ISSN 1808-8546 (ONLINE) 1808-3765 (CD-ROMs)

USO DA ÁGUA E DE TÉCNICAS DE MANEJO DE IRRIGAÇÃO NO CAFEEIRO CONILON

NATÁLIA GRAMELISCH SILVESTRE[1]; ELVIS PANTALEÃO FERREIRA[2]; GUSTAVO HADDAD SOUZA VIEIRA[3]; JÉSSICA BROSEGHINI LOSS[4] E GABRIEL PETERLE[5]

[1]Instituto Federal de Educação, Ciência e Tecnologia do Espírito Santo – IFES campus Santa Teresa, Rod. ES 080, km 93, 29.660-000, São João de Petrópolis, Santa Teresa, Espírito Santo, Brasil, e-mail:natygramelisch@gmail.com
[2]IFES campus Santa Teresa, Rod. ES 080, km 93, 29.660-000, São João de Petrópolis, Santa Teresa, Espírito Santo, Brasil, e-mail: epf150@hotmail.com
[3]IFES campus Santa Teresa, Rod. ES 080, km 93, 29.660-000, São João de Petrópolis, Santa Teresa, Espírito Santo, Brasil, e-mail: ghsvieira@gmail.com
[4]UENF, Av. Alberto Lamego, 2000 - Parque Califórnia, 28.013-602, Campos dos Goytacazes, Rio de Janeiro, Brasil, e-mail: jessicaloss54@gmail.com
[5]UFV, Av. Peter Henry Rolfs, s/n - Campus Universitário, 36.570-900, Viçosa, Minas Gerias, Brasil, e-mail: gabrielpeterle@gmail.com

1 RESUMO

Buscou-se verificar a percepção dos cafeicultores do município de São Roque do Canaã quanto ao uso racional da água e das técnicas de manejo de irrigação empregadas nas lavouras cafeeiras. Também, foi verificado se a assistência técnica exerce influência na sensibilização e no conhecimento dos produtores quanto ao uso adequado da água para irrigação no município, para tanto foram aplicados questionários aos produtores. A pesquisa contou com uma amostra de 100 cafeicultores que fazem uso de diferentes tipos de sistemas de irrigação, que foram divididos em dois grupos caracterizados pela localização da propriedade rural em relação à margem do Rio Santa Maria do Rio Doce (SMRD), agrupados também entre aqueles que recebem assistência técnica particular ou pública (CAT) e os que não recebem (SAT). Constatou-se que, em todas as propriedades SAT visitadas (avaliadas), a determinação da duração dos eventos de irrigação é feita arbitrariamente pelo produtor (ou proprietário), sem a utilização de critérios técnicos, contra 92% das propriedades CAT. Quanto à outorga, na margem esquerda do Rio SMRD, 64% dos produtores CAT e 76% dos produtores SAT são outorgados, já na margem direita, 100% dos produtores CAT e 92% dos produtores SAT entrevistados possuem outorga de uso da água.

Palavras-chave: irrigação, *Coffea canephora*, agricultura - assistência técnica, outorga, bacias hidrográficas.

SILVESTRE, N. G.; FERREIRA, E. P.; VIEIRA, G. H. S.; LOSS, J. B.; PETERLE, G. USE OF WATER AND IRRIGATION MANAGEMENT TECHNIQUES ON COFFEE CONILON CROP

Received on 02/02/2021 and approved for publication on 04/28/2021
DOI: http://dx.doi.org/10.15809/irriga.2021v26n2p422-438

2 ABSTRACT

We sought to verify the perceptions of coffee growers in the municipality of São Roque do Canaã regarding the rational use of water and irrigation management techniques applied to coffee plantations. It was also verified whether technical assistance influences the awareness and knowledge of producers regarding the proper use of water for irrigation in the municipality; for this purpose, questionnaires were administered to the producers. The survey included a sample of 100 coffee growers who use different types of irrigation systems, which are divided into two groups characterized by the location of the rural property in relation to the Santa Maria of Doce River (SMDR) river bank: those who receive private or public technical assistance (CAT) and those who do not receive (SAT). For all the SAT properties visited (evaluated), the determination of the duration of irrigation events is made arbitrarily by the producer (or owner), without the use of technical criteria, against 92% of the CAT properties. With respect to water use permits, on the left river bank of the SMDR River, 64% of the CAT producers and 76% of the SAT producers have water use permits, whereas on the right river bank, 100% of the CAT producers and 92% of the interviewed SAT producers have water use permits.

Keywords: irrigation, *Coffea canephora*, agriculture - technical assistance, water use permit, watersheds.

3 INTRODUCTION

The main economic activities of the municipality of São Roque do Canaã are commerce, pottery, ceramics, and woodwork, and coffee farming, which is generally cultivated in areas ranging from 5--50 hectares, is the main agricultural activity. São Roque do Canaã has 1,029 agricultural properties, approximately 90% of which are cultivated coffee, *Coffea species. canephora* (Conilon) and *Coffea arabica* (Arabica) (IBGE, 2019).

The municipality is located in the hydrographic basin of the Santa Maria do Rio Doce River, whose main watercourse originates in the municipality of Santa Teresa, and its main tributaries are Santa Júlia, São Bento Stream, São Dalmácio Stream, Picadão de São Roque Stream, São Sebastião Stream, São Pedro Stream, Santa Rosa Stream, XXV de Julho Stream and others (COMÉRIO *et al*., 2011). Annual rainfall has a historical average of 1,083 mm (TONINI, 2017), causing periods of drought that result in limitations to agricultural activities that depend on rainfall for the adequate development of coffee crops. In addition, long dry periods, commonly observed from May--September, affect river flow and, consequently, the availability of water for irrigation.

