



Agro-socio-productive characterization of the users of the ‘Maconta Abajo’ irrigation system, Manabí, Ecuador

Caracterización agro socio productiva de los usuarios del sistema de riego Maconta Abajo, Manabí, Ecuador

Authors

*Yaser Galarza Alava
✉ yaser.galarza@espam.edu.ec



Cristian Valdivieso López
✉ cristian.valdivieso@espam.edu.ec



Saskia Guillen Mendoza
✉ sguillen@espam.edu.ec



Lenin Vera Montenegro
✉ lveram@espam.edu.ec



Leonardo Vera Macías
✉ lvera@espam.edu.ec



Abstract

The research characterized the agro-socio-productive dynamics of users of the ‘Maconta Abajo’ irrigation system in Manabí, Ecuador, considering social, agro-productive, technical, and environmental dimensions. It worked with 44 producers, representing 50 active partners, applying a non-experimental descriptive explanatory design under the positivist paradigm with a mixed approach. Data collection was carried out using a structured survey, validated by experts and evaluated with the test-retest method. Social dimension: 81.8% of the plots are managed by men aged 57.9 ± 13.2 years, with agriculture as their main activity (72.7%). The X^2 test showed a significant association between gender and occupation, while schooling, tenure, title deeds, residence, financing, technical assistance, and viability showed no significant differences. In the agricultural production dimension, the cultivable area was 1.35 ± 1.56 ha, with fruit trees predominating at 34.15% and corn at 31.8%. There was a significant association between crop type, cultivable area, main water source, and irrigation type. Technical operational dimension: 95.5% make a payment per irrigated area twice a week. Significant associations were found between the variables type of payment, frequency of payment, and to whom the fee was paid. Environmental dimension: 79.5% were unaware of the authorized flow rate and 81.8% were unaware of the water source, with a significant association between flow rate and water quality analysis. The results indicated that the efficiency and sustainability of the parcel system depends on the interaction between social, productive, technical, and environmental aspects, highlighting the need for generational renewal, technical training, and equitable access to water resources.

Keywords: agricultural development, water resource management, technified irrigation, rural development, environmental sustainability.

Carrera de Ingeniería Agrícola. Escuela Superior Politécnica Agropecuaria de Manabí Manuel Félix López, Campus Politécnico El Limón, vía Calceta-El Morro, Ecuador.

Resumen

La investigación caracterizó las dinámicas agro-socio-productivas de los usuarios del sistema de riego Maconta Abajo, Manabí, Ecuador, considerando dimensiones sociales, agro-productivas, técnicas y ambientales, se trabajó con 44 productores, representativos de 50 socios activos, aplicando un diseño no experimental descriptivo explicativo, bajo el paradigma positivista con un enfoque mixto. La recolección de datos se realizó mediante encuesta estructurada, validada por expertos y evaluada con la prueba de test retest. Dimensión social, el 81,8% de las parcelas fueron administradas por hombres con una edad de $57,9 \pm 13,2$ años y actividad principal agricultura 72,7%. La prueba X^2 mostró asociación significativa entre género y ocupación, mientras que escolaridad, tenencia, título de propiedad, residencia, financiamiento, asistencia técnica y viabilidad no mostraron diferencias significativas. En la dimensión, agro-productiva, la superficie cultivable fue de $1,35 \pm 1,56$ ha, predominado frutales 34,15% y maíz 31,8%. Con asociación significativa entre tipo de cultivo, superficie cultivable, fuente principal de agua y tipo de riego. Dimensión técnica-operativa, el 95,5% realizó un pago por superficie con riego con una frecuencia de dos veces por semana. Se encontraron asociaciones significativas entre las variables tipo de pago, frecuencia de pago y a quien paga la tarifa. Dimensión ambiental, el 79,5% desconoció el caudal autorizado y el 81,8% la fuente hídrica con asociación significativa entre caudal y análisis de calidad del agua. Los resultados indicaron que la eficiencia y sostenibilidad del sistema parcelario dependió de la interacción entre aspectos sociales, productivos, técnicos y ambientales, resaltando la necesidad de renovación generacional, capacitación técnica y acceso equitativo al recurso hídrico.

