability during the lockdown were totally different in Damietta. Damietta is located on the Damietta branch of the Nile River and farms here are directly irrigated from main irrigation canals and the water is available throughout the year. The situation in Port Said is different where agricultural land is irrigated from small branches that take water from the Port Said Canal (a distributed branch from Ismailia Canal) and water is available in the final reaches of the branches only in winter. During summer supplied water volumes are small. The pandemic considerably affected the water availability of agricultural land located along the last reaches of canals. The reason for this can be attributed to the farmers' awareness level and social concern. Farmers along the upstream branches consumed more water during the pandemic as compared to before. They thought that by applying this measure, from their point of view, they may avoid any potential future shortage of water during the pandemic. The absence of an agricultural extension role is a keystone of this inequity of distribution between head and tail reach farmers [1].

Fertilizer prices were not changed during the lockdown and 50% of farmers said that there was no difference in prices during and before the lockdown. Part-time workers were available during the lockdown where 45% of farmers were affected during the pandemic. On the other hand, there was no change in workers' wages during the lockdown where 65% of farmers were not influenced and only 5% of them were moderately affected (Fig. 6a).

In Damietta, the situation of water and fertilizer availability was approximately similar to Port Said where no effect was detected and only 30% of farmers experienced the mild effect of the lockdown on fertilizer availability (Fig. 6b). Fertilizer price is the agricultural input that was most affected by the lockdown where 30, 30, and 40% of farmers answered that prices were severely, moderately, and mildly affected, respectively during the lockdown. Also, the availability of part-time workers was affected where 50% of farmers said that this parameter was moderately, and moderately to severely affected by the lockdown. The difference in farmers' opinions regarding the fertilizer price in Port Said and Damietta can be attributed to the different crop patterns that are cultivated in each region and the associated applied fertilizer amount. With larger agricultural holdings, the total increase in fertilizer price will be more pronounced. Damietta has a higher percentage of farmers having large agricultural tenure (more than five acres) as compared to Port Said (Fig. 4). The inconsistency of farmers' opinions concerning the change in worker wages between Port Said and Damietta can be attributed to workers' availability during the lockdown. Almost all workers in Port Said live close to the agricultural land. On the other hand, some workers in Damietta live in places far from the agricultural land which was considerably influenced by the curfew during the pandemic and thereby affected the workers' wages.

Results also show that activities related to agriculture, such as the process of fattening livestock and breeding birds, as well as cheese and ghee industries, were severely affected and moderately to severely affected (opinion of 95% of farmers in Port Said; Fig. 7a). This can be attributed to the reluctance of people to buy agricultural industry products during the pandemic due to either the curfew (i.e., transportation difficulties) or reduced consumption during the pandemic. Contrary to Damietta, the agricultural land of southern Port Said City is located far from the residential community. Moreover, fishing, transit trade, port services, and industrial activity are the main activities of Port Said City, while agricultural activities come in subsequent order after these activities (https://ask-aladdin.com/egypt-governorates/port-said-
On the other hand, in Damietta, agricultural land is located close to residential communities and agriculture is the main activity here. Another reason for the recession of agricultural industry products is that people preferred to save cash during the pandemic rather than buying extra food. In the same context, the farmers’ personal food consumption was greatly influenced were 25 and 60% of farmers faced severe and moderate to severe effects, respectively. About 50% of farmers’ income was moderate to severely affected due to the lockdown and 75% of farmers faced mild difficulty in selling their products.

Markets were affected where 70% of farmers experienced the mild effect of the lockdown on market availability. The reduction in the total income of Port Said farmers during the pandemic can be attributed to the increase of input costs and reluctance of major traders to buy crop production, to keep enough balance of cash during the pandemic. As the agricultural land in Port Said is newly reclaimed and farmers have recently moved to these lands, farmers have faced some difficulties in finding new markets for selling their products.

Fig. 6. Effect of pandemic lockdown on water and fertilizer availability, fertilizer price, part-time worker availability, and change in workers’ wages for (a) Port Said (b) Damietta.

