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The role of irrigation water management and improving agricultural soils in increasing crop productivity in light of the use of modern technologies

Mansour, H. A.*, M.S. Gaballah, Khalil, S.E., Pibars, S. K.

Water Relations and Field Irrigation Dept., Agriculture and Biological Institute, National Research Centre, 12322, Cairo, Egypt.

Abstract:

The aim of this research to performance analysis of irrigation water management and how to improving the agricultural soils for increasing the crop productivity under the conditions of modern agricultural technology. In such manner, I suggest the accompanying: 1. refreshing the water system techniques and disposing of the old strategies that prompted the consumption of the underground stock. 2. Sanctioning of boring wells so that each ranch has one well. 3. Focusing on the dirt through preparation the quality of natural treatment and diminishing the alkalinity of the dirt. 4. Building projects for modern re-energize of groundwater through boring and channels (Recharge through Pits and Shafts). 5. Consistently training ranchers about soil care, upkeep and conservation from saltiness. 6. Development of sorts of yields adjusted to the saline grounds, in a joint effort with the Center for Biosaline Agriculture in the country. 7. Expanding the quantity of tests taken for examination to incorporate a bigger region.

Keywords: Irrigation system, Water management, Agriculture, Soil fertility, Modern technology.

Introduction

Managing water resources in modern Egypt is a complex process that involves many consumers, shareholders, and capitalists who use water for irrigation, domestic utilities, industry and supply, hydropower generation, navigation and desalination. In addition, the Nile waters harmonize the ecosystems threatened by environmental pollution. Egypt also has large groundwater resources in the Western Desert. Egypt suffers from a major recent problem for its water resources, which is the imbalance between the increased demand for water and the availability of the available quantity. To solve this problem, it was necessary to coordinate with the ten Nile Basin countries, to ensure a future of abundant water. As a result, the Nile Basin Initiative holds a forum for such cooperation. In 1990, the Egyptian government launched three mega projects to increase irrigation on "new lands." It was located in the Toshka region in the New Valley Governorate, on the fringes of the western Nile Delta, and in North Sinai. These projects require large, continuous volumes of water that can only be mobilized through improved irrigation efficiency, wastewater reuse, and wastewater treatment on already irrigated "old lands.", (Hellal et al., 2021, Gaballah, et al, 2020, Pibars et al, 2020, Mansour et al, 2020a-d; Mansour and Aljughaiman 2020)

Water and soil are essential and important elements in human, animal or plant life, and their preservation, good management and development of their resources depends on their users in agriculture, industry or household purposes. Since the guidance bulletin is related to the agricultural aspect, we will discuss the use of water to irrigate agricultural crops and how to rationalize its use at the farm level. Groundwater is the main and important source for irrigating agricultural crops, due to the lack of rain, high rates of evaporation, and misuse of the irrigation process, which has led to a noticeable decrease not only in the quantities of groundwater extracted for agricultural purposes, but also in the deterioration of its quality. In order to preserve this important water resource, the state, represented by the Ministry of Environment and Water, has paid special attention to spreading water awareness through audio-visual devices, periodicals and lectures for workers in the agricultural sector. The rationalizing the use of irrigation water, In this bulletin, we also raise some questions about the reasons for the loss of irrigation water at the farm level and focus on its good management by knowing the factors that help in the process of rationalizing the use of irrigation water, (Mansour et al., 2019a-e, Hu et al., 2019, Abdalla et al, 2019, Jiandong, et al, 2019, Abd-Elmabod et al, 2019a-b, Tayel et al 2019a-c, Hellal et al, 2019, Mansour and Pibars 2019, Attia et al., 2019, Pibars and Mansour, 2019).

The point of this examination to execution investigation of water system water the executives and how to working on the rural soils for expanding the harvest efficiency under the states of present day horticultural innovation.

Agricultural water management

About 70 percent of the world's fresh water consumption is used in the agricultural sector, but the water-use efficiency in many countries is less than 50 percent. Nuclear and isotopic techniques provide data on water use, including losses due to evaporation from the soil, and help determine optimal irrigation schedules and improve water use efficiency. By 2050, the FAO predicts that global water needs for agriculture will rise by 50 percent in order to meet the growing demand for food caused by population growth. The world is seeing fresh water becoming an increasingly scarce resource, due to improper management, indiscriminate use and a changing climate. Water scarcity and water quality problems in many parts of the world represent a serious challenge to food security and environmental sustainability in the future. Addressing these issues requires improved land and water management. Together with FAO, the IAEA assists Member States in developing and adopting nuclear-based technologies to optimize agricultural water management practices, supporting intensified crop production and preserving natural resources.