Palabras clave: desarrollo agrícola, gestión de recursos hídricos, riego tecnificado, desarrollo rural, sostenibilidad ambiental.

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Introduction

Latin America is a region with great climatic, topographic and edaphic diversity, which favours agricultural development; this activity accounts for 27% of the world’s arable land (Arce, 2018). Agriculture plays a fundamental role in food production and in the economies of countries in the region. In Ecuador, approximately 26% of the economically active population is engaged in the agricultural sector, making it one of the main generators of exports of crops such as bananas, cocoa, roses and coffee (Cortés, 2023). In the province of Manabí, this activity is particularly significant, although it faces challenges related to an ageing workforce and low youth participation, which limits generational renewal (National Institute of Statistics and Census (INEC), 2021).

Agricultural production units in Manabí are generally small, with an average size of 5 hectares, and are usually transferred from generation to generation within farming families. This family-based organisation supports diversified agriculture, in which crops such as maize, bananas, cocoa and fruit trees ensure food security and contribute to the local economy (Prefectura de Manabí, 2025). However, producers face recurrent challenges, such as irregular water supplies, high pumping and hydraulic maintenance costs, limited availability of inputs and restricted access to technical knowledge. At the same time, most still use simple irrigation systems, such as flood irrigation, which has relatively low efficiency, generally below 45% (Food and Agriculture Organization of the United Nations (FAO), 2021).

Within its climatic characteristics, Portoviejo—like much of the province of Manabí—experiences a hydrological drought period lasting close to seven months of the year, from June to December, while the rainy season spans the five months from January to May (Mera, 2014). During this period, 91.98% of the annual precipitation is recorded, equivalent to 761.94 mm out of a total of 829.42 mm (National Institute of Meteorology and Hydrology (INAMHI), 2023). During the dry season, water demand is high and river runoff volumes are low (Mendoza et al., 2019). For this reason, during the dry period the area depends on the Poza Honda reservoir, which has a storage capacity of more than 100 hm³. From this hydraulic infrastructure originates the technified irrigation system known as ‘Maconta Abajo’ (Prefectura de Manabí, 2022). This system is located north of the site ‘Maconta Arriba’, bordered to the south by ‘Maconta Calderón’, to the east by Bijahual and to the west by Los Ángeles de Colón (Ruiz, 2014). The irrigated area of this system exceeds 100 hectares and directly benefits more than 70 families, as well as more than 300 people indirectly.

The present study aimed to characterise the agro-socio-productive dynamics of the users of the ‘Maconta Abajo’ irrigation system

in Manabí, Ecuador, considering social, productive, technical–operational and environmental aspects, and to identify the factors that influence the sustainable management of water resources in order to improve their efficiency and equity.

Materials and methods

Area of study

This study was carried out in the area of influence of the ‘Maconta Abajo’ irrigation system, located in the community of ‘Maconta Abajo’, Colón parish, within the canton of Portoviejo. It is geographically referenced between the coordinates 1°5’7.31” S and 80°22’10.49” W (figure 1).



Figure 1. Location of the area of influence of the ‘Maconta Abajo’ irrigation system.

Sample size

Within the framework of the research, the study population consisted of 50 producers, corresponding to the total number of active members of the ‘Maconta Abajo’ irrigation system, as registered in the consumer records of the ‘Las Palmas’ Irrigation and Drainage Board (Statutes of the ‘Las Palmas’ Irrigation and Drainage Board, 2021). To ensure data representativeness and an adequate level of statistical confidence, the sample size was determined using formula (1) for finite populations, as proposed by Arcos (2016).

$$n = \frac{(Z)^2(p)(q)(N)}{(d)^2(N - 1) + (Z)^2(p)(q)}$$

Where N is the population size (50 producers), p= 0.5 is the probability of success, q= 0.5 is the probability of failure, Z= 1.96 is the value corresponding to a 95% confidence level, and e= 0.05 represents the level of precision. The application of formula (1) resulted in a sample size of 44 producers, equivalent to 88% of the total population, all of whom were included in the study,

thereby ensuring statistical representativeness and the validity of the results obtained.