This situation has generated conflicts over water use, requiring interventions in the first instance by the Santa Maria do Doce River Basin Committee (CBH); by the state government, through the Espírito Santo State Water Resources Agency (AGERH) and its resolutions regarding the use of water resources; and by the Espírito Santo Public Prosecutor's Office (MPES) through the application of Conduct Adjustment Terms (TAC) and Community Cooperation Agreements (ACC) (STATE WATER RESOURCES AGENCY, 2019). Thus, criteria were established for the rational use of water from the Santa Maria do Doce River and its tributaries.

Notably, according to the National Water Resources Policy (PNRH), established by Law No. 9,433, of January 8, 1997 (BRAZIL, 1997), water is a public domain asset, and its management must always provide for its multiple purposes

(irrigation, industry, public supply, recreation, animal watering, navigation, etc.); however, in situations of water scarcity, the priority uses are those intended for human consumption and animal watering.

In the state of Espírito Santo, the government agency that provides technical assistance and rural extension is the Capixaba Institute for Research, Technical Assistance and Rural Extension (Incaper), which currently has offices in all municipalities in Espírito Santo. In São Roque do Canaã, in 2017, the Incaper provided technical assistance to 370 producers, 62.7% of whom were coffee growers. In 2018, 375 producers were assisted, 75.73% of whom were coffee growers. In 2019, 393 producers were assisted, 77.6% of whom were coffee growers (CAPIXABA INSTITUTE FOR RESEARCH, TECHNICAL ASSISTANCE AND RURAL EXTENSION, 2020). In these three years of data, an increase was observed both in the number of producers served and in the percentage of coffee growers in the region.

Given this scenario, the importance of strategies that enable the efficient and rational use of water resources in this municipality is evident. Therefore, it is essential to conduct diagnostic studies to assess how local farmers manage their irrigation systems, as well as to gather information on the limitations and challenges they face. Thus, this work can be used to support decision-making by companies and public technical assistance institutions, as well as by oversight agencies, but above all, by local producers.

The aim of this work was to verify the perceptions of coffee growers in the municipality of São Roque do Canaã, Espírito Santo, regarding the rational use of water and irrigation management techniques and to analyze the extent of the influence of technical assistance practices in increasing the awareness and knowledge of these producers regarding the appropriate use of water for irrigation activities.

4 METHODOLOGY

The municipality of São Roque do Canaã (Figure 1) is located in the state of Espírito Santo, central Espírito Santo mesoregion, Santa Teresa microregion, at the geographic coordinates 19° 44' 19" South latitude and 40° 39' 32" West longitude.

Figure 1. Spatialization of the municipality of São Roque do Canaã and the course of the Santa Maria do Doce River.

Source: Authors (2019).

The municipality has an area of 341.944 km2 [and] is located in the middle portion of the Santa Maria do Rio Doce River basin. It has a population of 12,318 inhabitants, a climate classified as Aw (hot and tropical, with dry winters), and is approximately 120 km from the state capital, Vitória (IBGE, 2019).

To outline the scenario of water use and management techniques employed in irrigation, the research was initially conducted according to the methodology proposed by Palaretti, Mantovani and Sediyama (2011), applying semistructured questionnaires (Appendix 1) *in situ* to producers, which allowed direct and interactive contact between researchers and the situation under study, in addition to allowing the observation of which socioeconomic factors and technical knowledge related to irrigation management practiced on the properties studied.

Strategically, the interviews took place in environments without any level of formality through guided conversation from January to August 2019, thus aiming to create an environment in which the interviewees could feel free to express themselves, which helped the researchers obtain more detailed qualitative information.

The study included a sample of 100 coffee producers using irrigation systems. The target producers were initially divided into two groups: 50% from the left bank and 50% from the right bank of the Santa Maria do Rio Doce River (RSMRD). This ensured that the main tributaries were not confined to one group and that irrigators were usually divided into two groups, the right bank and the left bank, when Conduct Adjustment Terms (TACs) were implemented. In this study, producers on each bank were further grouped into those receiving private or public technical assistance (CAT) and those who did not (SAT) (Table 1).

Table 1. Schematic of the research target groups. (width 10 or 15 cm, font 12)

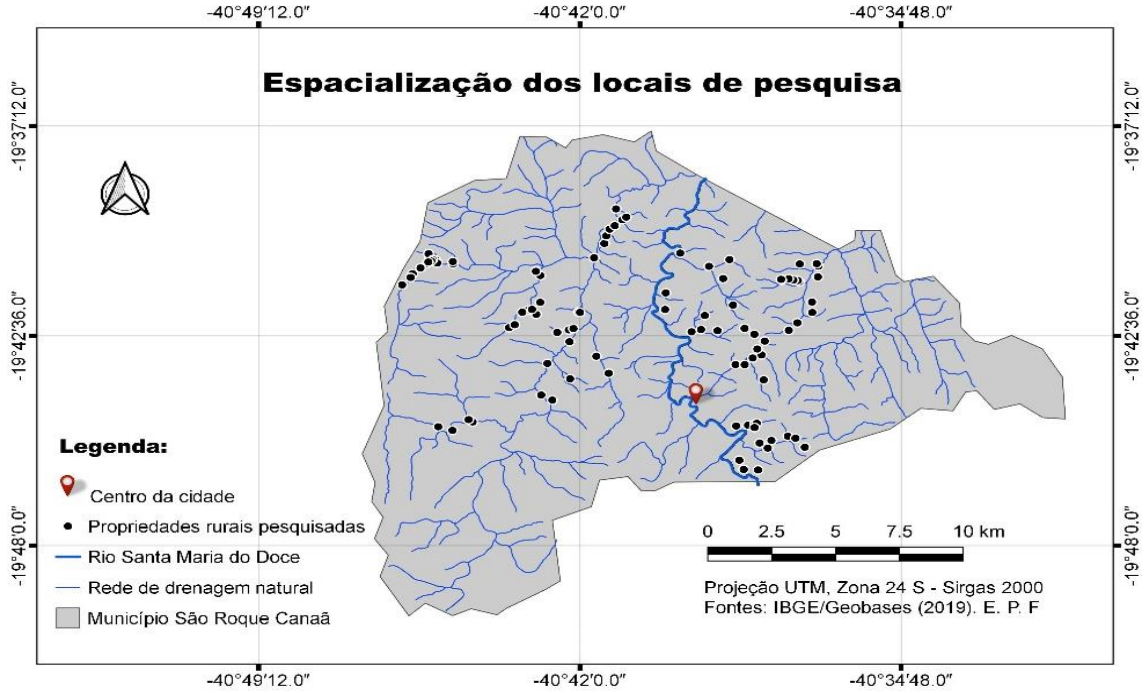
Outlining the research target audience		
Right bank	50%	25% CAT* 25% SAT**
Left bank	50%	25% CAT 25% SAT

*With Technical Assistance (CAT); **Without Technical Assistance (SAT).
Source: Authors (2019).

