

Ecotourism in the Páramos of Ayabaca, Piura: Conservation and Community Development

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ABSTRACT

High mountain ecosystems such as the Andean páramos represent areas of remarkable biodiversity and provide essential hydrological functions that sustain human well-being. In this context, rural development through ecotourism emerges as a strategic alternative to foster economic growth and reduce social inequalities in vulnerable communities. The present study aimed to evaluate the ecotourism potential of the area by considering its biodiversity and landscapes; to design an ecotourism experience that preserves both natural and cultural values while remaining economically and socially viable; and to identify the economic and social factors influencing the participation of local communities in ecotourism activities. The findings indicate that the Totorá-Laguna Azul de la Felicidad route possesses high ecotourism potential, supported by its rich natural and cultural heritage as well as by strong community commitment. The social dimension reveals broad acceptance of the proposed initiatives among community members, along with an emphasis on cultural conservation and collective identity. However, the economic dimension shows limitations, reflected in low levels of formal employment and income generation. It is concluded that ecotourism can be consolidated as a driver of sustainable development, provided that participatory governance, social equity, and local productive diversification are strengthened.

Keywords: Ecotourism, Páramos, Biodiversity, Community Development, Ecosystem, Community Participation, Paramuna Communities

INTRODUCTION

High mountain ecosystems, such as the Andean páramos, are characterized by distinct vegetation zones distributed across multiple altitudinal belts and play essential ecological roles, particularly in water regulation and carbon sequestration (Brück et al., 2023). The cultural importance of the páramo thus transcends local communities (Vergara & De Pellegrin, 2025). However, over the past two decades, these ecosystems have undergone intense transformations due to anthropogenic activities such as livestock grazing and agriculture, leading to changes in ecological structure and a reduction in ecosystem services. In this regard, Rey et al. (2025) argue that despite their importance, páramos are subject to anthropogenic pressures resulting from the ongoing conversion of native grasslands and shrublands into agricultural, forestry, and grazing lands. Furthermore, the páramo and its rural inhabitants, who are often socioeconomically vulnerable, face conservation policies aimed at delimiting, protecting, and regulating their livelihoods (Blake et al., 2023). Seasonal variability exacerbates these challenges, highlighting

the ecological sensitivity of these ecosystems and the need for further research and conservation efforts (Duque-Zapata et al., 2025). Such transformations diminish the páramos hydrological buffering capacity and water supply potential (Rey et al., 2025; Obando-Cabrera et al., 2025). Consequently, there is growing interest in the management and conservation of páramos, reflected in recent legislative changes in countries such as Colombia and Ecuador, which encompass large páramo areas (Mills et al., 2023; Lis-Gutiérrez et al., 2023). These countries have adopted sustainable livestock practices, which have proven essential for balancing production and environmental conservation.

Nature conservation activities are essential for the implementation of the ecotourism concept (Purnamawati et al., 2025). Therefore, ecotourism emerges as an alternative for community development, as it is defined as a form of responsible tourism that conserves the environment and enhances the well-being of local populations by increasing their income (Garnica-Jarrín & Yépez-Vera, 2025). The approach of this construct seeks to establish links with nature and local culture, to create products and services, and to identify the unique characteristics of the destination in order to continuously evaluate and improve the strategies implemented to meet visitor's needs (Méndez & Guerra, 2024). The growing interest of tourists in experiencing the cultural habits and beliefs of local communities has encouraged the organization of rural areas into small-scale businesses (Silva et al., 2021). Thus, tourism has become a key driver for revitalizing rural areas affected by depopulation, land abandonment, and economic decline (Uldemolins et al., 2025). Tourism activity has increasingly become a source of income generation in many parts of the world, particularly in places endowed with natural resources that have not yet been integrated into tourism infrastructure to foster sustainable development and local income generation (Oviedo et al., 2021; Luján-Vera et al., 2025). Identifying the tourism potential of ecosystems located in rural zones is not an easy task, since a tourism resource represents the known or latent potential of cultural or natural assets transformed to meet tourism demands (Luján-Vera et al., 2022). According to Cerón et al. (2023), natural and social resources alone are not sufficient to achieve rapid and successful tourism development; it is essential to analyze the substantive components of the productive fabric, considering economic activities, production linkages, internal employment, geographical location, territorial accessibility, and the role of local stakeholders. In this context, rural areas are increasingly fostering the search for new development alternatives that ensure resource sustainability and community empowerment, recognizing the diversity of nontraditional activities and uses that may take place within their geographical spaces (Contreras et al., 2025).

Despite the growing concern for ecosystem preservation, few studies have clarified the concepts related to ecotourism development and the challenges posed by economic and social factors influencing participation in such activities (Zhang et al., 2025). In this context, the present study focuses on the Páramo of Ayabaca-Piura and pursues the following objectives: (1) to assess the ecotourism potential of the area by considering its biodiversity and distinctive landscapes; (2) to design an ecotourism experience that preserves natural and cultural values while remaining economically and socially viable; and (3) to identify the economic and social factors that influence the participation of local communities in ecotourism activities. The relevance of this study lies in presenting an integrated approach that strengthens páramo conservation and promotes sustainable community development. The expected findings will provide a scientific foundation for public policies, participatory management strategies, and territorial investment initiatives in community-based ecotourism.