Methodological design, approach, and data collection instruments

To ensure the validity and reliability of the questionnaire, a mixed procedure was applied that combined expert validation and a test–retest trial. Expert validation followed the methodology of López (1998), assessing the relevance, coherence, and clarity of each question. Five specialists in water resource management and rural development participated, who reviewed the structure and suitability of the questionnaire, ensuring its correspondence with the social, agro-productive, technical-operational, and environmental dimensions of the study (table 1). Subsequently, the test–retest procedure was implemented following Sailema et al. (2022) and applied to a pilot group of eight producers, with a two-week interval between administrations of the instrument, obtaining a reliability coefficient of ($r= 0.89$). This result confirmed the temporal consistency and stability of the questionnaire, ensuring that the instrument provided reliable, systematic, and comparable information for the analysis of the variables investigated (figure 2).

Table 1. Systematization of variables.

Variable	Dimension	Categories/Indicators
Characterize the agro-socio-productive situation	Social	Gender; age of the landowner; occupation; land tenure; education level; property title deed; residence on the farm; access to financing; technical assistance; road access.
	Agro-productive	Farm size; predominant crops; cultivable area; annual production; main water source for irrigation; irrigation type; irrigated area.
	Technical-operational	Payment type; irrigation schedule; payment frequency; irrigation frequency; irrigation system fee; entity or person receiving the payment.
	Environmental	Authorized flow rate for irrigation; water quality analysis; name of the water source.

Note. The table shows the systematization of the variables in the present study across the social, agro-productive, technical–operational, and environmental dimensions, each with its respective categories.

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Figure 2. Administration of the questionnaire to producers in the “Maconta Abajo” irrigation system.

Statistical analysis

The data were processed using SPSS (Statistical Package for the Social Sciences). Descriptive statistics were applied, obtaining frequencies and percentages for categorical variables, as well as means and standard deviations for continuous variables. In addition, Pearson’s chi-square test was used to assess associations between the indicators of each variable within their respective social, agro-productive, technical–operational and environmental dimensions. A significance level of $p \leq 0.05$ was adopted, with higher values considered non-significant.

Results and discussion

Social dimension

A total of 81.8% of the plots in the community of ‘Maconta Abajo’ are managed by men, while only 18.2% are under the supervision of women. This distribution confirms the findings reported by Tito-Velarde (2021), who highlighted the persistent inequality in access to and control over productive resources in rural areas. The average age of producers was 57.9 ± 13.2 years, reflecting the absence of generational renewal in the agricultural sector, a phenomenon associated with youth migration to urban areas and the lack of incentives to remain in rural settings (Triana et al., 2024). With regard to occupation, agriculture constituted the main economic activity, accounting for 72.7%, followed by domestic work (13.6%), public employment (9.1%) and technical professions (4.6%). This pattern reveals low occupational diversification and a high level of dependence on agricultural activity, which increases vulnerability to market variability and instability (Montero et al., 2024).



With regard to educational level, the majority of producers had completed secondary education (50%), 36.4% reported having completed primary education, and only 13.6% had accessed higher education. This low level of schooling limited the adoption of technological innovations and the sustainable management of production systems, as reported by Guerrero et al. (2023). In relation to land tenure, 97.7% of the sample stated that they owned their plots; however, only 77.3% had formal title deeds, a condition that restricted access to financing and its allocation to the implementation of agricultural works or equipment (Martínez and Salazar, 2022). In addition, only 38.6% resided on their plots, which hindered constant supervision of crops.

