IRRIGATION EFFICIENCY EDUCATION: APPROACH OF SUPROMED PROJECT

R. Nciri[1], A. Bouselmi[1], H. Maaroufi[1], T. Jarrahi[1], F. Ghedifi[1]

[1]National Institute of Field Crops

Abstract

For many farmers in the central of Tunisia, irrigation for grain crops is a new practice, so they are looking for training, technology and information to increase water-use efficiency while maintaining or increasing yields. The SUPROMED project (Sustainable production in water limited environments of Mediterranean agro-ecosystem) was conducted and planned for grain crops by Engineers of the National Institute of field crops in Tunisia (INGC) to educate farmers and consultants on the use of irrigation water management strategies and irrigation scheduling. The knowledge gained through research and demonstration was transferred to farmers and consultants by Regional Extension Agents. Irrigation scheduling models IREY and MOPECO were used for good water management in the field . The lead farmer approach has been implemented and heavily promoted. Six workshops and field days conducted in this project during the 2020-2021 growing season on irrigation water management and irrigation scheduling. Topics provided an introductory overview of the basic topics needed to effectively and efficiently schedule irrigation for grain crops including: soil moisture sensors technologies, water quality, irrigation systems distribution uniformity and application rates. The workshops and field days were evaluated by using pre-and post-questionnaires for participants in order to compare their knowledge and practices on irrigation before and after the field days. The returned pre-survey rate "Irrigation scheduling" as the priority topic preferred by participants. 80 % of participants plan to use the IREY app to schedule their irrigation according to the returned post-survey Overall, workshops improved understanding of irrigation scheduling practices, general irrigation knowledge, and water use efficiency. In addition, many recommendations were provided in this project. These recommendations helped farmers to improve their knowledge on flow rate, pipe size, pump size and the best irrigation system for their farms. The main dissemination processes are field days, training of farmers, demonstration plots, Field visits, leaflets and brochures, audiovisuals etc. To estimate the potential profitability increase for durum wheat we used midpoint price and yield for returns above variable expenses for irrigated minus midpoint for average farm fields , based on 2021 budgets to be irrigated and this gave us the 'potential profit increase'. The estimated potential profit increase for 85 ha was 119,616.25 €. The estimated Return On Investment (ROI) in € is 9 to 1.

Keywords. Transfer of technology, Irrigation scheduling, water use efficiency, SUPROMED, Return On Investment.

1. Introduction

In Tunisia yield levels of irrigated grain crops are generally low, below 3.8 t/ha, and fluctuate considerably (Mazhoud et *al*., 2020). Inherent factors, including weak adoption of new agricultural technologies by famers, poor crop management, lack of improved cultivars, unfavorable growing conditions, and biotic and abiotic stresses explains this yield variability. In addition, water productivity does not exceed 0.9 kg/m^3 in irrigated area, while the average potential at research plots is greater than 1.66 kg/m^3 (Bhouri Khila et *al*., 2016). Crop management is generally inadequate and needs strengthening to improve cereal productivity under various cropping systems. This study was conducted in the region of Sidi Bouzid, located in the center-west of Tunisia, currently represents one of the main agricultural regions of the country. In this region, irrigation has known a remarkable development for decades. Irrigated