LITERATURE REVIEW

Páramo of Ayabaca

The páramo is primarily recognized for its strategic importance in carbon storage, water supply, biodiversity conservation, and early detection of climate change (Martínez et al., 2024; Berrones et al., 2023). It is also characterized as a unique and fragile high-mountain ecosystem of exceptional biodiversity and ecological significance (Obando-Cabrera et al., 2025). In Central and South America, the tropical Andes encompass a range of ecosystems with diverse climates, soils, flora, fauna, and landscapes (Murad et al., 2024; Molina et al., 2019). These ecosystems are distributed along the Andean mountain ranges of South America, including Colombia (14,434 km²), Ecuador (12,600 km²), and northern Peru (4,200 km²) (Carrión et al., 2023). They occur above the tree line at elevations ranging from 2,800 to 5,000 meters above sea level (Brück et al., 2023). These tropical alpine environments exhibit particular abiotic conditions, such as high daily temperature variation, frequent light precipitation events, average temperatures below 10°C, and strong winds (Meyers et al., 2023). The use and management of resources in páramo ecosystems generate conflicts among different interest groups – ranging from those advocating conservation approaches to those whose livelihoods depend economically on agriculture, livestock, and the construction of new infrastructure (Díaz-Ballesteros & Avellaneda-Torres, 2025).

The páramos and cloud forests of northern Peru are located within the biogeographic region known as the Huancabamba Depression, situated between Ecuador and Peru. This area is currently referred to as the Amotape-Huancabamba Zone (AHZ), which represents the lowest section of the Central Andes in South America (approximately 2,500 m a.s.l.) between 5° and 8° latitude (Torres et al., 2023). In northwestern Peru, specifically in the province of Ayabaca, there are several páramo areas, including the route connecting the community of Totorá with the impressive Laguna Azul de la Felicidad. This zone, characterized by its Andean landscape, endemic biodiversity, and cultural heritage, holds significant potential for sustainable ecotourism development. It is worth noting that the páramo remains in good ecological conservation status due to the organization efforts of local communities in the highlands of Piura (Sabogal, 2023).

Ecotourism Potential

Ecotourism is a development model with strong potential to transform communities and preserve cultures, having evolved as an alternative aimed at job creation and the advancement of local societies (Luján-Vera et al., 2025). It represents a promising sector of development that plays an important role in the growth of the global tourism industry and contributes to raising public awareness of natural and cultural values (Abylkassimova et al., 2024). In this sense, ecotourism enhances knowledge and emotional connections with the environment, enabling the development of sustainable and holistic practices that integrate culture and nature (Galimberti, 2024). Ecotourism seeks the conservation of natural resources and the well-being of local communities due to its capacity to promote a balance between economic development and environmental preservation (Pérez, 2019; Vergara et al., 2025). Within this context, the páramos of Ayabaca offer a unique opportunity to explore and enjoy nature while contributing to the development of local communities and the conservation of these fragile ecosystems, where ecotourism acts as a strategic ally for conservation efforts. Therefore, community-based ecotourism represents an alternative source of income generation for local populations and a means to mitigate existing environment conflicts (Baquero & Parrado, 2021)

Ecotourism in Totorá not only offers tourists an enjoyable experience in contact with nature but also contributes to the conservation of regional biodiversity. Cuevas & Rosas (2022) indicate that this activity serves as a pathway for both development and conservation in rural communities. Valuing and protecting natural resources such as the páramo is thus essential, as they constitute a natural and cultural heritage fundamental to improving the quality of life of local populations. In this context, concerns for environmental conservation, the protection of minimally disturbed areas, and the preservation of biological diversity have been integrated into tourism under the sustainability framework (Granados et al., 2024). Ensuring the sustainability of páramo ecosystem services – by maintaining and enhancing the multiple benefits they provide at both local and regional levels – is fundamental to the conservation of high Andean ecological systems. To achieve this, it is necessary to involve local communities in decision – making processes and in the monitoring of these areas (Beltrán-Dávalos et al., 2025).

Paramuna Communities and Community Development

Paramuna communities represent vital living spaces driven by a broad revitalization process that connects land-use planning with the sectoral dynamics of economic and cultural activities that shape them (Solís & Rodríguez, 2011). These spaces define a deeply rooted cultural identity; however, structural gaps persist, including a lack of infrastructure and communal spaces (Olivares, 2025), a gradual decline in services, an aging population, a predominant dependence on the primary sector, and depopulation (García-Prieto et al., 2023). Likewise, barriers to accessing skilled employment, limitations in land ownership, and geographical isolation generate structural inequalities that perpetuate gender subordination and hinder the recognition of the communities' economic contributions to the country (Maubrigades et al., 2025). In this sense, inequalities in rural development are determined by accessibility and the distribution of essential services, which create socioeconomic gaps and affect the quality of life of community residents (Sjaf et al., 2025).

Paramuna communities are also highly vulnerable to external impacts such as flooding, land loss, and climate-related risks (Swe et al., 2026). Climate-induced changes in biodiversity and ecosystems weaken traditional livelihoods (Flores et al., 2025). Nevertheless, these communities have incorporated activities such as ecotourism—hosting visitors and guiding nature-based experiences—and the cultivation of medicinal plants (thyme, borage, and chamomile) as viable alternatives for income generation (Arabollah et al., 2026). Additionally, they have combined agriculture and tourism to stimulate local agricultural production, create opportunities for residents and local food producers, and ensure a more equitable distribution of tourism income within the communities by offering visitors hands-on activities such as harvesting, planting, and collecting products, thus generating immersive and educational experiences (Sangnak, 2025).

