ISSN (e): 2250 – 3005 || Volume, 14 || Issue, 3|| May - June – 2024 ||
International Journal of Computational Engineering Research (IJCER)

Farming Project in a Community Using Irrigation Technology and Clean Energy

[1]Gerardo Olivas Córdova,
Master's degree student of Instituto Tecnológicode Chihuahua II,2
[2] Tecnológico Nacional de México Campus Nuevo Casas Grandes, Chihuahua, México
[3]Laura Antonia Ortega Chávez
Instituto Tecnológico de Chihuahua II, División de Estudios de Posgrado e Investigación, Chihuahua, México.

ABSTRACT
Water resources and agriculture are proportional, because the former is directly and positively correlated with the crop. On the other hand, it is important to note that in addition to irrigation it is necessary to take into account factors such as temperature, pests and others to achieve optimal cultivation. The positive effects of irrigation systems are directly reflected in the economic and social spheres, as they create jobs and give people the opportunity to grow high quality crops to increase their chances of participating in the agricultural sector. However, the environmental impact of irrigation systems must be seen as an aspect that needs to be improved. Because of this, this research aims to validate a model of technified irrigation and the use of clean energy in cultivation in order to determine its feasibility.

KEYWORDS: *Water resources, irrigation systems, environmental impact, water consumption.*
AMS Subject Classification:*05C12.*

Date of Submission: 12-06-2024 Date of acceptance: 24-06-2024

I. INTRODUCTION

According to Agrositio (2023), some of the strategies and technologies used in Israel to solve aridity and achieve successful agriculture are as follows:
1. drip irrigation technology
2. precision agriculture and monitoring technologies
3. adapted crops and agricultural management techniques
4. the development of agriculture in the last century has been conditioned by the availability of water resources.

On the other hand, Chihuahua is the largest state in the country and 73% of its territory is arid and dry, with very little rainfall, presenting limitations in the availability of water for human consumption and for productive activities, so it is important to preserve and use it rationally[1]. In the State, actions and works were contemplated to retain and use water in streams and rivers in the entity, within the framework of current laws, proposing infrastructure works such as the Palanganas Storage Dam in the Municipality of Casas Grandes.

Currently in the region of El Rusio, there is no electricity network coverage by the Federal Electricity Commission (C.F.E.), so the implementation of clean energies for this research project is a key part for its operation. The present research work intends to answer the question: With the help of irrigation technification and clean energies, is it feasible and profitable to create a cultivation project in the rural property of Colonia El Rusio, municipality of Casas Grandes, Chihuahua?

II. BACKGROUND

Irrigation Technification
Irrigation technification refers to the implementation of technologies in the irrigation process to improve water use efficiency and increase crop yields, so it is important to have a solid theoretical framework that provides a basis for research[2].
1.Theoretical approach to irrigation technification through water use efficiency in agriculture.
2.Theoretical approach for irrigation technification according to innovation in agriculture in recent years.

Efficient Water Use in Agriculture

One theoretical approach to irrigation technification could be the theory of water use efficiency in agriculture. This theory focuses on improving water use efficiency through the implementation of advanced irrigation technologies, such as drip and sprinkler irrigation, as well as the proper management of water resources [2].

As described by Castellanos (2000) in the Soil and Water Analysis Interpretation Manual (as cited in Proain Tecnología Agrícola, 2020), agriculture, globally, is the main user of water among the various purposes that humanity gives to this resource. Efficient management of water used for irrigation is a crucial element in the overall management of water resources, given that crop irrigation accounts for approximately 60% to 80% of uses and applications. Measurement and monitoring of the water present in the soil is an essential aspect of efficient irrigation water management. Knowledge of the state of water in the soil plays a fundamental role in irrigation management. Water availability to plants is linked to the amount of water that has entered the soil, especially in what is known as the root zone, where plant roots absorb water and essential nutrients [3]. Once water has penetrated the soil through infiltration and has been redistributed, a certain amount of water is available in the root zone that plants will use more or less immediately, or over time. It is important to note that the water content in plant tissues is significantly high; approximately 80% of the fresh weight of many herbaceous plants and up to 90% in some growing organs, such as leaves, fruits, as well as cauline and root apices, consists of water ([4].

