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RESEARCH ARTICLE

Socioeconomic factors determining the production of smallholder farmers of organic quinoa in the Peruvian Andes

Nelida Yauris[1]; Waldemar Mercado[2]; Malú Massiel Galindo-Sánchez[3]; Camilo Mamani[4]; Diego A. Sotomayor[5]; Eliet Amanca[1]*

[1] Universidad Antonio Ruiz de Montoya, Lima, Perú.
[2] Facultad de Economía y Planificación, Universidad Nacional Agraria La Molina, Lima, Perú.
[3] Facultad de Ciencias Agrarias. Universidad Nacional San Cristóbal de Huamanga, Ayacucho, Perú.
[4] Universidad Nacional de San Antonio Abad del Cusco Facultad de Ciencias Agrarias, Cusco, Espinar, Perú.
[5] Department of Environmental Engineering, Universidad Nacional Agraria La Molina, Lima, Perú.

* Corresponding author: amancah.08@gmail.com (E. Amanca).

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Abstract
Organic quinoa (*Chenopodium quinoa* Wild) cultivation embodies a holistic agricultural approach, integrating biological fertilizers to curtail reliance on insecticides and synthetic fertilizers and low levels of greenhouse gases. The objective of this paper was to identify the socioeconomic factors that determine smallholder farmer organic quinoa production. The socioeconomic factors of organic quinoa farmer in the district of San Jerónimo, Apurímac in Southern Peru associated with five groups of organic quinoa farmers. Primary data were collected from 109 smallholder farmers belonging to quinoa producers' associations, using a non-experimental and cross-sectional study design, that was analyzed with descriptive, correlational statistics and a logistic regression method involving the evaluation of 13 independent variables. Motivational factors are identified through the application of a qualitative and quantitative sequence of mixed methods design. The results show that high price is the most important explanatory variable, and it is also the one that smallholders primarily consider when cultivating organic quinoa. The second most important variables motivating such farmers are social factors, mainly those related to health benefits, food quality and lastly environmental benefits. The variables: quinoa income, distance to the land, membership in an association, technical assistance and mixed (own and hired) labor had an inverse relationship with organic quinoa production while land ownership had a positive but less significant effect on the production of organic quinoa ($p < 0.1$). In conclusion, organic quinoa producers are primarily influenced by financial reasons, followed by considerations of sustainability and the desire to obtain healthy, pesticide-free food for self-consumption. These findings of important factors in the adoption of organic agriculture by producer associations and the motivational aspects found for its continued production could be considered in agricultural policy proposals in the face of a world with greater demands for food and environmental protection.

Keywords: Organic agriculture; quinoa; motivational factors; socioeconomic factors.

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1. Introduction
The projected growing demand for food from 2010 to 2050, which could increase by 30 to 60% (van Dijk et al., 2021), is driving the adoption of intensive agricultural practices to improve crop yields. However, in the 21st century, the challenge is not limited to increasing crop yields alone but also includes the need to reduce the negative impact on the environment (Mouratiadou et al., 2024). In this context, organic agriculture is presented as a key solution to promote the sustainability of agricultural systems. Organic agriculture has the potential to reduce negative impacts on biological communities and improve soil health (Rodríguez et al., 2025), sustainable production and high-quality food (Lone & Rashid, 2024), conservation of agroecosystems including increased on-farm agrobiodiversity (Amancah et al., 2023; Zander et al., 2024), income security and strengthening of local communities for the economy (Meemken & Qaim, 2018), and promotion of public health (Grimm et al., 2023).
Since 2013, the organic productive sector has grown substantially worldwide; in 2020, the agricultural area certified under organic agriculture

was 74.9 million hectares, covering 1.6% of the world's agricultural land (Schlatter et al., 2022). Total retail sales, according to the Organic Agriculture Research Institute – International Federation of Organic Agriculture Movements (IFOAM), amounted to more than 120 billion euros. The country with the largest organic food market is the United States (49.5 billion euros), followed by Germany (15 billion euros), France (12.7 billion euros) and China (10.2 billion) (Schlatter et al, 2022). Organic farms provide considerable economic benefits, as they can be equally or more profitable compared to conventional farms (Ferdous et al., 2021; Meemken & Qaim, 2018; Setboonsarng & Gregorio, 2017). A 14 country meta-analysis concluded that organic farming is 22% - 35% more profitable than conventional farming on average (Crowder & Reganold, 2015). A global meta-analysis covering 66 crops conducted by Smith et al. (2020) reached a similar conclusion. Farmers are also attracted by the sustainability provided by the organic system, along with the desire to hand over their lands to the next generation in better conditions (Riar et al., 2017). However, the environmental benefits of the organic system are not so clear, especially when the intensity of the organic fields is increased. Organically managed fields can have a higher diversity of plants, fauna (insects, microbes, birds), more habitat and landscape diversity, which is due to less pesticide use, longer crop rotations and the maintenance of semi-natural landscapes (Meemken & Qaim, 2018; Reganold & Wachter, 2016). Smith et al. (2020) meta-analysis quantified the effects of landscape on the sustainability of organic and conventional agriculture using four socio-ecological sustainability metrics: 1) biotic abundance, 2) biotic richness, 3) performance and 4) profitability. They found that organic fields had greater biotic abundance and richness. However, the biodiversity benefits decrease as the surface area of organically farmed fields increases. This is because lower yields lead to large-scale production that can lead to greater loss of natural habitats and higher food prices. Therefore, there is a stream of researchers who propose a smart combination between organic and conventional agriculture to generate sustainable agriculture (Meemken & Qaim, 2018).

The importance of investigating the organic production of quinoa is due to its growing recognition throughout the world, not only for its cultural importance, nutritional and functional properties, but also for its ability to grow under conditions of soil salinity, drought, frost and in marginal soils (Angeli et al., 2020; Fuentes et al., 2012; Jaikishun et al., 2019). These characteristics have promoted its expansion into new areas outside its regions of origin, especially in Europe and the subtropical regions of the world, where it has provided good yields (Fuentes et al., 2012). Approximately 30% of quinoa produced in the main Andean countries is organic. However, expanding organic quinoa production into new regions presents challenges, particularly where Chenopodiaceae weed pests and diseases persist (Alandia et al., 2020).

