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# Farmer Preferences Regarding Andean Fruit Crops Across Six Municipalities in the Department of Nariño, Colombia

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## Abstract

Understanding the dynamics of crop choices in different regions is critical to designing effective strategies for sustainable agriculture and rural development. The experiment was carried out in six municipalities in the Andean region of the department of Nariño, Colombia. The correspondence analysis was used to explore the association between the preferences of farmers and cultivated fruit species. On farms of 90 fruit growers, seven Andean fruit crops were planted, including *Solanum betaceum, S. quitoense, Physalis peruviana, Passiflora pinatistipula, P. ligularis, P. edulis, R. fruticosus.* At the end of the experiment, a structured survey was carried out to ask the producers which crop they preferred to implement on their farm, and which one produced the worst experience. In addition, a general diagnosis of the main phytosanitary problems they had throughout the cultivation period was carried out. Arboleda and Sandoná farmers demonstrate a distinctive inclination towards *S. betaceum*, while Ipiales exhibits a preference for *P. peruviana*. Conversely, La Florida, Providencia, and El Peñol distinctly favor *S. quitoense*, with widespread acceptance for *R. glaucus* and *P. ligularis*. Farmers do not have a preference for planting P. pinatistipula in Ipiales. *S. betaceum* was intensified Anthracnosis and Potyvirus-related issues, affecting crop periods and fruit quality. *S. quitoense* faces altitude-dependent pathogen susceptibility, while *R. fruticosus* contends with downy mildew. Passion fruit confronts *Fusarium* sp., gray mold, and dieback. Tailored interventions are crucial for sustainable agriculture amidst diverse challenges. This research contributes valuable insights for informed agricultural planning and regional development policies.

**Keywords:** Agroecological conditions; Sustainable agriculture; Regional development; Fruticulture.

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## 1. Introduction

Recognizing the crop preferences of Andean fruits is crucial for designing effective strategies for sustainable agriculture and rural development. Despite the widespread acceptance of fruit production in the Andean region, uncertainty persists regarding the adaptation of certain varieties to the specific conditions of the area and their response to the challenges posed by pests and diseases. Several factors influencing farmer decision-making in Andean fruit production. Improve the intricate decision-making processes of farmers in Nariño, highlighting market prices, yield potential, susceptibility to pests and diseases, and cultural significance as pivotal influencers in farmers' choices of Andean fruit species for cultivation [1].

This lack of knowledge can demotivate producers, leading them to abandon the cultivation of these varieties and opt for alternative agricultural activities [2]. A deeper understanding of these dynamics would enable the development of more informed and effective strategies to support fruit production in the southwestern Andean region of Colombia. A deeper and more nuanced understanding of the underlying dynamics is indispensable. Not only does it serve as a bulwark against potential producer demotivation, but it also provides the basis for cultivating resilience and innovation within the fruit production landscape [3].

Andean crops have significant potential to expand their participation in international markets. These fruits serve as a source of economic income and constitute a primary source of vitamins and minerals with high nutritional value for consumers. Due to their nutraceutical properties, there is a growing demand for these crops in both national and international markets [4]. As consumers increasingly prioritize wellness, the nutrient-rich composition of Andean fruits positions them as sought-after commodities in the international marketplace [5].

Exotic fruits are in high demand in both national and international markets. However, pest and disease infestations have significantly hampered their production in Colombia. These constraints are particularly pronounced in the department of Nariño, which lags in adopting technologies and good management practices. In the case of *S.*

*quitoense* cultivation, the average yield is considerably lower than in other departments of Colombia [6]. According to the National Fruit Plan, Nariño needs to cultivate an additional 1000 hectares in the next 10 years. Nevertheless, phytosanitary issues and the lack of technological advancements remain the primary impediments to expanding the cultivated area for Andean fruit crops [7].

The careful selection of fruit species adapted to local conditions is fundamental for designing sustainable agricultural strategies and effectively managing pest and disease challenges [8]. Climatic conditions can favor the occurrence of pests and diseases in Andean crops, complicating management measures and influencing farmers' preferences for specific crop species. Therefore, this study aims to examine the preferences of fruit growers for Andean crops and compile a record of the primary phytosanitary issues in six municipalities within the Andean region of the department of Nariño, Colombia.

## 2. Material and Methods

The study was carried out in six municipalities in the department of Nariño, including Arboleda, Ipiales, El Peñol, La Florida, Providencia, and Sandoná. The agroclimatic conditions in the studied municipalities vary, offering a diverse backdrop for agricultural activities. Arboleda has an average relative humidity of 83%, a temperature of 20 °C, and an annual precipitation of 1720 mm. Ipiales has an average relative humidity of 81%, temperatures ranging from 12 °C, and an annual precipitation of 1802 mm. El Peñol maintains an average humidity level of 77.5%, temperature of 16.7 °C, and annual precipitation measuring 2645 mm. La Florida experiences an average relative humidity of 77.5%, a temperature of 16.5 °C, and an annual precipitation of 1384 mm. Providencia maintains an average relative humidity of 77.5%, a temperature of 24 °C, and an annual precipitation of 858.9 mm. Sandoná maintains a relative humidity of 82%, an average temperature of 18 °C, and annual precipitation measuring 1091 mm. These diverse environmental conditions shape the agricultural landscapes of each municipality.

