

## Typology of cape gooseberry producers in the department of Nariño, Colombia

David Rodríguez Puertas  
Lizeth Tatiana Luna Mancilla  
José Manuel Campo Quesada  
Gissela Fernanda Guerrero Diaz  
Diego Hernán Meneses Buitrago  
Housseman Steven Ramos Zambrano  
Luis Felipe Rincón Manrique<sup>§</sup>

Colombian Corporation for Agricultural Research-Agrosavia-Obonuco Research Center. Via Pasto-Obonuco km 5, Pasto-Nariño, Colombia. (dpuertas@agrosavia.co; lluna@agrosavia.co; jcampoq@agrosavia.co; gfguerrero@agrosavia.co; dmeneses@agrosavia.co; hramos@agrosavia.co).

<sup>§</sup>Corresponding author: lfrincon@agrosavia.co

### Abstract

For a long time, the segment of production of exotic fruits has been positioning itself as an important productive and economic alternative to traditional crops in several regions of the country. Particularly, cape gooseberry (*Physalis peruviana* L.) has shown a notable increase in productive areas and international trade, which consolidates it as a species with high potential in the segment of cold climate fruits. In the department of Nariño (Colombia), the introduction of the crop is relatively recent, so there is still a need to know in detail the productive and environmental conditions in which the crop is produced and the socioeconomic characteristics of the producers in the region. For this, a characterization survey was designed, applied to cape gooseberry producers in the department of Nariño between 2019 and 2020. The information obtained was subjected to multivariate factor analysis of mixed data (FAMD) and multiple correspondence analysis MCA for categorical variables and the hierarchical cluster-type analysis, through Ward's algorithm, as a result, eight variables with discriminatory power were identified, which made up three clusters. Each group with distinctive characteristics in relation to the production area, degree of technification of the crop, use of labor and marketing strategies, among others, which give a clear specificity. With the information generated, it is expected to develop studies aimed at adjusting agronomic production models adapted to the environmental and socioeconomic conditions of growers. Additionally, the results obtained constitute a fundamental input for the orientation of policies to strengthen the regional chain.

**Keywords:** Andean fruits, family farming, statistical analysis, typology.

Reception date: July 2021

Acceptance date: August 2021

## Description of the system and methodological strategies

This manuscript is part of the research results of the project ‘adjustment of a productive agronomic model of the improved cape gooseberry varieties Andina and Dorada, in producing areas of Colombia’.

In Colombia, cape gooseberry (*Physalis peruviana* L.) is one of the fruit species with significant margin of growth and development, with a sown area of 1 713 ha and average yields of 12.4 t ha<sup>-1</sup>, the crop is among the first five fresh fruits for export in the country, after bananas, avocados, plantains and purple passion fruit (MADR, 2019). With international destination markets such as the Netherlands, Germany and the United States of America, in addition to leading fruit exports in Latin America, followed by Peru and Ecuador.

On a national scale, Nariño ranks fourth with a share of 6% of total production with a yield of 6.8 t ha<sup>-1</sup> reported for 2018 (MADR, 2019), additionally, it has been becoming an important cultivar due to promotion programs, consolidation of marketing channels, less impacts by diseases, among other aspects, which give the crop a relevant place at the regional level.

Cape gooseberry as well as the different agricultural production systems includes multiple components or subsystems that interact in time and space (Coronel and Ortuño, 2005). These production systems or farms are not organized identically, each has its own unique elements that determine unrepeatable properties and characteristics. However, many times these share characteristics and properties that make them similar in some aspects and their similarities allow them to be grouped for various purposes (García and Calle, 1998).

Under this conceptualization, the analysis of agricultural typology provides a possible solution, which simplifies the enormous diversity in complex systems, building clusters (groups) that involve the classification of farms on which similar recommendations could be made (Alvarez-Sánchez *et al.*, 2019). Therefore, the characterization and typification of agricultural producers is fundamental, which contributes to the design of public policies that contribute to the provision of technologies and government support as a basis for agricultural competitiveness in the regions (González-Flores *et al.*, 2018).