In this context, social transformation has reshaped community interactions in modern society, influencing the development of mutual support networks and social relationships (Su & Duan, 2025). Communities function as essential social units where local cultural identity and participation play a crucial role (Lu & Wang, 2025). Local

development thus emerges as an alternative to alleviate poverty—understood as material deprivation and unequal access to resources and social opportunities (Bayas & Naranjo, 2025). This form of development integrates tangible (physical) aspects and social or intangible components that address a wide range of interdisciplinary concerns (Wang et al., 2025). Moreover, it is locally driven—by traditional leaders and community groups—and can also be supported through government investment (Bourke et al., 2025; Sigismundo, 2025). Within this framework, community co-management has emerged as an innovative approach to natural resource management, achieving biodiversity conservation, community economic development, and social well-being through enhanced cooperation and interaction between local communities and conservation agencies (Wang & Li, 2025). This model promotes resource integration and the balancing of interests, generating shared benefits in both ecological protection and economic development (Gao et al., 2025). Consequently, active community participation fosters new ideas, concepts, and positive attitudes that facilitate the adoption of innovative initiatives (Ma et al., 2025), such as crop diversification, land stewardship, and livelihood diversification (Andrista et al., 2025). These community-led and community-developed initiatives serve as the foundation for generating innovative social enterprises (Price et al., 2025).

Socio-Ecological Systems Theory

The páramos possess significant scientific, cultural, and ecological value due to their flora, endemic avifauna, and unique landscapes—that is, they perform essential ecological functions. Ecosystem services encompass the natural conditions and benefits provided by ecosystems, serving as a crucial link between human society (human survival) and natural systems (Zhong et al., 2025). In this context, socio-ecological systems theory is fundamental for examining the interactions between individuals and their environments, as it integrates the social environment and human behavior within a multilevel ecological framework. This theory is commonly structured into three levels: the microsystem, mesosystem, and macrosystem (Tang et al., 2025). It provides a comprehensive perspective on human actions and their environmental impacts, establishing the basis for a more conscious and reciprocal relationship between both dimensions (Billedeau et al., 2025). Accordingly, it becomes essential to understand beliefs and behaviors by considering the multiple contexts in which individuals are situated, since humans possess an innate capacity to interact with their environment (Sheng et al., 2025). Hence, the socio-ecological perspective, derived from ecology and resilience theory, offers insights into transitional contexts conceived as ecological systems, emphasizing the understanding of system vulnerability and adaptive capacity (Hong et al., 2025).

Global Environmental Impacts

Rural communities depend heavily on natural resources for their livelihoods; however, they are particularly vulnerable to the impacts of climate change and face unique challenges in responding to and recovering from environmental disasters (Xie & Chen, 2025). Climate change is a global concern, and annual precipitation varies spatially across Andean and tropical forest zones in Peru, Ecuador, and Colombia (Veneros et al., 2025). These manifestations of global change appear in multiple forms—such as rising temperatures and variable rainfall patterns—that directly affect rural livelihoods (Mramba & Mapunda, 2025). Such global phenomena have become major threats to terrestrial ecosystems, as they exert direct effects on biological richness and abundance over time (Pulido & Ramos, 2016). Consequently, the environmental impacts occurring in páramo ecosystems lead to significant ecological degradation and affect local populations by compromising the quality of water sources that supply communities (Camacho et al., 2025). Furthermore, the environmental degradation of these ecosystems is exacerbated by conflicts over land use and ownership. To transform these environmental conflicts into opportunities, it is necessary to integrate and balance the social, economic, and environmental dimensions (Lis-Gutiérrez et al., 2023).

MATERIALS AND METHODS

Study Area

The study was conducted in the rural community (caserío) of Totorá, located 50.3 km from the district of Pacaipampa, in the province of Ayabaca, Piura region, northern Peru. The community's páramo lies at an elevation of over 3,500 meters above sea level. This area is characterized by its high ecological value, the presence of native vegetation, and abundant water sources that support a diverse range of local flora and fauna. Its main ecosystem services include hydrological regulation and water supply. The landscape features mountainous terrain with lagoons and waterfalls that play an essential role in the hydrological cycle and provide water to the region's main river system.



Figure 1. Schematic diagram of the study area. Geographical location (country, region, province, district, and study area). The figure shows the location of the sampling points: (a) Totorá community, (b) páramo ecosystem, and (c) Laguna Azul de la Felicidad.

The community has approximately 180 inhabitants whose main economic activities include agriculture, livestock farming, and aquaculture—specifically the breeding and sale of trout. Agricultural production is primarily intended for self-consumption, with only a small portion sold in local and external markets. This activity takes place on the gentle slopes of the surrounding hills, where coffee, potatoes, and maize are the main crops cultivated by the community.

Research Design

The research was developed under a mixed-methods approach, integrating a qualitative component for territorial characterization and community participation (semi-structured interviews and participatory mapping) and a quantitative component for analyzing the economic and social factors associated with the willingness of the local population to engage in ecotourism activities. The study aimed to assess the ecotourism potential of the páramos of Ayabaca and to design a tourism experience that fosters community development. For this purpose, the qualitative approach was employed to capture the perceptions and knowledge of key community stakeholders. Within this framework, a descriptive and propositional research design was adopted. Interviews were used as the main data collection technique to identify the hydrological resources and key cultural elements that contribute to the design of the ecotourism experience.

