Research article

Apuntes del CENES
ISSN 0120-3053
E -ISSN 2256-5779
Volume 43 - N° 78
July - December 2024 Pages 209 - 234

Fertilizers in agricultural production: a review of the perception of use

Sol Valeria Vicente Solano *
Margarita Elluz Calle Arancibia **

Date of receipt: March 23, 2024
Date of approval: June 18, 2024

Abstract: The objective of this research was to analyze the perception of farmers on the use of fertilizers in agricultural production in the Cunas Valley, Junin, Peru, addressing the dependence of these inputs for agricultural productivity and the various factors that influence their use. A qualitative approach was used with the hypothetical deductive method of non-experimental and cross-sectional design. The population was 250 farmers in the same water sub-sector, selecting a sample of 47 by non-probabilistic convenience sampling. Data collection was carried out in two stages: open interviews with 7 farmers and a questionnaire with 40 farmers. The results showed that fertilizers are crucial, especially for crops such as potato and corn, with a notable preference for diammonium phosphate (72.5 %), potassium chloride (57.5 %) and ammonium nitrate (37.5 %). However, 92.5% of farmers face difficulties in acquiring fertilizers, despite a 70% increase in their availability. The conclusion highlights the need for government policies that improve the accessibility and distribution of fertilizers, and specifically support small and medium-scale farmers to ensure sustainable agricultural development in the region.

Key words: consumer economics, empirical analysis, agriculture, natural resources, energy, environment, other primary products, Peru.

JEL codes: D11; N56; O13; Q19; Q20.

How to Cite:
Vicente Solano, S. V., & Calle, M. (2024). Fertilizers in Agricultural Production: An Analysis of the Perception of Use. Apuntes del Cenes, 43(78). Pp. 209 - 234. https://doi.org/10.19053/uptc.01203053.v43.n78.2024.17532

* Bachelor in Economics, Universidad Continental, Huancayo, Peru. 70037135@continental.edu.pe
https:// orcid.org/ 0009-0001-0404-6634
** Economist. Master in Education. Universidad Continental, Huancayo, Peru. Mcalle@continental.edu.pe
https://orcid.org/0000-0001-5564-5488

Fertilizers in Agricultural Production: An Analysis of the Perception of Use.

Abstract: The objective of this research was to analyze the perception of farmers on the use of fertilizers in agricultural production in the Cunas Valley, Junín, Peru, addressing the dependence of these inputs for agricultural productivity and the various factors that influence their use. Using a qualitative approach, 250 farmers were studied and a sample of 47 was selected through non-probabilistic convenience sampling. Data collection was carried out in two stages: open interviews with 7 farmers and a questionnaire with 40 farmers. The results showed that fertilizers are crucial, especially for crops such as potatoes and corn, with a notable preference for diammonium phosphate (72.5%), potassium chloride (57.5%) and ammonium nitrate (37.5%). However, 92.5% of farmers face difficulties in acquiring fertilizers, despite a 70% increase in its availability. The conclusion highlights the need for government policies that improve the accessibility and distribution of fertilizers, and specifically support small and medium-scale farmers to ensure sustainable agricultural development in the region.

Keywords: consumer economics, empirical analysis, agriculture, natural resources, energy, e n v i r o n m e n t , other primary products, Peru.

INTRODUCTION

Agriculture is one of the most important sectors in the economic activity of many countries. In Peru, this sector contributed 6 % to the gross domestic product (GDP) for 2018 and 2019 (Ministry of Economy and Finance [MEF], 2023). Globally, family farming accounts for 70-80 % of arable land, and supplies 80 % of food (Food and Agriculture Organization of the United Nations [FAO], 2022a). In Peru, family farming is crucial, representing 97% of the 2.2 million agricultural units and employing 83% of agricultural workers (Ministerio de Agricultura y Riego [MIDAGRI], 2021).

Within this local and global scenario, fertilizers stand out as indispensable materials that promote the growth of agricultural areas and optimize production in the sector. Moreover, given their importance, a significant increase in the demand for fertilizers is expected both at the local and global levels.

globally as well as in Latin America. According to estimates by the Central Reserve Bank of Peru (BCRP, 2022), between 2021 and 2024, fertilizer consumption in Latin America is expected to increase by 2.2 million metric tons, which means a contribution of approximately 13% to global fertilizer consumption (BCRP, 2022).

In the specific case of Peru, World Bank data (2023) reveal that annual fertilizer consumption, measured in terms of nitrogen (N), phosphorus oxide (P_2O_5) and potassium oxide (K_2O), reaches 470,000 metric tons. This consumption represents about 0.26 % of the world total and about 2 % in Latin America. These figures not only underscore the growing importance of fertilizers in Peruvian agriculture, but also highlight the need for efficient management of these inputs to boost agricultural productivity and meet both local and global demands in an increasingly interconnected world (Valdivia, 2022).

The inherent connection of food generation, fertilizer application and the global agricultural economy underscores the need for a balanced and sustainable strategy to ensure food security and economic progress in Peru and the world (Posadas, 2022a). Fertilizers not only increase crop productivity, but also improve soil quality by providing essential nutrients for healthy crop growth and correcting nutritional deficiencies. Therefore, their timely application is crucial to maintain agricultural productivity and soil health, thus ensuring sustainable development in local agriculture (Dirección Regional de Agricultura de Junín [DRA], 2022).

The Junín region, specifically the Mantaro and Cunas valleys, faces significant challenges in agricultural production. According to data from the Ministry of Agriculture and Irrigation (MINAGRI, 2022), agricultural productivity in the region has experienced variations due to climatic factors and management problems. In 2021, the production of certain crops such as corn and potatoes was affected by prolonged droughts, which generated significant losses for local farmers. This situation highlights the importance of understanding the current state of agricultural production in the Cunas Valley to identify areas for improvement and promote more efficient and sustainable practices (MINAGRI, 2022).

Farmers' perception of fertilizer uses is essential to promote more sustainable and efficient agricultural practices. According to a recent survey conducted by the National Institute of Statistics and Informatics (INEI, 2023), there is a lack of knowledge among farmers about the function and proper application of fertilizers. According to this entity, only 40% of farmers are aware of the benefits of organic fertilizers compared to chemical fertilizers. This suggests the need to address this issue and provide training and technical assistance to improve fertilizer use in the region (INEI, 2023).

