# Guidelines for sustainable water management in agriculture: Exploring new options

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# GUIDELINES FOR SUSTAINABLE WATER MANAGEMENT IN AGRICULTURE: EXPLORING NEW OPTIONS

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## ABSTRACT

A central issue around which the recent growth literature has evolved is that of sustainable development. In this perspective, expansions of interest in the analyzing of water resources and the problems to which they are applied should be taken in account. In order to reducing and rationalizing water consumption in agricultural irrigation in Tunisia, an essential factor for the protection of water resources and for a sustainable development, we propose some policy recommendations.
This article attempts to further analysis of the role of new options for a better management of irrigation water. It takes into account some potential forms of technological innovation for sustainable development. For this purpose, this paper tries to give some possible reflections that help us to develop the analytical tool that may help us to improving the way towards the amplification of the analysis paradigm.

**Keywords:** Sustainable development, water resources, water management, water use efficiency, irrigation, innovation.

## 1. INTRODUCTION

In recent years, agricultural water has helped meet rapidly rising demand for food, and has contributed to the growth of farm profitability and poverty reduction as well as to regional development and environmental protection. After several decades of publicly funded surface irrigation, and more recently of privately developed groundwater irrigation, remaining opportunities to harness new resources for agriculture are fewer and more expensive. Investment is increasingly focused on rehabilitating and improving the existing systems.

As considered a limiting factor for economic development, water management requires special attention. So, undertaking development of sustainable solutions to 21st century water resource problems becomes a strategic imperative. But, this is combined with some problems relating to the management of water. Water resources are becoming scarce. The most critical constraint facing the country is the growing shortage of water resources.

In Tunisia, the acceleration of agricultural development has stepped up the pressures on the country's water resources, triggering an increase in their demand accompanied by the deterioration of water quality. Water productivity remains generally low, and returns to public investment generally disappointing, especially in large-scale irrigation. New solutions are needed, based on new management options and widely available technologies. In addition, better governance, best practice sharing, market instruments and broader alliances are needed to avert a crisis.

## 2. METHODS

To understand the practices of irrigation by farmers and its impact on sustainable development, we chose a research strategy based on empiricism and hypothetic deductive method. To verify a causal relationship, we have chosen as unit of analysis the Tunisian farmers. These individuals, with different generations, practicing irrigated agriculture which relates their income. Their plots are mainly located in areas where there is a more or less significant volume of groundwater.

This work is based on responses from 50 people (men) questioned in situ, i.e. at their place of work (mostly fields) or at home. Sampling was done randomly but all use irrigation for at least a year. We tried to select a fraction to be the most representative of the reference population. Besides explanatory intends of this research, the significant number of farmers interviewed justifies our use of a questionnaire survey. We tried to get the richest and the most objective possible information, limiting the risks of reciprocal influence between the interviewer and the interviewee. we have tried to collect the information collected and then to treat them so that they are put into a form that can provide answers to various questions. Thus, we created a database with the "Excel" software. Then, all information is stored and analyzed in the SPSS software specially designed for this purpose.

## 3. AGRICULTURE AND WATER RESOURCES IN TUNISIA

The field of agricultural water management covers irrigation and drainage as well as water management in rained agriculture. Recent concerns about, on the one hand, rising food prices and food security and, on the other hand, increasing water scarcity, climate change, and the high proportion of water used in agriculture are drawing attention to the urgent need to improve water management. In a context marked by the search for food sufficiency and satisfaction of social needs of the population, governments have focused their efforts of operation of more intense the available natural resources and especially, water, farmland, rangelands and fisheries resources.

### 3.1. The role of agriculture in the economy of Tunisia

Despite the limited resources of land and water, agriculture plays an important role in the economy: it represents a tenth of GDP, exports and investment and employs almost one fifth of the workforce. It is a major source of income for many households in rural areas, which often supplement their income through non-farm activities. During the 10th Plan, the average growth in real terms of production was around 2.6%, but the overall production has largely kept pace with the growing population and economy. The coverage of all needs for food rose by 65% between 1987 and 1991 to 78% between 2002 and 2006.