In each municipality, Andean fruit varieties were cultivated across 15 farms (Supplementary Table 1). Crop selection was tailored to the geographical and agroclimatic conditions of each municipality determined by geographical conditions (Supplementary Table 1). Each experimental plot featured at least two fruit crops in intercropping or monoculture. Planting was carried out in mid-2022, using high-quality seeds certified by the "Instituto Colombiano Agropecuario" (ICA) in all trials. Agronomic management adhering to Buenas Prácticas Agrícolas (BPA) was implemented across all farms. A direct survey was conducted with producers in each municipality to assess satisfaction with the implemented fruit crops. This survey aimed to determine each region's best and least favored crops based on environmental conditions. The structured survey was designed to ascertain producer preferences for each Andean fruit species. Simultaneously, a record was kept of the primary pests and prevalent diseases in each municipality to validate the information provided by the producers. This comprehensive approach seeks to thoroughly understand the interaction between crops, environmental conditions, and producer satisfaction, while confirming data on pests and diseases.

A Correspondence Analysis was employed to analyze the data from a semi-structured survey, and the chi-square test was performed to determine if there was a significant association between the selected categorical variables. Those that presented a significant level of association ($p$<0.05) were selected to build the perceptual map [9]. The correspondence analysis was carried out using the FactoMiner statistical package [10], and the graphs were made using the ggplot2 library [11] of the R v4.2.0 software [12].

## 3. Results

The analysis of categorical variables by correspondence analysis indicated a significant association ($p$<0.05) between the preference of farmers and the type of fruit trees selected, supported by the chi-square test. This statistically significant association underscores a meaningful correlation between the municipalities under investigation and their distinct preferences for specific fruit species. The perceptual map reveals the principal dimensions responsible for a substantial portion of the observed variability, ranging between 37.5% and 41.4% (Figure 1-2). These dimensions are pivotal in elucidating the relations inherent in the fruit species preferences across the surveyed municipalities.

Fruit producers in Arboleda and Sandona exhibit a discernible inclination towards *S. betaceum* crop, while Ipiales demonstrates a pronounced preference for cultivating *P. peruviana* (Figure 1). Remarkably, La Florida, Providencia, and El Peñol stand out for their robust preference for lulo *S. quitoense* (Figure 1). Simultaneously, blackberry R. glaucus and P. ligularis cultivation emerged as a wide choice among most farmers in the municipalities. These findings highlight the diversity in fruit species preferences and provide valuable insights into regional agricultural inclinations. In contrast, the agricultural landscape in Sandoná and Arboleda revealed a discernible reluctance among producers towards cultivating *S. quitoense*, marking it as a crop with notably poor acceptance in these regions (Figure 2). In Ipiales, a distinct rejection surfaced in relation to *P. pinatistipula*, indicating a prevalent resistance toward this cultivation among local producers (Figure 2). Furthermore, the municipalities of Providencia, La Florida, and Peñol exhibited a collective dissatisfaction with the production outcomes of *R. glaucus*, *P. ligularis*, and *S. betaceum*, signifying a suboptimal level of approval for these specific crops.

**Figure-1.** Correspondence analysis representing the association between municipal preferences and Andean fruit trees. The farmers were queried regarding their perspective on the optimal crop choice within their respective regions