After the acquired data were tabulated, the percentage corresponding to each variable present in the questionnaire was calculated, which allowed the determination of farmers' perceptions regarding the rational use of water and irrigation management techniques employed in coffee plantations among the groups evaluated.

Additionally, for each property visited, with the owner's consent, the geographic location coordinates were obtained via the Campeiro 7 GPS application (UNIVERSIDADE FEDERAL DE SANTA MARIA, 2014) for the subsequent creation of a map containing its distribution (Figure 2).

Figure 2. Map of the municipality of São Roque do Canaã, Espírito Santo, containing the spatial distribution of the properties visited along the course of the Santa Maria do Doce River.



Source: Authors (2019).

Additional data were obtained from the local INCAPER office regarding activities being developed in the municipality to encourage rational water use and their acceptance and adoption by producers. Information was also gathered

from the Santa Maria do Rio Doce River Basin Committee regarding irrigation initiatives undertaken in recent years and/or those currently underway in the municipality of São Roque do Canaã.

5 RESULTS AND DISCUSSION

Coffee farming in São Roque do Canaã has been a dominant activity for many years and is an important part of the municipality's economic base. The interviews concerning the history of coffee cultivation on the properties revealed that the crop has been cultivated for more than 30 years and has passed down from generation to generation.

The irrigation system most commonly used by the producers interviewed in the municipality is localized irrigation (microspray and drip). Microsprinkler (ballerina) and conventional sprinkler systems are also used, although the latter were less common in this study.

On the left bank of the Santa Maria do Rio Doce River (SMRD), the Tancredo and Santa Júlia streams are the tributaries most frequently used for coffee irrigation, both by producers receiving technical assistance (CAT) and by producers without technical assistance (SAT). On the right bank, the main water source is the SMRD River itself and, to a lesser extent, its tributary, the Rio XXV de Julho. Therefore, these bodies of water are the main indicators of locations where actions should be prioritized to guide producers in the rational use of water resources.

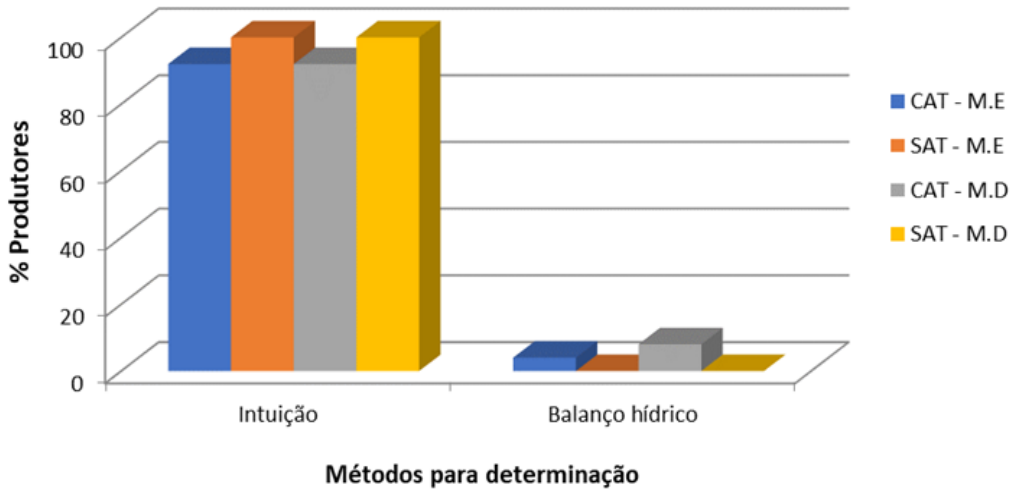
The drilling of artesian wells and the use of water for agricultural activities, especially irrigation, constitute another growing trend in the municipality. On the right bank of the SMRD River, groundwater exploitation by both CAT and, especially, SAT producers reaches 44% and 40%, respectively, which is equivalent to approximately four times the rate on the left bank. This intensity of groundwater use on the right bank is likely due to greater oversight of water use in the Santa Maria do Doce River basin and the absence of restrictions on groundwater use, making this water source a less bureaucratic alternative for producers.

The exploitation and use of groundwater is a concern, given that it can compromise springs and recharge water bodies. To make matters worse, producers (landowners) lack technical knowledge on how to manage water use for irrigation, which directly interferes with determining the water needs of coffee trees, preventing accurate calculation of the water depth to be applied and the appropriate duration of irrigation shifts. This, consequently, results in the inappropriate use of water resources, resulting in the waste of this valuable natural resource.

Oster and Wichelns (2003) warned that, to achieve the sustainability of irrigation projects, effective actions are necessary, which are carried out by both the farmer and public bodies, with the aim of minimizing the degradation of surface water and groundwater and avoiding the waste of water during its collection, conduction and application to the crop.

On farms, irrigation timing is mostly intuitively determined by farmers, accounting for 100% of the SAT producers and 92% of the CAT producers interviewed, both on the left and right banks (Figure 3). This practice makes accurate measurement of the required amount of water, increasing electricity costs, potentially compromising crop and fertilizer use, and causing soil degradation, among other factors, impossible. The remaining 8% of CAT producers on both banks of the SMRD use a water balance, which is obtained through irrigometers and tensiometers to determine the amount and duration of irrigation depth.