Fertilizer availability in the Cunas Valley can be a crucial factor influencing agricultural production. According to MINAGRI data (2022), some farmers in the region face difficulties in accessing quality fertilizers due to distribution and supply problems. It is estimated that only 60% of farmers have regular access to these inputs, while the remaining 40% face similar obstacles, which has had a direct impact on agricultural production. Specifically, these delays affected the planting of short-cycle crops such as maize and potatoes, as noted in the report by Lozano et al. (2018). The delay in the distribution of fertilizers by the Regional Directorate of Agriculture of Junín affected agricultural production.

The use of fertilizers also improves soil quality by providing essential nutrients for healthy crop growth and correcting nutritional deficiencies. However, fertilizers also improve soil quality by providing essential nutrients for healthy crop growth and correcting nutritional deficiencies. Therefore, their timely application is crucial for maintaining agricultural productivity and soil health, which ensures sustainable development in local agriculture (DRA, 2022).

Fertilizer demand by farmers can be influenced by various factors. According to research conducted by the National Institute for Agrarian Innovation (INIA, 2021), it is essential to understand farmers' perceptions of fertilizer demand in order to promote its adequate and sustainable use. During the last planting season, a 15% increase in the demand for nitrogen fertilizers was observed due to the expansion of cash crops in the region. An informed and oriented demand can contribute significantly to improve the efficiency and profitability of agricultural production in the Cunas Valley (INIA, 2021).

Agricultural policies exert considerable influence on farmers' decisions and practices regarding the use of fertilizers and other agricultural inputs (Fernandez, 2021). According to the data provided, these policies play a crucial role in the use of fertilizers and other agricultural inputs (Fernandez, 2021).

The results reveal that 70 % of the farmers surveyed expressed concerns about the implementation of certain policies that limit access to subsidies for the purchase of fertilizers. This understanding is essential to ensure proper management of agricultural resources and to promote the competitiveness of the sector in the region (MINAGRI, 2022).

Thus, Peruvian agriculture, especially in the three main crops (corn, potato and rice), is highly dependent on fertilizers, which constitute a significant percentage of production costs. It is estimated that fertilizers account for 20-30% of total costs per hectare for these crops (MINAGRI, 2022). This high share highlights the need for adequate and efficient fertilizer management to ensure the profitability of agricultural activities. Fertilizer use is essential to meet the nutritional needs of crops and improve agricultural productivity. Soils in Peru vary in chemical composition, with common deficiencies of nitrogen, potassium, phosphorus, calcium and other essential micronutrients. These nutrients are crucial for crop growth and development, and their deficiency can significantly limit agricultural yields (DRA, 2022). The use of fertilizers makes it possible to correct these deficiencies and ensure optimal production.

Despite the importance of fertilizers, their use and management in the Cunas Valley, Junín region, presents several challenges. Irregular availability of fertilizers, limited knowledge about their application, and economic and political barriers negatively affect agricultural productivity in the region. In addition, current agricultural practices do not always consider the specific soil characteristics and nutritional needs of crops, which can lead to inefficient use of fertilizers and reduced sustainability of the agricultural system.

The central hypothesis of this research is that proper management and technical knowledge on fertilizer use can significantly improve agricultural productivity in the Cunas Valley. Several studies have demonstrated the importance of training and technical assistance for farmers in fertilizer management. Previous research in other regions of Peru and in countries with similar agricultural conditions has shown that access to adequate information and resources can increase the efficiency of fertilizer use and, consequently, agricultural productivity (Fernandez, 2021; INIA, 2021).

It is necessary to consider here the specific nutritional requirements of the crops included in the analysis. The soils of the Cunas Valley present varied chemical characteristics in for the presence of nitrogen, potassium, phosphorus, calcium and other minor elements. Evaluating these characteristics can allow for a better understanding of fertilizer needs and the formulation of more precise recommendations for crop management in the region. Therefore, the general objective of this research is to analyze the perception of farmers regarding the role of fertilizers in agricultural production in the Cunas Valley, Junin, Peru.

This will be achieved by (1) describing the situational state of agricultural production in the Cunas Valley in the Junin region of Peru; (2) identifying farmers' perceptions of fertilizer use in agricultural production; (3) identification of farmers' perception of the influence of fertilizer supply on agricultural production; (4) identification of farmers' perception of fertilizer demand on agricultural production; and (5) identification of farmers' perception of the influence of agricultural policies on agricultural production.

LITERATURE REVIEW

In the agricultural field, fertilizers have become fundamental elements to improve crop productivity and quality, since they are chemical or natural substances used to enrich the soil and improve the quality of the crops.

supply essential nutrients to plants (De la Torre & De Janvry, 2010). Whether of organic or inorganic origin, fertilizers are applied to crop areas to provide the elements necessary for optimal plant growth. These crucial nutrients include nitrogen, phosphorus, potassium and other micronutrients, which are essential to ensure that crops receive the vital components they need. This agricultural practice, supported by studies such as that of Reyes and Cano (2022), not only ensures abundant harvests, but also contributes significantly to sustainable agricultural production and the country's economic development.

The theoretical framework of this research is based on the diffusion of innovations theory of Piñeiro et al. (2021), which explains how, why and at what rate new ideas and technologies diffuse in different cultures. Applied to agriculture, this theory suggests that the adoption of improved agricultural practices, such as efficient fertilizer use, depends on several factors, including farmers' knowledge, perceptions, and attitudes, as well as institutional support and government policies. Previous studies have explored fertilizer perception and use in different agricultural contexts. For example, research conducted by INIA (2021) and the National Institute of Statistics and Informatics (INEI, 2023) has provided valuable information on fertilizer per- ception and use in different agricultural contexts.

The results of these studies will serve as a reference for the discussion of the data and results in this research. These works will serve as a reference for the discussion of the data and results in this research. In addition, several studies have corroborated that optimal crop nutrition, facilitated by the proper application of fertilizers, leads to environmental benefits by reducing pressure on agricultural land expansion and promoting more efficient and sustainable agricultural practices (Hernández et al., 2022).