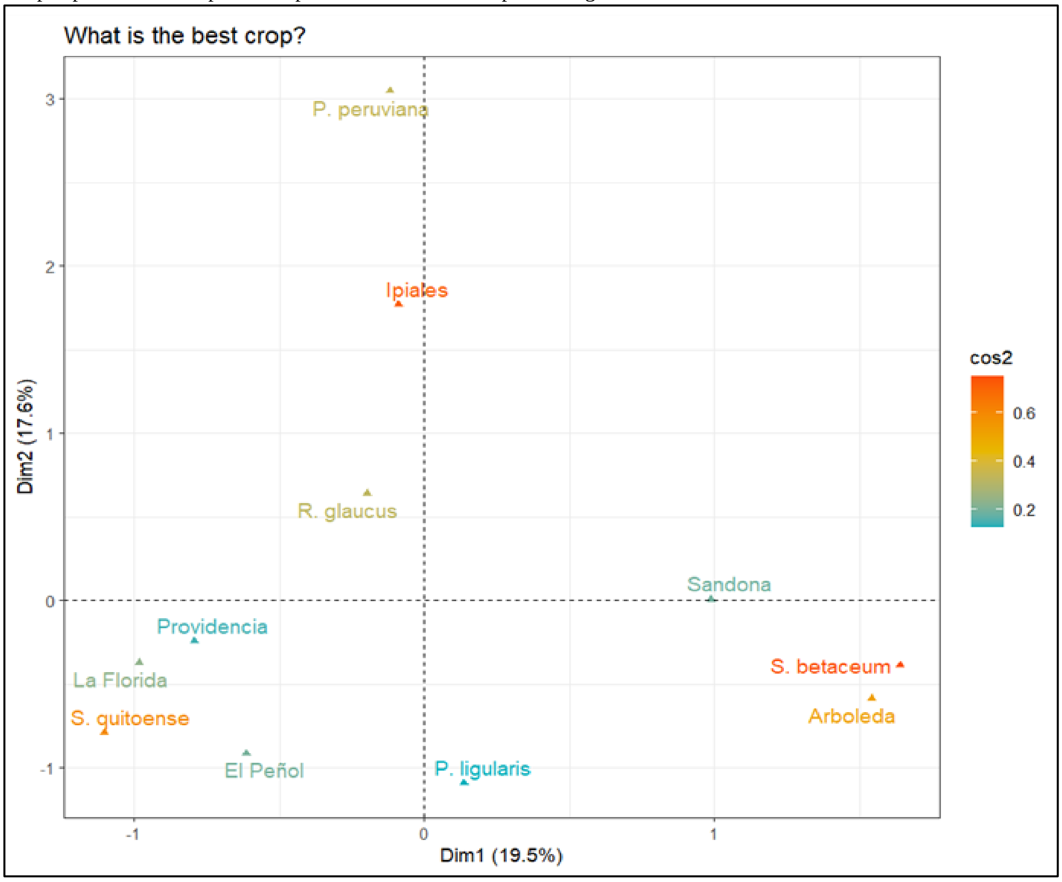
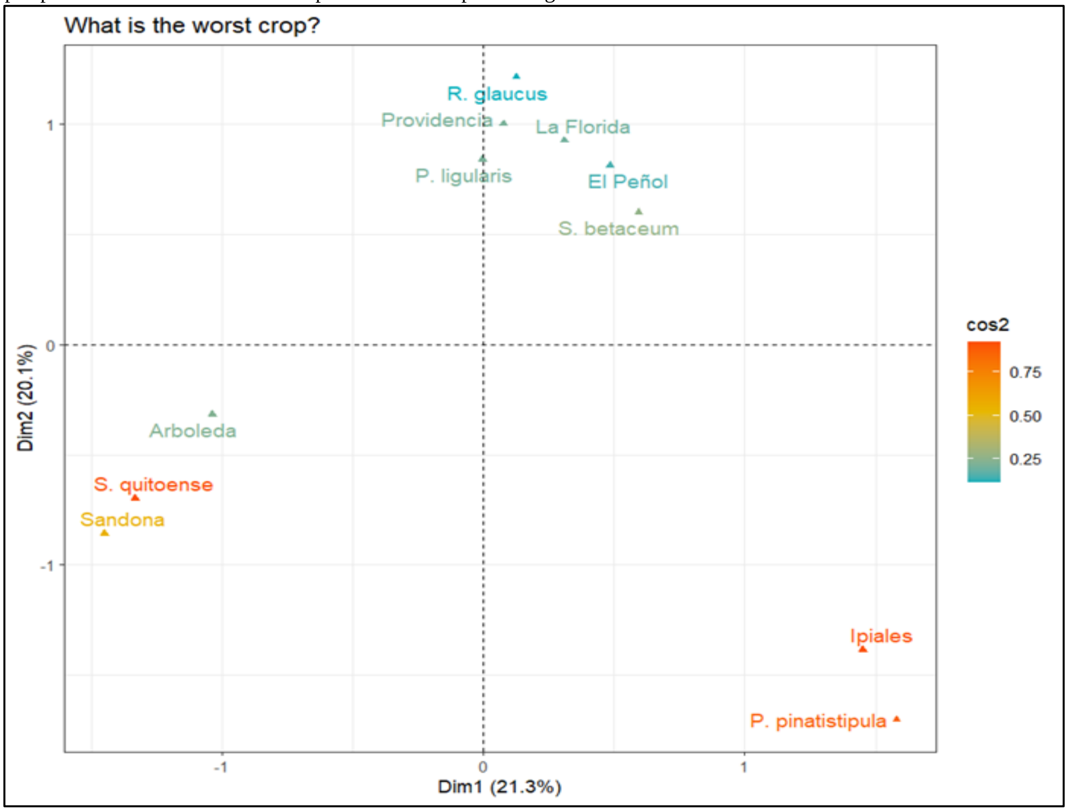



**Figure-2.** Correspondence analysis representing the association between municipal preferences and Andean fruit trees. The farmers were queried about their perspectives on the least favored crop within their respective regions