areas in the region increased by 60% between 1987 and 2014 **(**DGAT, 2016**)**. This region is marked by low water resources, which are increasingly in demand. (Hamdi et al., 2015). About 80% of these areas are irrigated from surface wells (12334 wells) and by deep drillings (1504 drillings) (DGAT, 2018). The problem of availability of water resources is even more accentuated and influenced by the temporal and spatial variability of precipitation (Ghazavi et *al.*, 2012; Hamdi et *al.*, 2015). In order to ensure optimal use and maximize water efficiency, it is necessary to adopt new techniques of irrigation water management through new approach of agricultural extension. To foster the adoption of technical innovations and improve yields, PRIMA initiated the SUPEOMED project (Sustainable Production in water limited environments of Mediterranean agro-ecosystem) from the 2019/2020 crop year in the region of Sidi Bouzid. This project is financed by PRIMA program Section1 and coordinated by University of Castile-La Mancha (Spain). It was designed to support farmers to manage crops irrigation, maximize grain crops production, and ensure sustainable development. The aim of SUPROMED is to enhance the economic and environmental sustainability of farming systems through a more efficient management of water, energy and fertilizers (SUPROMED, 2019). The most important implementations of this project include applied research trials and dissemination activities. These activities aimed to increase agricultural production and productivity through the development and promotion of soil moisture monitoring using sensors, new smart apps to schedule irrigation, efficient use of scarce water resources and promote the adoption of improved technologies. The approaches of dissemination activities carried out in the framework of the project are field days, training of farmers, field demonstration, farmers' field visits, lead famer approach, implication of local institutions and their regional advisory services, leaflets and brochures, audiovisuals etc.

2. Materials and Methods

2.1. Selection of the study area

The study was conducted in two municipalities in the region of central West of Tunisia (Figure 1). These delegations are Sidi Bouzid-West and Souk Jedid which belong administratively to the Governorate of Sidi Bouzid. The study area is under the influence of an arid climate. The average rainfall is around 250 mm/year. The average monthly temperature is around 19°C. The maximum temperature is recorded in July (33°C). The average evapotranspiration is around 131.5 mm/month. The average wind speed is 2 m/s with hot Saharan winds in summer and temperate winds in winter (Hamdi et *al.* 2015).

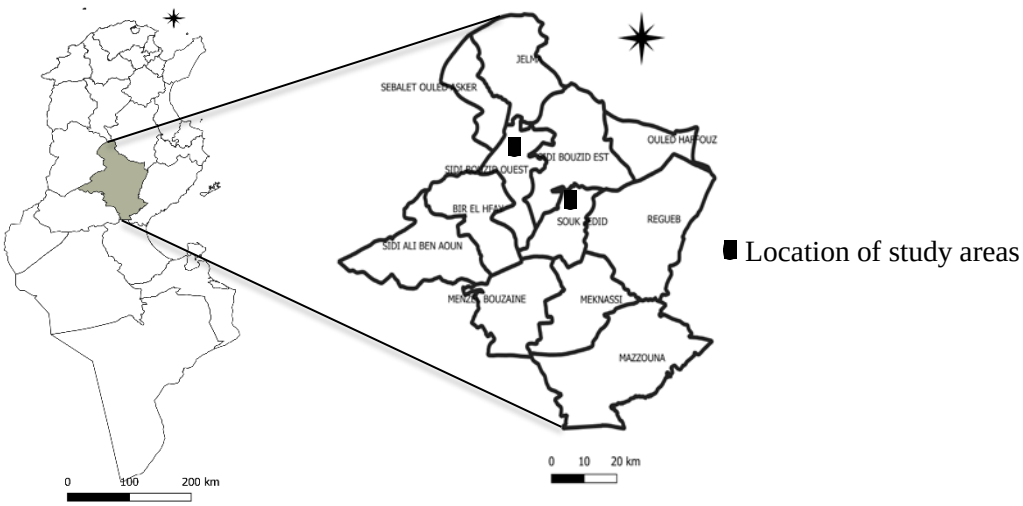

Figure 1. Geographic location of the study area

2.2. Data collection

The data and information comes from documentation and surveys with farmers. The total number of farmers monitored during the growing crop season 2020/2021 is 28. A sample of 17 farmers was chosen for the surveys. The data were collected during September, 2021 to November, 2021. The impact of the dissemination activities has been assessed through:

- The motivation of farmers to learn new practices and gain skills in irrigation management.

- The knowledge gained through the dissemination activities.

The project outcomes were evaluated through the estimation of 'potential profit increase' and the Return On Investment (ROI) (Lee and Kotler, 2011; Lee, 2010). To estimate the potential profitability increase of durum wheat crop we used midpoint price and yield for returns variable expenses above for irrigated minus midpoint for average farm fields, based on 2021 budgets. The ROI was obtained by dividing the potential profitability by the expenses to educate farmers on irrigation management (including personnel time and labor costs, equipment, etc.).