Using science to improve water conservation

In order to ensure food security and sustainable management of water used in agriculture, there is an urgent need to increase crop productivity for every drop of water used in the agricultural sector and thus to ensure increased water use efficiency without negative impacts on the quantity and quality of water downstream. Improvements in handling water resources must be based on an integrated approach to managing soil, water, plants and nutrients. This should include determining optimal irrigation times and introducing more efficient irrigation systems, such as drip irrigation. Soil fertility has to be improved in order to ensure that crop growth is not constrained by nutrient or physical obstacles and that every drop of water can be fully utilized for growth. Efficiency in crop water uptake can be achieved by scheduling irrigation based on demand, taking into account the water needs of different crops, their growth stages and the prevailing environmental conditions. Agricultural water use efficiency can be improved by minimizing water losses due to evaporation from the soil compared to what is lost due to vegetation in fields. The ability to quantify soil evaporation and plant transpiration provides information on the amount of irrigation needed for specific crop types and growth stages, and this information plays a key role in water conservation and management.

The contribution of nuclear and isotopic techniques

Nuclear and isotopic techniques play an important role in providing the information needed to develop strategies for improving agricultural water management:

• The isotopic signatures of oxygen-18 and hydrogen-2 in water from field crops allow us to determine the distribution of irrigation water between soil evaporation and plant transpiration, thus providing information necessary to improve crop water use efficiency.

• Neutron sounding soil moisture measurement is an ideal tool for measuring soil water in the immediate vicinity of crop roots, providing accurate data on water availability. This technique helps to determine the optimum irrigation schedule and is the most appropriate tool for measuring soil moisture in saline conditions. It is also widely used to calibrate conventional humidity sensors.

• The nitrogen-15 isotopic signature is used to track the movement of tagged nitrogen fertilizers in soil, crops and water, which is essential to identify factors that can affect nitrogen fertilizer application efficiency and water quality in agricultural areas. The combined isotopic signatures of nitrogen-15 and oxygen-18 in nitrate enable the identification and separation of sources of nitrate pollution in agricultural drainage basins.

• Cosmic ray neutron sounding is used to assess water flows at the landscape level with the aim of developing strategies for sustainable management of land and water use.

Rationalizing the use of irrigation water

Why rationalization?

What are the reasons for the loss of irrigation water at the farm level?

There are many reasons, the most important of which are:

1. Irrigation networks.

2. The irrigation methods used.

3. Crop selection.

Irrigation networks:

Before starting the cultivation, it is necessary to focus on the design of the network, as well as the development of programs for the periodic maintenance of it. A- Network Design: The design of the irrigation network is established by knowing the following data:

♣ Quantities of irrigation water available on the farm after counting the number of wells and their locations

♣ On the farm, as well as the flow of each well to facilitate the process of providing water needs

♣ For crops in the required quantity and at the right time for irrigation.

♣ Topography of the farm to help the farmer know the cost of the required survey and determine

♣ The number and locations for laying the main and subsidiary irrigation pipes, valves, and others.

♣ Irrigation works in order to facilitate the service process on the farm. The type of crop to be planted and the cultivable area.

Figure 1. Irrigation systems networks types.

Network maintenance:

The maintenance of the irrigation network is one of the most important operations that help in raising the efficiency of irrigation. The farmer must take into account the following matters: ♣ Periodic maintenance of main and subsidiary irrigation pipes, pumping units and valves to ensure that they work with high efficiency in order to avoid water loss during operation. ♣ Ensure that drips, bubbles and sprinklers operate regularly and with high irrigation efficiency and do not suffer from blockage, especially during the use of relatively high salinity irrigation water. ♣ Installing the appropriate filters to remove the impurities suspended in the irrigation water. ♣ Washing the main and subsidiary pipelines at the beginning and end of each agricultural season and all that is necessary. ♣ Providing irrigation materials in the farm warehouse so that the lack of necessary materials does not cause disruption and delay in the maintenance process and consequently the loss of irrigation water at the farm level.

Figure 2. Irrigation systems networks maintenance.

Irrigation methods used:

Agricultural crops are irrigated by traditional irrigation methods (basins and faucets) and by modern methods (drip, bubbles and sprinklers). ♣ It should be noted here that traditional irrigation methods lead to the loss of irrigation water due to the low efficiency of irrigation when used, as it may reach (50% - 60%), and therefore water management at the farm level becomes a difficult matter that requires a lot of skilled labor and continuous follow-up while doing irrigation process. ♣ We recommend the use of modern irrigation methods (drip - bubbles and sprinklers) due to their high efficiency (85% - 95%), but it is necessary to know the type of crop to be grown and choose ♣ the appropriate way to add irrigation water. ♣ The correct choice of crop irrigation method helps in raising the efficiency of using irrigation water (meaning increasing production from the volumetric unit of irrigation water).