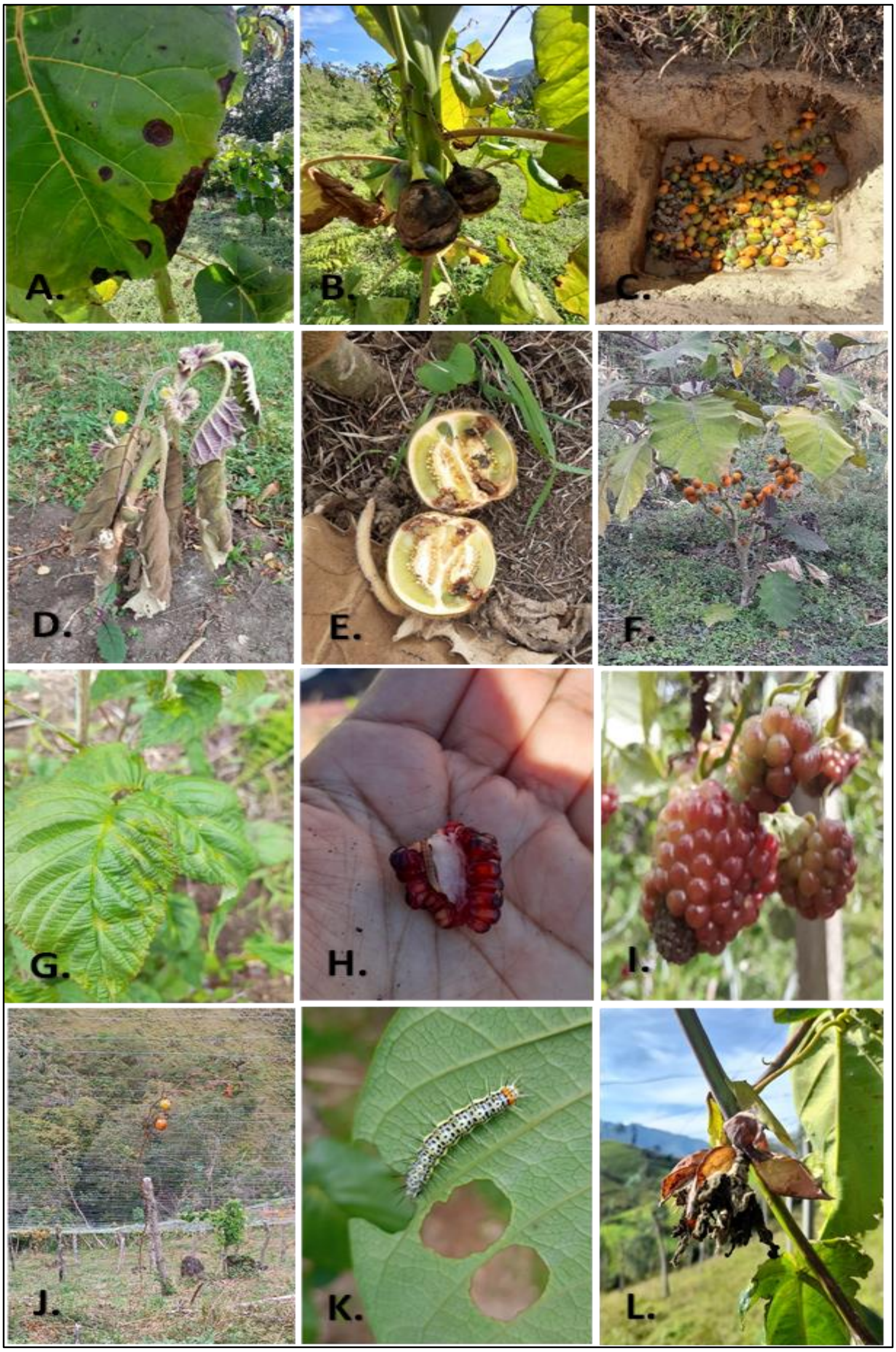



The study identifies distinct groups of municipalities in Colombia based on their crop preferences. In *S. betaceum* cultivation, viral diseases, particularly Potyvirus, have intensified, reducing crop periods and diminishing fruit quality. Anthracnose, caused by *Colletotrichum* sp. is a primary concern despite control measures (Figure A-B-C). S. *quitoense* has limited approval in higher-altitude areas due to susceptibility to pathogens like *Phytophthora* sp.

and *Fusarium* sp.. At the same time, lower-altitude regions experience severe attacks by pests like *Neoleucinodes elegantalis* (Figure D-E-F). Downy mildew (*Peronospora* sp.) restricts yields in *R. fruticosus*, causing significant losses (Figure G-H-I). Passion fruit cultivation is impacted by *Fusarium* sp., causing vascular wilting, and prevalent diseases in La Florida include gray mold (*Botrytis cinerea*) and dieback (*Nectria haematococca*) (Figure J-K-L). This information informs tailored interventions for sustainable agriculture and rural development, considering the diverse challenges faced by different crops in various agroecological conditions.

This exploration of producer sentiments towards various cultivations underscores the regional diversity in acceptance levels and provides valuable insights into the factors influencing the success or failure of specific crops in distinct locales.

**Figure-3.** The main pests and diseases recorded that are the most limiting in Andean fruit crops. (A, B, C) Symptoms of anthracnose (*Colletotrichum* sp.) in *S. betaceum*, affecting leaves and fruits; (D) *S. quitoense* plant severely affected by *Sclerotinia* sp.; (E) *S. quitoense* fruits affected by the *Neoleucinodes elegantalis* borer; (F) *S. quitoense* plants a regionally adapted variety in municipalities of the northern department of Nariño; (G) *R. fruticosus* plants with symptoms of *Oidium* sp. and (H) fruits affected by the fruit fly (*Anastrepha fraterculus*); (I) symptoms of *Peronospora* sp. in *R. fruticosus* fruits; (J) dieback of *P. ligularis* caused by *Nectria haematococca*; (K) larva of the Piriedae family defoliating a *P. ligularis*; (L) symptoms of *Botrytis cinerea* in *P. ligularis* flowers



## 4. Discussion

The findings indicate a potential categorization of municipalities into three distinct groups based on their Andean crop preferences. The initial group comprises El Peñol, Providencia, and La Florida, the second encompasses Sandoná and Arboleda, with Ipiales forming a slightly distant third group. The observed spatial separation among these groups is likely attributed to the agroecological conditions prevalent in each municipality. Ipiales stands out with markedly distinct climatic conditions compared to the other municipalities, potentially influencing the growth and development of specific crop types. For instance, the unique climate in Ipiales may favor the cultivation of crops different from those thriving in the lower-altitude municipalities of El Peñol, Providencia, and La Florida, where conditions are more conducive to warm climate crops. This distinction in agroecological factors contributes to the discernible grouping of municipalities based on their crop preferences and underscores the significance of considering local climatic nuances in agricultural planning and decision-making.