### 3.2. Water resources in Tunisia

Water resources are increasingly in demand with the onset of severe phenomena overexploitation of groundwater causing salinisation and degradation of agricultural land particularly in irrigated areas irrigated with water containing salt. Fossil water southern oasis is not spared by this threat. More than 38% of groundwater is from this non-renewable fossil groundwater.

Tunisia, because of its location between the Mediterranean and the Sahara, is an arid country on the majority of its territory. This dryness, combined with the variability of the Mediterranean climate, water is a resource both scarce and unevenly distributed in time and space. The country has about 4250 million m3 of exploitable resources which 3598 million m3 considered renewable, for the year 2006, respectively, the equivalent of 420 m3 and 354 m3 per capita per year, while usage confused.

Water consumption in Tunisia is characterized by a large agriculture consumes water. In fact, this activity consumes about 82% of the available potential, followed by drinking water and industrial water. All socio-economic activities continue to evolve over the next period with increases in the quantities consumed water with the exception of the agricultural sector which is experiencing stagnation or even a decline from 2012.

## 4. RESULTS

The main results of the questionnaire are listed below:

- We found that nearly 86% of farmers (43 individuals) operating in areas suitable for irrigation. However, there remains a significant proportion (14%) who invests in areas not favorable to the operation of irrigation;
- On a sample of 50 individuals, there were 49 individuals (98%) who do not have a statement or a debit authorization waters although they operate in areas suitable for irrigation;
- Used plot size varies; it is from one hectare to 3 hectares for the largest, with a mean of 1.86 hectares. The median indicates that half of the individuals cultivate a parcel of at least 2 hectares;
- It was found that only 6% of farmers have a volumetric valve;
- Nearly 54% of operators install their irrigation equipment by themselves;
- In our simple, early 20% of the farmers use the runoff irrigation method;
- In a set of 50 farmers, we identified only four practicing the spray irrigation;
- The majority of farmers (72%) are engaged in drip irrigation;
- The consideration of the water needs of the plant during irrigation is high (70% of farmers take this into consideration). We also noticed that for 28% of the farmers (14 out of 50), this amount of water is determined on the basis of optimizing the performance or quality of the crop.

## 5. COMPREHENSIVE ASSESSMENT OF WATER MANAGEMENT IN AGRICULTURE

Truly integrated approaches to managing joint future water needs are required.

### 5.1. Rehabilitation and modernization of irrigation systems

- Having a debit authorization for water provide a framework for levies on land to prevent water scarcity and sharing sustainably and equitably this resource.
- Volumetric valve or other means to quantify the sampling is essential to help manage water resources and organize levies on the scale of a watershed.. The farmer must have a device (system and programming) correctly installed and functional. He must also know the amount of rainfall on or near its operations. To do this, he must have at least one rain gauge.
- Plots to uniform slope and low amplitude are well suited to irrigation because they reduce costly excavation. Apart from specific topographical conditions, the pipes channels are running freely, without being affected by inequality topographical and soil; and water losses and the amount of water is relatively low.

- The maintenance of the installation can prevent certain fungal diseases and can raise the appearance of water leakage. An irrigation system must be maintained, repaired over time. To remain effective, each piece must be replaced by a piece of identical characteristics. It is therefore important to keep all the technical information.
- To better conserve the amount of water, sprinkler irrigation is recommended in the following cases. This method of watering is discarded in regularly windy areas (winds greater than 4 or 5 m / s significantly degrades the homogeneity of the spray) and also when irrigation is done with salt water on the foliage of plants sensitive to salt.
- The drip irrigation allows limiting losses by evaporation and percolation. It also helps reduce weed growth. Therefore, the choice of irrigation system will determine his driving. A drip system is more efficient, but under certain conditions, the spray may be recommended. Note that this analysis is a static approach since we made observations in a given time.
- The drip irrigation has several advantages in terms of saving the amount of water in a sustainable development that aims to protection of groundwater.