In Peru, quinoa production has increased significantly, resulting in its cultivation in various regions of the country. In particular, the cultivation of organic quinoa has grown substantially because it is a product in high demand in the international market (Cancino-Espinoza et al., 2018). This demand has led to higher prices and has encouraged producers to allocate larger areas to quinoa cultivation, especially in coastal regions such as Arequipa, Lambayeque and La Libertad, among others (Bedoya-Perales et al., 2018). These regions, the Peruvian government is also promoting the production of quinoa, through the "PROQUINUA" project, which was carried out by the Ministry of Agriculture, with the cooperation of the regional governments through their regional agriculture management and the support of the entities such as Agro-rural and the Instituto Nacional de Innovación Agraria. Providing them with access to certified quality seeds, technological assistance, crop health surveillance, and access to credit (Espinoza et al., 2021). It also promotes the production of quinoa to improve the food security of the Andean population through food assistance programs. One of these programs is the Programa Nacional de Seguridad Alimentaria, which authorizes the purchase of Andean agricultural products, such as quinoa, directly from small local farmers.

Its expansion has improved quinoa producer incomes (Bedoya-Perales et al., 2018). However, this intensification linked to price and international demand, can lead to unsustainable production systems, with high long-term social, economic, and environmental impacts Gómez et al. (2016), Romero-Carazas et al. (2023) and Bonifacio et al. (2023) highlight the adverse impacts evident in Bolivia due to increased quinoa production, where the intensification of quinoa production raises concerns, both in terms of soil degradation and the diversity of natural resources (Alandia et al., 2020). Peru could also suffer from such impacts given its high levels of quinoa production (Bedoya-Perales et al., 2018). Furthermore, land use change is one of the primary concerns in the country, given that onethird of its surface is considered to suffer from desertification as a result of salinization and soil erosion. In addition to this, most of the Peruvian territory is categorized as very highly vulnerable to disasters, climate change and food insecurity (Bedoya-Perales et al., 2018).

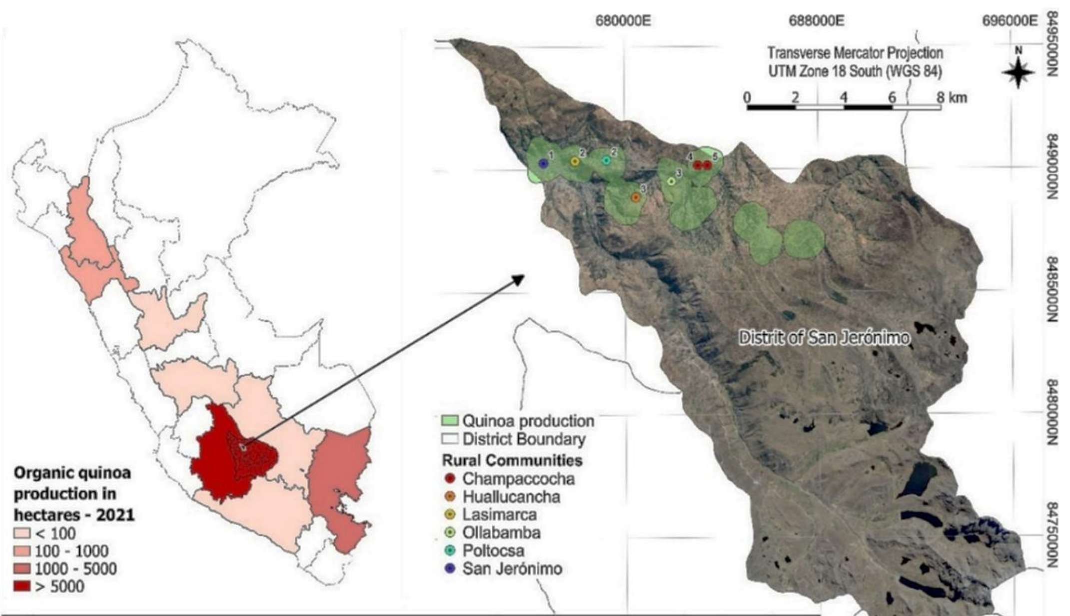
For this reason, the cultivation of organic quinoa has been promoted not only because it is a product with high demand in the international market (Cancino-Espinoza et al., 2018), but also because of its environmental benefits of the organic system (Rodríguez et al., 2025). Along these lines, studies that evaluate the factors that influence farmers' decisions to change from conventional to organic practices have been developed by Azam & Shaheen (2019), Ullah et al. (2015), Sodjinou et al. (2015), Ojiako et al. (2015), Riar et al. (2017) and Reganold & Wachter (2016), pointing out that increased price, profitability and product performance gain importance in decision-making to opt for the organic production system; since farmers also identify that the generate public goods, such as the increase in agrobiodiversity, the improvement of quality and plant cover, therefore, greater communal resilience in the face of the environmental management crisis (Zander et al., 2024). Likewise, obtaining healthy food free of pesticides, the sustainability provided by the organic system and the desire to hand over the land to the next generation in better conditions influence the adoption of the organic system (Guo et al., 2022).

The increase in organic quinoa production may be correlated with factors such as access to financial resources, availability of labor, knowledge and adoption of organic agricultural practices, as well as government policies and international market demands. It is in this context that this paper presents and discusses the socioeconomic factors that influence the production of organic quinoa by smallholder farmers in areas where quinoa production increased during the last 10 years in Peru.

2. Methodology

Study Area

This study was conducted in the San Jerónimo district in the province of Andahuaylas, in the department of Apurímac, in southern Peru. Located at an altitude of 2944 m s. n. m. with an area of 253.26 km^2, where there is a large amount of organic quinoa production (Figure 1). The study was conducted in five organic quinoa producer associations, which were interviewed face to face.



Nro.	Association name	Location	N° associates	Nh
1	Association of Quinoa and Kiwicha Producers "Grano de Oro"	San Jerónimo	43	31
2	Association of Agricultural Producers "Lasimarca Poltoccsa"	Lasimarca, Poltoccsa	35	25
3	Agroindustrial Producers Association "Nueva Visión"	Ollabamba, Huallucancha	23	17
4	Association of producers "Unidos en Siembra de Champaccocha"	Champaccocha	35	25
5	Association of Agricultural Producers "Nuevo Progreso"	Champaccocha	16	11
		Total	152	109

Figure 1. Location of the study area, San Jerónimo in the province of Andahuaylas and quinoa producer organization.

Sampling and Data Collection

Quantitative and qualitative cross-sectional data was collected from smallholder farmers who were active members of the quinoa producers' associations of the San Jerónimo district. The sample size was calculated based on information from the Agrarian Directorate of the Gobierno Regional de Apurímac (2021). The sample size was determined using a stratified probabilistic sampling technique. Interviews with 109 heads of household were conducted in 2021. The information was collected using a structured questionnaire based on Azam & Shaheen (2019), Sodjinou et al. (2015) and Ullah et al. (2015) (Supplementary material).