The availability of financing was limited: 90.9% of producers relied on their own resources, while only 9.1% accessed private credit, reflecting the structural barriers to entering the rural financial system (Tomalá and Manya, 2023). This was compounded by a lack of technical assistance, reported by 95.4% of producers, which limited the modernisation of cropping systems and the implementation of sustainable practices (Maldonado et al., 2023). A total of 65.9% of respondents considered road accessibility to be good, while 34.1% perceived deficiencies in access to quality roads, increasing transport costs and hindering commercialisation (Pérez et al., 2021).

In the social dimension, the chi-square (χ^2) test revealed a statistically significant association between the variables of gender and occupation ($p \leq 0.05$), confirming that agricultural activity was concentrated mainly among men, while women participated more frequently in domestic or support tasks (table 2), in line with what was described by Vega and Castro (1978). In contrast, variables such as educational level, land tenure and property title, residence on the plot, financing, technical assistance and road accessibility did not show significant associations ($p \geq 0.05$). These results suggest that the characteristics analysed were distributed relatively homogeneously among producers, which is consistent with Dirven (2021), who argued that the limitations of the rural sector are determined primarily by structural factors rather than by specific sociodemographic differences.

Agro-productive dimension

In the study community, 52.27% of producers had less than 1 ha, while 25% owned between 1.1 and 3 ha, evidencing marked variability in farm size. This pattern was associated with fragmentation processes resulting from family inheritance and demographic pressure, factors that have progressively reduced plot size (Triana et al., 2024).

Table 2. Social dimension.

Variable	Statistic	Category	
Gender	Percentage	Male	81.8
		Female	18.2
Owner age	Mean	Age (years)	57.9
		DE	13.2
Occupation (*)	Percentage	Housewife	13.6
		Farmer	72.7
		Engineer	4.6
		Public sector worker	9.1
Education (ns)	Percentage	Primary	36.4
		High school	50.0
		Superior	13.6
Land tenure (ns)	Percentage	Owned	97.7
		Rented	2.3
Residence on the plot (ns)	Percentage	Yes	38.6
		No	61.4
Property title (ns)	Percentage	Yes	77.3
		No	22.7
Financing (ns)	Percentage	Private entities	9.1
		Own resources	90.9
Technical assistance (ns)	Percentage	Hired engineer	4.6
		No assistance	95.4
Road access (ns)	Percentage	Good	65.9
		Fair	25.0
		Poor	9.1

Note. Continuous variables are presented as mean ± standard deviation, and categorical variables were analyzed using the Chi-square test (χ^2). A significance level of ($P \leq 0.05$, *) significant and ($P \geq 0.05$, ns) not significant was considered.

Despite this structural limitation, Zavaleta et al. (2022) argued that small production units can achieve acceptable levels of productive efficiency; however, the lack of capital and access to credit has restricted their capacity for modernisation and technological adoption. In line with this, Maldonado et al. (2023) emphasised that insufficient investment hinders the transition towards sustainable practices and the implementation of more efficient irrigation systems, thereby reducing competitiveness in the sector. In this context, the cultivable area averaged 1.35 ± 1.56 ha, reflecting high productive heterogeneity and an unequal distribution of resources.

Cropping mosaics consisted of 34.1% fruit trees, 31.8% maize, 15.9% plantain, 11.4% cocoa, 4.5% vegetables and 2.3% cassava. This mix of short-cycle and perennial crops generated

certain advantages when climatic conditions changed or when market prices fluctuated (Rojas and Saavedra, 2022). Despite the advantages of crop diversity, farmers who focused on a single crop still obtained higher immediate returns and found it easier to access global markets (Castillo et al., 2023). In the long term, mixed systems helped maintain soil quality and biodiversity; however, the expansion of this model has been constrained by the lack of technical assistance and public policies to support it (Espinosa et al., 2025). Only 31.8% of producers kept production records, revealing weaknesses in planning and financial management. This shortcoming was associated with low financial literacy and the predominance of empirical practices, which limited access to formal credit (Suescún, 2022). Nevertheless, Pérez et al. (2021) noted that empirical monitoring practices persist in rural areas and may be useful within subsistence economies, but are largely ineffective in contexts of commercial competition.

