Chapter 193

Evaluation of water use in agriculture: Problems and solutions

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ABSTRACT
Water, an essential substance for the existence and survival of the most diverse forms of life, may become scarce in this century, becoming as precious as oil. However, despite having a sufficient volume for the supply of fresh water, suitable for the consumption of the population, its geographic layout is disproportionately presented, being adversity, due to the non-uniformity of the distribution. As a result, countries with more than 40% of the world's population already exceed the supply of this water resource, and it is predicted that by 2025, there will be a 50% reduction in the per capita water supply, affecting various fields, such as agriculture, where it plays an important role in food security. The water used in the agricultural field has the purpose of growing fresh produce, sustaining livestock, cooling crops, controlling frost, and irrigation, which corresponds to almost 65% of freshwater withdrawals in the world. In this context, the present work aims to evaluate the problems related to the use of water in agriculture and the solutions that can be implemented.

1 INTRODUCTION

Water, a chemical substance formed by two atoms of hydrogen and one of oxygen, is an abundant natural resource on the planet, being essential for the existence and survival of the most diverse forms of life, however, even in this century, it can become as precious as oil, making it even more scarce (CHAKRABORTY, 2021).

Although the total volume of water available by the hydrological cycle presents a sufficient amount of volume to supply adequate fresh water to the population, the geographic disposition of these waters becomes adversity, due to its distribution not being uniform, therefore, some specific regions present greater, leaving other areas with a deficit of water resources (IJIOMA, 2021; VAIDYA, 2022).

Due to this inequality in the distribution of water resources, together with the population density around the world, the demand for these resources already exceeds the supply in several countries with more than 40% of the world's population. Furthermore, it is projected that by the year 2025, there will be a 50% reduction in per capita water supply, affecting the population and various fields such as agriculture (YUNUSA et al., 2018)

Water is a fundamental input for agricultural production and plays an important role in food security. The world demand for food production increases progressively at very high rates (CHAUHAN & KUMAR, 2020). Agriculture is the biggest user in terms of water consumption, with 65 – 75% of the freshwater used for irrigation, however, in some cases, the amount of water used can be up to 90% (REUTTER et al., 2018)

Agricultural water is the water used to grow fresh produce and sustain livestock, allowing us to grow fruits and vegetables and raise livestock, which is an important part of our diet (ZAHOOR et al., 2019). Agricultural water is used for irrigation, crop cooling, and frost control, among other things. According to the United States Geological Survey (USGS), water used for irrigation accounts for nearly 65% of the world's freshwater withdrawals, excluding thermoelectric power (MALO, 2020)

Some factors that can contribute to and affect water availability

of irrigation, as well as the quality: (I) Hereditary scarcity of water in some areas due to the geographic location where the precipitation index is very low, making the use of groundwater not feasible, due to economic reasons and transportation; (II) Increasing the intensity of cultivation on land that has already been cultivated and that consumes more water/unit of cultivated area; (III) Cultivation of crops on virgin lands that require a significant additional amount of water (horizontal expansion of water from irrigated agriculture), where this expansion has deteriorated the quality of groundwater and surface water in places where marginal lands were cultivated without having carried out an adequate management practice; (IV) Significant increase in the volume of good quality water, both industrially and domestically, due to population growth and higher living standards, which require greater demand; (V) Contamination of surface and underground water resources by a variety of point and diffuse sources of pollution. Because of this, agricultural water management must be increasingly integrated with other environmental and water management objectives (MASSARELLI et al., 2021; WANG et al., 2021). In this context, the present work aims to evaluate the problems related to the use of water in agriculture and the solutions that can be implemented.

2 PROBLEMS RELATED TO WATER IN AGRICULTURE

Agriculture can bring many benefits to human civilization, however, at the same time it brings a series of problems to the environment and living beings, such as:

2.1 DEGRADATION OF ENVIRONMENTAL AREAS (LANDSCAPE MODIFICATIONS)

According to SAMPAIO et al. (2021), the scenario determined for carrying out agricultural activities undergoes modifications, starting with the deforestation and replacement of native vegetation by cultivated vegetation with a different life cycle, where the shrub and tree vegetation of the Caatinga, predominant in the semi-arid region, is replaced by herbaceous pastures or short-cycle crops. In addition, the use of water with high salt content, poor use of wetting cycles, and non-use of drainage can lead to salinization.

2.2 AIR IMPACT

According to Bittencourt (2009), agriculture affects the quality of the air and atmosphere due to the production of CO_2 due to fires; methane that comes from rice production; nitrous oxide from fertilizers and manure; and ammonia from manure and urine. In addition, the burning of biomass to clean soil for planting emits various polluting substances into the atmosphere, which is a very common practice, but the pollution extends to regions beyond the origin of the fires.