Data Analysis

The model to address influential socioeconomic factors in the organic and conventional production of quinoa was the Logit binary (Harrell, 2015). The categorization of producers into "organic" and "conventional" is based on the dichotomous result of the decision to produce organically or conventionally, which characterizes the dependent variable (Y). Therefore, a producer is defined as "organic" when the variable Yi = 1 and as "conventional" when the Yi = 0. The following model is used to evaluate the adoption of organic agriculture in the study area (The variables are shown in Table A1 of Appendix).

$$\text{Logit }(Y) = \alpha + \beta_1 Age + \beta_2 Gen + \beta_3 Exp + \beta_4 DistTM + \beta_5 Income + \cdots + \beta_{13} MLabor + e$$

In the second part, this research explores the correlation between economic, social, marketing and government policy factors (Table A2 of Appendix), which was analyzed in a qualitative and quantitative sequence with a mixed methods design.

3. Results and discussion

Variables determining organic production of quinoa

The Logit model shows the effect of significant variables that affect the probability of growing organic quinoa (Table 1), thus, the variables with *p-value* less than the significance level ($p < 0.05$ and 0.01) are Log Quinoa Income, Distance to the market and the plot, Membership in an association, as they indicated that they began producing quinoa when the association was created and Technical Assistance and Manpower of labor 3. The variables with a *p-value* lower than the significance level ($p < 0.1$) are Land ownership 3 (owned and rented land) and Manpower of labor 2 (contracted labor members).

The confusion matrix test was performed on the nonlinear model for the R of count or prediction quality, showing that it is at 0.87, which indicates good quality of the model. Likewise, the Hosmer-Lemeshow test yielded 14.112 with a p-value of 0.07 (greater than the significance level of 0.05), therefore, there is not enough evidence to reject the null hypothesis that there is no difference between the observed values and the predicted values from the Logit model for the probability of growing organic quinoa.

The findings indicate that the coefficient for technical assistance is statistically significant at p-value < 0.01. This suggests that producers who receive training and technical support are more inclined to embrace organic farming practices. Dube et al. (2025) observed a significance level at p-value < 0.1 and noted a positive correlation between access to formal education on organic farming or agricultural advice and the adoption of sustainable practices among South African small farmers. According to their study, 70% of producers involved in organic agriculture benefit from some form of technical assistance. Embracing sustainable practices helps farmers comprehend the scientific reasons and benefits associated with these practices (Rizzo et al., 2024).

Labor also emerged as a significant factor in organic agriculture, with a less significance level ($p < 0.01$). This indicates that the likelihood of adopting organic farming increases when the workforce consists of family members and additional labor. In this regard, this result is according to the one mentioned by Godmaling et al. (2024), who highlighted that organic farming demands more labor, making it a crucial element for its implementation. Meanwhile, Dube et al. (2025) found that having more family members can help lower agricultural costs and enhance access to family labor, although this factor was not statistically significant.

The model can be illustrated through the results obtained in the Receiver Operating Characteristic (ROC) curve. The ROC curve plots how effectively each independent variable can distinguish outcomes. As illustrated in Figure 2, the positively salient curves (that is, those that are above the diagonal line of random guessing) are the best at distinguishing people's real decisions, while the curves below the diagonal distinguish people's decisions poorly. Thus, the higher the curve is above the upper left corner, the better the predictor will be and if it is closer to the lower right corner the prediction will be the opposite. The usefulness of ROC curves is both visual and mathematical, since by integrating them, the reader can find the AUC (area under the curve) and thus have the difference much clearer. The AUCs of the variables Access to loans, Technical Assistance, Age, Log Quinoa Income, Manpower of labor, Female, Ratio Membership in an association, Ratio Distance to market and plot, Ratio Property size and Household size and Land ownership are: 0.67, 0.77, 0.64, 0.72, 0.61, 0.41, 0.57, 0.62, 0.72 and 0.48, respectively.

After passing the tests of the econometric model, Table A3 of the Appendix shows a summary of all the marginal effects of the independent variables of the model. The variable LandO3 has a positive marginal effect of 0.175, in which the probability of cultivating organically increases by 17% if the ownership of land is mixed (owned and rented) in relation to ownership only of own or rented. Azam & Shaheen (2019) indicate that farmers who exclusively use leased farms are more concerned with economic factors such as price, yield, and profitability of organic products. Insecure land tenure limits the implementation of conservation or sustainability measures. In this sense, an organic farmer prefers to have their own rented land. The condition of having both owned and leased land often arises from the need to increase the production area, as the land owned is typically small, which would hinder the adoption of organic farming. At the same time, the Associations themselves rent land for organic cultivation to improve the soil of conventional farming (Fuller et al., 2021; Revilla, 2014).

The variable "Ratio Distance to market and plot", which has a significant negative effect at 5% with a marginal effect of -0.066 (Table A3, Appendix), indicates that the greater the distance from the producer's house to the most important land where they grow quinoa in relation to the distance to the nearest market where they sell their products, the probability of growing organic quinoa is reduced by 6.6%. Thus, producers with farms near their home will be more likely to grow organic quinoa. The result is consistent with the findings of Sodjinou et al. (2015), that found that conventional producers have their farms twice as far from their homes as organic producers, since proximity facilitates the transportation of necessary resources such as cow manure and essential materials for organic production. It is important to note that the barriers that limit the adoption of organic agriculture are the difficulties in accessing inputs and coping with low yields (Lone & Rashid, 2024). However, it should be considered that the land near the houses is generally smaller, which reduces the possibility of practicing some organic farming systems, such as rotation and intercropping.

