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a Counterfactual  
Regression  
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Colombia's Paddy  
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# Does Storing Pay Off? Evidence from a Counterfactual Regression Discontinuity of Colombia's Paddy Rice Storage Incentive (2013–2025)

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## Abstract

This study evaluates the effectiveness of Colombia's Dry Paddy Rice Storage Incentive Program (1997–2023), a policy instrument designed to stabilize rice prices and guarantee supply amid high seasonality and perishability. Using a regression discontinuity design (RDD) combined with regression kink discontinuity (RKD) elements and exploiting detailed daily and monthly price data, we analyze the program's effects on paddy rice prices, farmers' net margins, production decisions, and consumer prices. Results show that when mills actively participate, the program mitigates the seasonal decline in paddy prices, reversing pre-incentive downward trends and contributing to faster stabilization. In irrigated systems, the policy smooths producers' incomes by reversing negative profit trajectories, while in non-irrigated systems effects are weaker and inconsistent. The program also induces extensive production responses, as higher incentives correlate with larger harvested areas, and alter the transmission between paddy and white rice prices. Despite these short-term benefits, the policy exhibits structural inefficiencies: limited coverage, fiscal dependence, and distortions leading to oversupply and reduced competitiveness. Findings suggest that while stock stabilization can buffer shocks, Colombia's rice sector requires a transition toward differentiated, inclusive, and efficiency-enhancing instruments to ensure long-term sustainability, particularly in view of tariff elimination under international trade agreements. Overall, the findings recommend an orderly transition towards less distorting instruments differentiated by productive system.

**Keywords:** Stock-stabilization, public policy, Counterfactual, discontinuous regression, rice production, effectiveness analysis.

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## 1. Introduction

Rice is part of the basic food basket that constitutes food security around the world. According to information from the Food and Agriculture Organization of the United Nations (FAO), rice is the main source of calories for approximately half of the world's population; furthermore, it is considered a staple food in at least 34 countries. Similarly, the cultivation and sale of rice is one of the main sources of employment and income for at least 2 billion people around the world.

In Colombia, the national rice production in 2023 reached approximately 2.8 million tons, making it the second-largest rice producer in Latin America and the Caribbean (FAO, 2023). Furthermore, more than 98% of Colombian households include rice in their daily diet, with a per capita consumption of 56.7 kg per person per year (2023), well above the regional average (FAO, 2023). Given these indicators, ensuring sustainable production and efficient supply chains are key to meeting a demand that is both affordable and fundamental to national food security. Besides, in terms of the production chain, rice has three specific links and five specific stages, as follows:

- **Paddy rice production activities:** In this first step, farmers grow rice for sale, generally in the form of green paddy rice, meaning this rice is normally sold without undergoing a cleaning and drying process. This step encompasses the stages of input procurement and primary production.

- **Green paddy rice processing activities:** In the second step, processing agents purchase green paddy rice from agricultural producers and proceed to clean, dry, store, and transform it into white rice, brown rice, or other by-products for marketing. In this step, not only is value added to the initial product, but its composition is also changed; to obtain one kilogram of white rice, approximately 1.68 kilos of green paddy rice are required, since the drying, cleaning, and polishing processes reduce the weight ( Fedesarrollo, 2022). This step includes the processing and storage stages.

- **Distribution and marketing activities:** This last link considers distribution channels such as: i) selling white rice in bulk at the plant gate to wholesalers and distributors, who then sell it to retailers in supply centers; and ii) companies that have their own brand, which is already recognized by the end consumer, can distribute it to different points of sale, using their own means or through marketers and distributors. This link includes the distribution and marketing stages.

On the other hand, rice cultivation in Colombia presents three particularities that compromise its sustainability, which is why conventional policy instruments undertake multiple production and marketing efforts to ensure the grain supply. These are:

**1. Highly seasonal production.** The main planting is concentrated during the first half of the year (March–May), coinciding with the onset of the rainy season, while the secondary planting extends between June and September (Cadena Torres, Cuello Pérez, Romero Ferrer, & Pérez Cantero, 2021).. Furthermore, approximately 37% of the total planted area corresponds to the first half of the year and 63% to the second half, confirming the seasonal concentration of production (Escobar Fernandez, 2025).

**2. Climate-sensitive production.** In Colombia, rice production is particularly vulnerable to climate factors due to the coexistence of irrigated and rainfed systems. This structural duality means that in some areas of the country, excessive irrigation can lead to aquifer depletion, while in others, rainfed systems suffer direct production losses (low yields) due to exposure to extreme weather events such as droughts (UPRA, 2022).