Furthermore, to achieve the third objective, a non-experimental quantitative design was employed to identify the causes of the phenomenon, explaining the conditions under which it occurs and how each variable and dimension is interrelated. This allowed for the analysis and interpretation of quantifiable data to determine the demographic, economic, and social factors explaining participation in ecotourism activities (Hernández et al., 2014). The procedure for obtaining the results began with the development and validation of the survey instrument, which included comprehensive information related to the demographic, economic, and social factors influencing the participation of local communities in ecotourism activities. The survey method was chosen due to its effectiveness in collecting data efficiently and systematically (Ordoñez et al., 2024). Respondents were selected through purposive sampling, and a total of 150 surveys were administered to residents of the Totorá community (Pacaipampa–Piura). Data collection through the questionnaire generated a total of 4,950 data points, which were then analyzed using two econometric models—the Linear Probability Model (LPM) and the Logit Model. The dependent variable was dichotomized (1 = participation in ecotourism activities; 0 = no participation). These models were used to estimate the probability of participation in tourism activities based on explanatory variables and to evaluate the statistical significance of each factor. Data processing and statistical analysis were conducted

using STATA v.26, ensuring methodological rigor and analytical robustness in the interpretation of findings. The model is expressed as follows:

$$\begin{aligned} Part = & \beta_0 + \beta_1 \text{sexo} + \beta_2 \text{estado} + \beta_3 \text{edad} + \beta_4 \text{educ} + \beta_5 \text{prop} + \beta_6 \text{ingr} + \beta_7 \text{act} + \beta_8 \text{empl} \\ & + \beta_9 \text{nbasica} + \beta_{10} \text{templeo} + \beta_{11} \text{capacitacioneco} + \beta_{12} \text{beneficioseco} + \beta_{13} \text{serbancos} \\ & + \beta_{14} \text{prestamo} + \beta_{15} \text{mapoya} + \beta_{16} \text{hospedajeres} + \beta_{17} \text{eformal} + \beta_{18} \text{negocio} \\ & + \beta_{19} \text{atractiva} + \beta_{20} \text{apoyoemp} + \beta_{21} \text{acceptadares} + \beta_{22} \text{conservacionturis} \\ & + \beta_{23} \text{problemas} + \beta_{24} \text{formavida} + \beta_{25} \text{turorganizacion} + \beta_{26} \text{beneficioso} \\ & + \beta_{27} \text{accesoservicios} + \beta_{28} \text{mejora} + \beta_{29} \text{redessociales} + \beta_{30} \text{compartir} + \beta_{31} \text{identi} \\ & + \beta_{32} \text{ancesta} \end{aligned}$$

According to Vela & Carrasco (2021), the Linear Probability Model (LPM) can be understood simply as a linear regression model in which the error term μ_i and the dependent variable Y_i follow a Bernoulli distribution, and it is represented by the following model (Gujarati & Porter, 2010):

$$E(Y_i|X_i) = \beta_1 + \beta_2 X_{2i} + \beta_3 X_{3i} = \Pr((Y_i = 1|X_i))$$

This can be interpreted as follows: econometric theory indicates that Y_i follows a Bernoulli distribution and assumes that most continuous random variables follow this distribution, which is addressed by the probability that the variable takes the value 1, unlike the regressors, which in most cases generate a binomial distribution (Gujarati & Porter, 2010). According to the natural Logit model, as stated by Vela & Carrasco (2021), it is used in an econometric model to estimate the probability and predict any event, providing an optimal interpretation of the coefficients. This model is represented by the following formula: $P_i = E(Y=k) = \beta_1 + \beta_2 X_i$. Here, P_i represents the probability that an event, Y takes the value K , ranging between zero and one. X_i is the explanatory variable, while $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6$ are the estimated coefficients of the intercept and slopes.

RESULTS

Qualitative Study

Production Centers in Totora

Local enterprises in the Totora community represent a strategic opportunity for the development of sustainable ecotourism. Among the most notable activities are the production of handicrafts, trout aquaculture, and artisanal cheese making, all of which are aligned with the appreciation of local resources and the community's cultural identity. Trout farming in natural ponds has allowed for the diversification of the gastronomic offer, providing visitors with the opportunity to taste fresh, high-quality products. Similarly, the production of artisanal cheese from local cattle milk has been consolidated as a complementary economic activity, contributing to the sustainable use of agricultural resources. These enterprises not only strengthen the community's cultural identity but can also be integrated into ecotourism experiences, promoting responsible consumption and fair trade. Their integration with tourism activities generates opportunities for local development and fosters sustainable practices that benefit both the population and the ecosystem.

Water resource – Laguna Azul de la Felicidad

The Laguna Azul de la Felicidad is located in a high mountain area within the páramo ecosystem; it is a site of remarkable scenic beauty and ecological value. Situated in the district of Pacaipampa, in the province of Ayabaca, at an approximate altitude of 3,800 m.a.s.l., it is accessible via a route that departs from Totora, passing through beautiful Andean landscapes and wetlands, making it an ideal ecotourism destination. The lagoon is of glacial origin and is characterized by its intense blue color, which contrasts with the green of the surrounding páramo. Strong winds generate small waves on the surface, creating the impression of a strong current. It has an elongated shape and a relatively small surface area, but its beauty lies in its natural surroundings and its isolation in the high mountains. It is located at the heart of the páramo ecosystem, an area of great ecological importance due to its function as a water regulator and its endemic biodiversity. The flora around the lagoon includes ichu grass, while the fauna includes species such as the tapir (an endangered species) and the spectacled bear, among others. It is worth noting that these flora and fauna species can be observed along the route to the lagoon, as the journey from Totora takes approximately two and a half hours by mule.



Figure 2. Laguna Azul de la Felicidad – Pacaipampa

Tourist Experience Design

The tourist experience becomes tangible through the territory, as interactions are developed between the tourist and the host, as well as between the tourist and the tourist attractions (López et al., 2025). The design of tourist experiences involves creating and leveraging a niche of resources and activities that promote cooperation among different strategic points, aiming to serve as a driver for the economic development of these areas through tourism activities (Maldonado-Eraza et al., 2018). This design includes the identification of a network of routes for movement, as well as the integration of various elements unique to the area to facilitate visitor access (Noriega et al., 2018); recognizing that the tourist experience holds significant emotional meaning (Gama & Favila, 2024).