Within the economy, fertilizers are considered intermediate goods or essential inputs. Intermediate goods are products used in the manufacture of other goods and are not intended directly for final consumption. Fertilizers, since they are not consumed directly by people, but are used in the production of food and other agricultural products, are classified as vital intermediate goods. Their fundamental role in the agricultural supply chain lies in their contribution to the production process, since they improve efficiency and productivity in food production. Therefore, they play a crucial role in the country's agricultural economy (Mankiw & Taylor, 2019).

Prices represent the monetary values assigned to goods and services in the market, and reflect the willingness of buyers and sellers in commercial transactions. The dynamics between supply and demand

is crucial in determining prices: if demand exceeds supply, prices tend to rise, and vice versa. These prices act as important indicators of scarcity, attributed value and market conditions, and have a significant impact on the decisions of consumers, producers and economic agents in all sectors of the economy (Reguera, 2022).

In addition, it is crucial to recognize that changes in prices have a direct impact on the purchasing power of individuals, which affects their economic welfare. Although the utility function establishes preferences, to fully understand welfare variations, especially in situations of rising prices, it is essential to explore other measures. This deep understanding of price dynamics and their influence on economic welfare is indispensable for economists and policy makers in decision making (Garavito, 2014).

Fertilizer prices, determined by factors such as production costs and government policies, are critical to farmers' decisions and farm profitability. Variation in these prices can influence farmers' perceptions of their impact on production and their purchasing power, affecting their welfare (Mankiw & Taylor, 2019).

Likewise, the increase in fertilizer prices can disrupt the purchasing power of farmers, which is directly linked to their welfare. Although the utility function establishes preferences, it is essential to explore alternatives to assess welfare, especially in the context of rising fertilizer prices (Garavito, 2014).

Principle of the form

Supply and demand are crucial principles that regulate the relationship between producers and consumers in a market. In the case of fertilizers, supply represents the quantity that producers are willing to sell, influenced by costs and technology. Demand, on the other hand, indicates what farmers are willing to buy, affected by agricultural prices and weather conditions. The intersection of supply and demand establishes the price and quantity of fertilizer traded. Concepts such as price elasticity of demand and supply are essential to understand farmers' reactions to price fluctuations in the fertilizer market (Mankiw & Taylor, 2019).

In agriculture, fertilizers play a vital role in providing essential nutrients such as nitrogen, phosphorus and potassium, which are essential for plant development and fruit quality. Their proper use not only enhances productivity and diversifies

It also contributes to improving the quality of the food produced. However, it is crucial to responsibly manage its application, adapting it to the specific needs of the soil and crops. This involves employing precise techniques and quantities to maximize agricultural benefits and minimize environmental and health impacts. The adoption of sustainable agricultural practices is essential to achieve a balance between productivity and environmental conservation, thus ensuring responsible agricultural development (FAO, 2022b).

Agricultural tariff policies are strategies applied by governments to regulate trade in agricultural products through the imposition of tariffs, which are imposed on imports or exports of these products. In this sense, they could have a direct impact on the supply and demand of fertilizers. Imposing tariffs on fertilizer imports can raise costs for farmers by increasing input prices, which in turn could affect both demand and farmers' perception of the relationship between fertilizer prices and their crop production (WHO, 2022).

Considering future expectations as a key concept for the understanding of the future.

In this regard, they refer to the predictions that economic agents make about the future behavior of key variables, such as prices, income and market conditions. Along these lines, future expectations can influence fertilizer supply and demand. For example, if farmers anticipate an increase in fertilizer prices in the future, they may choose to purchase larger quantities in the present to avoid higher costs, which would affect both current demand and farmers' perceptions of the relationship between fertilizer prices and agricultural production (Mankiw & Taylor, 2019).

Climatic conditions are considered in the environmental setting in which agricultural production takes place, including factors such as temperature, humidity, rainfall and soil quality. In this context, climate and agricultural conditions can play a significant role in fertilizer supply and demand. Adverse climatic changes, such as droughts or floods, can negatively affect crop production, which could influence the demand for fertilizers to improve soil quality and maximize crop yields. Farmers' perceptions of the influence of fertilizer prices on agricultural production may also be influenced by their experience in the production of fertilizers.

adaptation to changing climatic conditions (International Fertilizer Association [IFA], 2021).

Agricultural production refers to the process of growing, tending and harvesting plants and crops for the purpose of obtaining food, vegetable products and agricultural raw materials. It involves a series of activities ranging from soil preparation, planting, irrigation, application of inputs such as fertilizers and pesticides, to harvesting and processing of the products obtained. Agricultural production is essential for the supply of food and resources for human and animal populations, and is a fundamental part of the economy in many regions of the world (Inter-American Institute for Cooperation on Agriculture [IICA], 2022).

The crop season refers to the period of time during which specific agricultural activities related to the cultivation and management of a particular type of crop or crops are carried out in a given region. This season may vary depending on factors such as climate, soil conditions and local agricultural practices. It includes activities such as planting, irrigation, application of fertilizers and pesticides, crop growth monitoring and harvesting. The duration of an agricultural season can vary from a few months to more than a year, depending on the type of crop and climatic and environmental conditions (IICA, 2022).

In this framework, Gertler et al. (2017) argue that diversification of planting seasons helps farmers reduce vulnerability to climatic and market variations. This strategy allows maintaining economic stability and food security in farming communities. By diversifying crops and planning plantings at different times of the year, farmers can mitigate climate risks, diversify their income, improve soil health and ensure food stability.

STUDY METHOD

The present study is a basic type of research, which is developed from a theoretical perspective, using existing theories as a reference. Its objective is to seek new knowledge without a specific and immediate practical purpose (Bernal, 2010). The research focuses on the problem of the increase in fertilizer prices and its influence on production in future agricultural seasons.

The investigation methodology used follows the hypothetico-deductive method, since deductive logical procedures are employed, starting from a premise or *a priori* assumption that requires to be demonstrated (Sánchez et al., 2018).