Figure 3. Methods used to determine the effects of irrigation time on properties.



Legenda:
CAT – Com Assistência Técnica; SAT – Sem Assistência Técnica;
M. E – Margem Esquerda; M. D – Margem Direita.

Source: Authors (2019).

Water balance is a method that allows the estimation of water requirements and consequently irrigation requirements for a given crop (ASCOLI *et al*., 2017). Knowing the water storage capacity of a soil and its moisture content allows for better crop yield management, as it allows the identification of water deficiency and its correction (SENTELHAS; ANGELOCCI, 2012).

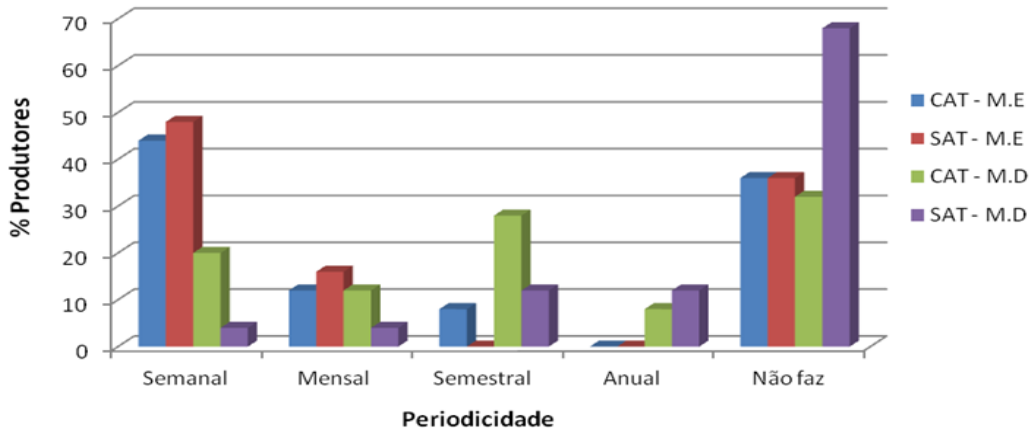
Notably, only CAT producers use irrigation management with tensiometers and irrigometers to determine irrigation shifts, corresponding to 8% of the respondents on each bank. Carvalho's (2018) study on rainfall variability and water availability for use in irrigated agriculture in São Roque do Canaã, in the Tancredo microbasin, concluded that none of the sampled properties used technical indicators for irrigation management. Therefore, a modest but significant shift in irrigation management among producers is observed.

Preventive maintenance of irrigation systems aims to ensure that the correct amount of water is evenly applied to each plant in the agricultural area, in addition to contributing to the system's useful life. According to Netafim Brazil (2010), irrigation system maintenance can be performed daily, weekly, and/or monthly. Daily maintenance is recommended whenever the system is in use. Above all, flow and pressure should be monitored to identify and correct abnormalities. Weekly chemical or drag cleaning of hoses is recommended, in addition to general cleaning of the pump assembly and filter elements. Monthly pressure measurement in the hydraulic system is recommended. However, there is no necessarily rule for proceeding in this order (NETAFIM BRASIL, 2010). The survey revealed that most producers perform preventive maintenance on irrigation systems, even at a frequency considered inadequate.

On the left bank (Figure 4), preventive maintenance is performed weekly by 44% of the CAT producers and 48% of the SAT producers interviewed, whereas 36% of the producers interviewed, both the CAT and the SAT, do not perform preventive maintenance. On the right bank, most maintenance performed by CAT

producers is performed biannually (28%); SAT producers also perform biannually (12%) and annually (12%); preventive maintenance is not performed by 32% of the CAT producers and 68% of the SAT producers. The main preventive maintenance performed by producers is opening the ends of the line to remove impurities contained in the hoses.

Figure 4. Frequency of preventive maintenance in irrigation systems.



Legenda:
CAT – Com Assistência Técnica; SAT – Sem Assistência Técnica;
M. E – Margem Esquerda; M. D – Margem Direita.

Source: Authors (2019).

On the right bank, it was observed that CAT producers demonstrate greater awareness of the importance of proper irrigation system maintenance, which may be a direct reflection of the technical assistance received. In this scenario, data presented by Palaretti, Mantovani, and Sediyama (2011) highlight that one of the basic pillars for irrigation quality is the quality of the operational workforce, especially during the daily operation phase of the project, where negligence can occur and compromise system maintenance and management.

The collection of meteorological data is not common among farmers in the municipality, yet those who do so do not use these data to manage irrigation. The research revealed that rainfall measurements are the primary data collected, and this practice is used solely to inform farmers about rainfall volume, not irrigation management. Therefore, training for these farmers is necessary to guide the use of meteorological information when calculating irrigation depths.

The survey revealed that on the left bank, 76% of the CAT producers and 60% of the SAT producers interviewed did not collect meteorological data. On the right bank, 52% of CAT producers and 68% of SAT producers do not collect data. Carvalho (2018) noted that although climate variables are still rarely used in the agricultural sector of the municipality studied, climatic factors such as precipitation and temperature are decisive in the decision-making process because of the specificities of each crop in relation to these variables.

Properly sizing an irrigation system can help producers achieve higher productivity and reduce production costs, increasing profitability (GOOD AGRONOMIC PRACTICES, 2021). With respect to irrigation system sizing, 52% of CAT producers and 56% of SAT producers on the left bank stated that the system was adequately sized, whereas these figures were

equal for the right bank: 48% for CAT producers and 88% for SAT producers. Because CAT producers receive quality technical information about irrigation, they are able to discern and perceive problems that are typical of poor sizing, reflected in the results obtained here, where a lower percentage of reports of well-sized systems are found. Some SAT producers, although stating that their system was adequately sized, revealed during the interviews that it was necessary to adjust some valves to "balance" the water output so that pressure was adequate in the sectors.

