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IRGATEC SYSTEM: SUSTAINABLE USE OF WATER IN THE AGRICULTURAL ENVIRONMENT

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ABSTRACT: The definition of irrigation management is of fundamental importance in irrigated agriculture. The objective of this study was to optimize the use of water in agriculture, reducing the environmental impact caused by the waste of water in agricultural practices. A localized irrigation management system was developed consisting of an application and an analog sensor. The system proved efficient, being able to determine the irrigation time and the losses of water by percolation, providing a more efficient use of the water.
Keywords: Management, sustainability, water.

SISTEMA IRGATEC: USO SUSTENTÁVEL DA ÁGUA NO MEIO AGRÍCOLA

RESUMO: A definição do manejo da irrigação é de fundamental importância na agricultura irrigada. Diante disso, o presente trabalho teve como objetivo otimizar o uso da água na agricultura, diminuindo o impacto ambiental provocado pelo desperdício de água nas práticas agrícolas. Foi desenvolvido um sistema de manejo de irrigação localizada constituído de aplicativo e sensor analógico. O sistema mostrou-se eficiente, sendo capaz de determinar o tempo de irrigação e as perdas de água por percolação, proporcionando um uso mais eficiente da água.
Palavras-chave: Manejo, sustentabilidade, água.

INTRODUCTION

The availability of water for agriculture is threatened by competition from domestic and industrial uses. About 70% of the total water consumption in the world is destined for irrigated agriculture. This figure is estimated to be even higher, on the order of 90%, for many developing countries. (KIJNE, 2001). The world's irrigated area per person has declined steadily from a peak of 48 ha 1000-1 people in the late 1970s due to population growth exceeding the regional irrigation growth rate. For example, in Pakistan, which is highly dependent on irrigation for food production, it went from over 180 ha 1000-1 people in 1975 to 110 in 1997 and is expected to decrease to around 70 ha 1000-1 people in 2015. (KIJNE, 2001).

According to Bernardo (1995), the determination of the amount of water needed for crops is one of the main parameters for the correct management of any irrigation system. The direct method (lysimeter) uses very expensive equipment, making its use in the daily management of irrigated agriculture unfeasible. Indirect methods offer the estimation of ETo, with the Penman-Monteith-FAO method considered standard. Some computer programs and spreadsheets were developed to facilitate irrigation management. However, the computer programs developed are aimed at technicians and not at farmers, making their applicability difficult. In addition to management methods that use atmospheric variables, other methods can be used, such as sensors for measuring water moisture or soil tension. These methods are essential in monitoring deep percolation.

MAIN GOAL

Optimize the use of water in agriculture, reducing the environmental impact caused by the waste of water in agricultural practices.

Specific objectives

- Develop a tool to optimize the use of water in agriculture;
- Determine an indirect method to calculate reference evapotranspiration;
- Develop an analog sensor for the indirect monitoring of water in the soil;
- Facilitate irrigation management for family farmers and entrepreneurs.

METHODOLOGY

Initially, the main methods for estimating reference Evapotranspiration (ETo), an essential parameter for irrigation management, were identified, as well as methods for estimating water in the soil. The Hargreaves-Samani model was identified as being more accessible to the irrigator according to Gonçalves et al. (2009) and Conceição & Marin (2003) and Irrigás as the method of indirect measurement of water in the soil. Based on the choice of the ETo estimation method, the computational application that composes the IRGATEC system was developed.

The computer graphic interface was developed in Microsoft.NET platform, which allowed its use in mobile phones and personal computers. The programming language used was “C Sharp”. For the development of the program, the problem in irrigation management and the possible alternatives for solving the problem were initially observed.

Faced with the problem, an algorithm was built for the development of the computer program that would assist in the management of irrigation. The reference evapotranspiration (ETo) estimation model proposed by Hargreaves-Samani was used, represented by the following equation:

$$ETo = 0{,}023 \times Ra \times (Tmáx. - Tmín.)^{0,5} \times (Tméd. + 17{,}8) \quad \text{(eq. 1)}$$

Where: ETo – reference evapotranspiration (mm dia-1); Ra – solar radiation at the top of the atmosphere, expressed in evaporation equivalent (mm day-1); Tmax – maximum air temperature (ºC); Tmin – minimum air temperature (ºC); Tmed – average air temperature (ºC).

Table 01. Solar radiation at the top of the atmosphere (Ra) on the 15th of each month, expressed in evaporation equivalents (mm day-1) for different southern latitudes (degrees).