3. Results and Discussion

3.1. Disseminations activities

3.1.1. Demonstration plots

Establishment of pilot plots using water-saving irrigation techniques based on the right irrigation scheduling. The approach adopted based on the selection of 02 classes of farmers: 1) one leader farmer and 2) two average farmers. At the leader farmer level, the field was divided into two subplots: the first managed according to SUPROMED recommendations (mainly water management) and the second managed by leader farmer as he usually does. The same management as leader farmer was applied in the average fields. The monitored crops are durum wheat and forage oat. These crops are considered as strategic where their areas must be developed and their productivity increased. The SUPROMED plots used as demonstration to the averages farmers and to other farmers in the project area. They will be used to bring farmers together during field days or during farmer to farmer visits.

3.1.2. Field days

Farmers gathered in front of field demonstration of each leader farmers. The field days aimed to provide ample opportunities for farmers and stakeholders to interact and also learn about modern farming technologies being introduced and promoted by the project as well as share experiences that are useful to agricultural development. The most important topics of the field days were: irrigation management and irrigation system. Demonstrations soil moisture measuring tools in the fields were carried out to help farmers feel confident with their irrigation scheduling decisions. Moreover, the field days were concerned other topics, such as: varieties adaptation and soil preparation, basic fertilization, nitrogen fertilization, weed control, disease control and machinery adjustment. 06 field days were carried out during growing season 2020-2021. In order to make these field days a success, the project team sought to coordinate with local stakeholders to participate in the organization and inform farmers. The mission of the event is to share grain crops irrigation management strategies that can help farmers to apply the

right amount of water to their crops to produce top yields, reduce energy costs, leave more water in the aquifer, and avoid nitrate leaching.

Figure 2. Photos of some field days events in the study areas

3.1.3. Field visits

During the growing crop season 2020-2021, 21 visits to farmers' field were carried out. They aim to highlight existing experiences in irrigation and innovative production techniques, but also any needs and expectations that may be expressed on site by farmers in terms of technical advice. Many recommendations were provided in this project. These recommendations helped farmers to improve their knowledge on irrigation scheduling using new technologies such as the use of IREY smart app, MOPECO model and flow rate, pipe size, pump size and the best irrigation system for their farms.

Figure 3. Some photos of advisors visits

3.1.4. Lead farmer approach

The lead farmer approach is a participatory method for the transfer of technology to neighbor farmers. It was adopted by the SUPROMED project to disseminate good agricultural practices, which farmers learn from leader farmers, to ensure their adoption on a larger scale. The main goal is to create educated farmers on farming techniques especially on irrigation management. The leader famer can play a role as network “injection points” (Figure 4) or optimal entry points in maximizing and speeding up information and technology diffusion (Ragasa, 2020). The regular training of leader farmers has strong and consistent effects on the awareness and

adoption of most agricultural practices promoted. In the framework of SUPROMED project, 03 leader farmers in the two study areas were regularly trained on good agricultural practices of grain crops during a growing season.