2.3 IMPACT ON WATER

The inadequate use of water in agriculture can cause several pollution problems, including:

2.3.1 Esgotamento dos lençóis freáticos

The depletion of groundwater is becoming an environmental problem, mainly in developed and developing countries, and this happens when water consumption reaches and exceeds the natural rate of water replacement, with this, problems occur mainly in the economy and damage serious and even irreversible environmental damage. The excessive use of these waters in coastal areas ends up causing salt water to contaminate aquifers, making them unsuitable for irrigation and consumption without treatment with large expenditures of economic resources (BIERKENS & WADA, 2019)

2.3.2 Flooding and Salinization

The incorrect use of irrigation, such as excessive use and inadequate drainage, has led to several problems such as flooding, which occurs with the elevation of groundwater levels, impairing plant growth and soil structure (OZSAHIN et al., 2022).

Already in salinization, the accumulation of dissolved solids in water and soil increases and can occur in irrigated and non-irrigated areas, as very susceptible soils, with about 20% of the total area being affected, and can no longer be used. Semi-arid countries have 10 to 25% of their irrigated areas affected by salinization (RENGASAMY et al., 2022).

2.3.3 Pollution by fertilizers

According to BIJAY-SINGH and CRASWELL (2021), nitrate leaching into the soil has become a problem in several industrial countries since the 1970s. Several countries in Europe use concentrations of this element close to or exceeding 50 mg / L. The nitrate used brings problems to human health and favors the eutrophication of lakes, rivers, and coastlines. This problem occurs because the nitrogen used exceeds the amount that plants can absorb, this amount being variable, according to the type of plant and soil, and may vary between regions. In addition, it results in high levels of fish mortality and algae blooms, which can affect aquaculture, where these algae can produce toxins that affect fish and humans.

2.3.4 Pollution by pesticides

According to RAMLI et al. (2022), the use of pesticides in agriculture has increased significantly in the last 35 years. According to researchers, this increase corresponds to a rate of 4 to 5.4% / per year. However, the increased use of these compounds also raises the level of pollution, in developed and developing countries, with developing countries being the ones that use them the most. Developed countries are adopting stricter measures for the use of pesticides, in addition, the increased demand for organic foods is contributing to the reduction of the use of these compounds.

2.4 DECREASE IN THE VOLUME OF AQUIFERS

The constant expansion of areas for agricultural purposes, together with the intensive use of groundwater for agricultural activities in arid and semi-arid countries and regions, has been inducing a significant decrease in the volume of aquifers (NUNES et al., 2022).

3 SOLUTIONS RELATED TO WATER IN AGRICULTURE

To reduce the environmental impacts related to water in agriculture, some measures are being used:

3.1 DIGITAL WATER MONITORING

Using artificial intelligence for better water quality and less waste, digital monitoring is one of the promising techniques currently active. From the collection of data based on geographic information systems by sensors and satellite images, the timing of irrigation is done automatically, allowing for a reduction of up to 60% in water consumption (HABEEB E WELI, 2021).

3.2 DRIP IRRIGATION

To avoid the constant waste of water in irrigation, a viable alternative is the use of drip irrigation, which allows the supply of water resources by fertilizers directly to the roots of plants, in an automated way, and in this way, water can be saved by up to 80 %, in crops such as cereals, vegetables, sugar cane, coffee. In addition, the use of this tool allows for other simultaneous work, such as reducing the appearance of fungi and weeds (DESHMUK et al., 2020).

3.3 HYDROPONICS

Present in many vegetable crops in the world and Brazil for decades, hydroponics is a technique in which cultivation is carried out using an inert medium, such as gravel, with holes for each seedling, being enriched vertically from the highest to the lowest. , where the water, together with the fertilizer, irrigates the plants, circulating through the system. This technique can save up to 90% of water consumption (SHARMA et al., 2018).

3.4 WATER STORAGE IN DRY REGIONS

According to YIFRU et al. (2021), dry regions, such as arid and semi-arid regions, suffer from water shortages and go through long periods without rain. An alternative to solve this problem is the storage of water in these regions, increasing the availability of water, using water collection structures, where in addition to storing water, it filters and protects it from contamination and evaporation, with low maintenance costs.

3.5 RECYCLING OF WASTEWATER

Wastewater recycling is a process that manages water that has been used for domestic purposes. This technique removes pollutants from water, based on the action of magnetic nanoparticles, with a ferromagnetic core, and external coating and is capable of removing the most different types of pollutants, such as hydrocarbons, organic compounds, and even heavy metals, which are more difficult to remove. removed, then allowing wastewater to be recycled with the potential for agricultural reuse (SALIU E OLADOJA, 2021).

Among countries that use this reuse, Israel, where 60% of its area is desert, presents better water management due to the use of this innovative system, being a country that recycles water to be used in agriculture. Currently, approximately 90% of wastewater is recycled (MEGERSA AND ABDULAHI, 2015).

4 CONCLUSION

Several studies address the main causes of inappropriate use of water in agriculture, reporting the impacts they cause on the environment. In addition, some works address strategies associated with the sustainable use of water resources, as alternatives for better management of their use. There are alternatives for better efficiency in the use of water in agriculture and collective systems.