Tourist experience planning begins with a clear definition of its objectives, values, and priorities, which will guide its design while considering future adjustments. Once implemented, it is essential to evaluate acceptance by the tourist demand and, based on the results, make continuous improvements in service quality, resource management, and the experience offered, ensuring its long-term sustainability and competitiveness. In this sense, continuous monitoring of visitors' perceptions and preferences allows for progressively adapting new activities according to their expectations, achieving a satisfactory experience (López-Guzmán & Sánchez, 2008). The design of tourist experiences must be holistic and retrospective to effectively evaluate the overall destination experience for visitors (Rong et al., 2023). From a cultural perspective, it clearly defines the knowledge related to the anthropology of experience, where tourism is a socio-cultural practice that aims to broaden mutual understanding among the various social groups involved (Gama & Cisneros, 2023). Considering the aforementioned elements, there is an opportunity to propose a tourist experience based on the valorization of representative elements in the community of Totorá. Accordingly, emblematic sites, villages, houses, páramo landscapes, lagoons, and production centers have been integrated, combining them into ecotourism activities. In this way, the proposed tourist experience will ensure visitors have the necessary conditions for the proper development of activities, and various members of the local community will be prepared to welcome and guide them to each identified resource, where they will participate in meaningful ecotourism activities.



Figure 3. Ecotourism route design

From a cultural perspective, the route holds high historical and ethnographic value, as local communities preserve traditional practices related to agriculture and natural medicine. The transmission of this ancestral knowledge regarding the sustainable use of natural resources can be incorporated into ecotourism experiences, promoting environmental education and immersive tourism. Through geographic mapping, three strategic areas were identified for the installation of viewpoints and interpretive trails (located 500 meters from the community). These will allow visitors to enjoy panoramic views of the natural surroundings, enriching their ecotourism experience. They will also provide visitors with opportunities to learn more about local biodiversity, geography, and culture through informational signage and guided tours.

Quantitative Study

Table 1. Descriptive statistics by item of demographic, economic, and social factors

Item	f	%	f	%	Total
	Yes		No		
Participation	126	84%	24	16%	150
Sex	80	53%	70	47%	150
Home owner	117	78%	33	22%	150
Employment	39	26%	111	74%	150
Basic needs	73	49%	77	51%	150
Generates employment	26	17%	124	83%	150
Ecotourism training	24	16%	126	84%	150
Economic benefits	17	11%	133	89%	150
Financial services	0	0%	150	100%	150
Requested loan	0	0%	150	100%	150
Municipality support	37	25%	113	75%	150
Lodging establishments	29	19%	121	81%	150
Formal employment	6	4%	144	96%	150
Business growth	51	34%	99	66%	150
Attractive	150	100%	0	0%	150
Support for enterprises	103	69%	47	31%	150
Accepted by residents	148	99%	2	1%	150
Conservation of local culture and traditions	141	94%	9	6%	150
Social problems	0	0%	150	100%	150
Way of life	19	13%	131	87%	150
Tourism has favored organization	89	59%	61	41%	150
Beneficial	125	83%	25	17%	150
Access to services	44	29%	106	71%	150
Improved conditions	16	11%	134	89%	150
Social networks	56	37%	94	63%	150
Sharing	146	97%	4	3%	150
Cultural identity	136	91%	14	9%	150
Ancestral knowledge	118	79%	32	21%	150

Table 1 reflects a comprehensive overview of demographic, economic, and social factors linked to community participation and the impact of tourism activity. From a demographic perspective, it is observed that 53% of the population corresponds to a predominant sex and that 78% are homeowners, indicating residential stability. In the economic realm, the results show significant limitations: only 26% report having employment, and barely 17% perceive that job opportunities are generated, while financial services and loans are nonexistent, reflecting structural barriers to access to capital. However, the social dimension shows greater strengths, as 84% actively participate, 99% of residents accept the initiatives, and 94% support cultural conservation, in addition to high levels of identity

(97%) and ancestral knowledge (79%). Despite the low incidence of formal employment (4%) and economic benefits (11%), tourism activity is perceived as attractive (100%) and beneficial (83%), contributing to the strengthening of social networks (37%) and improving the sense of community belonging. This highlights a marked contrast: while economic dimensions face significant challenges, social and cultural factors emerge as fundamental assets for the sustainable development of the community.

Next, the linear probability model is presented, which identifies that the items of sex, marital status, education level, homeownership, income, main activity, basic needs, employment generation, municipal support, acceptance by residents, conservation of local culture and traditions, as well as sharing, are significant; however, the items of sex, income, main activity, and sharing have a negative effect.

This result suggests, firstly, that being a woman or belonging to certain gender groups may decrease the probability of participation, which evidences the persistence of gender gaps in access to community and tourism opportunities. Secondly, higher incomes are associated with a lower probability of involvement, supporting the idea that ecotourism is mainly perceived as an economic alternative for those with fewer resources. Thirdly, the negative main activity could indicate that those with formal jobs or more stable economic activities prioritize those occupations over ecotourism, which is seen as a secondary activity. Finally, the negative effect of the item "sharing" can be interpreted as social resistance linked to the distribution of benefits, where the perception of inequality or lack of community trust limits the willingness to participate actively.

