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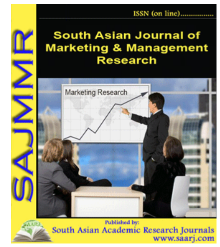

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WATER, AGRICULTURE, AND FOOD: ISSUES AND CHALLENGES

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ABSTRACT

Population growth, rising food demands, increasing competition for water, decreased supply reliability, climate change, climate uncertainty, and droughts, decline in critical ecosystem services, competition for land use, changing regulatory environments, and less participatory water resource governance are all contributing to increased difficulties and challenges in water resource management. The need for sustainable food security for our global population, as well as the need to protect the environment, including natural and man-made ecosystems and landscapes, has increased the demand for integrated, participatory, and scalable solutions that focus on various levels of irrigation and nature water management, from field crop to catchment and basin scales. Meanwhile, in the last 30 years, the challenges and issues surrounding water management for agriculture and food have evolved dramatically, and the role of active management of the components of the water cycle is becoming increasingly important, as their dynamics are critical to ensuring water use sustainability, particularly in agriculture and natural ecosystems. Different areas, however, confront unique problems related to water shortages, climate, governance, and population demands. The most significant and immediate issue is providing adequate food for a rising population, which is inextricably linked to agricultural water management challenges, particularly irrigation management. This study examines the difficulties and gains made in irrigated agriculture over the past 30 years, with an emphasis on water management and its contribution to food security and rural community well-being.

KEYWORDS: *Crop water requirements, Energy, Evapotranspiration, Irrigation management, Water governance, Water management, Water scarcity.*

1. INTRODUCTION

Agriculture's primary challenge is to produce enough food for a growing population in a complex environment that includes population growth and urbanization, poverty, increased food demands, ever-increasing competition for water and land, climate change, climate uncertainty, and droughts, variable supply reliability, decline in critical ecosystem services, and changing regulatory environments. This problem and its ramifications are inextricably linked to difficulties in agricultural water management, particularly irrigation management, as discussed further in this article. On those different issues, numerous research and information are being generated, especially in relation to food security and nutrition (FSN)[1]. FAO is releasing a series of studies on different aspects of FSN, including climate change's effect on FSN and water-food connections. Among the related recommendations are: (a) ensuring sustainable ecosystem management and conservation for stable availability of water of appropriate quality; (b) an integrated approach to water and FSN policies; (c) improved water management in agriculture and agricultural system adaptation to improve water use performance and water productivity, particularly in the face of water scarcity; and (d) fostering a culture of water conservation. It's worth noting that, although accounting for just 16 percent of cultivated land, irrigated agriculture is projected to provide 44 percent of global food by 2050[2].

The Centre International de Hautesétudesagronomiquesméditerranéennes(CIHEAM) took a unique but complementary strategy to promoting the development of knowledge needed to achieve food security in the Mediterranean, including water problems with those related to other natural resources such as land, climate, biodiversity, and energy. Meanwhile, given the importance of energy resources in the food chain, from the field to the consumer, the integrative idea of Water-Energy-Food Nexus is gaining traction, leading to its acceptance by a number of organizations[3]. Others added the component land use, which highlights the rationale for land use rivalry with non-agricultural sectors, as well as the need of land preservation and landscape conservation.

This article examines a variety of methods to water and energy problems and issues in agricultural processes, with a particular focus on food production. Then there's irrigation water usage, with an emphasis on the problems that come with water use and consumption, as well as irrigation water management, with the goal of evaluating the role of this Journal in innovation in these areas.

2. DISCUSSION

2.1. Water, Energy and Food Nexus:

Irrigation's function in boosting food production has been studied for a long time, but previous methods were restricted in scope, for example, just examining the effects of irrigation performance on food output. Carruthers et al. examined the need for increased food production from irrigation, concluding that not only is efficient expansion and intensification of irrigated agriculture required, but there is also a need to better understand the links between water scarcity, food production, food security, and environmental sustainability[4]. De Fraiture also mentioned the necessity for an integrated and interdisciplinary modeling method to investigate the links between economic trends, agricultural policy, and water usage, and proposed the WATERSIM model to accomplish these goals[5]. Hanjra et al. conducted a review of factors influencing FSN, particularly those related to water, by examining the links between water supply and food security, with a focus on climate change adaptation, land and water conservation, crop development and adoption, irrigation modernization, and international food trade reform[6]. Rosegrant et al. looked at the effects of water shortage on agricultural water usage and the implications for FSN[7]. These writers addressed policies, institutions, and investments required to guarantee availability to water for food production, as well as soil deterioration, groundwater depletion, rising water pollution, the destruction of water-related ecosystems, and inefficient use of previously established water resources. In their review, few authors focused on the utilization of non-conventional water for food production in water-scarce areas.