The results suggest that *S. betaceum* is an appreciated fruit species in Arboleda and Sandoná. The cultivation of this fruit species may be attributed to its adaptability to the local climate and its resistance to the principal diseases, mainly viruses. Municipalities like Ipiales were previously well known for being highly productive tree tomato (*S. betaceum*) crops, but viral diseases, particularly those caused by Potyvirus. There is evidence indicating the impact of no fewer than 14 viruses on *S. betaceum* crops [13]. The viral issue in *S. betaceum* has not only extended but also intensified, as evidenced by reports from various municipalities in Nariño, such as Ipiales. These reports highlight a notable rise in both the incidence and severity of the virus within these regions [14]. Furthermore, in Ipiales, symptoms of the purple tip phytoplasma (*Candidatus phytoplasma*) and the vector (*Bactericera cockerelli*) were found in a complex of viral diseases that practically completely destroyed some tree tomato experimental lots, as showed by Noboa and Viera [15]. Consequently, this escalation has led to a diminished productive period for the crops and a notable reduction in both the quantity and quality of fruit accessible in the market of some regions. The challenges posed by viral diseases highlight the need for robust strategies and interventions to enhance the resilience of *S. betaceum* crops and sustain farmers' livelihoods in some regions. Interestingly, the tree tomato crop has demonstrated commendable adaptability in Arboleda and Sandoná, even in the face of a warmer climate. The successful acclimatization of the tomato crop and the apparent absence of prevalent viral inoculums likely contribute to the positive reception and widespread acceptance of this species among farmers in these regions.

In *S. betaceum* plants, the anthracnose *Colletotrichum* sp. represents the primary crop disease in Colombia due to its extensive distribution and the percentage of losses it causes in the productive regions of the country. Despite implementing control measures involving fungicide use, recorded losses range from 10% to 25% of harvested fruits [16]. Despite employing various control methods, the disease caused losses exceeding 25% of the harvested fruits in the Arboleda municipality.

In contrast to the widespread acceptance of *S. betaceum*, the cultivation of *S. quitoense* faced limited approval in the municipalities of Arboleda and Sandoná. This discrepancy can be attributed to the heightened susceptibility of higher-altitude areas to pathogens like *Phytophthora* sp. and *Fusarium* sp., significantly impacting *S. quitoense* cultivation. These pathogens pose substantial limitations to lulo production in elevated tropical conditions, with *F. oxysporum* causing yield reductions of up to 16% in the Nariño department [17]. Conversely, lower-altitude conditions witnessed more severe attacks by pests such as the fruit borer *Neoleucinodes elegantalis* [15]. According to Galvis and Herrera [18], damage caused by the borer ranges from 13% to 40%. It constitutes the most limiting pest in naranjilla crops, affecting cultivation across an altitudinal range from 978 to 2560 meters above sea level [19]. However, agroclimatic conditions promoted effective control of pests and diseases in *S. quitoense* in Providencia, El Peñol and Florida, contributing to greater acceptance of *S. quitoense* in these regions.

In passion fruit cultivation, the severity and incidence of diseases are linked to the agroclimatic conditions in which the crop is established, the trellising system, and the agronomic management practices employed by producers. Passion fruit faced severe damage due to vascular wilting caused by *Fusarium* sp. Entire experimental lots were devastated by this pathogen, rendering it the most limiting factor for this crop [20]. Certain passion fruit species exhibit resistance genes to this disease, offering potential utility as rootstocks or as a gene source for the genetic improvement of this species [21]. This could be an important technology for the management of *Fusarium* sp. For the municipality of La Florida, gray mold of floral buds caused by Botrytis cinerea, resulting in losses exceeding 50% of floral structures, and dieback induced by *Nectria haematococca*, leading to necrosis on the stem causing wilting of leaves and widespread plant death [22], are the prevalent diseases responsible for losses and floral abortions, directly impacting the production and yield of the crop.

Downy mildew (*Peronospora* sp.) in *R. fruticosus* is a disease that restricts yields in this crop in Colombia. Recently, it has been recognized as an economically significant disease that can cause losses of 20% to 30% of the harvested fruit [16]. In the municipality of Arboleda, Peronospora and Oidium sp. exhibited epidemic characteristics, leading to a diminished crop yield. Consequently, producers did not embrace this cultivation as a potential productive alternative for the region.

The study's findings provide valuable insights into regional agricultural inclinations and can inform policies and strategies to promote sustainable agriculture and rural development. By understanding farmers' preferences in different regions, policymakers can design targeted interventions to support the cultivation of popular fruit species and improve farmers' livelihoods. Additionally, the study highlights the diversity in fruit species preferences across regions, which underscores the need for tailored approaches to agricultural development.

## 5. Conclusions

In conclusion, this study delineates distinct regional preferences and challenges in Andean fruit cultivation across municipalities. Categorical analysis and perceptual mapping reveal three discernible groups based on crop choices, reflecting agroecological influences. *S. betaceum*, while widely accepted in Arboleda and Sandoná, faces escalating viral challenges, necessitating targeted interventions. Conversely, *S. quitoense* encounters limited approval in higher altitudes due to pathogenic susceptibilities. Disease analyses underscore the impact on crop viability, emphasizing the importance of disease-resistant varieties and tailored control measures. The study underscores the imperative of adaptive approaches in addressing emerging challenges and diversifying agricultural practices to enhance resilience in varied agroclimatic conditions.