Innovation in Agriculture

Another theoretical approach could be the theory of innovation in agriculture. The theory focuses on the adoption of new agricultural technologies and practices by farmers, and how this can improve the productivity and sustainability of the agricultural sector. In the context of irrigation technification, this theory could be used to investigate the factors that influence farmers' adoption of advanced irrigation technologies.

The key to optimal crop yields lies in the implementation of an appropriate irrigation program. Efficient water application is essential for optimal development and, ultimately, to achieve crop profitability [5]. Several factors, such as climate, soil type, plant species, crop stage, and irrigation system, influence this process. Various techniques are employed to improve irrigation efficiency. In addition, it is crucial to know soil moisture parameters, such as saturation point, field capacity, permanent wilting point, and usable moisture, to determine when and how much to irrigate [6].

Saturation point (SP): this is considered to be the maximum amount of water that the soil can retain and is affected by the content and type of clay and by the concentration of organic matter it contains. The saturation point of a soil ranges from 10% for coarse sands and up to 150% for very clayey soils or for histosols with very high organic matter content.

1.Field capacity (FC): the field capacity represents the amount of water that can be retained in a soil against the force of gravity, after irrigation or rainfall that has wetted the entire soil. According to Aguilar (1988), sandy textured soils have 5 to 16% field capacity; sandy loam textured soils have 10 to 20%; loam textured soils have 15 to 30%; clay loam textured soils have 25 to 35% and clayey textured soils have 30 to 70%, depending on clay content and type.
2.Permanent wilting point (PMP): the percentage of moisture in a soil at which plants wilt and can no longer recover, even when placed in an atmosphere saturated with moisture.
3.Useable Moisture (MOH): is the difference of the CC and PMP representing the usable moisture holding capacity.

Soil moisture monitoring is crucial for farmers to optimize production, conserve water, reduce environmental impacts and save money. In addition to facilitating accurate decisions on the amount and timing of irrigation, it also aligns crop water requirements with the amount of water applied. This avoids unnecessary losses due to deep percolation or runoff, as well as under-application of water. Irrigation technification plays a vital role in this process, as it contributes to more efficient and accurate water resource management, improving agricultural sustainability and profitability[6].

III. METODOLOGY

The development of this research will be as follows:
1. Identification of the business and the quantitative and qualitative analysis of the market: to know and determine the type of crop suitable for the land.
2.Technical and environmental impact study: obtain the necessary data through soil use and management tests, soil fertility, application of clean energies such as solar panels, design the project plans, and determine if the water supply will be adequate after technification.

3.Economic-financial study: compare costs, investment versus benefits.

For the above, it will be based on the following methodology.