The research design is non-experimental and cross-sectional, which means that t h e variables were not manipulated and the information was collected at a single point in time through surveys applied to the sample (Mendoza, 2014). The research uses the qualitative approach; as it helps to deepen the understanding of complex phenomena such as the case of the increase in fertilizer prices, it is also useful to explore emerging areas, understand subjective and emotional aspects, and validate or develop theories in social, cultural or psychological disciplines (Hernández et al., 2014).

The level or scope of the research is descriptive, that is, it details the characteristics, behaviors and opinions of the farmers in relation to the topic, without intervening or manipulating the variables. The research collects detailed information on farmers' perceptions and experiences, which provides a complete and comprehensive view of the picture without the need for causal or explanatory inferences. This methodological design is consistent with a descriptive scope, which seeks to provide a detailed picture of the reality faced by farmers in the face of rising fertilizer prices (Hernández et al., 2014).

Population and sample

The present study focuses on the agricultural population belonging to the Board of Users of the Cunas Hydraulic Subsector, which is composed of 250 farmers. To carry out the research, a sample of 47 farmers was selected using the non-probabilistic convenience sampling method: in a first stage, an interview with open-ended questions was conducted with 7 farmers; subsequently, using the information obtained in these interviews, a questionnaire was designed and administered to 40 farmers through surveys. The criteria used for this selection were based on subjective factors such as accessibility, time availability and predisposition of the participants.

The survey technique and the questionnaire were used as an instrument to collect data. A questionnaire with 20 items was designed to gather information directly related to the research topic. The questionnaire was vali- ded by expert judgment; likewise, its validity was calculated under the criterion of Aiken's V coefficient and its reliability by Cronbach's Alpha coefficient (Pino, 2018).

Data collection processing

The data collected were processed and analyzed using an Excel matrix to organize the information. The descriptive analysis was performed with SPSS 26 statistical *software*, after checking the normality of the data.

Ethical considerations

The confidentiality and privacy of the participants was guaranteed, ensuring that the information provided would not be disclosed without their consent. Informed consent was given prior to participation, clearly explaining the objectives of the research, the intended use of the data, and any potential risks. In addition, it was ensured that participants were free to withdraw at any time without penalty or other negative consequences. The questions were designed to avoid any bias that might influence participants' responses. Likewise, transparency in communication and honesty in the presentation of results are key principles to maintain the ethical integrity of this research.

RESULTS AND ANALYSIS

In order to collect information, 47 farmers from the Cunas Valley participated in the survey. interviews and surveys were conducted. In terms of gender, a majority of the sample was male, representing 62.5 % of the total, while women represented 37.5 % of the total. Although the difference is not very wide, it suggests a slight male predominance in the surveyed sample. This finding may have important implications when analyzing certain gender-related behaviors or attitudes in the context studied (Annex 6).

Current status

The preponderance of potato and corn in agricultural production in the Cunas Valley is reflected in the fact that 90 and 57.5 % of farmers, respectively, consider them as their main crops (Table 1). These crops stand out in the agricultural production of the Cunas Valley, along with the diversified presence of additional crops such as carrot and garlic, and manifest the complexity and importance of agricultural activity in the region in line with the report conducted by DRA (2022), which provides a comprehensive view of the local agricultural structure, which may allow for a deeper understanding of how changes in fertilizer prices could affect farmers' eco nomy.

It also indicates an adaptive strategy in the face of price increases in the

fertilizers. And it is in agreement with Lozano et al. (2018), as it reflects farmers' ability to adjust their farming practices according to market conditions and thus maximize production and mitigate the risks associated with reliance on a single planting season. This flexibility highlights farmers' ability to meet the challenges of adaptability to climatic and economic changes.

The majority of farmers operate on a relatively small scale, with 47.5% of them having less than 5 hectares of planted land (Table 1). This figure highlights the prevalence of small-scale farmers in the region. Furthermore, this data, supported by the MINA-GRI report (2022), highlights the predominance of small-scale farmers in the region and suggests that rising fertilizer prices could impact this segment more acutely. Smallholder farmers could face additional challenges in maintaining their profitability, due to their limited capacity to absorb cost increases and their reduced access to technological and financial resources. This situation underscores the importance of implementing specific policies to support small-scale farmers and ensure food security and sustainable rural development.

The range of harvest expectations among farmers in the Cunas Valley, where 60% expect to harvest between 1 and 15 tons, and 32.5% expect to harvest between 16 and 30 tons, reflects both the moderate and considerable production capacity in the region (Table 1). This situation underscores the importance of effectively managing agricultural resources, including inputs such as fertilizers, to ensure optimal and sustainable production. It also highlights the need for policies that promote equitable access to these inputs, given the importance of family farming in the local and global economy, as emphasized by FAO (2022a).

The Huancayo market is the main place of sale (70 %), which reveals a marked dependence on local markets for the commercialization of agricultural products in the region (Table 1). This situation may have significant implications for farmers' ability to adjust the selling prices of their products and to cope with increases in production costs, such as those associated with fertilizers. In addition, the presence of 25% of farmers selling in the Lima market indicates a diversification in marketing strategies, which could offer additional opportunities, but also pose logistical and competitive challenges. In this context,

According to BCRP (2022), it is important to implement policies that promote the diversification of marketing channels and provide logistical support to farmers, in order to ensure the resilience of the agricultural sector to fluctuations in the prices of agricultural products.

prices of inputs and competition in local and regional markets.

Table 1 below presents a summary of the most relevant results regarding the current planting situation in the Cunas Valley.

Table 1. Current situation

Items	Results
Main crops	Potato (90 % of farmers), corn (57.5 %), carrot (37.5 %), garlic (30 %)
Planting seasons	1 season (37.5 % of farmers), 2 seasons (37.5 % of farmers), 1 season (37.5 % of farmers), 2 seasons (37.5 % of farmers) (45 %), more than 2 seasons (17.5 %)
Extent of land planted	Less than 5 hectares (47.5 % of farmers), 5-10 hectares (32.5 %), more than 10 hectares (20 %)
Tons expected to be harvested	1-15 tons (6 0% of the farmers), 16-30 tons (32.5 %), more than 30 tons (7.5 %)
Sales locations	Huancayo market (70 % of farmers), Lima market (25 %), Chupaca market (2.5 %), wholesaler at the farm (2.5 %).
Profit from product sales	In general, it is considered that there will be gains in the

Fertilizer use

The data show that dia- mmonium phosphate is the most frequently used fertilizer, with a frequency of 72.5 %, followed by potassium chloride (57.5 %) and ammonium nitrate (37.5 %) (Table 2). This could be, as suggested by Reguera (2022), a preference for fertilizers that offer essential nutrients such as phosphorus, potassium and nitrogen, crucial for optimal crop growth and development in the region. In addition, it could be influenced by soil composition and the specific needs of local crops, highlighting the importance of fertilizer management adapted to local agricultural conditions to maximize productivity and long-term sustainability.