**3. Highly perishable production.** Freshly harvested rice often reaches a moisture content above 20%, making it especially vulnerable to mold damage, degradation, and pest attacks if not dried within 2 to 3 days (Juganas, Regalado, & Ramos, 2023). In many cases, post-harvest losses can reach 20%, especially in areas where farmers lack efficient drying systems or adequate storage infrastructure (Ibrahim, 2018).

This document seeks to identify and implement a counterfactual methodology to evaluate the effectiveness of the Dry Paddy Rice Storage Incentive Program. This is done to analyze the efficacy and effectiveness of the main rice agricultural policy instruments, considering: competitiveness, sustainability, scope, and relevance, to identify opportunities for improvement in Colombia's rice policy. We contribute to the stabilization literature via a multi-year temporal quasi-experimental design for Colombia and outline differentiated policy implications.

## **2. Background: Dry Paddy Rice Storage Incentive Program, a strategy for innovation and rural development in Colombia**

The primary objective of innovation in rural development is to enhance the quality of life for rural populations, including those primarily engaged in agricultural and livestock activities, as well as those not directly involved. Innovation should be oriented toward the preservation of natural and social resources to ensure long-term sustainability. Innovation is conceived in social, cultural, and technological terms (Arfini, et al., 2019).

Social innovation initiatives in rural development focus on the valorization of local productive resources and the creation of related networks, the preservation of natural and cultural resources, the revitalization of the identity of rural areas, the establishment of new production facilities in non-agricultural and service sectors, and the improvement of the quality of life in rural areas, particularly for disadvantaged groups such as women, youth, and people with disabilities (Novikova, 2021).

Innovation and the use of agricultural technologies have the potential to positively impact agricultural productivity, developing regions' economic well-being, and the rural population's quality of life (Shpykuliak & Sakovska, 2020).

However, the outcome and magnitude of these changes are difficult to estimate, as they depend in part on the type of technology or innovation used. In this sense, we present three different forms of innovation that lead to differentiated impacts on the population: i) innovations focused on natural resource management and pest control (improving soil quality, conserving natural resources, increasing production and yields); ii) integrated agriculture, which combines several agricultural practices such as crop rotation and diversification; and iii) agricultural mechanization, which involves the use of machinery and equipment to improve efficiency (Shpykuliak & Sakovska, 2020).

Within these types of innovation and rural development, the Colombian government's Dry Paddy Rice Storage Incentive Program corresponds to an initiative related to mechanization and efficiency improvement, in the sense that by drying green paddy rice, which is perishable, it can be stored in perfect conditions to replenish the market at a time of low production, thus allowing the supply of rice, which is a vital food for the food security of Colombians, to remain constant.

The Dry Paddy Rice Storage Incentive Program is a policy instrument for the rice sector that was implemented from 1997 to 2023 with the conviction of avoiding disruptions to the country's rice harvest market and abrupt price fluctuations that could harm producers and consumers of the grain.

As a technical justification, rice cultivation and the entire agroindustry surrounding it are vital to the Colombian economy. It is the second most predominant short-cycle crop in the country, with approximately 13,000 producers (DANE, 2024) located in nearly 200 municipalities, whose income depends on this activity for 90% of their production (MINAGRICULTURA, 2021).

Furthermore, rice is a staple for food security and sovereignty in Colombia. According to the Agricultural and Rural Planning Unit, per capita consumption in 2021 was 42 kg, and according

to the 2024 Life Quality Survey carried out by the National Administrative Department for Statistics (DANE), it reached 1.77 pounds per capita per week (around 45.8 kg per year) (DANE, 2025) DANE, 2014) (MINAGRICULTURA, 2022).

Besides, the green paddy rice production is highly seasonal, especially in the Eastern Plains and Bajo Cauca areas, as they primarily use non-irrigated production systems, which depend on rainfall cycles. Thus, we observe high harvest periods in rice cultivation between July and September of each year, peaks that have represented an average of 52.1% of annual production (MINAGRICULTURA, 2021). Furthermore, green paddy rice is a highly perishable product, making it impossible to store.

The program acts as an incentive to withdraw a portion of available paddy rice inventories when they increase (second half of the year) and to market them when inventories naturally decrease (first half of the following year). Under this incentive, the government allocates resources to cover part of the mill's storage costs in exchange for the adoption of a price band for the green paddy rice paid to the farmer. This prevents the mills from bearing the total cost of storing the harvest, stabilizes income for the producer, and guarantees supply to consumers during the deficit period (Fedearroz, 2023).