In this sense, the following manuscript presents the results of the research work aimed at typifying cape gooseberry producers in the department of Nariño. This study was carried out in two cape gooseberry-producing areas of the department of Nariño, the first located in the south, made up of the municipalities of Ipiales, Pupiales, Puerres, Gualmatán and Córdoba and the second in the north of the department, made up of the municipality of San Pablo. The collection of information was carried out from a survey applied to 133 producers identified through the non-probabilistic sampling technique called snowball (Ortega *et al.*, 2017).

In the case of the identification of the variables for the typification of producers, the recommendations of González *et al.* (2018) were employed, using, in quantitative variables, the coefficient of variation (CV) and in categorical variables, the index of qualitative variation (IQV), with a selection criterion greater than 70% for the first of them and in categorical variables of 0.7 (Alvarez *et al.*, 2019).

Once selected, a multivariate factor analysis of mixed data (FAMD) was performed (Kassambara, 2017), accompanied by a hierarchical cluster-type grouping analysis, using the method of Ward's algorithm (Peña, 2002). For the development of statistical methods, the libraries FactoClass (Elias *et al.*, 2018); Factoextra (Kassambara and Mundt, 2020); FactoMiner (Husson *et al.*, 2020); dplyr (Wickham *et al.*, 2019) of the R software v.3.2.2<sup>®</sup> (R DevelopmentCore Team, 2013). To validate this typification of producers, a workshop was held with a group of producers and expert technicians of the cape gooseberry production system.

### **Typology of cape gooseberry producers**

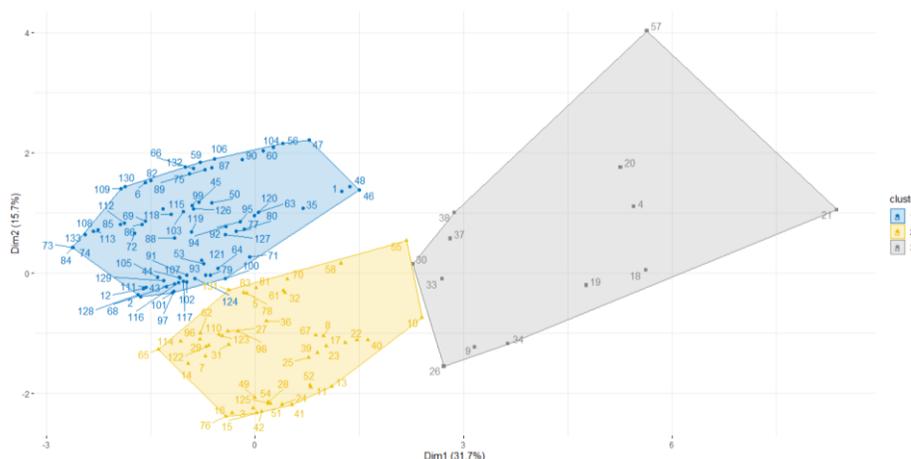
As a result of the application of the survey of productive and socioeconomic characterization applied to cape gooseberry producers, one hundred and sixty-eight (168) quantitative and qualitative variables were collected, which met the afore mentioned criteria, of which twenty-six (26) were selected. These variables were subjected to the application of PCA analysis, which allowed a second debugging to be carried out, to discard the variables that had less significance in the dimensions. As a result, eight variables (four qualitative and four quantitative) were selected.

Which were the most decisive for the production system: experience in cultivation (CV:100.9%), total area (CV:190.7%), total number of plants in production (CV:182.4%), production alternatives (CV:66.1). Although the variable described does not meet the CV criterion (greater than 70%), it was included in the hierarchical analysis due to its importance in the production system for the continuity of the crop.

Technical assistance (IQV:0.99), labor (IQV:0.96), certification of the lot (IQV:0.81), level of technification (IQV:0.83). As a result of the statistical analysis, it was possible to reduce the information to four dimensions that concentrate 67.7% of the total variance, dimensions one and two accumulate 47.4% of the variance. Authors such as Alvarez *et al.* (2014) state that a greater variance of 60% is significant in multivariate analyses.

The variables with the greatest contribution to dimension one were: total plants in production (22.9%), actual cape gooseberry area (19.09%), experience in the production of cape gooseberry (15.61%), level of technification (14.49%) and commercial alternatives (13.04%), in summary, dimension one provides information on the different components of the study (technical, social and economic), meanwhile, for dimension two, the variables that contributed most to the variance were: technical assistance (27.87%), certification of the farm (26.2%) and level of technification (21.95%), this dimension gives information about the technical component of the study. Finally, in dimensions three and four, the variables with the greatest significance were dominant labor in the crop (hired and family) (72.93%, 47.02%) and level of technification of the crop (24.98%, 36.38%).