This finding shows that some implemented systems have sizing flaws, also revealing the need for better technical preparation of those who offer and market the service, which, when not correctly executed, influences the planning of irrigation shifts, since the volume of water applied by each emitter will be uneven, thus interfering with the development of the plants and water and electricity consumption.

According to Testezlaf (2017), errors in system installation can reduce equipment lifespan, increase maintenance costs, make undesirable operational adjustments, and increase production costs. The study revealed that on the left bank of the SMRD River, more producers are responsible for assembling the irrigation system than on the right bank. The results were as follows: 80% of CAT producers and 84% of SAT producers on the left bank and 72% of CAT producers and 76% of SAT producers on the right bank.

This scenario is concerning, given that not all producers have sufficient technical knowledge for this setup, which may highlight a previously discussed issue: inadequate system sizing. The low level of training and qualifications of those directly responsible for the operation and maintenance of irrigation systems significantly impacts water application efficiency, especially in areas with lower technological levels (MAROUELLI *et al*., 2011).

Notably, there is a difference between the terms efficiency of use and efficiency of application: the use refers to the relationship between production (kg) and the amount of water applied (mm), and the efficiency of application refers to the volume of water that was applied and what was actually used, involving variables such as losses due to evaporation, percolation, runoff, etc.

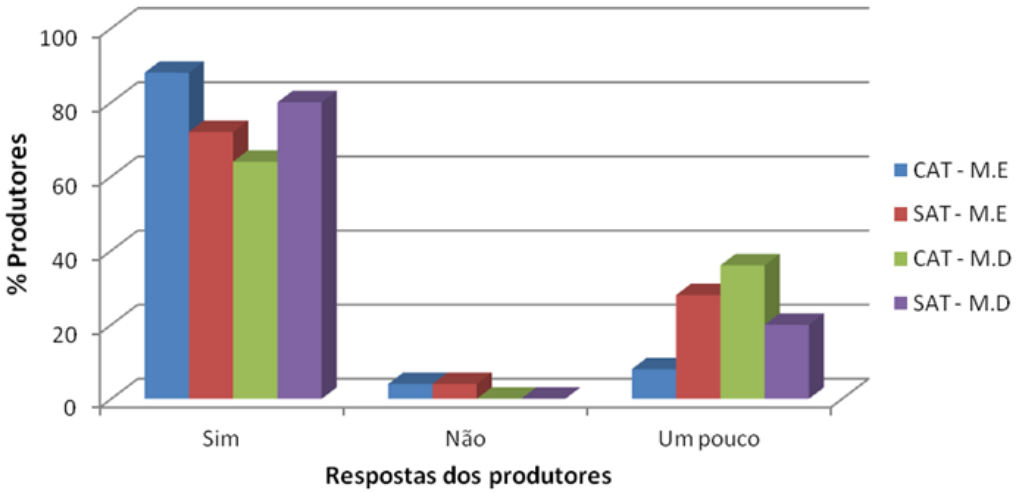
Carvalho (2018) reported that at the time of his research, only three rural property projects had installed an irrigation system in the Tancredo Microbasin, demonstrating that many systems were installed without prior planning and adequate sizing, resulting in complaints regarding the pressure and flow of their irrigation systems.

Irrigation management is a technique that aims to reconcile how, how much, and when to irrigate, serving as a strategy to increase crop yield and conserve water resources (NATIONAL RURAL LEARNING SERVICE, 2019). Irrigation management, combined with strategies such as rainwater storage and use and the adoption of conservation soil management and cultural practices, would lead to a reduction in the frequency of irrigation with water from surface and groundwater resources, resulting in a decrease in water withdrawal and thus saving surface and/or groundwater sources.

During the interviews, it was noted that on the left bank (Figure 5), 88% of the CAT producers and 72% of the SAT producers expressed belief in the benefits obtained through the adoption of irrigation management. On the right bank (Figure 5), this rate among the group of producers who do not receive technical assistance increases, representing 80% of SAT producers and only 64% of CAT producers. Therefore, it is recommended to find ways to train producers. regarding irrigation management

and its benefits, mainly those located on the right bank, aiming at the adoption of new and adequate management methods, such as the use of tensiometers and/or irrigometers, which are more reliable methods than the intuition of producers, thus providing economic and environmental benefits.

Figure 5. Credibility that the producer claims to have in irrigation management.



Legenda:
CAT – Com Assistência Técnica; SAT – Sem Assistência Técnica;
M. E – Margem Esquerda; M. D – Margem Direita.

Source: Authors (2019).

According to Mantovani, Zinato, and Simão (2006), awareness, an integrated vision, technology, and operationality are extremely important for adopting an irrigation management program, which will promote optimized input use, increased productivity, profitability, and expansion of the irrigated area in areas with limited water resources. In this sense, the study revealed that on the left bank, 84% of CAT producers and 96% of SAT producers do not use any irrigation management method. On the right bank, 92% of CAT producers and 100% of SAT producers do not use any management method; therefore, technical assistance may be more focused on mineral nutrition and plant pathology than on the adoption of irrigation management techniques.

With respect to obtaining a water resource use right grant, producers, especially those on the left bank, are reluctant to undertake the process, citing concerns about the implementation of water usage charges. The grant is the administrative act by which the State Water Resources Agency grants the requesting user the right to use surface and groundwater resources for a specified period. The importance of grants is linked to the quantitative and qualitative control of water use, ensuring fair and balanced distribution among users, as well as ensuring the sustainability of watercourses.

Notably, the request for water use rights is mandatory and must be requested for all uses under the conditions specified in Federal Law No. 9,433/1997 (NATIONAL WATER AGENCY, 2019). The types of water used to be granted and those that may be exempt from a grant—insignificantly used—vary according to the water body. Those that do not require a grant from the government, considered insignificant uses, are determined when the water flow rate used is less than that defined by law.