REFERENCES

Bierkens, m. F. P., wada, y. Non-renewable groundwater use and groundwater depletion: a review. Environmental research letters, v. 14, n. 6, p. 063002, 2019. 10.1088/1748-9326/ab1a5f

Bijay-singh, craswell, e. Fertilizers and nitrate pollution of surface and ground water: an increasingly pervasive global problem. Sn applied sciences, v. 3, p. 518, 2021. Https://doi.org/10.1007/s42452-021-04521-8

Bittencourt, m. V. L. Impactos da agricultura no meio-ambiente: principais tendências e desafios. Economia & tecnologia, v. 18, 2009. Http://dx.doi.org/10.5380/ret.v5i3.27144

Chakraborty, s. K. Water: its properties, distribution, and significance. Riverine ecology, v. 1 p. 23–55, 2021. Https://doi.org/10.1007/978-3-030- 53897-2_2

Chauhan, j. S., kumar, s. Wastewater ferti-irrigation: an eco-technology for sustainable agriculture. Sustain. Journal of water resource, v. 6, n. 31, 2020. Https://doi.org/10.1007/s40899-020-00389-5

Deshmukh, s., chavan, s., zodge, p., dalvi, p., jadhav, a. Smart drip
Irrigation using iot. Inventive communication and computational technologies, v. 89., p. 1315–1321, 2020. Https://doi.org/10.1007/978-981-15- 0146-3_129

Habeeb, n. J., weli, s. T. Combination of gis with different technologies for water quality: an overview, hightech and innovation journal, v. 2, n. 3, 2021. Http://dx.doi.org/10.28991/hij-2021-02-03-10

Ijioma, u. D. (2021). Evaluation of water situation and development of drinking water management plan for aba city, southeast nigeria (doctoral dissertation, btu cottbus-senftenberg).

Malo, m. Water: heart of agriculture. Biotica research today, v. 2, n. 8, p. 735-738, 2020.

Massarelli, c.; losacco, d.; tumolo, m.; campanale, c.; uricchio,
V.f. protection of water resources from agriculture pollution: an integrated methodological approach for the nitrates directive 91–676-eec implementation. International journal of environmental research and public health, v. 18, p. 13323, 2021. Https://doi.org/10.3390/ijerph182413323

Megersa, g., abdulahi, j. Irrigation system in israel: a review. International journal of water resources and environmental engineering, v. 7, n. 3, p. 29 - 37, 2015. 10.5897/ijwree2014. 0556

Nunes, k. G., costa, r. N. T., cavalcante, i. N. Gondim, r. S., lima,
S. C. R. V., mateos, l. Groundwater resources for agricultural purposes in the brazilian semi-arid region. Revista brasileira de engenharia agrícola e ambiental, v. 26, n. 12, 2022.

Ozsahin, e., alturk, b., ozdes, m. Et al. Gis-based spatial prediction of poor-drainage areas using frequency ratio: a case study of tekirdag province, turkey. Applied geomatics, v. 14, p. 369–386, 2022. Https://doi.org/10.1007/s12518-022-00439-x

Rengasamy, p., de lacerda, c.f., gheyi, h.r. salinity, sodicity and
Alkalinity. Subsoil constraints for crop production, p. 83 - 107, 2022. Https://doi.org/10.1007/978-3-031-00317-2_4

Reutter, b., lant, p. A., & lane, j. L. Direct and indirect water use within
The australian economy. Water policy, v. 20, n. 6, 1227-1239, 2018. Https://doi.org/10.2166/wp.2018.055

Saliu, t.d., oladoja, n.a. nutrient recovery from wastewater and reuse in agriculture: a review. Environmental chemistry letters, v. 19, p. 2299–2316, 2021. Https://doi.org/10.1007/s10311-020-01159-7

Sharma, n., acharya, s., kumar, k., singh, n. Chaurasia, o. P.
Hydroponics as an advanced technique for vegetable production: an overview. Journal of soil and water conservation, v. 17, n. 4, p. 364-371, 2018. 10.5958/2455-7145.2018.00056.5

Suradi, a. R., ramli, f., taslim, a. I. S. Perilaku petani dalam penggunaan pestisida kimia di kabupaten enrekang. Jurnal sains agribisnis, v. 2, n. 1, p. 21-31, 2022.

Vaidya, r. The illusions of liquid rulers, 2022.

Wang, r., wang, q., dong, l., & zhang, j. Cleaner agricultural production in drinking-water source areas for the control of non-point source pollution in china. Journal of environmental management, v. 285, p. 112096, 2021. Https://doi.org/10.1016/j.jenvman.2021.112096

Yunusa, i. A., zerihun, a., & gibberd, m. R. Analysis of the nexus between population, water resources and global food security highlights significance of governance and research investments and policy priorities. Journal of the science of food and agriculture, v. 98, n. 15, 5764-5775, 2018. Https://doi.org/10.1002/jsfa.9126

Zahoor, s. A. Ahmad, s., ahmad, a., et al. Improving water use efficiency in agronomic crop production. Agronomic crops, p. 13–29, 2019. Https://doi.org/10.1007/978-981-32-9783-8_2