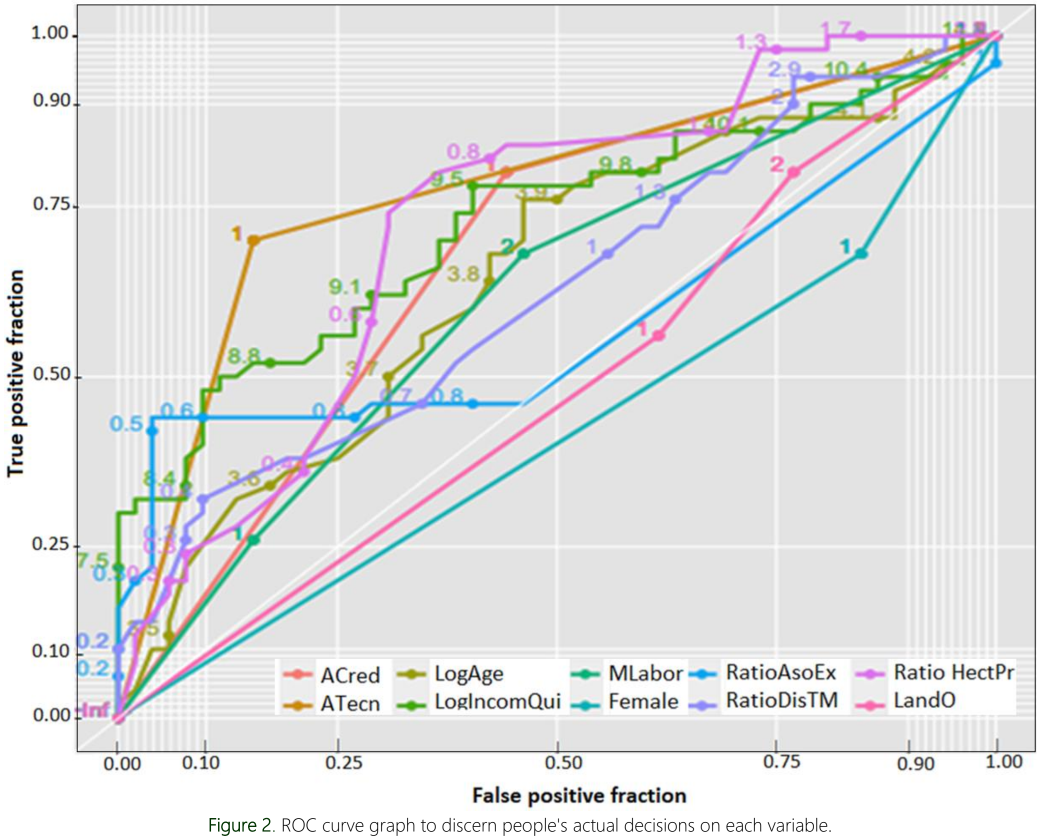


Figure 2. ROC curve graph to discern people's actual decisions on each variable.

Table 1
Results of the logit model

Dependent variable = Quinoa-organic		
Log Quinoa Income		-0.711** (0.349)
Ratio Distance to market		-0.604** (0.280)
Ratio Membership in an association		-3.093** (1.341)
Ratio Property size and Household size		-0.598 (0.708)
Age		-0.002 (0.025)
Gender 1 (Female)		0.712 (0.782)
Technical assistance		-2.612*** (0.765)
Access to loans		-0.904 (0.704)
Land ownership 2 (Leased land)		1.003 (0.937)
Land ownership 3 (owned and rented land)		1.700* (0.874)
Manpower of labor 2 (contracted labor members)		-1.773* (0.943)
Manpower of labor 3 (Family and contracted labor)		-2.395*** (0.901)
Constant		13.083*** (4.084)
Observations	102	
Log Likelihood	-35.793	
Akaike Inf. Crit	97.586	

Note: *p<0.1; **p<0.05; ***p<0.01.

The technical assistance variable (ATecn) is significant, with a marginal effect of -0.37. The inverse effect of this variable may be because, in the study area, organic producers receive little technical assistance (38% of respondents mentioned receiving technical assistance). According to Espinoza et al. (2020), private and public entities within the Peruvian agricultural sector provide technical assistance to quinoa producers; however, the advice is concentrated in other places with greater production and genetic biodiversity of quinoa such as Puno, Ayacucho, Junín and Cusco, evidencing that there is still a need to intensify technical assistance adapted to the reality of other regions, according to the variety and characteristics of the quinoa requested by the market (Espinoza et al., 2020). Pinedo-Taco et al. (2022) indicate that limited technical assistance can represent a critical factor for the sustainability of organic quinoa production. Azam & Shaheen (2019) point out that technical assistance plays a fundamental role in the sustainable development of agriculture, promoting competitiveness in the understanding of the importance of organic food, the organic production system, and the adoption of new technologies.

On the other hand, the variable income obtained from the sale of quinoa (LogIncomeQui) is significant with an inverse relationship in the adoption of organic quinoa, there is an average annual income from quinoa of USD 2312.33 with a standard deviation of 1.187, this represents a moderate standard deviation, which is related to the marginal contribution of the effect (-0.078). In the context of the Ayacucho region, Pinedo Taco et al. (2018) notes that the average income from the sale of quinoa from traditional cultivation ranges between 149.40 and 299.11, while organic production generates income ranging from 299.11 to 1,496.71. Despite the fact that the average annual income of producers in the San Jerónimo district exceeds these ranges, a study on sustainability conducted in the districts of Andahuaylas, Talavera, and José María Arguedas in the Apurímac region indicates that the level of sustainability of organic production, specifically in economic terms, reveals that the household income indicator from quinoa sales does not reach 50% of the value established as the minimum sustainable level (Pinedo-Taco et al., 2022).

The variable Labor (MLabor3) is significant at 10% (inverse relationship), this suggests that if the labor system is mixed (hired and family) in relation to only family labor, the probability of producing organic quinoa is reduced by 2%. As Dube et al. (2025) point out, the composition of the family group significantly influences labor dynamics in agriculture. A large family group provides farmers with greater access to family labor, whereas a smaller group necessitates maintaining a mixed system that includes hired labor. The production of organic quinoa in the San Jerónimo district is peculiar, as it is an alternative production activity. Family members will usually prefer to work on the same land property rather than generating other income in other activities, except for activities that generate complementary income. Studies such as (Soltani et al., 2014) show that organic farmers have greater labor needs compared to conventional ones, due to activities such as weeding, carried out manually in organic agriculture and which leads to hiring more workers. The greater workload falls on women than on men in organic cotton production (Altenbuchner et al., 2018); It is not far from the reality of organic quinoa, although men are registered as members of the association, women carry out a large part of the agricultural activities in the production of organic quinoa.