The average annual crop yield was $4,297 \pm 11,925 \text{ kg} \cdot \text{ha}^{-1}$, which indicates high diversification as a function of the balance between management practices and agroecological inputs. Intriago et al. (2021) attributed these differences to edaphic factors and agronomic management, while Burgos (2021) argued that the use of agroecological practices favours greater long-term yield stability. Maldonado et al. (2024) contended that profitability did not depend exclusively on production volume, but also on input costs and the dynamics of agricultural markets, which are characterised by volatility in prices and demand.

With regard to access to water resources, 77.3% of producers used irrigation, 4.6% relied on wells, and 18.2% did not have a stable water source, demonstrating inefficient management of available water, particularly in the context of scarcity. In recent years, several studies have been published highlighting advances in optimal water use and integrated systems; in this regard, Acero and Lanchipa (2021) pointed out that the lack of technology and training limited their effectiveness, and that the overexploitation of water resources led to erosion or degradation of agricultural substrates. Meanwhile, Campos and Cuadrado (2023) explained that asymmetric control of water generated productive conflicts and constrained agricultural expansion.

Micro-sprinkler irrigation was the most widely used system (77.3%), followed by flood irrigation (18.2%) and drip irrigation (4.55%), reflecting a gradual transition towards more efficient systems. Ríos and Gil (2021) highlighted that micro-sprinkler irrigation reduces water losses, although its efficiency depends on pressure and proper maintenance (Cardona et al., 2021). Despite its lower sustainability, flood irrigation persists due to its low cost and ease of implementation, as irrigation modernisation requires investments that may be inaccessible to small producers (Hernández, 2025). Irrigation covered an average area of $0.95 \pm 1.02 \text{ ha}$, suggesting a lack of uniformity in distribution. According to Martínez and Salazar (2022), irrigation facilitates production stabilisation by minimising climatic vulnerability; however, Ramírez et al. (2021) pointed out that improvements in irrigation efficiency depend on water management and technological upgrading. Limitations were also observed, such as unequal access to water and limited available investment. Nevertheless, these constraints can be addressed through technologies such as drip irrigation or the use of soil-moisture sensors, which optimise

resource use and improve profitability (Rojas and Saavedra, 2022).

The chi-square (χ^2) test in the agro-productive dimension showed a highly significant association ($P \leq 0.05$) between the variables of main water source and type of irrigation, indicating that access to water resources determined the level of technological adoption by producers. Likewise, significant differences ($P \leq 0.05$) were identified between crop type and cultivable area of the farm, confirming that larger production units tended to concentrate on commercial crops, whereas smaller units maintained mixed or subsistence systems. In contrast, variables such as cultivable area, production record keeping and irrigated area did not show significant differences ($P \geq 0.05$), suggesting a homogeneous distribution of these productive characteristics (table 3). These results are consistent with those reported by Triana et al. (2024), who argued that rural productive development depends more on comprehensive policies of technological upgrading and training than on the expansion of farm area.

Table 3. Agro-productive dimension.

Variable	Statistic	Category	
Farm size (ns)	Percentage	Less than 1 ha	52.3
		1.1 ha and 3 ha	25.0
		3.1 ha and 5 ha	6.8
		More than 5 ha	15.9
Crops (*)	Percentage	Fruits	34.1
		Maize	31.8
		Plantain	15.9
		Cacao	11.4
		Vegetable	4.5
		Cassava	2.3
Cultivable area	Average	hectares	1.4
Production data (ns)	Percentage	Si	31.8
		No	68.2
Annual production	Average	$\text{kg} \cdot \text{ha}^{-1}$	4298
	DE		11925
Main water source for irrigation (**)	Percentage	Irrigation system	77.3
		Well	4.6
		None	18.2
Type of risk (ns)	Percentage	Microsprinkler	77.3
		Drip	4.6
		Flooding	18.2
Low-risk area	Average	hectáreas	0.95
	DE		1.02

Note. Continuous variables are presented as mean \pm standard deviation, and categorical variables were analyzed using the chi-square test (χ^2). A significance level of ($P \leq 0.05$, *) significant and ($P \geq 0.05$, ns) not significant was considered.