	MÊS											
LATITUDE	JAN	FEV	MAR	ABR	MAI	JUN	JUL	AGO	SET	OUT	NOV	DEZ
0°	15	15,2	15,7	15,3	14,4	13,9	14,1	14,8	15,3	15,4	15,1	14,8
2º	15,3	15,7	15,7	15,1	14,1	13,5	13,7	14,5	15,2	15,5	15,3	15,1
4º	15,5	15,8	15,6	14,9	13,8	13,2	13,4	14,3	15,1	15,6	15,5	15,4
6º	15,8	16	15,6	14,7	13,4	12,8	13,1	14	15	15,7	15,8	15,7
8º	16,1	16,1	15,5	14,4	13,1	12,4	12,7	13,7	14,9	15,8	16	16
10º	16,4	16,3	15,5	14,2	12,8	12	12,4	13,5	14,8	15,9	16,2	16,2
12º	16,6	16,3	15,4	14	12,5	11,6	12	13,2	14,7	15,8	16,4	16,5
14º	16,7	16,4	15,3	13,7	12,1	11,2	11,6	12,9	14,5	15,8	16,5	16,6
16º	16,9	16,4	15,2	13,5	11,7	10,8	11,2	12,6	14,3	15,8	16,7	16,8
18º	17,1	16,5	15,1	13,2	11,4	10,4	10,8	12,3	14,1	15,8	16,8	17,1
20º	17,3	16,5	15	13	11	10	10,4	12	13,9	15,8	17	17,4
22º	17,4	16,5	14,8	12,6	10,6	9,6	10	11,6	13,7	15,7	17	17,5
24º	17,5	16,5	14,6	12,3	10,2	9,1	9,5	11,2	13,4	15,6	17,1	17,7
26º	17,6	16,4	14,4	12	9,7	8,7	9,1	10,9	13,2	15,5	17,2	17,8
28º	17,7	16,4	14,3	11,6	9,3	8,2	8,6	10,4	13	15,4	17,2	17,9
30º	17,8	16,4	14	11,3	8,9	7,8	8,1	10,1	12,7	15,3	17,3	18,1
32º	17,8	16,2	13,8	10,9	8,5	7,3	7,7	9,6	12,4	15,1	17,2	18,1
34º	17,8	16,1	13,5	10,5	8	6,8	7,2	9,2	12	14,9	17,1	18,2
36º	17,9	16	13,2	10,1	7,5	6,3	6,8	8,8	11,7	14,6	17	18
38º	17,9	15,8	12,8	9,6	7,1	5,8	6,3	8,3	11,4	14,4	17	18,3
40º	17,9	15,7	12,5	9,2	6,6	5,3	5,9	7,9	11	14,2	16,9	18,3

Source: Author.

To determine crop evapotranspiration (ETc) the following equation was used:

$$ETc = ETo \times Kc \qquad \text{(eq. 2)}$$

Where: ETc - culture evapotranspiration (mm dia-1); Kc - crop cultivation coefficient (dimensionless). To determine the irrigation time (Ti) the following equation was used:

$$Ti = 60 \times \frac{TR \times ETc \times Sl \times Sg}{Qg \times Ei} \qquad \text{(eq. 3)}$$

Where: TR - irrigation shift (day); Sl - spacing between the sides (m); Sg - spacing between drippers or plants (m); Qg - dripper flow (L s-1); Ei - application efficiency (dimensionless). The program was developed from the sequence shown in Figure 1.

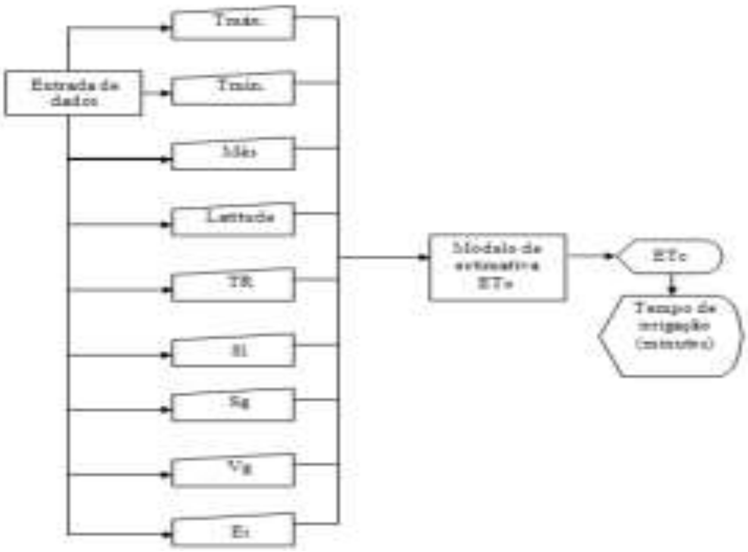

Figure 1. Development scheme of the mobile management program for drip irrigation.

RESULTS

The program has great mobility and portability, being able to be installed on a mobile phone (cell phone), is easy to handle, as the data entry process is similar to a calculator. In addition to the ease of use of the program, irrigation management only needs the air temperature of the area to be irrigated to determine how long the irrigation system should be on. The analog sensor provided the efficient monitoring of water losses in the soil through deep percolation. In this way, the atmospheric management is validated.

SOCIAL RELEVANCE OF THE PROPOSAL

The project will optimize the use of water in the irrigation process, avoiding the waste of water resources. The savings generated by the rational management of water can make it available for other uses. The application is easy to use, making it closer to the farmer, facilitating its applicability in the field. With a more efficient use of water, there will be less waste of fertilizer by leaching or runoff. With the water crisis that the state of Ceará faces, the application can be a viable alternative to irrigated perimeters that use localized irrigation.

IMPACT OF THE PROPOSAL ON THE SCHOOL COMMUNITY

The research project provided a greater contextualization of environmental problems linked to water and food production. The students had the opportunity to apply mathematical and environmental concepts related to solving the identified problem. Learning through research consolidated knowledge and developed critical thinking in the school community, in addition to stimulating the search for knowledge.

FINAL CONSIDERATIONS

Farmers will have the opportunity to perform more accurate irrigation, reducing surface runoff and leaching of nutrients carried away by excess water. This will provide an economy of nutrients and a lower environmental impact aimed at contamination of the water table.

REFERENCES

BERNARDO, S. **Manual de Irrigação.** 6 ed. Viçosa: UFV,1995. 657p.

GONÇALVES, F. M.; FEITOSA, H. O.; CARVALHO, C. M.; GOMES FILHO, R. R.; JÚNIOR, M. V. **Comparação de métodos da estimativa da evapotranspiração de referência para o município de Sobral-CE.** Revista Brasileira de Agricultura Irrigada, Fortaleza, v.3, n.2, p.71-77, 2009.

KIJNE, J. W. **"Lessons learned from the change from supply to demand water management in irrigated agriculture: a case study from Pakistan.**" Water Policy 3(2): 109-123. 2001.