When examining the referred integrative concept of Water-Energy-Food Nexus as shown in Fig. 1, it is clear that complexity is added in comparison to the sole consideration of water-agriculture-food interactions: on the one hand, it brings challenging questions about energy into consideration; on the other hand, virtual water enters the picture. The latter is a tough notion to grasp: it is reasonable to include the transfer of water incorporated in food items, particularly grains, but how this transfer is understood is debatable. Virtual water may be useful from a commerce standpoint, but it has little use as a sensible water management problem.

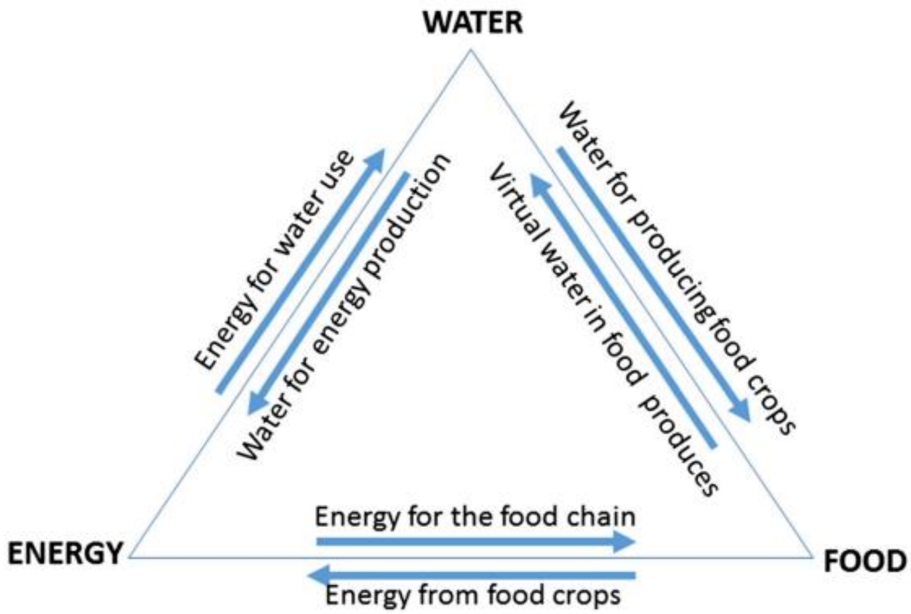

Fig. 1 A schematic representation of the Water Energy Food Nexus[8]

2.2. Food, Irrigation, and Cropping Systems Nexus:

Food production has seen a lot of innovation in the past 30 years, especially in terms of cultivation methods, new crop types, and irrigation. However, the majority of the improvements are technical, and they have not been followed by changes in farmer involvement in water and irrigation system administration. The difference between small and big farms has widened, with the latter adopting a range of contemporary technology and management solutions, as well as continuing to embrace current research findings, especially precision agriculture in commercial farms. Smallholders, on the other hand, suffer financial shortages, limited access to better technology and innovation, lack involvement in water governance, and are often afflicted by poverty. Land fragmentation is substantially linked with inefficiency and poor farm profit in India, while land ownership and crop variety are associated with agricultural efficiency. Small farms, on the other hand, are more intense and may be more efficient in their use of inputs than big farms. Climate, cropping orientation, access to land property, and the kind of political authority all make a difference. Nonetheless, improvements in water management are significant; if they are more readily adopted by big and commercial farms, they contribute to small farm intensification, better resource use, and increased land and water productivity, for example, drip irrigation.

The Food-Irrigation-Cropping Systems Nexus is shown in Figure 2. Its goal is to show how agricultural systems differ depending on the food crop in question, as well as local knowledge and socio-cultural factors. Irrigation may play a key part in the chosen farming systems to support the crop's suitable water requirements, depending on the local climate, soils, land characteristics, and water availability. Finally, food product qualities, customer and market preferences, and agro-industry needs all influence irrigation management in terms of water deficit control and scheduling. The Food-Irrigation-Cropping Systems Nexus, on the other hand, varies with farm size and orientation, as well as access to technology and money, as mentioned briefly above, and reflects poverty effects.