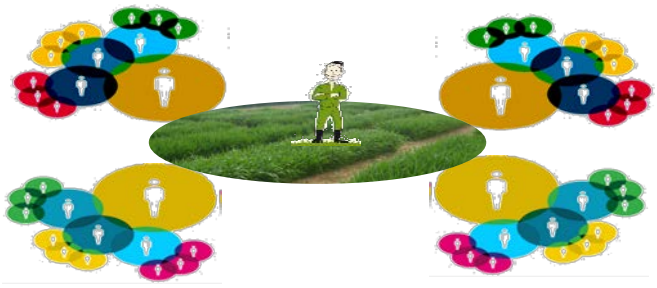

Figure 4. Illustration of lead farmer approach

3.1.5. New technology

- ***IREY smart app***

The Smart irrigation app "IREY" was developed to provide real-time irrigation schedules in Tunisia for selected crops (i.e., wheat, barley, sugar beet, oat and corn). Irrigation schedules in the Smartphone app and on the web was based on water balance methodology using weather data from multiple resources (Bouselmi et *al*., 2022). This app has been improved through the SUPROMED project, by integrating weather data from remote sensing such as rainfall and evapotranspiration. In addition, daily temperature data has been integrated to calculate the length of development stages using the growing degree-days. IREY has been used to advise farmers during field visits, field days, and warn them through Short Messages by recommending the right irrigation application at the right time.

- ***MOPECO model***

MOPECO is a Spanish model available on the web and ensures the management of the irrigation of a wide range of crops (field crops, vegetables, tree crops, etc.). The model estimates crop yield, production and gross margin as a function of the irrigation depth (Ortega Alvarez ´ et al., 2004). MOPECO has been calibrated for annual crops in Tunisia (i.e., durum wheat, Oat and onion) during two successive growing seasons 2019-2020 and 2020-2021. Then, the farmers and technicians of Sidi Bouzid were educated on the use of this model.

3.1.6. Short Message Service

SUPROMED adopted the Short Messaging Service (SMS) technologies as a tool to allow farmers and Extension Agents timely access to technical knowledge and to increase technology adoption. A database with the phone numbers of farmers and regional technicians has been created in order to send them information: 1) about the field days that will be organized, also 2) to send them alerts on irrigations events with the right dose and the right time and 3) concerning the technical package messages like fertilization, disease control etc. 54 farmers

subscribers in the SMS database in the study area. 09 SMS were sent during the 2020-2021 campaign on irrigation scheduling and 03 on the technical package.

3.1.7. Leaflets, brochures and posters

11 synthetic document were developed in the context of the project. The objective is to present in a synthetic way in the first hand activities of the SUPROMED project and second hand the best irrigation management and good agricultural practices. These documents aimed to increase agricultural production and productivity through learning and promotion of soil moisture monitoring, new smart apps to schedule irrigation.

Figure 5. Some leaflets and brochures elaborated through SUPROMED project

3.1.8. 3D video

The most influential, watched and shared content is undoubtedly the video format. it is an effective, fast solution, which has a great impact. The SUPROMED project produced a 3D video to promote IREY smart app and how to use it. This video is in Arabic with English subtitles. This video has been published on social media, so that it is available to a large number of users.

3.2. Project indicators

3.2.1. Participation in SUPROMED events

The majority of participants in SUPROMED events were farmers and they present 58 percent of participants, 50% of them farm have a fields between 5 and 10 ha. The participation of technicians from the region is also significant, at 23%. They will transfer the information and knowledge to other farmers.