The variable RatioAsocEx is statistically significant but has a negative influence, indicating that the longer the number of years affiliated with an association relative to the number of years as a quinoa producer, the probability of maintaining organic cultivation decreases by 33%. Quispe & Prudencio (2024) indicate that economic indicators of quinoa production can incentivize farmers in some communities to adopt agrochemical practices to guarantee higher yields and even ensure their subsistence. This reduces the likelihood of adopting organic crops. However, producers with more years of experience have found that crops with greater application of agrochemicals are more prone to natural phenomena such as frost, hail, and floods (Alanoca & Apaza, 2018), consequently, in recent years, farmers have revitalized the practices organics. On the other hand, belonging to a producer association does not have a positive influence, which could be explained by Ma et al. (2018), who asserts that apple farmers belonging to agricultural cooperatives may encourage greater investment in organic soil amendments, but does not completely replace the use of chemical fertilizers. Regarding the level of productive capacity within associations, a study conducted in the district of Andahuaylas, adjacent to the district of San Jerónimo, by Rejas et al. (2021), indicated that only 19.5% of the associations have a high level of productive capacity. This is due to many associations facing limitations in accessing financing, productive technology, and certified seeds. This level of productivity in the region, combined with market accessibility conditions and adverse climatic factors, reduces the sustainability index of organic quinoa production. As a result, many producers tend to resort to conventional agriculture to offset economic losses (Pinedo-Taco et al., 2022).

The variable Access to Loans does not have a significant influence on organic adoption because 64% of respondents mentioned they have not received a loan to finance quinoa production as they can invest without issue (40%) and the interest rate is high (24%). Similarly, the variables age and female gender were not significant, indicating that organic quinoa production does not depend on age or gender. The lack of significance of gender in the adoption of an agricultural crop could be due to the absence of gender-based associativity restrictions. Nonetheless, leadership in production is often assumed by the husbands or partners of women, which is reflected in the fact that only 25% of producers are women among the total associates in the evaluated associations. Despite this, many of the agronomic tasks of organic crops are carried out by women, although their work often remains invisible (Pickering, 2024). Other studies highlight the importance of women's participation in organic production (Malá & Malý, 2013; Olarte & Gouvêa, 2016; Sodjinou et al., 2015; Soltani et al., 2014). Possible reasons include greater social empathy among women, the maternal role of women, and their desire to maintain child health, among others (Malá & Malý, 2013). In this regard, it is worth mentioning that women are the silent drivers of change towards sustainable production systems and healthier diets.

The adoption of organic quinoa in the district of San Jerónimo was influenced by factors such as technical assistance, expanding the cultivation area through land leasing, and product pricing, within an association system. However, the negative significance level associated with technical assistance, sales income, and the duration of membership in an association are indicators that could affect the continuity of quinoa adoption and, consequently, its sustainability. This is confirmed by Pinedo-Taco et al. (2022), who indicate that the sustainability of organic quinoa production is influenced by factors such as sales income, access to credit, technical assistance, and the level of organization within associations. In the study conducted by Villegas-Casaverde et al. (2025), only three certified organic quinoa producer associations were found in the district of San Jerónimo in 2023. This reduction in the number of associations demonstrates the low level of sustainability in organic quinoa production. Villegas-Casaverde et al. (2025) also points out that the low level of sustainability is influenced by a moderately inadequate level of associativity, as producers face competitive disadvantages due to factors such as low educational levels, lack of government commitment, insufficient technical assistants, human resources, and lack of strategic alliances with international markets. The challenge regarding the limited technical assistance in organic farming forces many farmers to resort to conventional practices with greater assistance available (Dimitri et al., 2025).

Analysis of motivational factors

The motivational factors were analyzed with the skewness and kurtosis values of the collected data were calculated to evaluate their normality, finding that all values derived from the variables were within the recommended range of ±2 (Trochim & Donnelly, 2006). In addition, a reliability analysis was carried out to measure the internal consistency of the scales and the interrelationship between variables. Subsequently, Cronback's α value (0.87) was calculated, considered significantly good, since the cut-off point is 0.70 and the maximum expected value is 0.90 (Tavakol & Dennick, 2011). Table A4 (in Appendix) presents the results of the motivational factors and their indicators; the score obtained according to the average and includes the hierarchical ranking of the most important values for the classification. The results obtained from the factors and each of the indicators have been classified based on the mean and standard deviation, so a "Rank" priority ranking was considered.

The results show that the average score of the high price variable (I1) is the most important with 4.94 and what farmers consider when growing organic quinoa. In descending order, the variables follow: I7 (health benefit), I6 (quality food), I9 (environmental benefits), I10 (certification benefits), I12 (greater interest and recognition), I19 (technical assistance), I5 (lower risk of loss of investment), I4 (higher profitability), and I8 (avoid chemicals). These results are consistent with the findings of Sodjinou et al. (2015), Azam & Shaheen (2019), Riar et al. (2017) and Yanakittkul & Aungvaravong (2020), that found that organic producers are attracted for financial reasons, and this increases when economic benefits increase. Organic producers are also motivated by the sustainability of production and obtaining healthy, pesticide-free food, given the “Rank” of the indicators such as health benefits (I7), quality food (I6) and environmental benefits (I9). These findings are consistent with Zhang & Wang (2024) and Riar et al. (2017) that point out that producers are also concerned about their health, the environment and soil fertility. Stanly et al. (2024) noted that indigenous communities have observed that the use of agrochemicals, such as pesticides and synthetic fertilizers, can lead to long-term deterioration in soil fertility and reduced crop resilience. For this reason, they have decided to adopt the use of organic fertilizers as a strategy to promote sustainable agriculture. Therefore, both economic incentives and environmental and health concerns motivate the adoption of organic quinoa production.

To analyze and evaluate the degree of relationship between each indicator of the factors, a zero-order correlation was carried out. The cross-sectional sum of the variables grouped by factors that influence the organic production of quinoa shows that, together, the marketing components are the main influencing factors, followed by social, economic factors and government policy. The zero-order correlation between the main factors (Figure 3) indicates a strong positive relationship between marketing and social (0.28), and economic and political (0.23), and a moderate relationship between marketing and economic (0.12), and political. with marketing (0.13), and there is no relationship between economic and social.

In the marketing group, the benefits of certification and greater interest or recognition stood out to be important in the organic production of quinoa, due to being recognized and having higher prices. However, in Peru and other developing countries, Organic Certification continues to be one of the main challenges for small producers, because greater associativity and participation is required, in addition to respecting ecosystems and compliance with national production aligned with the requirements of international certifications (Espinoza et al., 2020). Likewise, the indicator greater interest and recognition play an important role in choosing a crop; thus, in quinoa, its nutritional value and ability to adapt to various climate conditions has been increasing interest and international recognition. Gandhi & Zhou (2014) consider that marketing factors such as increasing awareness and market demand are important for organic production.