Potato emerges as the crop most favored by fertilizer use, with a frequency of 70 %, underlining its preponderance in local agriculture; it is followed by corn, with a frequency of 35 %, indicating its relevance in the area's agricultural production (Table 2). Although to a lesser extent, carrots and garlic also experience considerable benefits from fertilizer use, each with 12.5 % frequency. This pattern

suggests a fertilizer distribution oriented towards the most economically and nutritionally important crops in the region, reflecting local preferences and needs, as suggested by DRA (2022).

On the other hand, farmers show a preference for traditional methods to improve soil quality, of which turning the soil is the most common, with a 50 % frequency, followed by letting the soil rest for a period of time, with a 42.5 % frequency (Table 2).

The perception of improvements in both crop quality and yield due to fertilizer use is predominant among farmers, with 65% reporting improvements in both aspects (Table 2). However, a
17.5 % indicated that they did not observe a difference in production, which could indicate the need for adjustments in fertilization practices or product selection. This finding highlights the importance of continuously evaluating fertilization strategies to maximize the benefits in agricultural production, in accordance with INIA (2021).

In terms of decision-making on fertilizer use, there is a strong influence of farmers' personal experience, with 75% basing their decisions on this factor.

(Table 2). However, it is also notable that a significant percentage of 27.5 % consider expert recommendations, which underlines the need for technical advice to optimize fertilizer use in the region. Likewise, 22.5 % make decisions based on soil analysis, indicating an awareness of the importance of understanding soil characteristics for effective fertilization, as suggested by DRA (2022).

It is important to emphasize that the vast majority of farmers, a large part of them
92.5% consider fertilizers essential for the growth and development of their crops. This high degree of recognition of the importance of fertilizers reflects their critical role in Cunas Valley agriculture, where they contribute significantly to the productivity and sustainability of local crops, as seen in Mankiw and Taylor's (2019) theory. However, it is important to address the concerns of the small percentage (7.5 %) who do not consider them essential, as this could indicate areas where improvements in fertilizer understanding or application are needed (Table 2).

Table 2 below summarizes the most relevant results regarding the use of ferti- lizers in the Cunas Valley.

Table 2. Fertilizer use

Items	Results
Most frequently used fertilizers	Diammonium phosphate (72.5%), potassium chloride (57.5%), ammonium nitrate (37.5 %), sulfate and magnesium (22.5 %)
Crops that benefit the most	Potato (70%), corn
(35%) with the use of fertilizers. Method to improve soil quality	Turning the soil (50 %), with guano preparation (7.5 %), resting for a period of time (42.5 %).
	Yes, improvement in quality and production (65 %). Yes, only in quality (10 %). Yes, only in production (7.5 %). No, no difference (17.5 %).
Decision for fertilizer use	By experience (75 %), by expert recommendations (27.5 %), according to soil analysis (22.5 %), no specific method (2.5 %).
Importance of fertilizers for crops	Essential (92.5 %), non-essential (7.5 %)

Fertilizer supply

The majority of farmers in the Cunas Valley purchase their fertilizers in Chupaca (representing 90% of the sample). This data suggests a significant dependence on local suppliers in this area, possibly due to proximity and accessibility (Fernandez, 2021). Only a small percentage chooses to buy in Huancayo (7.5 %) or Lima (2.5 %), which could indicate a preference for closer and more practical suppliers (Table 3).

Local stores emerge as the main suppliers of fertilizers to farmers in the Cunas Valley, with 75% of total purchases made in these establishments (Table 3). This distribution suggests a diversity of suppliers in the fertilizer market, ie, demonstrates that there is no monopoly in this area and highlights the vital role of local stores in supplying agricultural inputs to the community in contrast to the DRA (2022).

Although most farmers perceive an increase in fertilizer availability, with 70% reporting this phenomenon, there is still significant concern about the availability of these inputs, with 62.5% reporting that it affects their purchasing decision. This finding suggests that farmers are taking proactive measures to ensure fertilizer supply in the face of possible fluctuations in availability (Table 3).

Despite these efforts, 92.5 % of the farmers report facing

difficulties in acquiring fertilizers at times, which could represent a major challenge for local agricultural production if not adequately addressed. Lack of access to these key agricultural inputs can negatively impact crop productivity and yields in the region.

It is remarkable that the preference for the use of animal guano is so high; 95% of the farmers consider that the use of animal guano is a very important factor in the use of guano. this type of fertilizer (Table 3). This data suggests a strong preference for organic fertilizers in the community, possibly influenced by environmental and sustainability considerations, as well as the availability and accessibility of these inputs (Mankiw & Taylor, 2019).

The table below summarizes the most relevant results regarding fertilizer supply in the Cunas Valley.

Fertilizer supply

Items	Results
Where to buy fertilizers Store	Chupaca (90 %), Huancayo (7.5 %), Lima (2.5 %)
where to buy	Mayra Stores (30 %) Percy store (20 %), Yauca store (15 %), Mary store (10 %), Paty store (7.5 %), other (17.5 %)
Fertilizer availability	Increased (70 %), decreased (7.5 %), no change (22.5 %)
Affecting availability on the purchase decision	Buy more in advance (62.5 %), do not affect their decisions (7.5 %), reduce their purchases (25 %).
Difficulty in acquiring fertilizers	Sometimes (92.5 %), never (7.5 %)
Consideration of using another fertilizer	Animal manure (95 %), other natural fertilizers (5 %)

Fertilizer demand

Most farmers consider that price (51.7%) is the most influential factor in their decision to purchase fertilizers, followed by quality (46.7%) (Table 4). In this regard, Garavito (2014) suggests that, although quality is still important, the economic aspect has a signi- ficant weight in farmers' purchasing decisions. In addition, a small percentage mention climate and recommendations as important factors, highlighting the complexity of the factors that influence these decisions.