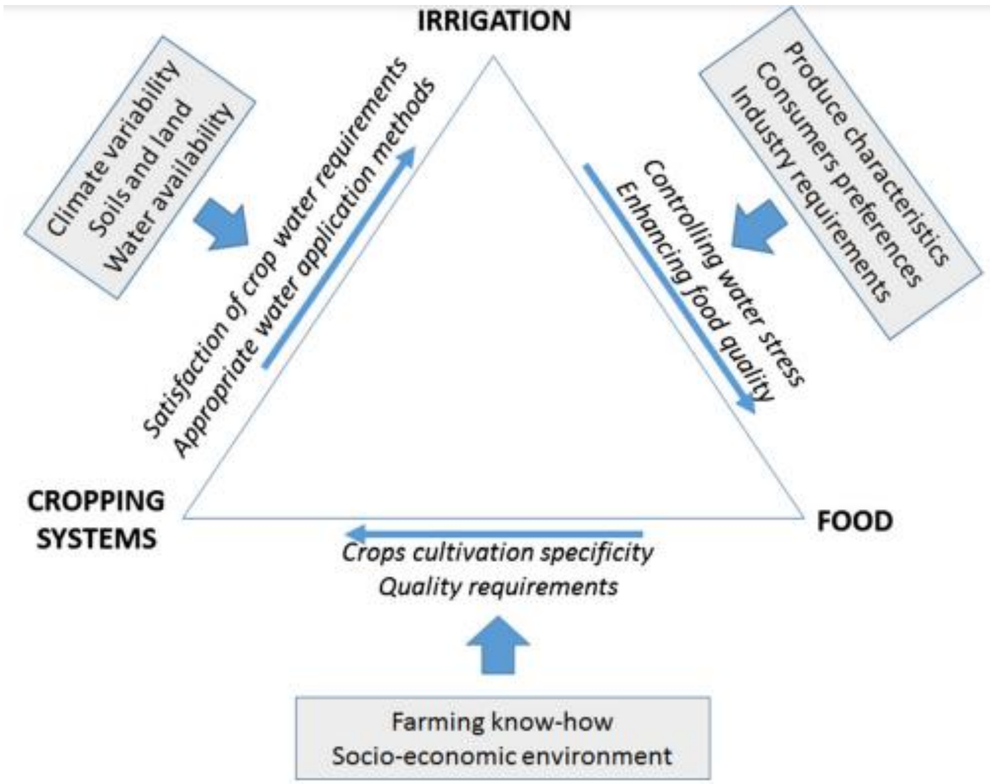

Fig. 2 A schematic representation of the Irrigation-Cropping System-Food Nexus[9]

2.3. Irrigation and Agricultural Water Management Innovation and Challenges:

2.3.1. Reference Crop Evapotranspiration:

The two-step crop coefficient – reference evapotranspiration ($Kc – ET_{ref}$) method was developed worldwide by Doorenbos et al. to estimate crop water needs in a practical manner[10]. The crop coefficient (K_c) adjusts the reference ET to account for crop-specific impacts on ET and their change throughout the crop growing season. ET_{ref} reflects the main weather-induced effects on water consumption. Standardized Kc values at typical crop stages were given for a variety of crops, and four techniques for estimating ET_{ref} were suggested depending on data availability.

ET_{ref} is defined as the rate of evapotranspiration from a hypothetical reference crop with an assumed crop height of 0.12 m, a fixed daily canopy resistance of 70 s m1, and an albedo of 0.23, which closely resembles evapotranspiration from an extensive surface of green grass of uniform height, actively growing, completely shading the ground, and not short of water. This formulation allowed the Penman-Monteith (PM) equation to be parameterized, resulting in the PM-ET_o equation, a standardized grass crop reference (ET_o) equation. ETo is often referred to as potential ET, especially in hydrologic research. The PM-ET_o equation's parameter calculation was also standardized. The PM-ET_o was chosen as a worldwide applicable reference technique on the basis that physics are physics everywhere. As a result, if the physics-based PM-ETo technique is properly set up utilizing high-quality weather measurement data from a few sites, it should suffice as a worldwide foundation for crop ET. Comparative investigations of PM-ET_o and local ET measurements, as well as regional studies, have substantially proven the PM-ET_o equation's applicability to a wide range of settings.

2.3.2. Crop Water and Irrigation Requirements:

Crop water needs (CWR) during a crop season or a specific time period are considered to equal the total of crop ET (ETc, mm) for that time period. The net irrigation needs (NIR) are the net depth of water needed to meet CWR in addition to available soil water in the root zone, precipitation and capillary rise, and the depth of water required for salt leaching in the root zone. The ratio NIR/BWUF, where BWUF is the beneficial water usage percentage of the applied water, is used to calculate gross irrigation needs (GIR), which are the consequence of inefficiencies in irrigation water application[11]. CWR is derived from ETc, while NIR is derived from the crop root zone's soil water balance, which often necessitates the employment of models.