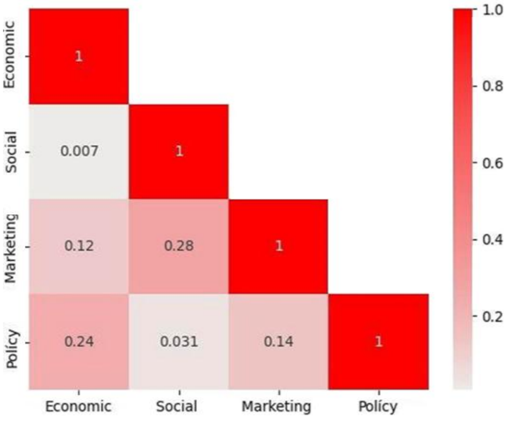


Figure 3. Correlations between factors.

In the government policy group, as mentioned by the respondents, producers find limitations in accessing financial support, therefore, they do not consider motivational factors such as credit/loan facility, conversion compensation, manure/fertilizer subsidy and export opportunity, for the adoption of organic quinoa cultivation. This is affirmed for Durham & Mizik (2021), who points out that financial and technical support is needed for the viability of a change in the agricultural practices of peasant family farming, however, governments do not give sufficient importance in terms of budget, campaign credits and investment. Despite these financing limitations, technical assistance, training, and support in market linkage, such as those provided in the San Jerónimo district by institutions like the NGO Cesal, the Coopsur cooperative, and to a lesser extent by Cagma, Fondo Empleo, and Sierra Exportadora, have been essential for producers affiliated with associations to adopt organic quinoa cultivation. Studies by Malá & Malý (2013), Azam & Shaheen (2019) and Soltani et al. (2014), reveal that the adoption of the organic system grows as a result of the compensation of conversion and subsidy by the government, since a conversion period requires three years to transform the conventional method to the organic process, and it is perceived that during the early conversion period, the level of crop production decreases significantly and affects the farmer's profits. Therefore, government support through conversion subsidies should be unconditional during the transition period to the organic method.

Figure 4 presents the distribution of all observations between the variables based on the levels of responses grouped into factors. The purple color corresponds to the group of economic factors that motivate organic quinoa production (high price, higher yield/production, higher profitability, lower cost, lower investment risk), in which most of the responses lean towards the level of agree and strongly agree. Blue corresponds to the group of marketing factors that motivates the organic production of quinoa (market/demand assured, greater interest and recognition, appropriate warehouse and future perspectives), where most of the responses lean towards the level of agreed and totally agree. The green color corresponds to the group of political factors that motivate the production of organic quinoa, in which most of the responses lean towards the level of completely disagree and disagree, given that most of the participants in this study indicated not being supported both in credit/loan facilities, conversion compensation, manure/fertilizer subsidy and export opportunities. Finally, the yellow color corresponds to the group of social factors that motivate the production of organic quinoa, in which most of the responses lean towards the level of agreement and total agreement, according to the fact that most participants in the present study agree that quinoa provides quality food, health benefits and environmental benefits. The main factors motivating producers to adopt organic quinoa cultivation are social, economic, and marketing, rather than political. In other words, producers are driven by aspects in which they do not face as many limitations or difficulties in access, unlike political factors, where government support is scarce (Durham & Mizik, 2021).

Finally, other authors have identified various factors that influence the adoption of organic agriculture in different countries and crops. These factors differ from those found in this study, although they agree on the relevance of the farmer's age and gender in the adoption decision (Table 2).

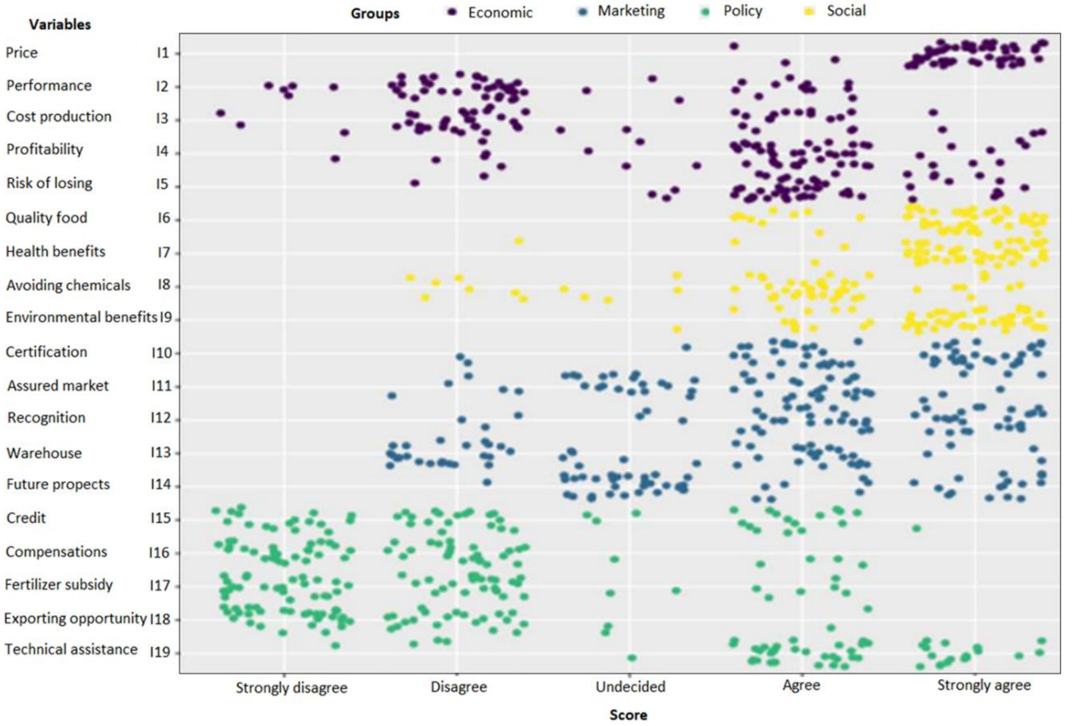


Figure 4. Political, social, economic, and marketing factors grouped by level of motivation in organic quinoa farming for small-scale associated farmers.