It is notable that the vast majority of farmers (82.5 %) consider that selling more produce in one season has an impact on the next season's fertilizer demand (Table 4). According to IICA (2022), there is a direct relationship between production

The demand for agricultural inputs, such as fertilizers, indicates the need to maintain soil productivity and ensure optimal yields for future harvests.

In addition, the majority of farmers (82.5 %) report that they buy more fertilizer each season (Table 4). This, according to Reguera (2022), could reflect an increase in the scale of production or the intensification of agricultural practices that require greater use of inputs such as fertilizers. However, it is encouraging to see that some farmers (12.5 %) keep their purchases constant, suggesting efficient management of agricultural inputs.

Finally, the general perception of an increase in fertilizer demand by the majority of farmers (80%) is consistent with the trend of increasing purchase of fertilizers each season (Table 4). This increase in demand could be driven by several factors, such as the growth of the agricultural industry, the expansion of cultivated area or the adoption of inten- sive agricultural practices, as suggested by Mankiw and Taylor (2019).

The following table summarizes the most relevant results with respect to fertilizer demand in the Cunas Valley.**Table 4.**

Items	Results
Influence on the purchase decision	Price (51.7%), quality (46.7%), recommendations (8.3 %), weather (6.7 %)
Considerations on product sales one season and their influence on the next season's fertilizer d e m a n d .	
Buy more fertilizer each season	I buy more (82.5%), buy the same (12.5 %), buy less (5 %)
Considerations on the demand (purchase intention) for fertilizers	Increase (80 %), no change (12.5 %), decrease (7.5 %)

Agricultural tariff policies, future prospects and climatic conditions

Seventy percent of farmers believe that government policies or support programs influence fertilizer demand. This perception suggests that government policies

The existence of a significant percentage (30 %) who do not perceive this influence indicates a divergence in the perception of the influence of fertilizers on farmers' purchasing decisions, either by increasing or decreasing the demand for fertilizers, which is consistent with information from FAO (2022b). The existence of a significant percentage (30 %) that does not perceive this influence indicates a

divergence in the demand for fertilizers.

sity of opinions and possibly a lack of clarity about the real impact of these policies (Table 5).

As for future price expectations, the vast majority of farmers (65%) expect an increase in fertilizer prices. This expectation may be due to factors such as increased global fertilizer demand, raw material shortages or changes in trade policies (Reguera, 2022). However, it is important to note that a significant proportion of farmers (12.5%) are uncertain about future prices, reflecting the uncertainty in the fertilizer market and the need to closely monitor its evolution (Table 5).

In addition, the majority of farmers (92.5 %) consider that the changes in climatic conditions influence fertilizer purchases (Table 5). This suggests a strong awareness among farmers about the interaction between climate and agricultural productivity, as well as the need to adapt to these changes through the appropriate use of fertilizers (Garavito, 2014). In addition, it can be inferred that farmers are exploring various strategies to cope with these changes, such as employing another type of fertilizer, increasing the amount of fertilizer applied, and using organic fertilizers. This highlights the importance of adaptation and resilience in agriculture in the face of climate challenges.

The following table presents a summary of the most relevant results regarding agricultural tariff policies, future expectations and climatic conditions in the Cunas Valley.

Table 5. Agricultural tariff policies, future expectations and climatic conditions

Items	Results
Considerations on government policies or support programs and their influence on fertilizer demand (or purchase).	Influence: can be bought more or less (70 %), no influence (30 %)
Expectation of future fertilizer prices	Will increase (65 %), will decrease (10 %), will remain the same (12.5 %), not sure (12.5 %)
Consideration of changes in climatic conditions and their influence on fertilizer purchases.	Influence (92.5 %), no influence (7.5 %), change type of fertilizer (41.7 %), increase amount of fertilizers (25 %), use organic fertilizers (10.4 %).

General analysis

The results indicate the participation of 40 farmers in the collection of data. It is important to note that this sample represents a significant part of the local farming community and provides a solid basis for analysis.

In addition, considering that local farmers face diverse challenges, it is essential to have a representative sample to understand their practices and needs.

As for the main crops, potato and corn stand out for their importance in the local agricultural economy. The data show that 90 % of farmers consider potato as their main crop, followed by maize with 57.5 %. These findings are consistent with previous research conducted by MINAGRI (2021), which identified potato and maize as strategic crops in the region due to their high yields and market demand. Furthermore, the presence of additional crops such as carrots and garlic is evidence of the diversification of agricultural production and the farmers' ability to adapt to market demands, which is crucial for the sustainability and economic resilience of the region (DRA, 2022).

The distribution of farmers between one and two planting seasons reflects a diversified production strategy and an adaptation to market conditions and changes in fertilizer prices. It should be noted that this diversified strategy can help mitigate the risks associated with dependence on a single planting season and maximize agricultural production in the region. This finding is consistent with Gertler et al. (2017), who argue that.

diversification of planting seasons allows farmers to reduce vulnerability to climatic and market variations.

In terms of scale of production, most farmers operate on a relatively small scale, with less than 5 hectares of sown land. This finding underscores the predominance of small-scale farmers in the region and highlights the potential challenges faced by these farmers, especially with regard to profitability and the ability to absorb cost increases, such as those associated with fertilizers. MINAGRI (2022) studies suggest that small farmers tend to face greater difficulties in accessing quality inputs and competitive prices, which can affect their productivity and sustainability.

The analysis of fertilizer use reveals interesting patterns in terms of the types of fertilizers most used and their impact on different crops. Diammonium phosphate emerges as the most used fertilizer, followed by potassium chloride and ammonium nitrate, reflecting a preference for nutrients essential for crop growth. In addition, the general perception of improvements in crop quality and production due to the use of fertilizers highlights their importance in local agriculture. According to studies by IICA (2022), the appropriate use of fertilizers can

significantly increase crop yields, although correct dosage and application is also required to avoid environmental problems.