The Program acts as a price stabilizer through supply control or stock stabilization mechanism. Price stabilization is one of the most important objectives of agricultural policy, especially in developing countries (Fertő, 1995).

The stock stabilization mechanism has been widely used in developing countries to prevent the price of agricultural products from falling. The government can usually control stocks at two stages in the production chain, either by restricting the area under cultivation or by stabilizing stocks through government purchases of surpluses (Fertő, 1995).

Before the implementation of the Program, the Colombian government operated an institute called the *Instituto de Mercadeo Agropecuario* (IDEMA), that controlled supply and demand of agricultural goods by managing purchases, imports, storage, sales and exports of non-perishable goods, such as rice. One of the most important tasks of the IDEMA was to intervene in times of high seasonal supply to buy, transport and store the goods to ensure later availability and prevent dramatic price falls. Due to inherent inefficiencies in the institution, this often led to cost overruns and quality issues that generated losses and hindered marketing. As the country moved towards a more open economy in the 1990's, The IDEMA lost its monopoly on imports and exports, which led to operating losses of up to COP 90,161 million (around U\$100 million) in 1995, that had to be covered by the government. In addition, the distribution processes faced major inefficiencies, including logistics failures, poor inventory and financial management, inadequate store placement, and lack of accountability (Ballesteros, 1998).

In this context, a version of the Program was created in 1996 as way to shift responsibilities away from IDEMA towards private actors. The program was a success, with an average of 75,975 tons of paddy rice stored under the Program per month for four months at a total cost of COP 3,267 million (around U\$3.1 million). As a comparison, in 1994 IDEMA intervened in the rice market for 82,431 tons at a loss of COP 12,267 million (U\$ 14.8 million) (Ballesteros, 1998). In this case, the Rice Storage Incentive acted as an innovation that presented an alternative to the national government purchase program and solved many of the operational issues that plagued the previous system.

(Reutlinger, 1976) concludes that stock levels that are optimal in terms of direct costs and benefits are likely to be too low to allow for satisfactory levels of stabilization; however, buffer stock programs operated with insurance-oriented storage rules could provide adequate protection against extreme shortages. Along the same lines, report that stock control improves the objective and subjective well-being of small farmers by 20% and 15%, respectively.

The theoretical and methodological contextualization of how the Paddy Rice Storage Incentive Program corresponds to an innovation and rural development strategy in Colombia provides a systemic, evidence-based understanding of how each activity within the strategy contributes to the desired impact on the rice supply chain.

According to (Schut, y otros, 2022), impact-oriented innovation must begin with a shift in perspective, moving from a fragmented view to a territorial approach. To achieve this, stakeholders must characterize existing innovations, analyze the current situation, design expansion strategies, negotiate with stakeholders, and implement and evaluate them. This structured approach is crucial for identifying and overcoming obstacles that hinder effective ownership, thus ensuring that strategies are optimized to achieve the most substantial possible impact.

### **3. Data and Methods**

#### **a. Theoretical framework: stock stabilization**

Agricultural markets in developing economies are often highly vulnerable to price volatility, driven by seasonality, climatic shocks, and low short-term supply elasticity. This volatility poses significant risks to food security, rural incomes, and macroeconomic stability. In this context, price stabilization mechanisms based on inventory control have historically been used as public policy tools to smooth market fluctuations (Dana & Gilbert, 2009) (Wright & Williams, 1982).

Stock stabilization involves the accumulation of commodities during periods of surplus and their release during times of scarcity, with the goal of keeping prices within a desired band. This logic underpins buffer stock programs, usually managed by public or semi-public agencies, which aim to mitigate both price spikes that harm consumers and price drops that hurt producers (Galtier, Vindel, & Timmer, 2013) (Varangis, Gilber, & Dehn, 2004).

As an evaluation of this mechanism, (Reutlinger S. , 1976) concluded that stock levels that are optimal in terms of direct costs and benefits are likely to be too low to allow for satisfactory levels of stabilization. However, buffer stock programs operated under insurance-oriented storage rules could provide adequate protection against extreme shortages in grain supply at a reasonably low cost. On the other hand, (Abokyi, Strijker, Asiedu, & Daams, Buffer Stock Operations and Well-Being: The Case of Smallholder Farmers in Ghana, 2022B) found that participation in buffer stock operations improves the objective and subjective well-being of smallholder farmers by 20 % and 15 %, respectively. The authors demonstrate that the economic, social, and environmental aspects of farming life could become public policy priorities for improving well-being, given their strong correlation with farmers' welfare.