2.3.3. Irrigation Scheduling and Management:

To achieve excellent yields and profitability, effective water usage, and manage irrigation's environmental effects, proper irrigation scheduling (IS) is required. Fertilizer timing has long been thought to be linked to IS, resulting in better yields and less nitrogen pollution and greenhouse gas emissions. Farmers' knowledge or observations of plant water status and/or soil water monitoring, as well as remote sensing plant water status, may be used to determine irrigation frequency. Furthermore, models are often used to assist farmers' IS advice, particularly when combined with remote sensing data. These methods necessitate a decision on irrigation depths, which is usually made using models or automated devices. Precision irrigation is the application of these technologies, which include a wide range of measurement and wireless communication devices, on commercial farms, primarily for tree and vine crops, and with pressured irrigation, which is frequently automated. IS choices are determined by soil water holding capacity, crop type (vegetables vs. cereals), and irrigation method (infrequent irrigation with big depth for surface irrigation vs. frequent irrigation with tiny depths for center-pivots and micro-irrigation, as previously discussed). Furthermore, IS choices are influenced by food crop quality needs, which are mostly determined by customer preferences and industry, as well as water availability, which may necessitate the use of deficit irrigation.

3. CONCLUSION

While considering both the food-water-energy nexus and the food-cropping systems-irrigation nexus, the significance of water and irrigation in supporting food security was addressed. Despite the fact that irrigation varies in space and with the socio-economic and environmental circumstances of the people, it has been shown that irrigation may play a dominating role in FSN settings. Increased food crop yields, particularly grains, were clearly affected by fertilizer use, better crop cultivation techniques, and direct and indirect energy use, but it was also apparent that water and irrigation are critical for achieving food security and feeding the world's growing population. However, it should be emphasized that environmental sustainability must be closely linked to food security.

Progress in irrigation, particularly of food crops, shows that the conditions are in place to achieve appropriate FSN: crop evapotranspiration processes are becoming better understood, leading to advances in estimating crop water and irrigation requirements; irrigation scheduling has advanced dramatically as crop water use becomes better understood, allowing computer modeling to provide advice to farmers. WARM is helping to disseminate information on these topics, primarily in relation to drought and water shortage problems and issues, as well as off-farm pressurized system design, management, and energy control. However, a few other challenges require better solutions, such as controlling increased water competition between sectors, making water allocation mechanisms fair and transparent, improving water actors' participation in water governance, and recognizing and protecting the interests and rights of all users, particularly the most susceptible and disadvantaged, necessitating the development of a new gender paradigm in water use and irrigation and contributing to the welfare of village population.

REFERENCES

1. L. S. Pereira, "Water, Agriculture and Food: Challenges and Issues," *Water Resour. Manag.*, 2017, doi: 10.1007/s11269-017-1664-z.

2. H. Green *et al.*, "Healthy and sustainable diets for future generations," *J. Sci. Food Agric.*, 2018, doi: 10.1002/jsfa.8953.

3. C. de Fraiture, D. Molden, and D. Wichelns, "Investing in water for food, ecosystems, and livelihoods: An overview of the comprehensive assessment of water management in agriculture," *Agric. Water Manag.*, 2010, doi: 10.1016/j.agwat.2009.08.015.

4. I. Carruthers, M. W. Rosegrant, and D. Seckler, "Irrigation and food security in the 21st century," *Irrig. Drain. Syst.*, 1997, doi: 10.1023/A:1005751232728.

5. C. De Fraiture, "Integrated water and food analysis at the global and basin level. An application of WATERSIM," 2007, doi: 10.1007/978-1-4020-5591-1-12.

6. M. A. Hanjra and M. E. Qureshi, "Global water crisis and future food security in an era of climate change," *Food Policy*, 2010, doi: 10.1016/j.foodpol.2010.05.006.

7. M. W. Rosegrant, C. Ringler, and T. Zhu, "Water for agriculture: Maintaining food security under growing scarcity," *Annu. Rev. Environ. Resour.*, 2009, doi: 10.1146/annurev.environ.030308.090351.

8. C. Zhang, X. Chen, Y. Li, W. Ding, and G. Fu, "Water-energy-food nexus: Concepts, questions and methodologies," *Journal of Cleaner Production*. 2018, doi: 10.1016/j.jclepro.2018.05.194.

9. I. El-Gafy, "Water–food–energy nexus index: analysis of water–energy–food nexus of crop's production system applying the indicators approach," *Appl. Water Sci.*, 2017, doi: 10.1007/s13201-017-0551-3.

10. J. Doorenbos and W. O. Pruitt, "Guidelines for predicting crop water requirements," 1977.

11. L. S. Pereira, I. Cordery, and I. Iacovides, "Improved indicators of water use performance and productivity for sustainable water conservation and saving," *Agric. Water Manag.*, 2012, doi: 10.1016/j.agwat.2011.08.022.