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**Supplementary:**

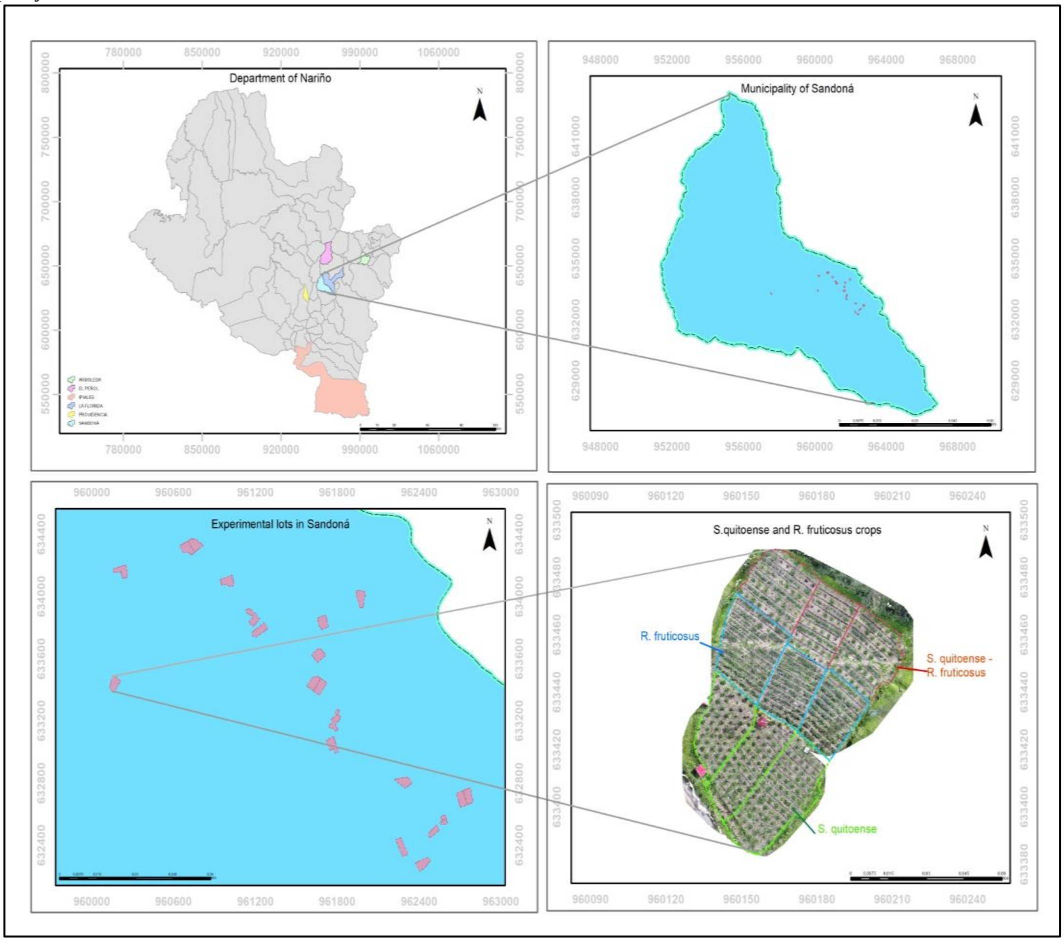


**Figure-1.** Maps of the study area, indicating the six municipalities of the department of Nariño. In more detail, we see the distribution of crops in the municipality of Sandoná