The Colombian case, the Dry Paddy Rice Storage Incentive Program represents a hybrid form of stock stabilization. Rather than managing physical stocks directly, the government provides storage subsidies to private actors (such as mills or cooperatives), incentivizing them to withhold paddy rice during harvest peaks and release it during the off-season. This mechanism indirectly controls supply to maintain price stability (Fedearroz, 2023).

The program is particularly relevant in Colombia due to the pronounced seasonality of rice production and its central role as a staple food (DANE, 2024) (MINAGRICULTURA, 2021). This model can be considered an institutional innovation within classical stock stabilization approaches, shifting logistical operations to the private sector while preserving a public objective of supply management (Galtier, Vindel, & Timmer, 2013) (Schut, y otros, 2022).

(Galtier, Vindel, & Timmer, 2013) argues that in countries where futures markets are absent or ineffective, stock stabilization mechanisms can serve as a legitimate and effective tool to achieve rural development and food security goals, provided they are well-designed and physically sustainable.

## **b. Data sources and variables**

To evaluate the effect of the Dry Paddy Rice Storage Incentive Program, we primarily relied on secondary data available for various links in the Colombian rice market. The information on green paddy rice prices was obtained from two different sources that differ in the level of data aggregation. Firstly, Colombia's National Statistical Office (DANE in Spanish) has collected monthly data for municipalities with rice mills from 2013 to 2024 through the

Information System of Prices and Supply of the Agricultural Sector (SIPSA in Spanish). Additionally, Colombia's Mercantile Exchange (*Bolsa Mercantil de Colombia*) records daily data on green paddy rice at the departmental level since 2016. The evaluation was performed using the two variables as dependent variables to test the consistency of the results at both the geographical and time levels.

A time-specific database was created based on the legal acts issued for the Dry Paddy Rice Storage Incentive Program since 2013, which outlined the exact dates when the incentive would be active, the minimum prices at which paddy rice needed to be purchased in rice mills, and the quantity of rice covered by the program. The database was utilized at both the daily and monthly levels, depending on the price variable applied in the evaluation. Additionally, the actual amount spent by the program per year was included to account for its magnitude in the assessment.

To evaluate how the program impacted the rice farmers' income, a new variable, producers' profit margin, was created by subtracting total production costs from the green paddy rice price information mentioned above. The former is at the rice-producing region<sup>4</sup> level, while the latter is at both the municipal and departmental levels. The data on production costs is published by Colombia's National Federation of Rice Producers (FEDEARROZ) on a per-semester basis, by type of irrigation system (non-irrigated and irrigated rice crops).

### **c. Methods: RDD and RKD**

To empirically assess the impact of the Dry Paddy Rice Storage Incentive Program on the price of green paddy rice and rice producers' income, we performed an evaluation using elements of both a sharp regression discontinuity design (RDD) and a sharp regression kink discontinuity (RKD) design. Initially proposed by (Thistlethwaite & Campbell, 1960), RDD is a quasi-experimental method for evaluating the causal effects of interventions, where the units' treatment status is determined by the threshold of an underlying variable  $X_i$ . An RDD is defined as sharp if the assignment  $D_i$  is a deterministic function of the forcing variable  $X_i$ :

$$D_i = \begin{cases} 1 & \text{if } X_i \geq c \\ 0 & \text{if } X_i < c \end{cases}$$

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<sup>4</sup> In Colombia, there are six rice-producing regions based on their weather conditions and water availability: *Llanos Orientales* (East Plains), *Centro*, *Bajo Cauca* (southwest area), *Costa Norte* (north coast), *Santanderes*.

So, all units with an  $X_i$  value of at least  $c$  are always treated, while those under the cutoff point ( $c$ ) are assigned to the control group (Imbens & Lemieux, 2008). To estimate the effect of being treated by an intervention, the RDD approach compares the mean outcomes of the variable  $y_i$  between observations just above and just below the cutoff point ( $c$ ) under the assumption that they only differ in their  $X_i$  values, therefore in their treatment status providing valid counterfactuals.