Table 2. Econometric estimation of the linear probability model

Regressor variables	Estimate	Std. Error	t	Pr(> t)
Constant	0.224	0.271	0.830	0.409
Sex	-0.257	0.044	-5.810	0.000
Marital status (estado)	0.277	0.050	5.520	0.000
Education level	0.086	0.039	2.230	0.027
Homeowner	0.177	0.055	3.190	0.002
Income	-0.134	0.036	-3.730	0.000
Main activity	-0.047	0.016	-2.850	0.005
Basic needs	0.180	0.039	4.650	0.000
Generates employment	0.185	0.051	3.650	0.000
Municipality support	0.375	0.054	6.930	0.000
Accepted by residents	0.494	0.162	3.060	0.003
Conservation of local culture and traditions	0.187	0.087	2.140	0.034
Sharing	-0.359	0.127	-2.830	0.005
		Evaluation		
F(12, 137)	26.42			
Prob > F	0.00			
R-squared	67.19%			
Adj R-squared	69.83%			

To analyze the probability of participation in ecotourism activities by local communities, a binary logistic regression model was employed, expressed by the following formula:

$$P(\text{participation}) = \frac{1}{1 + e^{(\beta_0 + \beta_1 \text{sector} + \beta_2 \text{bolsa} + \beta_3 \text{tamaño} + \beta_4 \text{multi} + \beta_5 \text{edad} + \beta_6 \text{sosteni} + \mu)}$$

Where:

Participation: represents the likelihood of engaging in ecotourism activities by local communities, coded as 1 if the individual participates and 0 if not.

Sector: refers to the visitor's gender, where 1 denotes female and 0 denotes male.

Marital Status: indicates the visitor's marital condition, with 1 representing single and 0 representing any other status.

Education Level: denotes the educational attainment, with values assigned as follows: 1 for primary education, 2 for secondary education, 3 for technical studies, and 4 for university studies.

Owner: indicates whether the individual owns their home, where a value of 1 denotes ownership and 0 indicates non-ownership.

Income: represents the income level, where a value of 1 corresponds to an income of 500 soles or less, 2 corresponds to an income between 501 and 1000 soles, 3 corresponds to an income between 1001 and 2000 soles, and 4 corresponds to more than 2000 soles.

Basic Needs: represents the satisfaction of basic needs, where a value of 1 indicates that basic needs are met, and 0 indicates that they are not satisfied.

Employment Generation: indicates whether employment has been generated, with 1 representing the generation of employment and 0 indicating that employment has not been generated.

Table 2 shows that the variables significant in explaining participation in ecotourism activities include sex, with an estimate of $\beta = -6.93$; $p < 0.05$; marital status, with an estimate of $\beta = 11.13$; $p \leq 0.05$; education level, with an estimate of $\beta = 6.82$; $p < 0.05$; homeownership, with an estimate of $\beta = 6.09$; $p \leq 0.05$; income, with an estimate of $\beta = -3.23$; $p < 0.05$; and basic needs satisfaction, with an estimate of $\beta = 7.01$; $p \leq 0.05$. These variables are statistically significant, with the model exhibiting a goodness-of-fit of 0.70.

The binary logistic regression model demonstrates, based on the confusion matrix, a higher predictive accuracy for positive cases (90.9%). Overall, the model correctly classifies 90.1% of the cases, indicating an optimal fit for the Logit model.

Table 3. Econometric estimation of the Logit model

Regressor variables	Estimate	Std. Error	z	P> z	dy/dx	Pr(> t)
Constant						
Sex	-6.93	2.674	-2.590	0.010	-0.4%	0.010
Marital status (estado)	11.13	3.824	2.910	0.004	0.8%	0.004
Education level	6.82	2.615	2.610	0.009	0.1%	0.009
Homeowner	6.09	2.781	2.190	0.029	1.9%	0.029
Income	-3.23	1.251	-2.580	0.010	-0.1%	0.010
Basic needs	7.01	2.394	2.930	0.003	0.5%	0.003
Generates employment	1.23	1.262	0.980	0.329	0.0%	0.329
				Evaluation		
McFadden	0.70					
McFadden(adjusted)	0.58					
Predictability of positive values	97%					
Predictability of negative values	90.9%					
Total predictability	96.0%					

The marginal effects of the variables significant at the 5% level in the chosen model are as follows:

The relative probability of participating in ecotourism activities for individuals identifying as female is 0.4% lower. Although the magnitude of this effect is small, it indicates a slight disadvantage for women compared to men when engaging in ecotourism initiatives. This result may reflect social and cultural barriers associated with traditional gender roles, economic restrictions related to lower income or access to resources, and even limitations in available time due to domestic responsibilities.

The relative probability of participating in ecotourism activities for individuals who are single is 0.8% higher compared to those in other marital statuses. Although the percentage appears minor, it represents a significant social behavior trend. Singleness may be associated with greater flexibility of time, fewer family responsibilities, and more autonomy in decision-making, factors that facilitate willingness to engage in ecotourism initiatives. This finding also suggests that commitments arising from marriage or cohabitation, such as household or childcare duties, may limit active participation in these activities, especially in rural contexts where domestic workloads are often more demanding.

The relative probability of participating in ecotourism activities for individuals with education levels above basic education is 0.1% higher compared to those with only basic education. This indicates that education plays a differentiating role, as a higher level of formal education is often associated with better understanding of the environmental, social, and economic benefits of ecotourism, as well as greater capacity to take advantage of training and employment opportunities in this sector. Similarly, higher educational attainment enhances willingness to engage in organizational and community management processes, which are essential for the sustainability of these initiatives.