In Damietta, the effects of the lockdown were slightly smaller than in Port Said. Markets, farmers’ personal consumption, agricultural-related activities, and farmers’ income were not markedly influenced during the lockdown where 70, 60, 60, and 40% of farmers were not affected, respectively. The inconsistency of the situation between farmers in Port Said and Damietta can be attributed to the stability of agricultural communities in Damietta as compared to Port Said. The agricultural land in Damietta is established areas of the Nile Delta. These lands are fertile and applied farming practices have long traditions. Farmers of these areas have sufficient experience to market their crop products compared to farmers in emerging agricultural communities (i.e., southern Port Said). It is worth mentioning that farmers in both Port Said and Damietta confirmed the absence of agricultural extension roles both before and during the COVID-19 pandemic. This put more burden on the farmers’ shoulders, especially in southern Port Said. The agricultural extension can compensate for unsuitable agricultural practices in newly reclaimed land and should act as a link between farmers and the government to overcome obstacles facing farmers [6]. Thus, activating the role of the agricultural extension is a must for achieving agricultural sustainability [4]. Nevertheless, increasing the role of the research institutes and universities in supporting extension activities is necessary to enhance extension services and methods, especially, the practical ones in order to develop the farmers’ knowledge and awareness.

3.3. Precautionary measures

Farmers’ awareness about the virus danger is higher in Port Said than in Damietta although farmers there are more educated. Only 5% of farmers in Damietta are committed to precautionary behavior such as wearing a mask, keeping social distance, and using sanitizers, while 15% of farmers in Port Said always adhere to these
About 60% of farmers in Damietta do not care about precaution or take safety actions to stop spreading the virus although they are highly educated. This percentage is quite small (only 17%) in Port Said and 38 and 30% of farmers are occasionally and often wearing the mask, keeping social distance, and using sterilizers, respectively. 

A low population density relative to the agricultural holdings may be the reason for ignoring precautionary measures. Although, the online registration for getting a Coronavirus vaccination was launched in Egypt last February, about 60 and 50% of farmers in Port Said and Damietta, respectively, did not register until now. These ratios reflect the low awareness level of farmers against the danger of Corona [30].

Table 2 shows farmers’ answers on awareness regarding the application of modern irrigation management and how to improve their crop production, thereby, achieving agricultural sustainability regardless of pandemics. In the beginning, farmers were asked about their need for funding (i.e., loans) during the pandemic period. Then, the remaining questions were directed to measure and analyze the reasons for farmers’ resistance toward applying new irrigation practices. About 90% of southern Port Said farmers showed their need for loans (e.g., from International Fund for Agricultural Development (IFAD), where the total IFAD financing in Egypt is about 519.28 million US$ [14]). However, only 10% of Damietta farmers showed the same needs. These answers concur with farmers’ answers in both areas regarding the effect of the pandemic on total farmers’ income. As well, these answers support the financial situation (as explained in sections 3.1.3 and 3.2) of farmers in both cities.

Farmers’ satisfaction level regarding their crop production is much higher in Damietta as compared to Port Said. This is logical since Damietta represents old-established agriculture of the Nile Delta that is fertile, and the agricultural practices have been in function for a long time [9]. Southern Port Said represents new agricultural areas suffering from salinity problems at a different level. Moreover, the lack of farmers’ experience to deal with such saline land dramatically affects crop production. Therefore, the resistance of Damietta farmers of converting to new irrigation
management is much stronger than for Port Said farmers even if this management would contribute to saving irrigation water.

About 90% of Southern Port Said farmers have the intention to attend online training and workshops on new irrigation management and remote-control methods if they are launched. Less desire was observed by Damietta farmers based on the good agricultural situation of their land (from their point of view). Poor technological knowledge (as earlier shown in section 3.1.4) may be another reason for the relatively weak desire of Damietta farmers. Although, the education level of Damietta farmers is higher than for Port Said farmers, 70% of Port Said farmers believe that switching to remote irrigation and agricultural management control systems can increase irrigation efficiency and help in optimal utilization of irrigation water. This result concurs with research by Omar and Moussa [27], Amer et al. [2], and FAO [10]. This figure is only 20% for Damietta farmers.