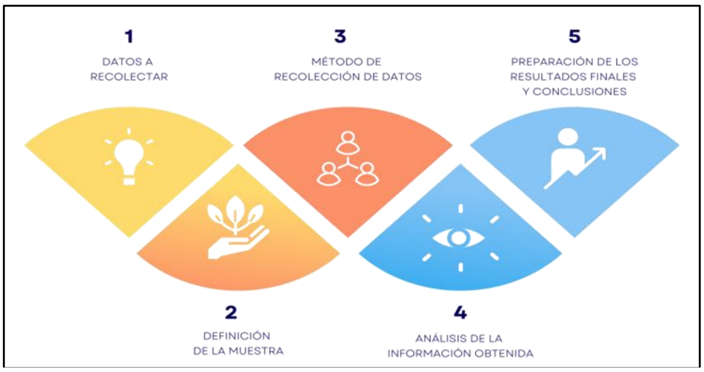

Figure 1: Methodology
Source. Authors

IV. RESULTS

1. Of the three types of crops selected as suitable for the project, the minimum relative humidity percentage that can be reached is 45%, determined by the chili plant. Since the same space where the three types of crops are to be planted is not recommended that the humidity percentage be below this percentage.
2.Of the crops selected as suitable for the research, the maximum relative humidity percentage that can be reached is 60%, determined by the pumpkin and corn plant, being the same space where the 3 types of crops are intended to be planted, it is not recommended that the humidity percentage be above this percentage.
3.The ideal range of optimum relative humidity is between 45% and 60%.
4.So far, records have been taken for 13 days, the first hour spectrum to raise the record ranges between eight and 10 hours, the second between 12 and 16 hours of the day. This is to try to measure the percentage of humidity at an early hour of the day and at another time of the day when the heat is higher.
5.Of the 26 records collected so far, 23% are below the range of 45% relative humidity, 0% above the range of 60% relative humidity, and finally 77% fall within the range of 45% and 60% relative humidity.
6.The ideal range of optimum relative humidity is between 45% and 60%.
7.So far, records have been taken during 13 days, the first hour spectrum to take the record ranges between eight and 10 hours, the second between 12 and 16 hours of the day. This is to try to measure the percentage of humidity at an early hour of the day and at another time of the day when the heat is higher.
8.Of the 26 records collected so far, 23% are below the range of 45% relative humidity, 0% above the range of 60% relative humidity, and finally 77% fall within the range of 45% and 60% relative humidity.
9. So far, 77% of the number of records indicate that the percentage of relative humidity is ideal for growing chili, squash and corn plants.

Using solar energy for pumps is more cost-effective than other energy sources because it involves only the initial installation costs. Consequently, this approach has become competitive for use in irrigation systems. It presents an attractive alternative in terms of reduced electricity costs. In addition, the equipment can be installed in locations that have stand-alone operation, without electricity [7].

V. CONCLUSION

Technified irrigation systems, as well as the use of renewable or clean energies are a viable alternative for areas where it is not possible to have an electricity supply system and there is very little rainfall. Because of this, it is of utmost importance to have studies that endorse these systems and that can be replicated throughout the most arid zones within a region or even the entire country. In addition, a strong initial investment is required and this will depend on what you want to grow, the hectares you want to plant, among other factors, but with the use of these systems water savings will be significant, and the generation of electricity will not be centralized so the investment will return and the gains for farmers and the entire supply chain were reflected even with the investment for both irrigation technology and for the electrical system.

REFERENS

[1] M. L. Crouch, H. E. Jacobs, and V. L. Speight, "Defining domestic water consumption based on personal water use activities," *Journal of Water Supply: Research and Technology-Aqua*, Aug. 2021, doi: 10.2166/aqua.2021.056.

[2] M. Laita *et al.*, "Optimizing water use and crop yield with deficit irrigation techniques: A comprehensive overview and case study from Morocco," *Multidisciplinary Reviews*, vol. 7, no. 4, p. 2024074, Jan. 2024, doi: 10.31893/multirev.2024074.

[3] E. Bicamumakuba, M. Ashrafuzzaman Gulandaz, R. Ali, and S.-O. Chung, "An loT-Based Drip Irrigation System for Precise Water Management in Sandy Soil Greenhouses," 2024, [Online]. Available: https://www.researchgate.net/publication/377335630

[4] M. Ali, M. R. Ali, M. A. Gulandaz, M. A. Haque, M. S. Kabir, and S.-O. Chung, "Development of a sandy soil water content monitoring system for greenhouses using Internet of Things," *Precision Agriculture Science and Technology*, vol. 5, no. 3, pp. 169–180, Sep. 2023, doi: 10.12972/pastj.20230014.

[5] E. López-Mata, J. J. Orengo-Valverde, J. M. Tarjuelo, A. Martínez-Romero, and A. Domínguez, "Development of a direct-solution algorithm for determining the optimal crop planning of farms using deficit irrigation," *Agric Water Manag*, vol. 171, pp. 173–187, Jun. 2016, doi: 10.1016/j.agwat.2016.03.015.

[6] L. Myeni, T. Mdlambuzi, D. G. Paterson, G. De Nysschen, and M. E. Moeletsi, "Development and Evaluation of Pedotransfer Functions to Estimate Soil Moisture Content at Field Capacity and Permanent Wilting Point for South African Soils," *Water (Basel)*, vol. 13, no. 19, p. 2639, Sep. 2021, doi: 10.3390/w13192639.

[7] B. Bhattacharjee, P. Sadhu, A. Ganguly, and A. Naskar, "Integrated green submersible pumping system for future generation," *Facta universitatis - series: Electronics and Energetics*, vol. 34, no. 1, pp. 37–51, 2021, doi: 10.2298/FUEE2101037B.