For example, the use of the drip irrigation method for the cultivation of the Rhodes and Rhodes crops has led to a decrease in the amount of added irrigation water compared to irrigation in basins (Jet crop) and sprinkler irrigation (Rhodes fodder).

The preliminary results of irrigating palm trees also showed that the drip irrigation method (24 liters / hour) is the best during the first five stages of date palm tissue cuttings cultivation.

Figure 3. Different irrigation systems networks.

Crop selection

Different crops need certain amounts (needs) of added irrigation water during their growth periods. Which means that we have to calculate what the crop needs of water to meet its needs? Emphasis should be placed on developing an irrigation program, taking into account the following factors: Climatic data, soil type, different stages of crop growth, cultivation method ♣ (open field or protected cultivation) ♣ It is also necessary to know the quality of the added irrigation water, as plants differ in the extent to which they tolerate the quantities of dissolved salts in the water and the quality of its constituent elements, as this affects production. Salts also affect the soil (secondary salinization). ♣ In the case of irrigating crops with water of a sensitive quality to the plant, it is necessary to add the seedlings needs (meaning additional quantities of irrigation water in order to wash the dissolved salts in the irrigation water present in the soil. These quantities are calculated through equations that take into account the salinity of the irrigation water and the salinity of the soil, as well as the method of irrigation used.

Figure 4. Different crops under irrigation systems networks.

The role of the farmer:

♣ Using trained labor to carry out various agricultural works, including the irrigation process. ♣ Submitting observations to the competent authorities through the agricultural extension agents who are considered ♣ The link between the farmer and the engineer/specialist. ♣ Participation in conducting applied experiments on his farm (allocating an experimental field to an application ♣ Agricultural Research Outputs) ♣ Commitment to research outputs, especially in the field of irrigation, as we believe that ♣ Water, not land, is the most important in irrigated agriculture.

The role of the authorities:

♣ Conducting applied research related to farmers' problems and focusing on introducing modern technologies to raise production and preserve water resources. ♣ Strengthening the role of agricultural extension by providing the Agricultural Extension Department with extension workers with scientific and practical qualifications. ♣ Awareness of farmers through audio-visual devices and their participation while conducting field experiments on their farm. ♣ Rehabilitation and training of cadres locally and abroad. ♣ Developing water legislation and following up on its implementation through the relevant institutions ♣ To reduce random digging, excessive pumping, and the use of groundwater for non-agricultural purposes. Requiring farmers to use modern irrigation methods (drip, bubbles, sprinklers) in coordination with the Agricultural Extension Department of the Ministry and researchers in agricultural research centers in the country irrigation improvement program Providing water to the agricultural sector is one of the main strategic objectives behind which Egypt aims to secure enough water to serve the growing population with limited resources. But the extent of potential savings in water and agriculture, and how best to achieve such an achievement, have caused some controversy. While the efficiency of irrigation at the field level may be low due to the predominance of flood irrigation, the efficiency of the general system is generally high due to the return of flows. Water conservation strategies in Egypt do not focus much on water-saving irrigation techniques such as sprinkler irrigation or drip irrigation. Instead, it is based on the experience of farmers who lack the factor of estimating time and quantities of water supply, they irrigate at close times to each other and waste a lot of water. The feasibility of saving water in Egyptian agriculture was evaluated for the first time through some pilot projects in the framework of water use The USAID-funded Egypt Water Use and Management Projects (EWUP) started in 1977. The program showed that in order to achieve water savings, it is important that farmers are allowed to participate more in irrigation management through water user associations, to provide Continuous flow instead of alternating flow in branch canals, to replace watering cans, to replace individual, select pumps, and to establish an irrigation advisory service. To be followed by the development of field irrigation systems and direct pricing of irrigation water in later stages, based on the lessons learned from the “Water Projects Use and Management Program” and the government’s strategy for the National Program for Irrigation Improvement in 1984, which was approved by the National Assembly in 1985. The strategy, with the support of USAID, was initiated in eleven pilot areas, starting with the Surrey Canal with 120,000 acres (50,400 hectares) in Minya Governorate.