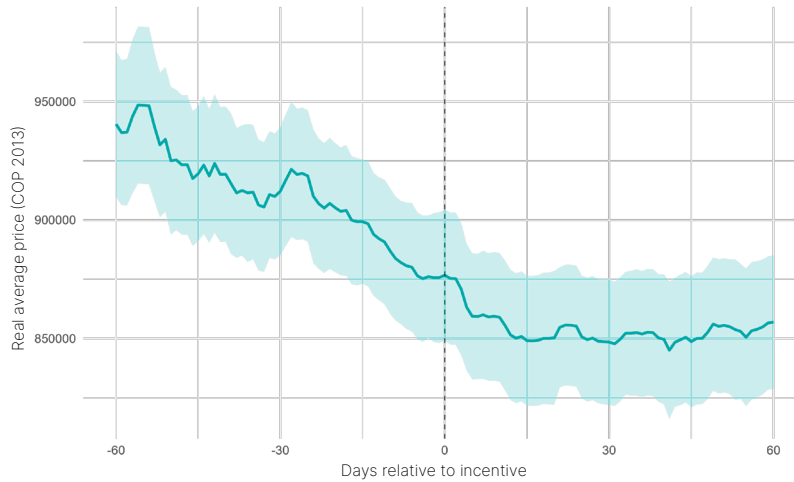
We used an RDD approach to evaluate the Dry Paddy Rice Storage Incentive Program, considering the exact day the legal act regulating it started operating as the cutoff point ( $c$ ) and the days relative to it as the running variable  $X_i$ . As depicted in Table 1, the exact date the incentive was implemented varied by year between 2013 and 2023. Starting from that date onwards, rice mills had to buy green paddy rice from producers according to the conditions of that year's legal act. So, it seems plausible to assume that the rice purchased on the days close to the starting date of the policy, both before and after, was traded in similar market and environmental conditions with the only difference of being treated or not, based on their relative position to the cutoff point  $c$ .

**Table 1. Starting date of the Dry Paddy Rice Storage Incentive Program per year (2013 - 2023)**

Year of the incentive	Starting date
2013	16 of July
2015	4 of September
2016	5 of August
2017	11 of August
2018	31 of August
2019	1 of August
2020	15 of August
2021	9 of August
2022	4 of August
2023	24 of July

According to experts in the Colombian rice sector, this variation on the starting day of the policy was due to external, mainly political, factors that were not possible to anticipate by the farmers or the rice mills owners. This can be visualized graphically in Figure 1 where is possible to notice that the green paddy rice price, the outcome variable of interest  $y_{it}$ , do not have big shifts close to the starting date of the program.

**Figure 1. Average price of green paddy rice relative to the day the Program started (+/- 60 days)**



**Source: Elaborated by authors based on data from *Bolsa Mercantil de Colombia***

Since the RDD approach focuses on assessing the intervention effect on the mean level of the outcome variable  $y_i$ , and we are also interested in evaluating the change rate of prices before and after the policy is implemented, we used elements of the RKD design. RKD emerges as a way to adapt the design to policy settings where the discontinuity in the treatment assignment is not a discrete jump but rather a change in the slope of the likelihood of being treated at certain levels of  $X_i$ , also known as a kink point (Card, Lee, Pei, & Weber, 2015) (Dong, 2011). That is the case for interventions that are gradually implemented based on the values of an additional variable, which implies a discontinuity in the first derivative of the assignment function rather than the one depicted in equation (1). Although this type of discontinuity is not the case for the Dry Paddy Rice Storage Incentive Program, we took from RKD the focus on evaluating the change in slope of the outcome variable  $y_i$  just below and above the cutoff point as observations move along the forcing variable  $X_i$ .

Its focus on observations in a range close to the cutoff point makes the effect estimate constrained just to those observations, formally defined as a Local Average Treatment Effect (LATE) and mathematically defined as:

$$Y_i = \alpha + \tau D_i + \beta_1(X_i - c) + \beta_2 D_i * (X_i - c) + \varepsilon_i$$

Where  $Y_i$  is the outcome variable of interest,  $D_i$  is the binary variable for treatment assignment,  $\tau$  is the LATE of the program (focus of the RDD approach), and  $(X_i - c)$  is the relative position of observation  $i$  to the cutoff point. The coefficients  $\beta_1$  and  $\beta_2$  can be interpreted as the slope of the outcome variable before and after the cutoff point, respectively.

#### **d. Limitations**

This study provides novel evidence on the effectiveness of Paddy Rice Storage Incentive Program, yet several limitations must be acknowledged.