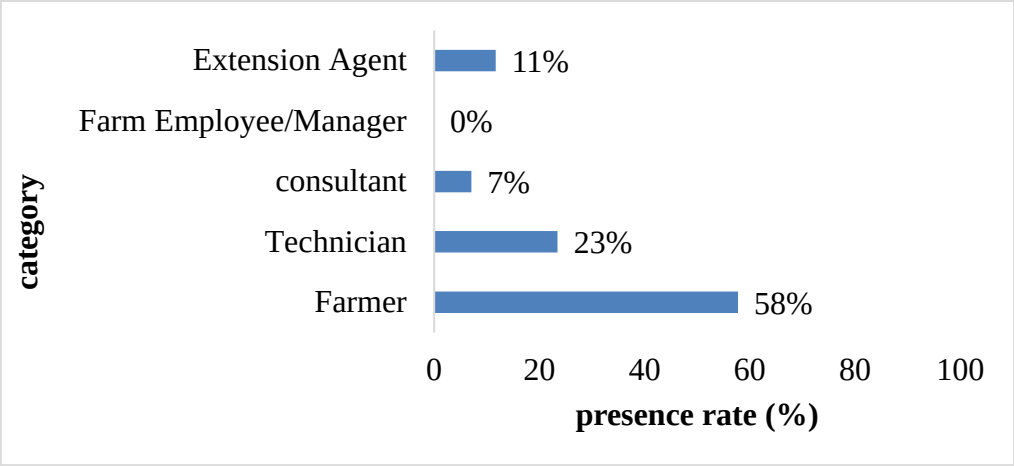

Figure 6. Attending rate in the SUPROMED events by category

3.2.2. Knowledge Improving

A majority of survey respondents reported increased knowledge about 71%. The increase in water efficiency takes second place with 64% of responses. A significant number of farmers answered that they change their management practices (43%).

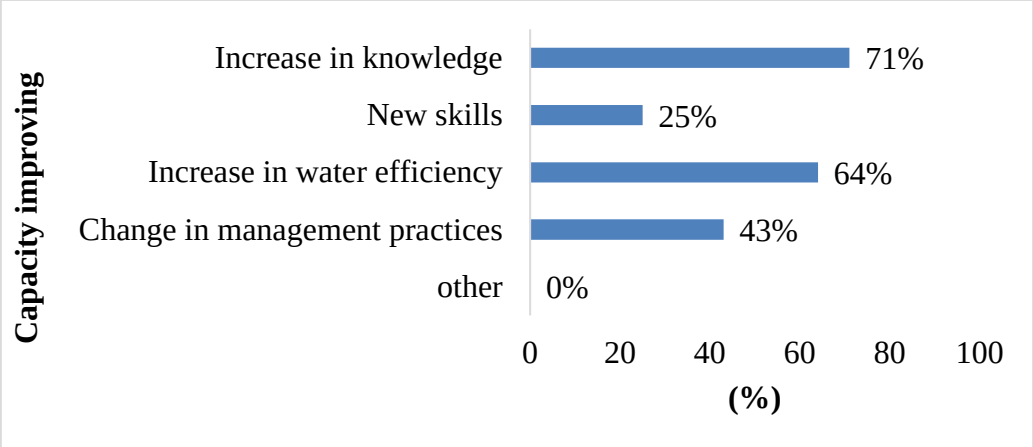

Figure 7. Survey results on Knowledge improving of farmers

3.3. Project Outcomes

One way to estimate a project's value relative to cost is through a series of calculations, known as Return on Investment (ROI). The total monetary cost to implement and evaluate this project during 2020-2021 growing season was 13468 €. The number of farmers who adopted the new technology of durum wheat of the project are 17, with 05 ha fields area. The benefit gained by dissemination activities by engaging in proper irrigation practices is 34,64 q/ha, with a potential profit increase of 119616 € for 85 ha. The ROI calculated in € is 9 to 1.

4. Conclusion

This study has contributed to understanding the structure of relationships of information transfer among SUPROMED project, farmers and institutions. A better irrigation scheduling and good agriculture practices of grain crops can enhance water efficiency, gaining an economic advantage for farmers while also preserving the environment. The dissemination approach

adopted in the project was characterized by diversification of methods of message transfer through 1) direct contact between extension agent and farmer by demonstration plots, field days and field visits or 2) indirect contact involving intermediaries such as Lead farmer approach, leaflets and brochures, SMS and audiovisuals and 3) new technologies like IREY smart app and MOPECO. This dissemination model let to reach a larger number of farmers. This approach provides the accurate, reliable and useful information to farmers timely. However, some weaknesses which could hinder the implementation of dissemination activities. There are mainly related to problems of trust among some farmers and institutions and the resistance to change; they keep using their traditional practices. The education level and age of farmers hinder the technology transfer process. Moreover, the participation of farmers at the field days and workshops was important, reflecting their interest in the information and knowledge provided by the project. The feedback from farmers showed that these activities increased their knowledge in good practices and water efficiency. ROI is useful in program planning because it provides an estimation of the costs and benefits of disseminations activities, as well as the monetary values that are associated with change. The results showed a benefit of 9 € against every 1 € spent by the project.

Acknowledgements

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