The relative probability of participating in ecotourism activities for homeowners is 1.9% higher compared to non-homeowners in ecotourism areas. This result suggests that property ownership fosters a stronger sense of belonging and territorial stability, enhancing willingness to commit to sustainable initiatives that enhance the local environment. Moreover, the security provided by homeownership allows individuals to plan long-term, facilitating interest in activities such as ecotourism, which depend on the care and conservation of natural resources. Conversely, individuals without property often have weaker community attachment and continuity, which limits their level of engagement.

The relative probability of participating in ecotourism activities decreases by 0.1% for individuals with higher incomes compared to those with lower incomes in ecotourism areas. This may be because higher-income individuals prioritize other economic or recreational alternatives outside the local context, reducing their willingness to engage in community-based ecotourism activities. In contrast, lower-income individuals perceive ecotourism as an opportunity for economic diversification and supplementary income, explaining their higher participation rates. This finding highlights that ecotourism is largely viewed as a subsistence or economic improvement strategy for vulnerable groups, while wealthier groups tend to diversify their activities toward more profitable or socially prestigious options.

The relative probability of participating in ecotourism activities increases by 0.5% for individuals whose basic needs are met compared to those whose needs are unmet in ecotourism areas. This indicates that minimum economic security facilitates willingness to participate in collective initiatives, as individuals with assured livelihoods can dedicate time, effort, and resources to complementary activities such as ecotourism. In contrast, individuals still facing basic needs shortages tend to focus their energy on daily survival, reducing their interest or capacity to engage in community and sustainable activities.

The parametric ROC curve shows the overall performance of the test (area under the curve), yielding a global performance of 97.65%. Accordingly, the centered estimates for sensitivity, specificity, and area under the curve indicate that the parametric estimators are the most accurate for each point. This translates into a classification capacity of correctly predicting participation versus non-participation of local communities of 97.65%.

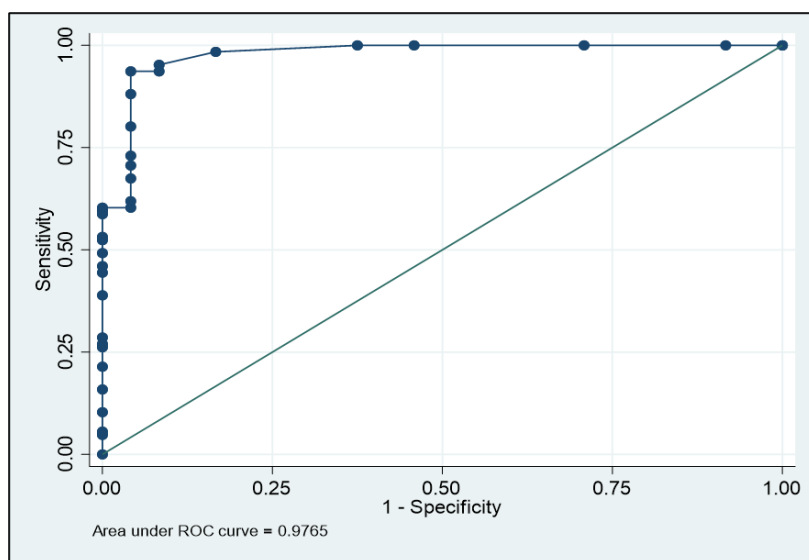


Figure 4. Sensitivity and Specificity of the Model

DISCUSSION

The analysis of tourism experiences in rural areas helps identify the aspects that visitors value most during rural tourism activities (Ibrahim et al., 2025). This strategic approach highlights attractive destinations and ensures that visitors fully enjoy their trips (Wang, 2024). Accordingly, designing an ecotourism experience in the Totorá community represents an opportunity for economic and social development. The study findings included tourist experiences encompassing both agrotourism activities (interaction between visitors and local farmers) and ecotourism activities (integration of visitors within the highland paramo ecosystem). According to Rodrigues & Sánchez-Martín (2022), experiential tourism in agrotourism is enhanced by quality lodging, a rustic and welcoming environment, tranquility, and the hospitality of farmers, their families, and neighbors. Similarly, Sahani (2021) emphasizes that the uniqueness, cultural diversity, and simple lifestyle of the local population are significant factors for tourist attraction. Tourist choice behavior should also be considered, as it is influenced by objective factors (geographic accessibility and availability of services) as well as subjective considerations (cultural relevance and

thematic identity) (Li et al., 2025). In this context, travelers' experiences can be significantly enhanced by providing basic and essential amenities (Jiang et al., 2024). From this perspective, in Totorá, the population has developed welcoming spaces that meet visitor expectations, fostering the creation of sustainable enterprises that contribute substantially to long-term sustainable economic development (Véliz et al., 2023).

Furthermore, the results show that the social dimension presents the greatest strengths: 84% of respondents actively participate, 99% of residents accept initiatives, and 94% support cultural conservation, alongside high levels of identity (97%) and ancestral knowledge (79%). These findings align with Arabollah et al. (2026), who report that residents have integrated activities within the paramo ecosystems, such as ecotourism (hosting visitors with guided nature tours) and the cultivation of medicinal plants (thyme, borage, and chamomile) (Sangnak, 2025). Therefore, tourism plays a fundamental role in the development of rural areas facing depopulation, land abandonment, and economic decline (Uldemolins et al., 2025). By generating employment and preserving traditions, it empowers women and youth, revalues cultural heritage, integrates small and medium-sized artisanal enterprises, and fosters community associations (Palomino et al., 2024). Tourism is thus considered an inclusive, transversal, and transdisciplinary activity, requiring input from multiple disciplines, including sustainability, eco-development, territorial planning, social responsibility, and shared accountability. This underscores the importance of collaboration with schools, host communities, and local populations (Chinchay et al., 2020). Within the economic dimension, 26% of residents reported having employment, and only 17% perceived the creation of job opportunities. Formal employment is minimal (4%) and economic benefits limited (11%); however, tourism is perceived as attractive (100%) and beneficial (83%). Barriers to access qualified employment, limited land ownership, and geographic isolation create structural inequalities that perpetuate gender subordination and hinder recognition of economic contributions to the country (Maubrigades et al., 2025). Consequently, rural areas are increasingly exploring new development alternatives that ensure resource sustainability and community empowerment, recognizing the diversity of activities and non-traditional uses that can be accommodated within their geographic space (Contreras et al., 2025).