Our analysis is particularly limited by data constraints. Production cost information from FEDEARROZ is only available at the regional–semester level, creating a mismatch with municipal and departmental price data that may introduce measurement error and attenuate estimated effects. In addition, daily price data from *Bolsa Mercantil de Colombia* are available only from 2016 at the departmental level, limiting our capacity to evaluate earlier program years and reducing the sample size for high-frequency analysis.

Regarding methodological limitations, the regression discontinuity design provides credible causal identification under specific assumptions. The validity of estimates depends on the absence of other discontinuous shocks at the cutoff, an assumption that cannot be fully verified. The rice sector operates amid overlapping agricultural policies, trade measures, macroeconomic conditions, and climate shocks, which our empirical strategy cannot fully control. These factors, coupled with the high seasonality and perishability of rice in Colombia, may limit the consistency of the estimates. Moreover, RDD captures Local Average Treatment Effects within narrow bandwidths, limiting external validity to the specific periods analyzed.

Finally, the Program exhibited a particularly atypical episode between 2017 and 2018: the structural break caused by the mill withdrawal makes interpretation difficult, given that these were years in which, despite the active incentive, market power was not the same. This mill withdrawal reveals an ambiguous effect of the intervention on purchase prices. However, this structural limitation allows us to introduce a discussion on the role of the participation of different market agents in the policy's effectiveness, within the framework of our impact-based innovation narrative.

Addressing these limitations will require more robust datasets and methods capable of managing variation in treatment intensity. Qualitative research on farmer and mill behavior can enrich interpretation. Despite these limitations, our findings provide credible evidence on the causal effects of stock stabilization policies and contribute to the broader literature on agricultural policies in developing economies.

## 4. Results

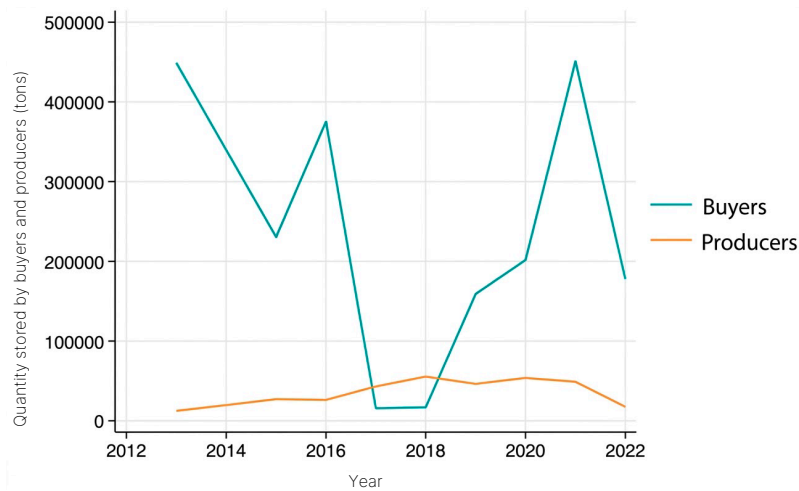
### a. Descriptive analysis and first considerations

To analyze the impact of an agricultural public policy, it is necessary to rigorously review the conditions under which it is implemented: operational design, coverage, dynamics, and trajectory over time. In this regard, it is crucial to note that although the rice storage incentive program was in place for more than 20 years (from 1997 to 2023), its coverage has not been uniformed from year to year. Program records show that implementation does not follow a technical pattern; instead, variability appears to be primarily determined by budgetary decisions and specific circumstances in each year.

Figure 2 shows the annual evolution of the quantity of paddy rice stored under the incentive program, differentiating between buyers (mills) and producers. We observe an asymmetry in volumes: buyers account for most of the incentivized rice storage, with levels exceeding 300,000 tons in some years, while producers consistently remain below 50,000 tons. Between 2017 and 2018, an exception occurred: mills did not participate in the incentive, which showed a storage volume close to zero for mills and a greater relative participation by producers.