**Supplementary:**

**Table-1.** Cultivated Andean fruit crops and the geographical conditions of each experimental plot

| Municipality | Sidewalk | Latitude | Longitude | Altitude (msnm) | Culture |
|---|---|---|---|---|---|
| Ipiales | Boqueron | 0'54'00,31" N | 77°32'56,84" W | 2576 | *P. pinatistipula - R. fruticosus* |
| Ipiales | Loma de Zuras | 0°53'42,10" N | 77°33'09,00" W | 2586 | *S. betaceum - R. fruticosus* |
| Ipiales | Loma de Zuras | 0°53'45,22" N | 77°33'09,38"W | 2620 | *P. pinatistipula - S. betaceum* |
| Ipiales | Boqueron | 0°53'53,60 N | 77°33'04,37" W | 2655 | *S. betaceum - R. fruticosus* |
| Ipiales | Loma de Zuras | 0°53'37,90" N | 77°33'59,83" W | 2676 | *P. pinatistipula - S. betaceum* |
| Ipiales | Camellones | 0°53'04,88" N | 77°34'39,87"W | 2686 | *S. betaceum - R. fruticosus* |
| Ipiales | Camellones | 0°53'14,34" N | 77°34'56,39 W | 2695 | *P. pinatistipula - S. betaceum* |
| Ipiales | Laguna de Vaca | 0°52'25,05" N | 77°35'26,56" W | 2736 | *P. pinatistipula - R. fruticosus* |
| Ipiales | Loma de Zuras | 0°53'15,98" N | 77°33'58,40" W | 2742 | *S. betaceum - R. fruticosus* |
| Ipiales | Loma de Zuras | 0°53'46,91" N | 77°33'25,73" W | 2751 | *P. pinatistipula - S. betaceum* |
| Ipiales | Guacan | 0°51'48,43" N | 77°35'16,90" W | 2753 | *P. pinatistipula - R. fruticosus* |
| Ipiales | Loma de Zuras | 0°53'40,90" N | 77°33'27,54" W | 2768 | *S. betaceum - R. fruticosus* |
| Ipiales | Loma de Zuras | 0°53'10,88" N | 77°33'53,01" W | 2770 | *P. pinatistipula - S. betaceum* |
| Ipiales | Laguna de Vaca | 0°52'24,55" N | 77°35'19,33" W | 2800 | *P. pinatistipula - S. betaceum* |
| Ipiales | Laguna de Vaca | 0°52'16,68" N | 77°35'10,57" W | 2812 | *S. betaceum - R. fruticosus* |
| Arboleda | Yunguilla | 1°28'02,28" N | 77°08'31,69" W | 1793 | *P. ligularis - S. quitoense* |
| Arboleda | Arrayanes | 1°30'51,24" N | 77°06'40,47" W | 1870 | *P. ligularis - S. betaceum* |
| Arboleda | Arrayanes | 1°29'55,94" N | 77°08'52,76" W | 1991 | *S. betaceum - R. fruticosus* |
| Arboleda | Arrayanes | 1°30'05,08" N | 77°08'18,70" W | 2145 | *S. quitoense - R. fruticosus* |
| Arboleda | El Tauzo | 1°30'09,83" N | 77°08'50,37" W | 2195 | *P. ligularis - R. fruticosus* |
| Arboleda | El Tauzo | 1°31'03,43" N | 77°08'09,78" W | 2333 | *P. ligularis - R. fruticosus* |
| Arboleda | La Aguada | 1°29'57,50" N | 77°07'50,01" W | 2393 | *P. ligularis - S. betaceum* |
| Arboleda | El Tauzo | 1°31'03,92" N | 77°08'35,98" W | 2416 | *S. quitoense - R. fruticosus* |
| Arboleda | Chiriurco | 1°30'37,96" N | 77°07'43,92" W | 2417 | *P. ligularis - S. quitoense* |
| Arboleda | Chiriurco | 1°30'36,85" N | 77°07'41,27" W | 2428 | *S. betaceum - R. fruticosus* |
| Arboleda | La Aguada | 1°29'40,54" N | 77°07'34,90" W | 2460 | *S. quitoense - R. fruticosus* |
| Arboleda | Chiriurco | 1°30'38,64" N | 77°07'33,09" W | 2465 | *P. ligularis - R. fruticosus* |
| Arboleda | Chiriurco | 1°30'44,63" N | 77°07'32,92" W | 2468 | *S. betaceum - R. fruticosus* |
| Arboleda | Chiriurco | 1°30'43,86" N | 77°07'30,38" W | 2479 | *P. ligularis - S. betaceum* |
| Arboleda | La Aguada | 1°29'44,59" N | 77°07'32,53" W | 2498 | *P. ligularis - S. quitoense* |
| El Peñol | Las cochas | 1°29'27.96"N | 77°27'16.30"W | 1427 | *S. quitoense-R. fruticosus* |
| El Peñol | San Francisco | 1°29'05.05"N | 77°24'37.80"W | 1432 | *S. betaceum-R. fruticosus* |
| El Peñol | Torrecilla | 1°28'58.51"N | 77°26'49.29"W | 1571 | *P. ligularis-S. betaceum* |
| El Peñol | Alto Peñol | 1°27'46.90"N | 77°26'58.19"W | 1669 | *P. ligularis-R. fruticosus* |
| El Peñol | Pindal | 1°27'45.63"N | 77°27'01.99"W | 1686 | *P. ligularis-S. quitoense* |
| El Peñol | San Francisco Alto | 1°28'43.09"N | 77°24'26.41"W | 1839 | *S. betaceum-R. fruticosus* |
| El Peñol | San Francisco | 1°28'15.28"N | 77°24'50.88"W | 1866 | *P. ligularis-R. fruticosus* |
| El Peñol | San Francisco Alto | 1°28'23.03"N | 77°24'39.58"W | 1958 | *S. quitoense-R. fruticosus* |
| El Peñol | Perejil | 1°27'10.05"N | 77°25'22.11"W | 2032 | *P. ligularis-S. quitoense* |
| El Peñol | Perejil | 1°27'10.05"N | 77°25'22.11"W | 2032 | *P. ligularis-S. betaceum* |
| El Peñol | San Francisco Alto | 1°28'03.06"N | 77°24'43.46"W | 2054 | *P. ligularis-S. betaceum* |
| El Peñol | San Francisco Alto | 1°28'03.06"N | 77°24'43.46"W | 2057 | *P. ligularis-S. quitoense* |
| El Peñol | San Francisco Alto | 1°28'16.06"N | 77°24'29.75"W | 2081 | *S. betaceum-R. fruticosus* |
| El Peñol | San Francisco Alto | 1°28'11.11"N | 77°24'27.31"W | 2086 | *S. quitoense-R. fruticosus* |
| El Peñol | San Francisco | 1°27'28.09"N | 77°25'04.25"W | 2143 | *P. ligularis-R. fruticosus* |
| La Florida | Pucará | 1°22'28.77"N | 77°24'55.09"W | 2139 | *S. quitoense-R. fruticosus* |
| La Florida | Pucará | 1°21'50.50"N | 77°25'07.84"W | 2226 | *S. betaceum - R. fruticosus* |
| La Florida | Picacho | 1°19'47.65"N | 77°25'54.42"W | 2153 | *P. ligularis-R. fruticosus* |
| La Florida | Yunguilla | 1°22'43.39"N | 77°25'35.50"W | 2120 | *P. ligularis- S. quitoense* |
| La Florida | Yunguilla | 1°22'43.39"N | 77°25'35.50"W | 2110 | *P. ligularis-S. betaceum* |
| La Florida | Loma Larga | 1°22'06.02"N | 77°21'51.98"W | 2160 | *P. ligularis-S. quitoense* |
| La Florida | Yunguilla | 1°22'21.94"N | 77°25'07.88"W | 2203 | *P. ligularis-R. fruticosus* |
| La Florida | Achupallas | 1°20'17.52"N | 77°24'54.58"W | 2335 | *P. ligularis-S. betaceum* |