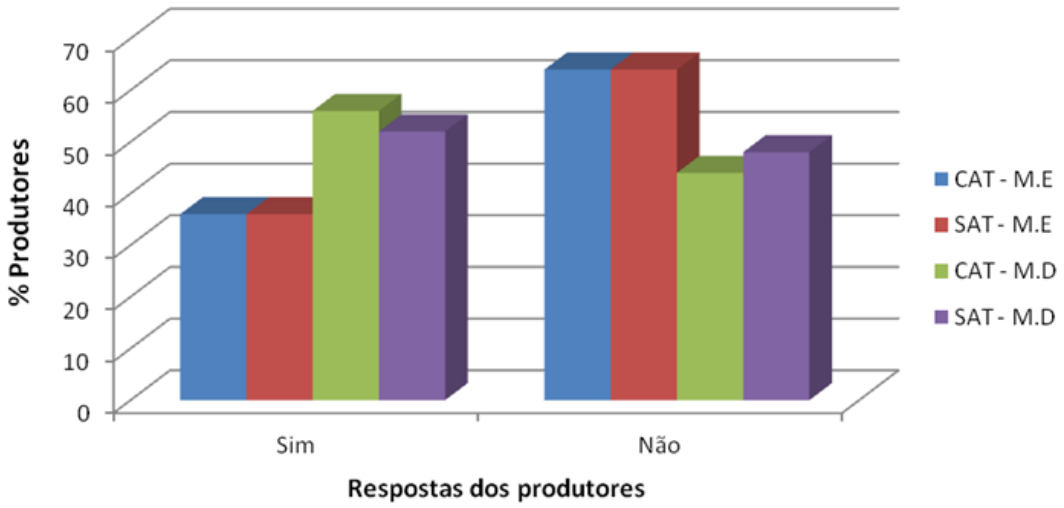
On the left bank of the SMRD River, 64% of the CAT producers and 76% of the SAT producers are licensed, whereas on the right bank, 100% of the CAT producers and 92% of the SAT producers interviewed are licensed. The greater number of licensed producers on the right bank is likely related to the fact that the tributary used for water collection is the SMRD River itself. Therefore, these producers are more subject to inspections because of the visibility and positive and negative impacts this river has on the social environment. Additionally, in Carvalho's (2018) study of the Tancredo microbasin in the municipality, the author concluded that the flow rates requested by users were 90.6% above the legally permitted abstraction rate.

Therefore, it is essential to promote actions that raise awareness among water resource applicants about the importance of water grants. To make it easier for applicants to apply for water grants, Agerh, like other states in the federation, implemented an online water grant application system in March 2020. The innovation developed by the institution optimizes the agency's work, streamlining the process of analyzing water grant requests and saving resources for both the state and citizens (STATE WATER RESOURCES AGENCY, 2020). A similar system is used by the National Water and Basic Sanitation Agency (ANA) through the Federal Water Use Regulation System (REGLA), a tool for requesting water grants for federal water resources (NATIONAL WATER AGENCY, 2015), which has already been implemented in some states.

However, it is important to note that the grant is precarious and can therefore be cancelled or suspended under certain conditions, namely, noncompliance with the terms of the grant; the need to meet priority uses (human consumption and animal watering); and the need for water to respond to emergency situations (BRASIL, 1997).

Regarding the existence of conflicts over water use (Figure 6), there were more reports of conflicts among producers who require water from the SMRD River, with 56% of CAT producers and 52% of SAT producers reporting that there had been some conflict over water use at some point. For producers who require water from other water bodies on the left bank, there was a lower level of conflict, with 36% of both CAT and SAT producers reporting conflict.

Figure 6. Conflicts over water use exist on the left bank of the Santa Maria do Rio Doce River and on the right bank.



Legenda:
CAT – Com Assistência Técnica; SAT – Sem Assistência Técnica;
M. E – Margem Esquerda; M. D – Margem Direita.

Source: Authors (2019).

The conflicts generated by the dispute over surface water sources, especially the waters of the Santa Maria do Doce River, are associated with the individualistic behavior of some of the user producers, especially those who demand significant volumes of water for crop irrigation and the expansion of agricultural activities without prior planning. These factors have contributed to a considerable contingent of the population present in the basin facing problems of a lack of water for irrigation and for the supply of water for human consumption, which should be assumed to be an unquestionable right, as per the priority provided by Law No. 9,433 of January 8, 1997 (BRASIL, 1997). Research published by Ferreira *et al*. (2011) described episodes of conflicts over water use in the Santa Maria do Rio Doce River basin.

Several actions have been implemented in the Santa Maria do Rio Doce River basin by the basin committee, which is made up of a collegiate body that is part of the National Water Resources Management System, composed of representatives of the public authorities, civil society and water users, whose objective is to guarantee the participatory, integrated and decentralized management of water resources.

The CBH-Santa Maria do Doce committee was established on April 25, 2005 (FERREIRA *et al*., 2011) and is currently quite active and functioning. Among its activities are informing and raising awareness among users in the basin regarding water scarcity, especially during droughts, aiming for rational use in agriculture and industry to meet human demand. The committee has also worked closely with AGERH and other environmental agencies to provide action and assistance in the basin.

Among other actions developed by the committee, we can list the intervention in the first instance regarding the conflict over water use, the promotion of lecture series to clarify doubts related to the grant, and partnerships with various environmental programs such as the Reflorestar Program, Barraginhas Program, and support for

Payment for Environmental Services (PSA), among others.

The "P22 - Program to Encourage the Rational Use of Water in Agriculture" initiative was implemented in the municipality with the aim of installing irrigometers. According to Gonzaga (2014), these devices measure the amount of evaporated water, converting it into the amount of water evapotranspired by the crop, indicating when and how much to irrigate. The P22 program also seeks to encourage the adoption of conservation practices in agriculture (COMITÊ DA BACIA HIDROGRÁFICA DO RIO DOCE, 2020b). The "P52 - Program for the Recomposition of Permanent Preservation Areas (APPs) and Springs" was also implemented to encourage the adoption and development of the Rural Environmental Registry (CAR) and reforestation projects for conservation purposes, promoting and encouraging sustainable agricultural practices (COMITÊ DA BACIA HIDROGRÁFICA DO RIO DOCE, 2020a).