Improving Soil Fertility:

Soil fertility is the ability of the soil to support the growth of plants and to achieve an optimum level of crop yield. Fertility can be improved by adding organic and inorganic fertilizers to the soil. Nuclear techniques provide data that improve soil fertility and crop production while minimizing environmental impact. Improving food security and environmental sustainability in agricultural systems requires an integrated approach to soil fertility management, maximizing crop production while minimizing the depletion of soil nutrient stocks and the degradation of soil physical and chemical properties that can lead to Land degradation, including soil erosion. Soil fertility management practices under such an approach include the use of organic fertilizers and inputs, crop and legume rotation, and the use of improved genetic material, combined with knowledge of how to adapt these practices to local conditions.

The Joint FAO/IAEA Division for the Use of Nuclear Techniques in Food and Agriculture assists Member States in developing and adopting nuclear-based technologies to improve soil fertility practices, thereby supporting crop production intensification and the conservation of natural resources. Various approaches to efficiently manage soil fertility Integrated soil fertility management aims to achieve maximum efficiency in agricultural use of nutrients and to improve crop productivity. This can be achieved by using grain legumes that enhance soil fertility through biological nitrogen fixation, and by using chemical fertilizers. Whether grown for grain, green manure, pasture or as a tree component of agroforestry systems, leguminous crops are of key value in their ability to fix atmospheric nitrogen, which helps reduce the use of commercial nitrogen fertilizers and enhances soil fertility. . Nitrogen-fixing legumes are the foundation of sustainable farming systems that include integrated nutrient management. The use of nitrogen-15 ensures an understanding of the dynamics and interactions between many groups of elements of farming systems, including nitrogen fixation by legumes and the utilization of soil nitrogen and fertilizer by crops, in both mono-crop and mixed cropping systems. Soil fertility can be further improved by incorporating cover crops that add organic matter to the soil, which leads to improved soil structure and contributes to healthy and fertile soils; and by using green manure or growing legumes to fix the nitrogen in the atmosphere through the process of biological nitrogen fixation; and through the use of precise doses of fertilizers, with the aim of compensating for the losses resulting from the uptake of plants and other processes; and by minimizing losses due to leaching down the root zone of crops through improved water and nutrient use.

The contribution of nuclear and isotopic techniques

The isotopes of nitrogen-15 and phosphorous-32 are used to track the movement of tagged nitrogen and phosphorous fertilizers in soil, crops and water, providing quantitative data on the efficiency of use, movement, sediment effects and transformations of these fertilizers. This information is useful in designing improved fertilizer application strategies. The nitrogen-15-based isotopic technique is also used to estimate the amount of nitrogen fixed from the atmosphere through the biological nitrogen fixation process of leguminous crops. The carbon-13 isotope signature helps quantify the incorporation of crop residues for soil stabilization and fertility improvement. This technique can also be used to assess the effects of soil conservation measures, such as incorporation of crop residues, on soil moisture and quality. This information makes it possible to determine the origin of soil organic matter and the relative contribution of different types of crops to it. Anti-soil erosion Soil erosion is a major global threat to the sustainability of agricultural ecosystems and land productivity. Fallout radionuclides and stable isotopes are used to measure the magnitude and sources of soil erosion, which can be controlled through efficient soil conservation practices. Globally, the area affected by land degradation is currently 1.9 billion hectares, or about 65 percent of the world's soil resources. Soil erosion is the largest contributor to this degradation, at 85 percent. Approximately 1.5 billion people - a quarter of the world's population - depend directly on food production from degraded lands. The world's agricultural systems lose more than 36 billion tons of fertile soil annually as a result of soil erosion. The economic cost associated with on-farm and off-farm soil erosion is estimated at $400 billion annually. Together with the FAO, the IAEA helps Member States strengthen capacities to use nuclear and isotopic techniques to improve soil erosion control practices, supporting crop production and conserving natural resources. Loss of topsoil threatens food security Intensive agriculture and deforestation are major causes of land degradation involving soil erosion, leaving large areas vulnerable to the loss of the fertile top layer of soil. This, along with the nutrients and chemicals associated with this soil loss in water bodies, poses a serious threat to sustainable agricultural production, environmental protection and food security in many regions around the world.

Conclusion:

In this regard, I recommend the following: 1. updating the irrigation methods and getting rid of the old methods that led to the depletion of the underground stock. 2. Legalization of drilling wells so that each farm has one well. 3. Paying attention to the soil through fertilization The characteristic of organic fertilization and reducing the alkalinity of the soil. 4. Building projects for industrial recharge of groundwater through drilling and canals (Recharge through Pits and Shafts). 5. Regularly instructing farmers about soil care, maintenance and preservation from salinity. 6. Cultivation of types of crops adapted to the saline lands, in coordination with the Center for Biosaline Agriculture in the country. 7. Increasing the number of samples taken for analysis to include a larger area

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