On the other hand, 85% of Port Said farmers are convinced that switching to remote irrigation and fertilization control systems is financially feasible in the long run, while only 20% of Damietta farmers believe this. Therefore, the desire for agricultural evolution is not dependent on the education level but mainly depends on farmers' evaluation of the situation of their agricultural lands. There is a big difference between the desire and the ability for switching to remote irrigation and fertilization control systems. Although farmers have the desire to apply remote irrigation systems and to spread this culture (if they learn) in surrounding agricultural communities, approximately all farmers in both cities do not have the financial ability to apply such systems on their lands. Therefore, the Egyptian government should encourage farmers to apply these systems by presenting funds and loans with fair conditions and credit facilities.

Flow meters should be widely implemented to regulate the farmers' water consumption which is now controlled by the government either for Nile water or groundwater as a source of irrigation. This will lead to the rational use of irrigation water and will motivate farmers to use remote irrigation systems [29]. Based on the results, effort should be paid to activate the agricultural extension role in the Egyptian agricultural communities. Ibrahim and Badawy [13] conducted a field survey relying on the social survey method to identify knowledge and execution levels of the El-Tina Plain farmers (newly reclaimed lands east Suez Canal, Egypt). They concluded that more attention should be paid to increase the role of agricultural extension services and methods, especially, the practical ones in order to develop the farmers' knowledge and awareness.

4. Conclusion

We believe that the current study is important for decision-makers and farmers of small-scale farms as it presents insights on measures that can be implemented not only to control any future pandemics but also to achieve sustainable development of agricultural communities in Egypt and other countries with similar agricultural and economic conditions. Based on that, the following conclusions can be drawn:

- a) Governmental contracts on crop production of newly reclaimed lands are the best way for improving farmers' returned benefits to compensate the reluctance of major traders for buying crop production during the pandemic.
- b) Activating the role of agricultural extensions is considered a key element for enhancing the agricultural culture for small-scale farmers and sustaining the agricultural industry in Egypt.
- c) Increasing the role of the research institutes and universities in supporting extension activities is necessary to enhance extension services and methods, especially, the practical ones in order to develop the farmers' knowledge and awareness.
- d) Agricultural land located at tail reaches of canals suffers from water shortage due to the unwise use of water at heads of irrigation canals. Thus, flow meters should be applied to control fair water distribution and rational use of water.
- e) The current situation of agricultural lands, farmers' financial capacity, and ineffective agricultural extension role are the governing factors toward switching to smart irrigation systems in small-scale farms.

Table 2
Answers of measures and policies section from farmers' interviews (a Port Said – b Damietta).

| (iv) Measurements and policies (%) | 10 ° & 90° (No effect) | 15 ° & 0° (Mild) | 25 ° & 10° (Moderate) | 50 ° & 0° (Moderate to severe) |
|-----------------------------------|------------------------|-----------------|----------------------|-----------------------------|
| To what extent farmers have searched for funding (loans) to help them during the pandemic period? | Yes (100° & 90°) | No (0° & 90°) |
| Do you want to increase its productivity? | Strongly desire (90° & 50°) | Somewhat desire (15° & 50°) | Have a good experience (0° & 0°) |
| If the answer to the previous question is yes: To what extent do you want to receive online training and workshops on irrigation, farming, and remote-control methods? | Do not know (15° & 20°) | Do not think so (15° & 60°) | Sure (70° & 20°) |
| Do you think that switching to remote irrigation and agricultural management control systems increases irrigation efficiency and helps in optimal utilization of irrigation water, which may lead to increased crop productivity? | Do not know (0° & 20°) | Do not think so (15° & 60°) | Sure (85° & 20°) |
| If you want to switch to a smart irrigation system: Do you have the financial ability to prepare the field or part of it? | Yes (15° & 0°) | No (85° & 100°) |
| If you apply a remote irrigation management system, can you spread this culture in the agricultural community around you? | Yes (85° & 70°) | No (15° & 30°) |
Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary material

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