However, when asked about their knowledge of the basin committee's initiatives, 88% of the CAT producers and 96% of the SAT producers on the left bank of the SMRD River stated that they were unaware. On the right bank, 64% of the CAT producers and 92% of the SAT producers also stated that they were unaware. This situation is concerning, given the low level of information among producers regarding the basin committee's activities and performance. Therefore, it is necessary for farmers to participate actively in the committee's meetings. It is also suggested that the committee's outreach channels be expanded to reach a greater number of producers. Similarly, suggestions are made to the competent agencies for organizing meetings, field days, projects, etc., to promote the mobilization of user producers regarding the means that enable the rational use of water and the proper management of irrigation systems.

With respect to the activities of Incaper, the government agency responsible for rural extension in the municipality, it has been developing lectures and training sessions to educate producers on the rational use of water for irrigation. The agency also encourages and supports rainwater capture and storage through strategic initiatives such as small dams (dams) and dry tanks so that this water not only contributes to groundwater recharge but is also used for irrigation.

6 CONCLUSIONS

The observed reality reflects that producers' knowledge regarding irrigation management is still very superficial, making it necessary to develop programs, workshops and/or training projects to promote behavioral changes related to the appropriate form of irrigation management in the municipality. These actions may also seek to encourage the adoption of methods that best suit the reality of each property, consequently increasing production, while at the same time, the demand for water resources can be reduced.

The way producers make decisions about when and how much to irrigate is predominantly intuitive, which is environmentally harmful, as it promotes the waste of water and energy, in addition to enabling the leaching of nutrients, leading to the impoverishment of soil fertility.

Producers with technical assistance had better knowledge levels regarding the adoption of irrigation management methods and the actions of the basin committee.

On the right bank of the Santa Maria do Doce River, there were more reports of conflicts over water use, as well as greater adherence to water use concessions.

7 ACKNOWLEDGMENTS

We would like to thank the Federal Institute of Education, Science and Technology of Espírito Santo – Ifes/Prodif for their financial contribution to the publication of this article.

8 REFERENCES

STATE WATER RESOURCES AGENCY. **Farmers can request Water Grants online starting this Monday (09)** . Vitória: Government of the State of Espírito Santo, 2020. Available at: https://agerh.es.gov.br/Not%C3%ADcia/agricultores-poderao-solicitar-outorga-da-agua-pela-internet-a-partir-da-proxima-segunda-feira-09. Accessed on: April 8, 2020.

STATE WATER RESOURCES AGENCY. **Critical Scenario** : Santa Teresa and São Roque do Canaã undergo water collection rotation for irrigation. Vitória: Government of the State of Espírito Santo, 2019. Available at: https://agerh.es.gov.br/Not%C3%ADcia/cenario-critico-santa-teresa-e-sao-roque-do-canaa-passam-por-rodizio-de-captacao-de-agua-para-irrigacao. Accessed on: November 11, 2020.

NATIONAL WATER AGENCY. **Granting of water resource use rights** . The Water Resources Situation in Brazil 2019. Brasília, DF: ANA, 2019.

NATIONAL WATER AGENCY. **Federal Water Use Regulation System** – REGLA. Brasília, DF: ANA, 2015. Available at: https://www.snirh.gov.br/cnarh/index.jsf. Accessed on: April 8, 2020.

ASCOLI, A.; HERNANDEZ, FBT; SENTELHAS, PC; TEIXEIRA, AHC; AMENDOLA, EC; ASCOLI, RT Irrigation requirements for sugarcane crops depending on harvest season . *In:* INOVAGRI INTERNATIONAL MEETING, IV. 2017, Fortaleza - CE. **Proceedings** [...] Fortaleza - CE: ABID, 2017. 1-10 p.

GOOD AGRONOMIC PRACTICES. **Irrigation, a practice that increases productivity in the field** . Curitiba: CropLife Brasil, 2021. Available at: https://boaspraticasagronomicas.com.br/boas-praticas/irrigacao/. Accessed on: March 27, 2021

BRAZIL. **Law No. 9,433 of January 8, 1997** . Institutes the National Water Resources Policy, creates the National Water Resources Management System, regulates item XIX of art. 21 of the Federal Constitution, and amends art. 1 of Law No. 8,001 of March 13, 1990, which amended Law No. 7,990 of December 28, 1989. Brasília, DF: Presidency of the Republic, Jan. 1997. Available at: http://www.planalto.gov.br/ccivil_03/LEIS/L9433.htm. Accessed on: Mar. 7, 2020.

CARVALHO, CS **Rainfall variability and water availability for use in irrigated agriculture in the Tancredo microbasin , municipality of São Roque do Canaã/ES** . 2018. Monograph Work (Postgraduate Lato Sensu in Sustainable Agriculture) – Federal Institute of Espírito Santo, Colatina, 2018.

COMÉRIO, A.; OLIVEIRA JÚNIOR, A. O; SPERANDIO, GM; SCHNEIDER, JM **Planning and action programs** – PROATER 2011 to 2013. Vitória: Incaper , 2011. 1 - 68 p.

DOCE RIVER BASIN COMMITTEE. **Understand the articulation between CBHs of the Doce River Basin and the Reforestation Program of the Government of the State of Espírito Santo** . Governador Valadares: CBH-Doce, 2020a. Available at: http://www.cbhdoce.org.br/reflorestar-es/entenda-a-articulacao-entre-cbhs-da-bacia-do-rio-doce-eo-programa-reflorestar-do-governo-do-estado-do-espirito-santo. Accessed on: April 26, 2020.