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| La Florida | Achupallas | 1°20'17.52"N | 77°24'54.58"W | 2355 | *S. quitoense-R. fruticosus* |
| La Florida | Plazuelas | 1°19'19.95"N | 77°22'13.33"W | 2273 | *S. betaceum - R. fruticosus* |
| La Florida | Pucará | 1°19'44.51"N | 77°22'01.17"W | 2344 | *P. ligularis-S. betaceum* |
| La Florida | Achupallas | 1°20'29.53"N | 77°25'19.00"W | 2396 | *P. ligularis-R. fruticosus* |
| La Florida | Achupallas | 1°20'23.64"N | 77°25'14.85"W | 2394 | *S. quitoense-R. fruticosus* |
| La Florida | Guascapata | 1°19'13.36"N | 77°23'44.96"W | 2424 | *S. betaceum-R. fruticosus* |
| La Florida | Plazuelas | 1°19'48.06"N | 77°23'18.47"W | 2494 | *P. ligularis-S. quitoense* |
| Providencia | Villa Nueva | 1°17'19.85"N | 77°36'4.08"W | 2202 | *S. quitoense-R. fruticosus* |
| Providencia | Villa Nueva | 1°17'14.40"N | 77°35'21.49"W | 2173 | *S. betaceum-R. fruticosus* |
| Providencia | Villa Nueva | 1°16'30.13"N | 77°35'15.28"W | 2156 | *P. ligularis-S. quitoense* |
| Providencia | Villa Nueva | 1°15'56.27"N | 77°35'9.85"W | 2265 | *P. ligularis-S. betaceum* |
| Providencia | Villa Nueva | 1°17'6.53"N | 77°36'0.93"W | 2285 | *P. ligularis-R. fruticosus* |
| Providencia | Villa Nueva | 1°15'45.27"N | 77°35'22.15"W | 2291 | *S. quitoense-R. fruticosus* |
| Providencia | Villa Nueva | 1°17'47.10"N | 77°35'57.12"W | 2173 | *S. betaceum-R. fruticosus* |
| Providencia | Villa Nueva | 1°17'26.01" N | 77°36'00.80" W | 2234 | *P. ligularis-S. quitoense* |
| Providencia | Villa Nueva | 1°17'6.53"N | 77°36'0.93"W | 2314 | *P. ligularis-S. betaceum* |
| Providencia | Villa Nueva | 1°17'4.92"N | 77°35'56.14"W | 2322 | *P. ligularis-R. fruticosus* |
| Providencia | Floresta | 1°15'33.76"N | 77°35'20.73"W | 2358 | *S. quitoense-R. fruticosus* |
| Providencia | Villa Nueva | 1°17'22.67"N | 77°35'53.65"W | 2315 | *S. betaceum-R. fruticosus* |
| Providencia | Villa Nueva | 1°15'44.68"N | 77°35'25.92"W | 2263 | *P. ligularis-S. quitoense* |
| Providencia | Floresta | 1°15'42.13"N | 77°35'18.02"W | 2342 | *P. ligularis-S. betaceum* |
| Providencia | Villa Nueva | 1°16'35.50"N | 77°35'42.90"W | 2325 | *P. ligularis-R. fruticosus* |
| Sandona | santa barbara | 1°17'05.13" N | 77°25'33.01" W | 2310 | *S. quitoense-R. fruticosus* |
| Sandona | santa barbara | 1°16'52.15" N | 77°25'19.69" W | 2418 | *S. betaceum-R. fruticosus* |
| Sandona | santa barbara | 1°17'07.31" N | 77°25'35.08" W | 2305 | *P. ligularis-S. quitoense* |
| Sandona | santa barbara | 1°17'05.14" N | 77°25'18.04" W | 2407 | *P. ligularis-S. betaceum* |
| Sandona | santa barbara | 1°17'09.61" N | 77°25'09.35" W | 2353 | *P. ligularis-R. fruticosus* |
| Sandona | santa barbara | 1°16¨52.31" N | 77°26¨07.32" W | 2373 | *S. quitoense-R. fruticosus* |
| Sandona | santa barbara | 1°16'31.69" N | 77°24'58.90" W | 2530 | *S. betaceum-R. fruticosus* |
| Sandona | santa barbara | 1°16'47.88" N | 77°25'16.41" W | 2455 | *P. ligularis-S. quitoense* |
| Sandona | santa barbara | 1°16'58.34" N | 77°25'18.81" W | 2409 | *P. ligularis-S. betaceum* |
| Sandona | santa rosa | 1°16'39.56" N | 77°25'16.89" W | 2463 | *P. ligularis-R. fruticosus* |
| Sandona | santa barbara | 1°16'52.15" N | 77°25'19.69" W | 2403 | *S. quitoense-R. fruticosus* |
| Sandona | santa barbara | 1°16'28.52" N | 77°24'44.55" W | 2558 | *S. betaceum-R. fruticosus* |
| Sandona | santa barbara | 1°16'13.61" N | 77°25'01.64" W | 2561 | *P. ligularis-S. quitoense* |
| Sandona | santa barbara | 1°16'23.79" N | 77°24'49.42" W | 2570 | *P. ligularis-S. betaceum* |
| Sandona | santa barbara | 1°16'28.52" N | 77°24'44.55" W | 2539 | *P. ligularis-R. fruticosus* |