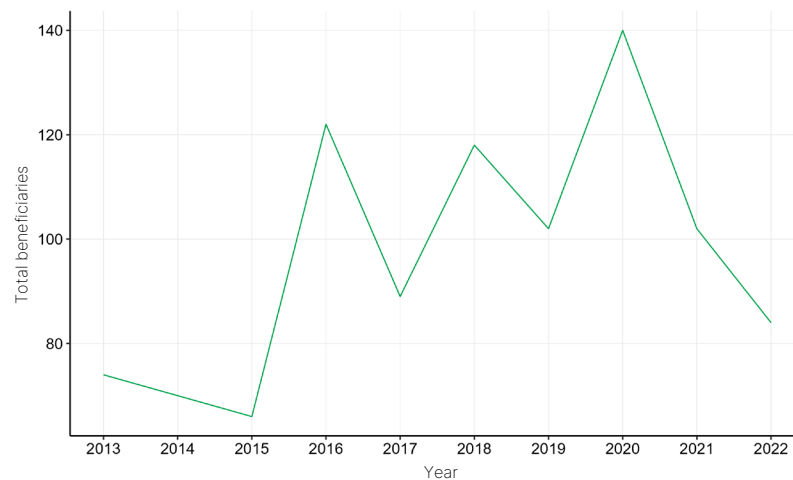
This operational discontinuity did not imply a proportional reduction in the total number of beneficiaries. Figure 3 shows that the total number of beneficiaries remained stable despite the withdrawal of buyers from the program in 2017 and 2018. This stability is achieved because most beneficiaries are producers who register to store their rice, but individual producers have very low storage capacity compared to green paddy purchasing companies. This finding suggests that, in those years, the program maintained its coverage through producer participation, albeit in significantly lower volumes. Conversely, peak beneficiary numbers in years such as 2016 and 2020 could be associated with temporary expansions of program coverage or specific budget adjustments.

**Figure 2. Tons stored under the incentive by type of beneficiary**



**Source: Elaborated by authors based on data from Bolsa Mercantil de Colombia**

**Figure 3. Number of beneficiaries under the incentive by type of beneficiary**

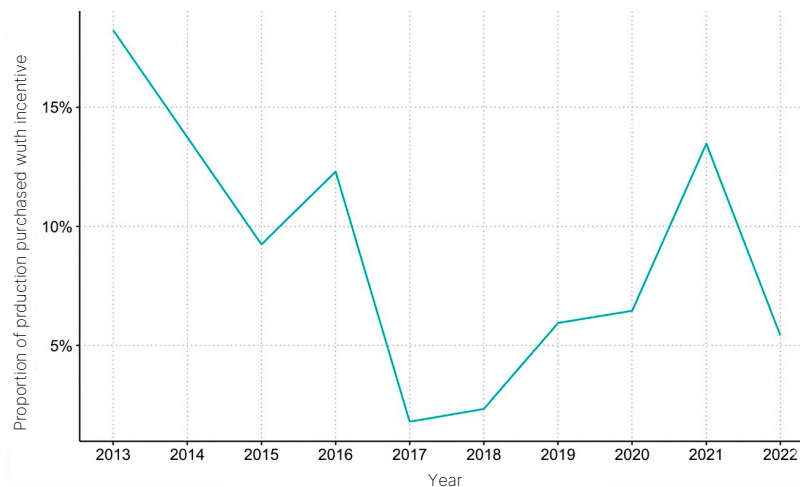


**Source: Elaborated by authors based on data from Bolsa Mercantil de Colombia**

Now, we must analyze the scope of the incentive in relation to its ability to impact the market. Figure 4 shows the proportion of national rice production purchased through the incentive program. We observe a sharp decline in the program's share of total production starting in 2013, falling from over 17% in that year to levels below 3% between 2017 and 2018, precisely the years of lowest buyer participation. Starting in 2019, a gradual recovery is evident, reaching nearly 14% in 2021, followed by a further decline in 2022. However, in 2022, a drop in share is observed again, falling below 6%. This behavior not only reflects operational and budgetary changes but also the variability in the program's degree of

intervention in the market, which must be considered when interpreting its impact. That is, beyond the number of beneficiaries or the amount of the incentive delivered, the actual scope of the program depends on the proportion of production purchased under its scheme, which determines its ability to influence prices and production decisions.