DOCE RIVER BASIN COMMITTEE. **Program to Incentive the Rational Use of Water in Agriculture (P22)** . Governador Valadares: CBH-Doce, 2020b. Available at: http://www.cbhdoce.org.br/programas-pap-2/p-22-bacias-hidrograficas-do-rio-manhuacu-e-santa-maria-do-doce. Accessed on: April 26, 2020.

FERREIRA, EP; FERREIRA, JTP; FERREIRA, AC; PANTALEÃO, FS; SILVA, WC Evolution and analysis of the actions of the Santa Maria Do Rio Doce river basin committee located in the state of Espírito Santo. **Encyclopedia Biosfera** , Goiânia, v. 7, n. 13, p. 1143-1152 , 2011.

GONZAGA, ACO **Beans** : the producer asks, Embrapa answers. 2nd ed. rev. and ampl . Brasília, DF: Embrapa, 2014.

IBGE. **2017 Agricultural Census** – Preliminary results. Brasília, DF: IBGE, 2019a. Available at: https://sidra.ibge.gov.br/pesquisa/censo-agropecuario/censo-agropecuario-2017. Accessed on: October 29, 2019.

IBGE. **Cities** : São Roque do Canaã. Brasília, DF: IBGE, 2019b. Available at: https://cidades.ibge.gov.br/brasil/es/sao-roque-do-canaa/panorama. Accessed on: October 29, 2019.

CAPIXABA INSTITUTE OF RESEARCH, TECHNICAL ASSISTANCE AND RURAL EXTENSION. **Producers** . São Roque do Canaã: Local Rural Development Office, 2020.

MANTOVANI EC; ZINATO, CE; SIMÃO, FR **Irrigation and fertigation management in guava cultivation** . Viçosa, MG: Livro Goiaba, 2006.

MAROUELLI, WA; OLIVEIRA, AS; COELHO, EF; NOGUEIRA, LC; SOUZA, VF Water management and irrigation. *In* : SOUSA, VF; MAROUELLI, WA; COELHO, EF; PINTO, JM; COELHO FILHO, MA **Irrigation and fertigation in fruit and vegetable crops** . Brasília, DF: Embrapa Information Technology, 2011. chap. 5, p. 157-232. Available at: https://ainfo.cnptia.embrapa.br/digital/bitstream/item/55931/1/IRRIGACAO-e-FERTIRRIGACAO-cap5.pdf. Accessed on: March 30, 2020.

NETAFIM BRAZIL. **Maintenance Manual for Localized Irrigation Systems** . Dept.: Technical Support. Ribeirão Preto: Netafim Brasil, 2010. Available at: https://docplayer.com.br/7541773-Netafim-brasil-manual-de-manutencao-para-os-sistemas-de-irrigacao-localizada-depto-suporte-tecnico.html. Accessed on: March 31, 2020.

OSTER, JD; WICHELNS, D. Economic and agronomic strategies to achieve sustainable irrigation. **Irrigation Science** , New York, vol. 22, no. 3, p. 107-120, 2003.

PALARETTI, LF; MANTOVANI, EC; SEDIYAMA, GC Characterization and diagnosis of irrigation systems and water management practices in citrus farming in northern São Paulo State. **Cadernos de Ciência & Tecnologia** , Brasília, DF, v. 28, n. 2, p. 531-551. 2011.

SENTELHAS, PC; ANGELOCCI, LR **Normal and sequential climatological water balance, crop and irrigation management** . Piracicaba: ESALQ/USP, 2012. Available at: http://www.leb.esalq.usp.br/leb/aulas/lce306/Aula9_2012.pdf. Accessed on: June 21, 2020.

NATIONAL RURAL APPRENTICESHIP SERVICE. **Irrigation** : management and handling. Brasília, DF: Senar , 2019.

TESTEZLAF, R. **Irrigation** : methods, systems and applications. Campinas: Unicamp: FEAGRI, 2017.

TONINI, VB **Climate classification and water balance extract for the district of São João de Petrópolis, Santa Teresa, ES** . 2017. Course Completion Work (Graduation in Agronomy) – Federal Institute of Education, Science and Technology of Espírito Santo, Santa Teresa, 2017.

FEDERAL UNIVERSITY OF SANTA MARIA. Center of Rural Sciences. Department of Rural Engineering. Geomatics Laboratory . **Campeiro 7 GPS Application** . Santa Maria: UFSM, 2014. Available at: http://www.crcampeiro.net/aplicativos.php. Accessed on: January 15, 2019.

9 ANNEX

Annex 1. Semistructured questionnaires were administered to producers.

QUESTIONNAIRE

Does the interviewee receive technical assistance? () Yes () No

() Right margin () Left margin

1. How many years have you been growing coffee on the property?
() 1-5 years () 6-10 years () 11-20 years () 21-30 years () It has always been cultivated

2. The irrigation system is as follows:
() Manual () Automated () Semiautomated

3. From which river do you collect water for irrigation?

4. How often should preventive maintenance be carried out on irrigation systems?
() Weekly () Monthly () Half-yearly () Annual () Does not

5. How do you determine the operating time of the irrigation system?

6. When irrigating, is it noted that the irrigation system has been sized appropriately (is there excess or loss of pressure)?
() Yes () No

7. Do you believe in the benefits of irrigation management?
() Yes () A little () No

8. Do you use any irrigation management method?
() Does not use a () tensiometer () Water balance () Class A tank

9. Does the property have a water permit for irrigation?
() Yes () I am submitting () No

10. What is your main source of water for irrigation?
() River () Spring () Artesian Well

11. Is there conflict over water use in the region?
() Yes () No

12. In your region, do you know of any action carried out by the CB of Rio Doce?
() Yes () No

13. Do you collect meteorological data?
() No () Precipitation () Solar radiation () Relative humidity () Wind speed () Temperature

14. What criteria are used to determine the purchase of the irrigation system?
() Price () Quality of service provided () Company location () Brand

15. Who installs the irrigation system when it is purchased:
() Consultants () Selling company () Farm employee