For the development of this study, three clusters or types of producers were obtained, differentiated at a Euclidean distance of 0.64, as can be seen in the factor map (Figure 1). Where cluster one grouped 54.13% of the sample (72 producers), cluster two 36.09% of the sample (48 producers) and number three 9.77% (13 producers). Once the clusters were identified, the information obtained was validated in the field through socialization with local experts in the production system.



**Figure 1. Factor map by individuals according to cluster grouping for the typification of cape gooseberry producers in the department of Nariño.**

### **Cluster 1. Small producers with low level of technification and low experience in the cultivation**

This group is made up of 54.1% of the cases studied, is mainly explained by the variables: certification of the lot, level of technification and provision of technical assistance. It is made up of producers who own on average 0.35 ha sown of cape gooseberry, with maximum extensions of 1.8 ha and have an average of 302 plants in production, there are also producers with crops in a state of renewal and crops that have not yet begun their productive stage.

They are characterized by having a low experience, 2.98 years on average, their level of technification is low, since none of the lots have quality certifications, most do not perform soil analysis, do not apply amendments, do not have an irrigation system and do not receive technical assistance from qualified personnel. On the commercial side, they have few offers to sell their production, they have 1.25 commercial alternatives on average, and the predominant sales presentation is the cape gooseberry without calyx. They are mainly located in the northern part of the department and a large part of the family income is derived only from the production of the cape gooseberry, most of them are in a condition of poverty, according to NBI results.

### **Cluster 2. Small producers, with medium level of technification and diversification of crops**

Made up of 36.1% of the cases studied, it is mainly explained by the variables: Level of technification, technical assistance and certification of the lot. It is made up of producers who own 0.48 ha on average, with an average of 588 plants in production and with an average experience of 3.37 years. Many of them are located in the southern area of the department, have technical assistance service, certified lots and medium technification level. In general, these producers keep records, do not use credits for the cultivation of cape gooseberry and have the habit of saving. The presentation of cape gooseberry with calyx is the predominant one for marketing and family income is derived from the sale of cape gooseberry and other agricultural products.

### **Cluster 3. Medium-sized producers with more experience and high level of technification**

It is made up of 9.8% of the cases studied, the variables that explain this group to a greater extent are: plants in production, area of cape gooseberry and years of experience. It is made up of the producers with the most experience in cultivation (11.23 years), compared to the other groups, represents, on average, the largest number of plants in production (3 893.7) and sown area (3.34 ha). Most have technical assistance, quality certifications, irrigation, soil analysis and application of amendments, so their level of technification is high. On the commercial side, they have 2.92 commercial alternatives, and have two presentations for sale: cape gooseberry with and without calyx. Producers keep records, have the habit of saving and leverage their cultivation of cape gooseberry through credits.

### **Conclusions**

The validation process presented coherence between the conformation of the groups of producers and their association with the reality of the territory and the productive system, based on sociodemographic, technical, economic and organizational criteria. The typification determined three clearly differentiated groups of producers among which the main technical, productive and marketing characteristics of the cape gooseberry growers in the department of Nariño are contained.

The grouping by segments shows between group 1 and 2 the absence of significant difference in the variables: cape gooseberry area, plants in production, years of experience and commercial alternatives; being the absence of technical assistance a low level of technification and lack of certifications of lots determining conditions to place the first group in a low level of technical and commercial development. Meanwhile, for the second segment of producers, having technical advice, an average level of production technification and certifications of lots places them at an average level of technification of the production system. For the third segment of producers, the variables cape gooseberry area, plants in production, experience in cultivation and commercial alternatives reflect a marked difference in comparison with groups 1 and 2.

The time of experience in the management of the crop is a determining factor due to the relatively short time that the introduction of cape gooseberry has in the department, this reflected in the average time of experience that the producers have. This leads to those who have more production time can have a better knowledge of the agronomic management of the crop achieving better cultural practices oriented to a process of gradual technification of production. This is leveraged by access to technical assistance services, whether contracted, public services or provided by marketers, which allow producers to be accompanied to gradually incorporate into decuous productive practices.