In terms of fertilizer supply and demand, it is important to note the significant dependence on local suppliers for the acquisition of these inputs. Most farmers purchase their fertilizer in Chupaca, suggesting a strong connection between local farmers and regional suppliers. However, concerns about fertilizer availability and difficulties in acquiring fertilizers sometimes indicate significant challenges faced by farmers in the region. According to INIA (2021), problems of fertilizer distribution and access can negatively affect agricultural productivity and the economic stability of farmers.

Finally, it is essential to highlight farmers' perception of external factors, such as government policies, climatic conditions and future price expectations, and how these influence their purchasing and production decisions. Awareness of these factors and farmers' adaptation to them are key aspects to ensure the sustainability and continued development of the agricultural sector in the Cunas Valley. According to Fernandez (2021), agricultural policies play a key role in ensuring the sustainability and continued development of the agricultural sector in the Cunas Valley.

The use of the agricultural landscape is crucial in shaping the agricultural landscape, and its proper design and implementation can significantly improve the resilience and competitiveness of local farmers.

Thus, the results of this study provide a detailed overview of agricultural practices in the Cunas Valley, highlighting the importance of fertilizers, diversification strategies, and the challenges faced by small-scale farmers. The integration of these findings with previous background and work provides a solid basis for developing policies and strategies to improve the productivity and sustainability of agriculture in the region.

CONCLUSIONS

The research highlights the dependence of farmers in the Cunas Valley on the use of fertilizers, which are fundamental for agricultural productivity in the region. It highlights the complexity of the factors that influence agricultural decisions, from economic and climatic considerations to government policies. The pressing need for policies that ensure equitable access to fertilizers and promote sustainable agricultural practices emerges as a clear priority. In this context, understanding farmers' perceptions of rising fertilizer prices emerges as a critical step to inform policy.

and programs aimed at promoting sound and sustainable agricultural development in the Cunas Valley and similar areas.

Agricultural production in the Cunas Valley is predominantly centered on crops such as potato and corn, which account for 90 percent and 90 percent, respectively.
57.5 % of farmers respectively. This concentration on specific crops reinforces the need for strategies and policies that support these crucial sectors. The diversification observed with additional crops such as carrots and garlic suggests a capacity to adapt to market demands, which is vital for the economic resilience of the region.

Additional data reveal that 47.5% of farmers operate on a scale of less than 5 hectares of sown land, a fact that highlights the prevalence of small-scale farmers in the region. This distribution suggests a diverse agricultural structure, but with a significant presence of small and medium-scale farmers, underscoring the importance of specific support policies for this segment. Small-scale farmers face unique challenges, including profitability and the ability to absorb cost increases, so a policy approach sensitive to these needs is crucial.

The data show that dia- mmonium phosphate is the most commonly used fertilizer, with a frequency of 72.5 %, followed by potassium chloride (57.5 %) and ammonium nitrate (37.5 %). In addition, 65 % of farmers report improvements in both crop quality and yield due to fertilizer use. These numbers highlight the importance and perceived effectiveness of fertilizers in local agricultural production. It is critical to promote proper fertilizer use to maximize these benefits and minimize negative environmental impacts.

Ninety percent of farmers in the Cunas Valley purchase their fertilizer in Chupaca, reflecting a strong dependence on local suppliers in this area. Despite 70% reporting an increase in fertilizer availability, 92.5% face difficulties in acquiring fertilizer on occasion, underscoring the importance of addressing challenges related to the availability and accessibility of these inputs. Improving distribution infrastructure and logistics can be an effective measure to ensure a steady and equitable supply of fertilizer.

The majority of farmers (82.5%) consider that selling more produce in one season influences the demand for fertilizer in the following season. In addition, 80% perceive an increase in the demand for fertilizers, indicating a growing trend in the need for these inputs for the next season.

maintain and improve agricultural production. This increase in demand suggests the need to ensure an adequate and accessible supply of fertilizers to meet farmers' needs.

Seventy percent of farmers perceive that government policies or support programs influence fertilizer demand. However, there is a diversity of opinions on the actual impact of these policies, a situation that highlights the need to properly evaluate and adjust agricultural policies to meet the needs and demands of farmers. Effective policies must be informed by farmers' perceptions and experiences to be truly useful and effective in supporting local agriculture.

Acknowledgments

I would like to express my deepest gratitude to God and also to my parents, whose patience and support helped me to write this article. *Sol Vicente*.

Financing

The authors declare that the research has been self-financed and, therefore, there is no real or potential conflict of interest with the presentation of the results of this research.

Declaration of conflicts of interest

The authors declare that they have no conflict of interest, potential or apparent, with any entity or individual that could influence the presentation of the results of this research.

Authors' contribution

Sol Valeria Vicente-Solano: writing, original draft. Margarita Elluz Calle-Arancibia: writing, proofreading and editing.

References

[1] Central Reserve Bank of Peru (2022). *Inflation Report. Panorama actual y proyecciones macroeconómicas 2022-2023.* https://www.bcrp.gob.pe/docs/Publicaciones/Reporte-Inflacion/2022/junio/reporte-de-inflacion-junio-2022.pdf.

[2] World Bank (2023). *Fertilizer prices decline, but affordability and availability issues persist.* https://shorturl.at/5TgmO

[3] Bernal, C. (2010). *Research Methodology* (3rd ed.). Pearson Educación de *Colombia.* https://abacoenred.org/wp-content/uploads/2019/02/El-proyecto-de-investigaci%C3%B3n-F.G.-Arias-2012-pdf.pdf.

[4] De la Torre, A. & De Janvry, A. (2010). *Fertilizers in Mexican agriculture: recent trends and future challenges.* El Colegio de México.

[5] Regional Directorate of Agriculture of Junín DRA (2022). *Soil analysis will allow boosting agriculture in Huancayo.* https://www.agrojunin.gob.pe/ analisis-de-suelos-permitira-potenciar-la-agricultura-en-huancayo/

[6] Fernández, J. (2021). *The agrochemical industry in Peru and its close relationship with Peruvian agriculture*. [Degree thesis], Universidad Agraria La Molina. https://repositorio.lamolina.edu.pe/bitstream/handle/20.500.12996/4795/fernandez-cespedes-jose-miguel.pdf?sequence=1&isAllowed=y

[7] Garavito, A. (2014). Welfare assessment of agricultural commodities: a review of the literature. *Journal of Rural Development*, *13*(2), 281-304.