Technical-operational dimension

A total of 95.5% of producers paid for irrigation according to the irrigated area, while 4.5% made no payment. This model facilitated system maintenance, although it may generate inequities in water use (Chile and Ortiz, 2021). Suescún (2022) suggested that the adoption of tariffs based on actual consumption increases equity and sustainability in irrigation



by encouraging more rational water management. Regarding irrigation schedules, the majority of producers (95.5%) irrigated between 7:00 a.m. and 3:00 p.m., while only 4.5% did so from 7:00 a.m. to 12:00 p.m. According to Ramírez et al. (2021), this practice may reduce irrigation efficiency due to factors such as evapotranspiration.

With respect to payment frequency, 95.5% of producers paid monthly, while 4.5% paid quarterly, reflecting a trend towards more frequent payments. According to Ramírez et al. (2021), payment periodicity is a key factor in the sustainability of irrigation systems, as it helps ensure the maintenance and operation of hydraulic infrastructure. In this regard, Chile and Ortiz (2021) stated that the preference for monthly payments may be influenced by farmers' income flows, as income is received periodically according to production cycles. In contrast, quarterly payments, although less common, may represent an advantage for certain producers with less regular incomes or longer crop cycles.

Regarding irrigation frequency, 75.5% irrigated twice a week, 20.5% three times a week, and 4.5% did not irrigate. This indicates a relatively consistent irrigation routine among most producers. According to Chile and Ortiz (2021), irrigation frequency is a necessary factor for water-use efficiency, as it directly influences plant development, soil conservation and the sustainability of agricultural systems.

Cost variability was reflected in a standard deviation of 9.29 USD·ha⁻¹, with an average irrigation system cost of 9.8 USD·ha⁻¹. Zavaleta et al. (2022) addressed the sustainability of small and medium-sized producers by proposing tariff equity through balancing payment levels and the operating costs of irrigation systems. Jaramillo et al. (2023) warned that the area-based payment model, predominant in 95.5% of cases, may discourage efficient water use. Zamora et al. (2021) demonstrated that payment based on consumed volume reduced water wastage. A total of 95.5% of producers made this payment to the irrigation board in order to ensure the proper functioning of the system, while 4.5% did not. Chile and Ortiz (2021) noted that collective water management occurs in scenarios where rules and administration are clear and transparent. Jaramillo et al. (2023) approached the issue from the perspective that strong governance and active user participation improve efficiency in water distribution.

The chi-square (χ^2) test in the technical–operational dimension revealed significant associations ($P \leq 0.05$) between the variables type of payment, payment frequency and recipient of the tariff, confirming that the financial structure and operational behaviour of producers were closely linked. By contrast, irrigation schedule

did not show significant differences ($P \geq 0.05$), suggesting that most producers followed a similar pattern of water application regardless of other factors (table 4). These results are similar to those reported by Chile and Ortiz (2021), who indicated that coordinated payments and collective participation strengthen water governance and system efficiency, and that the regulation of payments and irrigation frequency directly affects the sustainability and operation of irrigation systems.

Tabla 4. Technical-operational dimension.

Variable	Statistics	Category	
Type of payment (**)	Percentage	Irrigated area	95.5
		Do not make a payment	4.5
Irrigation schedule (ns)	Percentage	7:00 am to 3:00 pm	95.5
		7:00 am to 12:00 pm	4.5
Payment frequency (**)	Percentage	Monthly	95.5
		Quarterly	4.5
Irrigation frequenct (**)	Percentage	Two days per week	75.5
		Three times per week	20.5
		Do not irrigate	4.5
Irrigation system fee	Mean	Usd·ha ⁻¹	9.8
	DE		9.3
Recipient of this fee (**)	Percentage	Irrigation board	95.5
		Do not pay	4.5

Note. Continuous variables are presented as mean ± standard deviation, and categorical variables were analyzed using the chi-square test (χ^2). A significance level of ($P \leq 0.05$, *) significant and ($P \geq 0.05$, ns) not significant was considered.