The certification of lots that guarantees producers the possibility of accessing differentiated markets and therefore diversifying their commercial alternatives responds to the continuous process of technification of the crop advanced by a segment of them. The study concluded the broad margin of growth that the crop has in the department so that it can be an alternative for the diversification of producers' income to face fluctuations in the prices of traditional crops.

## Acknowledgements

The authors thank the Colombian Corporation for Agricultural Research (Agrosavia), ID: 1000642a. To Pedro Rodríguez Hernández, Carlos Andrés Benavides, Andrea Castro Jiménez and Martín José Jairo Piscal for their contributions at different stages of the development of this work.

## Cited literature

- Alvarez-Sánchez, D. E.; Gómez-López, E. D. y Ordóñez-Hurtado, H. R. 2019. Tipología de fincas productoras de arveja (*Pisum sativum* L.) en la subregión sur de Nariño, Colombia. Ciencia y Tecnología Agropecuaria. 20(3):659-67. [https://doi.org/10.21930/rcta.vol20\\_num3\\_art:1593](https://doi.org/10.21930/rcta.vol20_num3_art:1593).
- Alvarez, S.; Paas, W.; Descheemaeker, K.; Tittonell, P. y Groot, J. 2014. Construcción de tipologías, una forma de manejar la diversidad de las fincas: directrices generales para humidtropics. 40 p.
- Coronel-Renolfi, M. y Orduño, P. S. F. 2005. Tipificación de los sistemas productivos agropecuarios en el área de riego de Santiago del Estero, Argentina. Problemas del Desarrollo. Rev. Latinoam. Econ. 36(140):63-88. <https://doi.org/10.22201/iiec.20078951e.2005.140.7572>.
- Elias, C.; Campo, P.; Torres, C.; Díaz, I.; Sadinle, M. y Medina, J. 2018. Package ‘factoextra’. <https://cran.r-project.org/web/packages/FactoClass/FactoClass.pdf>. 1-34 pp.
- García, C. H. y Calle, L. M. 1998. Consideraciones metodológicas para la tipificación de sistemas de producción bovina a partir de fuentes secundarias. Ciencia y Tecnología Agropecuaria. 2(2):6-15. doi: 10.21930/rcta.vol2\_num2\_art:166.
- González-Flores, S.; Guajardo-Hernández, L. G.; Almeraya-Quintero, S. X.; Pérez-Hernández, L. M. y Sangerman-Jarquín, D. M. 2018. Tipología de productores de maíz en los municipios de Villaflores y La Trinitaria. Chiapas. Rev. Mex. Cienc. Agríc. 9(8):1763-1776. <https://doi.org/10.29312/remexca.v9i8.1722>.
- Husson, F.; Josse, J.; Le, S. and Mazet, J. 2020. FactoMineR: multivariate exploratory data analysis and data mining. <https://cran.r-project.org/web/packages/FactoMineR/index.html>. 25(1):1-18.
- Kassambara, A. 2017. Practical guide to principal component methods in R, PCA, (M) CA, FAMD, MFA, HCPC, factoextra. Statistical tools for high-throughput data analysis (STHDA). 1 ed. Francia. 29 p.
- Kassambara, A. and Mundt, F. 2020. Factoextra: extract and visualize the results of multivariate data analyses. R. package version 1.0.7. <https://cran.r-project.org/web/packages/factoextra/factoextra.pdf>.
- MADR (Ministerio de Agricultura y Desarrollo Rural). 2019. Dirección de cadenas agrícolas y forestales. Cadena de la uchuva. Colombia. 18 p.
- Ortega, R.; Sonego, M.; Pulido, J.; Crespo, A.; Mejías, E. y Sordo, L. 2017. Métodos indirectos para la estimación de poblaciones ocultas. Rev. Españ. Salud. Públ. 91:1-9. <https://www.redalyc.org/articulo.oa?id=17049838040>.
- Peña, D. 2002. Análisis de datos multivariantes. McGraw-Hill. 1<sup>ra</sup> ed. España. 201-226 pp.
- Wickham, H.; Romain, F.; Lionel, H. y Kirill, M. 2019. Dplyr: a grammar of data manipulation. R. package version 1.0.0.