Another finding indicates that being a woman or belonging to certain gender groups can reduce the likelihood of participating in ecotourism activities, highlighting the persistence of gender gaps in access to community and tourism opportunities. This result aligns with García-Prieto et al. (2023), who argue that residents of rural communities are predominantly employed in the primary sector, where depopulation and inequalities manifest in the distribution of essential services and limited access to locations, creating socioeconomic gaps that affect residents' quality of life (Sjaf et al., 2025). Given the realities faced by these communities, it is essential for them to act in an organized manner to defend their interests (Palomino et al., 2024). Local communities are therefore essential social units in which cultural identity and participation play a crucial role (Lu & Wang, 2025). Residents have modified community interactions in modern society, influencing the development of mutual aid networks and social relations (Su & Duan, 2025), driven both locally by traditional leaders and community groups, and externally by government agencies (Bourke et al., 2025; Sigismundo, 2025). Community participation enables collaborative work, empowers decision-making, and promotes environmental stewardship, thereby reducing social vulnerability with the goal of diminishing inequalities and maximizing solutions to shared challenges (González et al., 2024).

Participation in ecotourism activities is primarily perceived as an economic alternative for those with fewer financial resources. These activities adopt an ecosystem-focused approach, aiming to raise awareness among travelers and locals about sustainable use of natural resources and respect for natural and cultural heritage (Gutiérrez et al., 2021). In this regard, the design and interpretation of tours are considered essential to mitigating negative human and environmental impacts (Powell & Ham, 2008). Thus, the development of ecotourism is a crucial activity that promotes the well-being of local communities by improving economic development while conserving the environment (Pérez, 2019; Vergara et al., 2025). In this context, the Ayabaca paramos provide opportunities to explore and enjoy nature, contributing to the development of local communities, where ecotourism functions as a strategic ally in conservation efforts. Accordingly, participation in ecotourism activities represents a viable source of income generation for local communities (Baquero & Parrado, 2021).

CONCLUSIONS

The Totorá – Laguna El Azul de la Felicidad route possesses high ecotourism potential, grounded in the natural, cultural, and social richness of the area. This potential has facilitated the participation of the Totorá community in sustainable development initiatives through collaboration with academic projects, non-governmental organizations (NGOs), and competitive funding programs promoted by PROCENCIA. These initiatives have strengthened local autonomy, consolidating experiential tourism and complementary productive activities that reinforce social cohesion and community identity. However, the ecological fragility of Laguna Azul de la Felicidad necessitates responsible tourism management. In this regard, it is a priority to implement

conservation strategies based on environmental education and participatory management. Notably, this hydrological resource is registered in the Geographic Information System of the Ministry of Foreign Trade and Tourism (SIGMINCETUR).

The integration of ecotourism with local productive activities—such as trout aquaculture, cheese production, and handicraft making—constitutes a key strategy for economic diversification and sustainable income generation. To maximize their impact, it is necessary to improve quality control, promotion, and marketing processes for these products, ensuring their inclusion in responsible tourism circuits. Continuous training and access to commercial networks are essential to guarantee the viability of these initiatives. The sustainable development of ecotourism along the Totora – Laguna Azul de la Felicidad route will depend on implementing a participatory governance model that links community management with local and regional institutions. Establishing coordination mechanisms is essential to ensure the effective application of tourism regulations, the improvement of basic infrastructure, and the promotion of the destination within sustainable tourism networks. Physical and digital connectivity plays a crucial role in the destination’s competitiveness, highlighting the need for improvements in accessibility and signage. Ultimately, strengthening local governance and investing in infrastructure will consolidate the Totora – Laguna Azul de la Felicidad route as a benchmark for paramo ecotourism, ensuring its long-term environmental, economic, and sociocultural sustainability.

Participation in ecotourism activities in Totora is significantly influenced by social and economic factors that shape both the degree of community involvement and the perception of benefits. Socially, strengths include high acceptance of tourism initiatives, support for cultural conservation, and a strong sense of identity and ancestral knowledge exchange—elements that enhance community cohesion and the attractiveness of the destination. However, limitations persist related to gender inequalities and restricted access to community opportunities, highlighting the need for inclusive policies that promote equity in participation.

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Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Author Contributions

PELV: Conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, software, supervision, validation, visualization, writing – original draft, writing – review & editing. JMC: Conceptualization, investigation, methodology, supervision, validation, visualization, writing – review & editing. MVSM: Conceptualization, data curation, formal analysis, investigation, methodology, resources, software, supervision, validation, visualization, writing – original draft. LMGV: Methodology, validation, writing – original draft, writing – review & editing. RMEH: Conceptualization, data curation, original draft, software, writing – review & editing. RAPO: Supervision, validation, writing – original draft, software, writing – review & editing.

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