## 5.2. Dissemination of technologies and knowledge

- The sustainable development policy should facilitate farmers' access to training in farming methods while ensuring optimal technology and infrastructure necessary for their implementation are available. So, it would be good that farmers can make use of existing tools and practices for the efficient use of water, but in rural areas access is often limited.
- Collaborations across sectors and within the chain of agriculture can contribute to that technology and knowledge useful to actually reach those who need it most.
- In this perspective, we should encourage partnerships between the public and private sectors because they can effectively share knowledge and facilitate access to inputs. Various partnerships may actually facilitate the distribution of agricultural inputs, such as seeds and plant protection products, the implementation of agricultural infrastructure, such as irrigation systems and the construction of transport links ensuring water accessibility to the most remote areas.

## 5.3. Water savings methodologies

Farmers can reduce their water consumption by adopting certain techniques and making the right choice:

- The amount of water varies with climate and species and the degree of evolution of the vegetation. Changes due to climatic factors are essentially variable from one year to the other after the regime of temperature, rainfall, wind, humidity, etc;
- We must choose the irrigation time. The dominant physical quality of the plant is its temperature. The optimum temperature may be about 25 ° for the majority of plants during the active season of vegetation. A supply of very dry water on the land can lead to the phenomena of hydration which may dangerously raise the soil temperature. Thus, the farmer must know the consequences of excessive irrigation;
- Select crops according to their water consumption and climate: focus on crops that need less water;
- Collect rainwater;
- Choosing the right material to reduce water losses;
- Start irrigation when necessary; take into account the water content of soil and climatic conditions;
- Check the equipment to detect leaks and repair them automatically.

In this context, the rational management of harvest, store and process, acquires a considerable economic and environmental importance and requires a long-term strategy involving large investments and maintenance programs that affect the real cost of water.

### 5.4. Policy issues

In order to boost innovation policy in the agriculture sector in Tunisia, an essential factor for the protection of water resources and for a sustainable development, we propose the following policy:

- The developed policy must give primacy to water safe and reliable so that agricultural production is sufficient to ensure food security.
- Effective political action to address climate change and mitigate its effects is a prerequisite.
- It is necessary to increase investments on agricultural research in the field of water crisis and generate solutions in the form of protective infrastructure and agricultural tools helping to limit and adapt to the conditions of chronic lack water.
- Innovation plays a key role in preserving the amounts of irrigation water. Thus, it would be good that developed policy is based on scientific information and facilitates continuous innovation and development of technologies to improve the rational use of water and agricultural knowledge.
- The State shall undertake to provide farmers with the technology they need to maximize the efficiency and rational use of water, while recognizing that effective fight against the lack of water involves measures of from all participants.
- Policy for the sustainable management of water must enable and promote farming methods most constant and most effective to optimize the use of water in agriculture.

### 5.5. Human resources development

So, and in view of the observations made above, additional efforts should be considered to better inform farmers. Effective information contributes to the training of farmers in good agricultural practices and allows preserving the maximum amount of water:

- Training programs provide farmers with relevant knowledge on local plan essential to apply the techniques most rational in water management, optimize the levels of agricultural productivity and farming methods more sustainable.
- A transformation in the culture of water will affect all those involved in the management of water, namely planners, executive officers as well as the different users. It will interest all features that organize water management hat is to say the technical, legal, institutional, economic, social, cultural and ecological aspects.

## 6. CONCLUSION

Put technological innovation for sustainable development is a complex challenge, because the concepts of innovation and sustainable development are both multidimensional. Also characterize the technologies for sustainable development, knowing that the characterization should not focus only on the technology itself, but also on the process of design and delivery. The key to sustainable development lies in the following three: technology, organizational innovation, changes in lifestyles.

The agriculture sector, a major consumer of water, is one of the main drivers of development. The debate on the governance of water is always present. Research and development is a serious improvement potential for the future of agriculture. Saving water is a vital issue of sustainable development. So, agricultures shouldn't deplete water resources. In our study on water in irrigation area Sadaguia we found mismanagement of water. This calls to improve innovation efforts in order to generate economies of

quantities consumed. Thus, to support the human and economic development and preserve ecosystems, more efficient management of water resources based on new methods are needed.

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