Table 2
Results of the logit model

Authors (year)	Country	Crops	Population (n)	Factors associated with adoption of organic farming
Malá & Malý (2013)	Czech Republic	Mixed farm types (93% mixed, 4% plant, 3% livestock)	n = 531	Gender (C ± SE = +0.237 ± 0.115, p < 0.05) Farmer's age (C ± SE = -0.013 ± 0.004, p < 0.01) Mixed production (C ± SE = -0.297 ± 0.127, p < 0.05) Labour productivity (C ± SE = -0.072 ± 0.031, p < 0.05) Return on costs (C ± SE = +0.211 ± 0.095, p < 0.05) Localization in North West (C ± SE = +0.579 ± 0.167, p < 0.01) Localization in Central Moravia (C ± SE = +0.313 ± 0.142, p < 0.05) Localization in Moravia-Silesia (C ± SE = +0.437 ± 0.183, p < 0.05)
Ojiako et al. (2015)	Nigeria	Cassava farmers	n = 510	Plot size (C = +0.04, p < 0.01) Farmer's age (C = +0.04, p < 0.05) Education status (C = +0.07, p < 0.01) Awareness through workshops (C = +0.03, p < 0.05) Awareness through friends (C = –0.09, p < 0.01) Awareness through radio (C = –0.17, p < 0.01)
Sodjinou et al. (2015)	Benin - Suth Africa	Cotton	n = 191 Conventional farms = 98 Organic farms = 93	Age (C ± SE = 0.025 ± 0.014, p < 0.10) Gender (C ± SE = –1.542 ± 0.441, p < 0.01) Education (C ± SE = –0.118 ± 0.053, p < 0.05) Experience in cotton (C ± SE = –0.034 ± 0.021, p < 0.10) Centre region (C ± SE = 1.346 ± 0.641, p < 0.05) Distance to farm (C ± SE = –1.112 ± 0.326, p < 0.01) Household size (C ± SE = 0.052 ± 0.031, p < 0.10) Extension visits (C ± SE = 0.355 ± 0.073, p < 0.01)
Pradhan et al. (2017)	India	adoption of organic different crops	n = 90	Education: r = 0.257, p < 0.05 Annual income: r = 0.221, p < 0.05 Organic farming experience: r = 0.238, p < 0.05 Use of mass media: r = 0.229, p < 0.05 Institutional approach toward promoting organic farming: r = 0.288, p < 0.01 Innovation proneness: r = 0.297, p < 0.01 Farm size: r = –0.233, p < 0.05
Zhang et al. (2024)	China	Not crop-specific – study of farmers' willingness to practice agroecological/ eco-agriculture	n = 409	Education (C ± SE = 0.218 ± 0.082, p < 0.01) Household income (C ± SE = 0.134 ± 0.041, p < 0.01) Farm size (C ± SE = 0.275 ± 0.092, p < 0.01) Training access (C ± SE = 0.402 ± 0.115, p < 0.01) Extension services (C ± SE = 0.186 ± 0.077, p < 0.05) Risk preference (C ± SE = 0.291 ± 0.118, p < 0.01) Age (C ± SE = –0.024 ± 0.018, n.s.) Gender (C ± SE = –0.071 ± 0.113, n.s.)
Zieliński et al. (2024)	Poland	Various farm types (no single crop focus)	n = 848 organic farms = 207 conventional farms = 641	Possession of rented land (β = -1.213, SE = 0.317, p < 0.001) Farmer's age (β = 0.029, SE = 0.011, p < 0.05) Farmer has higher education (β = 0.601, SE = 0.196, p < 0.01) Value of assets per 1 ha of UAA (β = -0.00001, SE = 0.000004, p < 0.01) Crop diversity index (β = -0.803, SE = 0.142, p < 0.001) Farm area (β = -0.0059, SE = 0.0026, p < 0.05)
Martín-García et al. (2024)	Spain	Four fruit types	n = 679 Organic farms= 127 Conventional farms= 55	Labour productivity (SE: ±0.91, p < 0.05) Nitrogen surplus (SE: ±9.8, p < 0.01) Pesticide use (SE: ±0.67, p < 0.01)
Dube et al. (2025)	South Africa (Mpumalanga, Mbombela)	Crops typically in the region	n = 80 smallholder farmers	Gender (C ± SE = –0.71 ± 0.54, n.s.) Family size (C ± SE = 0.1 ± 0.08, n.s.) Farming Experience (C ± SE = –0.72 ± 0.05, n.s.) Farm Size (C ± SE = 0.06 ± 0.05, n.s.) Formal Education (C ± SE = 0.1 ± 0.05, p < 0.10) Farmer Group (C ± SE = 0.37 ± 1.31, n.s.) Organic Farming (C ± SE = 1.12 ± 0.65, p < 0.10)
Villegas-Casaverde et al. (2025)	Peru	Quinoa	n = 422 producers of 23 associations	Correlations between: Performance and Non-financial performance: r = 1.0 Number of members and Performance: r = 0.6 Number of members and Competitiveness: r = 0.5 Operating time and Number of members: r = 0.4 Operating time and Performance: r = 0.8 Operating time and Competitiveness: r = 0.1

C is the coefficient (regression weight), *SE* is the standard error, *n.s.* means not significant, *r* is Pearson correlation coefficient, *β* (beta) denotes a regression coefficient.

4. Conclusions

The results of this study revealed that the probability of growing organic quinoa increases by 17% if the producer grows on their own and rented (mixed) land. The probability of adopting organic quinoa is reduced by 6.6% when the producer has plots far from their home compared to those close by. Variables such as membership in an association, technical assistance, income obtained from the sale of quinoa and mixed labor (hired and family) had a negative influence with the adoption of organic quinoa in the San Jerónimo district. The high price was the most important factor among all the indicators evaluated and the most relevant for farmers when considering organic quinoa cultivation. The negative significance of the level of income from sales might be influenced by the fact that revenues do not exceed the minimum sustainable level. Other important indicators included health benefits, food quality, and environmental benefits. Producers are motivated by aspects in which they do not face as many limitations or difficulties in access, unlike political factors, where access to credit is limited. This study demonstrates that factors such as technical assistance, the duration of membership in associations, the expansion of cultivation area through land leasing, income from sales, and the availability of labor significantly influence the adoption of organic quinoa. However, failing to strengthen productivity levels through strategies for market linkage and ensuring the continuity of technical assistance with the support of authorities and organizations could affect the ongoing adoption of organic quinoa and, consequently, its sustainability.

These results provide valuable information for public policymaking and future research. It is interesting to analyze the low-motivation factors, such as access to credit, organic certification, and differentiated markets, that influence the sustainability of organic quinoa production and limit its adoption by small producers. It is also important to understand farmers' persistence in adopting organic farming when the crop loses its appeal in international markets, as is the case with quinoa.