[8] Gertler, P., Martinez, S., Premand, P., Rawlings, L., & Vermeersch, C. (2017). *Impact evaluation in practice.* World Bank Group. https://doi. org/10.1596/978-1-4648-0888-3.

[9] Hernández, R., Fernández, C., & Baptista, L. (2014). *Metodología de la investigación.* Editorial McGraw-Hill, Interamericana Editores. https://www.esup.edu.pe/wp-content/uploads/2020/12/2.%20Hernandez,%20Fernandez%20and%20Baptista-Metodolog%C3%ADa%20Investigacion%20Cientifica%206ta%20ed.pdf.

[10] Hernández, J., Gutiérrez, F., Serrato, R., González, A., & García, E. (2022). Integrated nutritional management: key tool for sustainable agriculture. *Revista Mexicana de Ciencias Agrícolas*, *12*(5), 1-16. https://doi.org/10.29312/remexca.v12i5.2290.

[11] Inter-American Institute for Cooperation on Agriculture IICA. (2022). *Sowing the seeds of tomorrow's agriculture today.* https://iica.int/es

[12] National Institute of Statistics and Informatics INEI. (2023*). Encuesta Nacional de Agricultura Familiar 2023.* https://www.gob.pe/institucion/inei/campa%C3%B1as/29810-encuesta-nacional-agropecuaria-2023.

[13] National Institute for Agrarian Innovation INIA (2021). *MIDAGRI creates multisectoral commission to guarantee purchase of fertilizers.* https://www.gob.pe/ institucion/midagri/noticias/657190-midagri-crea-comisión-multisectorial-pa- ra-garantizar-compra-de-fertilizantes

[14] International Fertilizer Association IFA (2021). *Fertilizers in the world*. https://www.fertilizer.org/about-fertilizers/fertilizers-around-the-world/

[15] Lozano, A., Alvarez, C. & Moggiano, N. (2021). Climate change in the Andes and its impact on agriculture: a systematic review. *Scientia Agropecuaria, 12*(1), 1-14. http://www.scielo.org.pe/scielo.php?script=sci_ arttext&pid=S2077-99172021000100101

[16] Mankiw, N. & Taylor (2019). *Principles of economics* (8th ed.). Cengage Learning.

[17] Mendoza, W. (2014). *Cómo investigan los enconomista: guía para elaborar y desarrollar un proyecto de investigación.* (1st ed.). Pontifica Universidad Católica del Perú. https://files.pucp.education/departamento/economia/lde-2014-05.pdf

[18] Ministry of Agriculture and Irrigation MIDAGRI (2021). *Family Agriculture*. https:// www.gob.pe/institucion/midagri/campa%C3%B1as/659-agricultura-familiar

[19] Ministry of Agrarian Development and Irrigation (2022). *Agricultural campaign 2021/2022 closes with crop growth in some regions.* https://www.gob.pe/institucion/midagri/noticias/652979-campana-agricola-2021-2022-closes-with-crop-growth-in-some-regions.

[20] Ministry of Economy and Finance (2023). *Annual report of the sectorial GDP*. Ministry of Economy and Finance.

[21] Food and Agriculture Organization of the United Nations FAO (2022a). *The state of food and agriculture.* https://www.fao. org/3/cb4476en/cb4476en.pdf.

[22] Food and Agriculture Organization of the United Nations FAO. (2022b). *The state of agricultural commodity markets 2022.*

https://www.fao.org/3/cc0471es/online/SOCO/2022/geography-trade-poli- cies-agriculture.html

[23] World Health Organization (2022). *Pesticide* Residues *in* Food. https://www.who.int/es/news-room/fact-sheets/detail/ pesticide-residues-in-food

[24] Pino, R. (2018). *Research methodology: development of designs to test hypotheses*. (2.a ed.) Editorial San Marcos.

[25] Piñeiro, V., Arias, Joaquín, Elverdin, P., Ibáñez, A., Morales, C. & Torero, M. (2021). *Promoting sustainable agricultural practices: from incentives to adoption and results*. Inter American Development Bank. https://publications. iadb.org/en/promoting-sustainable-agricultural-practices-from-incentives-to-adoption-and-results.

[26] Posadas, C. (2022a). *The importance of agrochemicals for Peruvian agriculture*. Lima Chamber of Commerce. https://www.camaralima.org.pe/ wp-content/uploads/2020/06/IDEXCAM-932_Los-efectos-de-la-covid-19-en-la-log%C3%ADstica-del-comercio-exterior.pdf.

[27] Posadas, C. (2022b). *The effects of COVID-19 on foreign trade logistics*. Lima Chamber of Commerce. https://www.camaralima.org.pe/ wp-content/uploads/2020/06/IDEXCAM-932_Los-efectos-de-la-covid-19-en-la-log%C3%ADstica-del-comercio-exterior.pdf.

[28] Reguera, E. (2022). The engine of the economy: discover market mechanisms. *Aprende Economía* https://aprendeeconomia.info/ mecanismo-de-mercado-economia/#que_es_es_un_mecanismo_de_mercado_

[29] Reyes, S. & Cano D. (2022). Effects of intensive agriculture and climate change on biodiversity. *Revista de Investigaciones Altoandinas, 24*(1), 1-16. https://doi.org/10.18271/ria.2022.328

[30] Sánchez, H., Reyes, C. & Mejía, K. (2018). *Manual of scientific, technological and humanistic research terms* (1st ed.). Ricardo de Palma University.

[31] Valdivia, R. (2022). *Development of the Peruvian fertilizer market under a global and sustainable approach*. [Undergraduate thesis], Universidad Nacional Agraria La Molina. https://repositorio.lamolina.edu.pe/bitstream/handle/20.500.12996/5449/ valdivia-diaz-rafael.pdf?sequence=1&isAllowed=y