Environmental dimension

A total of 79.5% of producers are unaware of the authorised flow rate of 35 L s⁻¹, which limited efficient management of the resource. In this regard, Cárdenas et al. (2021) emphasised that access to this information supports governance in plot-level irrigation systems. Chile and Ortiz (2021) indicated that its application optimised water use, while Jaramillo et al. (2023) warned about possible sanctions for non-compliance and the need to train the community to improve knowledge and the sustainability of irrigation. A total of 84.1% of producers carried out water-quality analyses, a key practice for preventing salinisation and soil deterioration (Castillo et al., 2023). Jaramillo (2024) noted that implementing this control supports sustainability and the environmental certification of the irrigation system; therefore, strengthening the technical training of personnel was recommended in order to optimise water

monitoring. Regarding knowledge of the water source, 81.8% were unaware of the origin of the water source supplying the irrigation system, limiting planning and resource conservation. Chile and Ortiz (2021) pointed out that identifying the source improves management and participation, reducing conflicts and vulnerability to climate change.

The chi-square (χ^2) test in the environmental dimension revealed a significant association ($P \leq 0.05$) between the variables authorised flow rate and water-quality analysis, showing that producers with greater knowledge of the authorised flow rate tended to adopt more technical and sustainable practices in resource management. In contrast, no significant differences ($P \geq 0.05$) were observed between the name of the water source and the other variables (table 5), suggesting a homogeneous and informal approach to water management in most cases. These results are consistent with those reported by Cárdenas et al. (2021), who indicated that water sustainability depends not only on the volume available, but also on the degree of organisation and community control over its use.

Table 5. Environmental dimension.

Variable	Statistics	Category	
Authorized flow rate for irrigation (**)	Percentage	Do not know the authorized flow rate	79.5
		Know the authorize flow rate	20.5
Water quality analysis (**)	Percentage	Yes	84.1
		No	15.9
Name of the water source (ns)	Percentage	Do not	81.8
		They know the flow source	18.2

Note. Continuous variables are presented as mean \pm standard deviation, and categorical variables were analyzed using the Chi-square test (χ^2). A significance level of ($P \leq 0.05$, *) significant and ($P \geq 0.05$, ns) not significant was considered.

Conclusion

Various characteristics were identified among the users of the system, reflecting social, productive, technical and environmental aspects. The predominance of men in plot management and the advanced age of producers indicate the need for generational renewal and support for cultural change in agriculture. Limitations in education and access to financing highlight barriers that must be overcome in order to promote the adoption of more advanced and efficient agricultural practices.

The considerable number of small farms, together with crop diversity, suggests a structure that is diversified and, in some cases, sub-optimal in production terms. The prevalence of localised irrigation compared with more traditional methods shows some progress towards greater efficiency in water use; however, limited access to resources and technical support continues to pose challenges. The area-based payment system

for block irrigation, combined with pre-established intervals between irrigation events, indicates a reasonable degree of order in operations, while also highlighting gaps in financing and technical assistance. Overall, this information provides a comprehensive description of current conditions within the irrigation system, while also indicating where actions and improvements are needed for better management of agricultural systems.

Conflict of interest

The authors declare that they have no conflicts of interest in this publication at any stage.

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Author contributions according to CRediT

Yaser Galarza Alava: methodology, investigation, formal analysis, writing-original draft, writing-review and editing. **Cristian Valdivieso López:** formal analysis, writing-original draft, writing-review and editing. **Saskia Guillen Mendoza:** conceptualization, formal analysis, methodology, investigation, writing-review and editing. **Lenin Vera Montenegro:** formal analysis, writing-original draft. **Leonardo Vera Macias:** writing-review and editing.