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Author Contributions

E. Amanca, N. Yauris and D. Sotomayor: Contributed to the design of the study and prepared the data and wrote the initial draft. **C. Mamani and M. M. Galindo:** Performed statistical analyses and prepared the figures. **D. A. Sotomayor and W. Mercado** Commented and contributed mostly to the discussion section. **All authors** contributed to the data interpretation and manuscript editing.

Conflicts of Interest

The authors declare no conflict of interest.

ORCID

N. Yauris https://orcid.org/0009-0009-1081-3340
W. Mercado https://orcid.org/0000-0001-7167-9581
M. M. Galindo-Sánchez https://orcid.org/0000-0002-9040-1427
C. Mamani https://orcid.org/0000-0001-5137-8642
D. Sotomayor https://orcid.org/0000-0003-0534-5625
E. Amanca https://orcid.org/0000-0002-3906-0620

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Appendix

Table A1
Socioeconomic factors utilized in the binary logistic regression

Dependent Variable		Notation	Category	Expected signs
Y Organic Quinoa		QuinoaOrganic	1 = organic 0 = conventional	
Independent Variables				
X1	Age	Age	Years	+/ -
X2	Gender	Female	Dummy* 1 = female 0 = male	+/-
X3	Level of Experience	Exp	Years producing quinoa	+
X4	Quinoa Income	IncomeQui	Annual income of the producer in nuevos soles	+
X5	Distance to market	DistM	Distance (in hours) between the producers' house and the nearest organic market where they sell their products	+
X6	Distance to plots	DistT	Distance (in hours) between the producers' house and their most important quinoa plots	+/-
X7	Membership in an association	AsocEx	Association membership in years	+
X8	Technical assistance	ATecn	(1) if the producer receives technical assistance and (0) the opposite.	+
X9	Access to loans	ACred	Loan granted (1 = yes, 0 = no)	+/-
X10	Household size	Pr	Number of household members who cook and eat together from the same pot	+
X11	Property size	Hect	Hectares	+
X12	Land ownership	LandO	Owned land (LandO1), Leased land (LandO 2), Both owned and rented = (LandO 3)	+/-
X13	Manpower of labor	MLabor	Family (MLabor1), Contracted (MLabor2), Family and contracted (MLabor3)	-

Table A2
Motivational factors for the adoption of organic agriculture

Motivational factors		Rating				
Economic factor						
I1	High price	1	2	3	4	5
I2	Higher performance/production	1	2	3	4	5
I3	Lower total production cost	1	2	3	4	5
I4	Greater profitability	1	2	3	4	5
I5	Lower risk of losing part or all an investment	1	2	3	4	5
Social factor						
I6	Quality food	1	2	3	4	5
I7	Health benefits	1	2	3	4	5
I8	Avoiding chemicals	1	2	3	4	5
I9	Environmental benefits	1	2	3	4	5
Marketing factor						
I10	Expensive certification	1	2	3	4	5
I11	Assured market/demand	1	2	3	4	5
I12	Greater interest and recognition	1	2	3	4	5
I13	Appropriate warehouse	1	2	3	4	5
I14	Future prospects	1	2	3	4	5
Government policy factor						
I15	Credit/loan facilities	1	2	3	4	5
I16	Conversion compensation	1	2	3	4	5
I17	Manure/Fertilizer Subsidy	1	2	3	4	5
I18	Exporting opportunity	1	2	3	4	5
I19	Technical assistance	1	2	3	4	5

Table A3
Marginal effects

	Factor	AME	SE	Z	P	Lower	Upper
1	Access to loans	-0.105	0.084	-1.248	0.212	-0.269	0.060
2	Technical assistance	-0.372	0.104	-3.578	0.000	-0.576	-0.168
3	Age	0.000	0.003	-0.097	0.922	-0.006	0.005
4	Log Quinoa Income	-0.078	0.035	-2.202	0.028	-0.147	-0.009
5	Manpower of labor 2	-0.200	0.097	-2.055	0.040	-0.391	-0.009
6	Manpower of labor 3	-0.268	0.090	-2.972	0.003	-0.445	-0.091
7	Gener 1 (Female)	0.080	0.088	0.904	0.366	-0.093	0.252
8	RatioAsocEx	-0.338	0.133	-2.541	0.011	-0.600	-0.077
9	Ratio Distance to market and plot	-0.066	0.028	-2.341	0.019	-0.121	-0.011
10	Property size and Household size	-0.065	0.077	-0.855	0.392	-0.215	0.085
11	Land ownership 2	0.105	0.098	1.078	0.281	-0.086	0.297
12	Land ownership 3	0.175	0.082	2.165	0.030	0.017	0.340

Table A4
Influence of motivational factors

	Variable	Group	Mean	Sd	Min	Q1	Median	Q3	Max	Rank
I1	High price	Econ.	4.9444	0.2312	4	5	5.0	5	5	1
I2	Higher performance/production	Econ.	2.4074	0.9421	1	2	2.0	3	4	
I3	Lower total production cost	Econ.	2.7963	1.1555	1	2	2.0	4	5	
I4	Greater profitability	Econ.	3.8333	0.8633	1	4	4.0	4	5	9
I5	Lower risk of losing part or all an investment	Econ.	4.0926	0.6521	2	4	4.0	4	5	8
I6	Quality food	Social	4.8148	0.3921	4	5	5.0	5	5	3
I7	Health benefits	Social	4.8889	0.4624	2	5	5.0	5	5	2
I8	Avoiding chemicals	Social	3.8148	0.8704	2	4	4.0	4	5	10
I9	Environmental benefits	Social	4.7407	0.4831	3	5	5.0	5	5	4
I10	Expensive certification	Market.	4.4074	0.7142	2	4	4.5	5	5	5
I11	Assured market/demand	Market.	3.5741	0.8150	2	3	4.0	4	5	
I12	Greater interest and recognition	Market.	4.2963	0.8156	2	4	4.0	5	5	6
I13	Appropriate warehouse	Market.	3.0741	1.0614	2	2	3.0	4	5	
I14	Future prospects	Market.	3.7037	0.9241	2	3	3.0	5	5	
I15	Credit/loan facilities	Polícy	2.3519	1.2462	1	1	2.0	4	5	
I16	Conversion compensation	Polícy	1.6667	0.8467	1	1	1.5	2	5	
I17	Manure/Fertilizer Subsidy	Polícy	1.7963	0.9592	1	1	2.0	2	4	
I18	Exporting opportunity	Polícy	1.5556	0.7439	1	1	1.0	2	4	
I19	Technical assistance	Polícy	4.1481	0.8558	1	4	4.0	5	5	7