**Figure 4. Proportion of production purchased by the incentive**



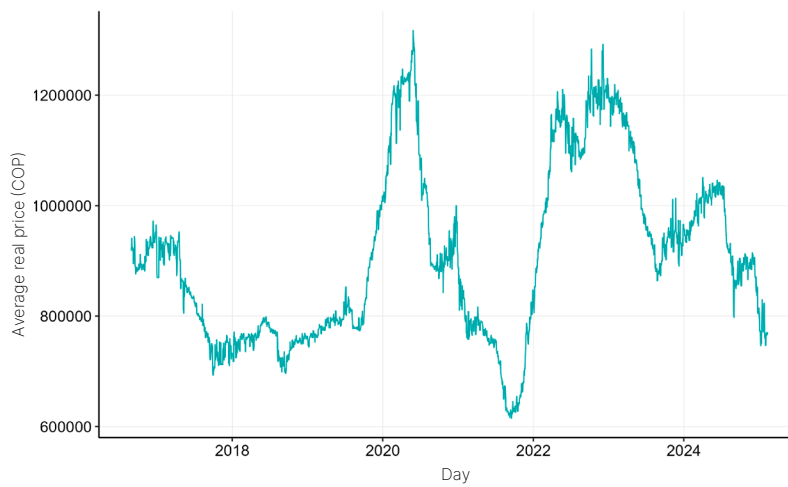
**Source: Elaborated by authors based on data from *Bolsa Mercantil de Colombia***

It is also important to provide an overview of the behavior of prices, production costs, margins, and national rice production levels in this descriptive exercise. This information allows us to identify patterns, asymmetries between observation units, and preliminary relationships that help interpret subsequent quantitative results. Descriptive statistics also allow us to validate the consistency of the data available for analysis.

Figure 5 shows the evolution of the average daily real price of green paddy rice at the mills, expressed in constant 2013 pesos. The series shows marked intra-annual volatility, with recurring declines coinciding with harvest months (mainly between July and September), followed by recovery phases toward the end of the year or the beginning of the following year. This pattern is repeated throughout the observed period and reflects the market's structural seasonality. The steepest declines are observed in 2021 and 2023, followed by considerable increases, suggesting the possibility of market interventions or adjustments that cushioned the decline, such as the implementation of the storage incentive program. This series is especially useful for capturing the immediate effect of policy measures, given its high temporal resolution, and justifies the use of identification strategies based on time discontinuities.

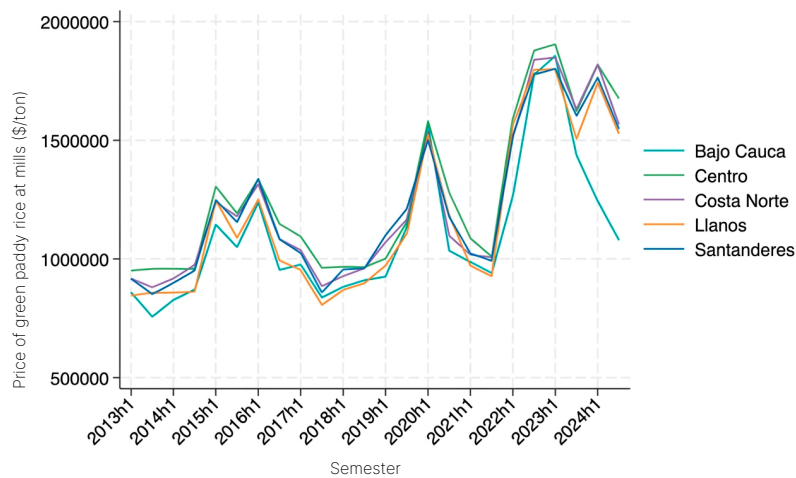
Figure 6 presents the average semiannual price paid per ton of rice at the mill, constructed from monthly data and disaggregated by rice-growing region. Although there are differences in price levels across regions, a general trend is evident, indicating a certain degree of market integration. We observe three price spikes: the first in 2016, the second in 2021, and the most recent in 2022, all followed by downward adjustments. These fluctuations are primarily explained by variations in production and inventory levels, as well as institutional and logistical conditions, including the operation of the storage program. The relative stability of differences across regions suggests that, although local conditions influence prices, national determinants (aggregate supply, industrial demand, and the presence of policy instruments) play a dominant role.

**Figure 5. Average daily green paddy rice prices (2013 constants)**



**Source:** Elaborated by authors based on data from *Bolsa Mercantil de Colombia*

**Figure 6. Green paddy rice prices at mills by rice growing area by semester**



**Source: Elaborated by authors based on data from DANE – SIPSA**

Another aspect to consider when evaluating the profitability of production is the cost structure of producers. In Colombia, this structure is strongly shaped by the production system (irrigated vs. non-irrigated), not only because of the costs directly associated with irrigation, but also due to the limited availability of irrigated land, which drives up land values. This divide also has a geographical dimension: the Centro, Costa Norte, and Santanderes regions rely almost exclusively on irrigated systems, while the Bajo Cauca and Llanos regions depend predominantly on non-irrigated systems (see Table 2).

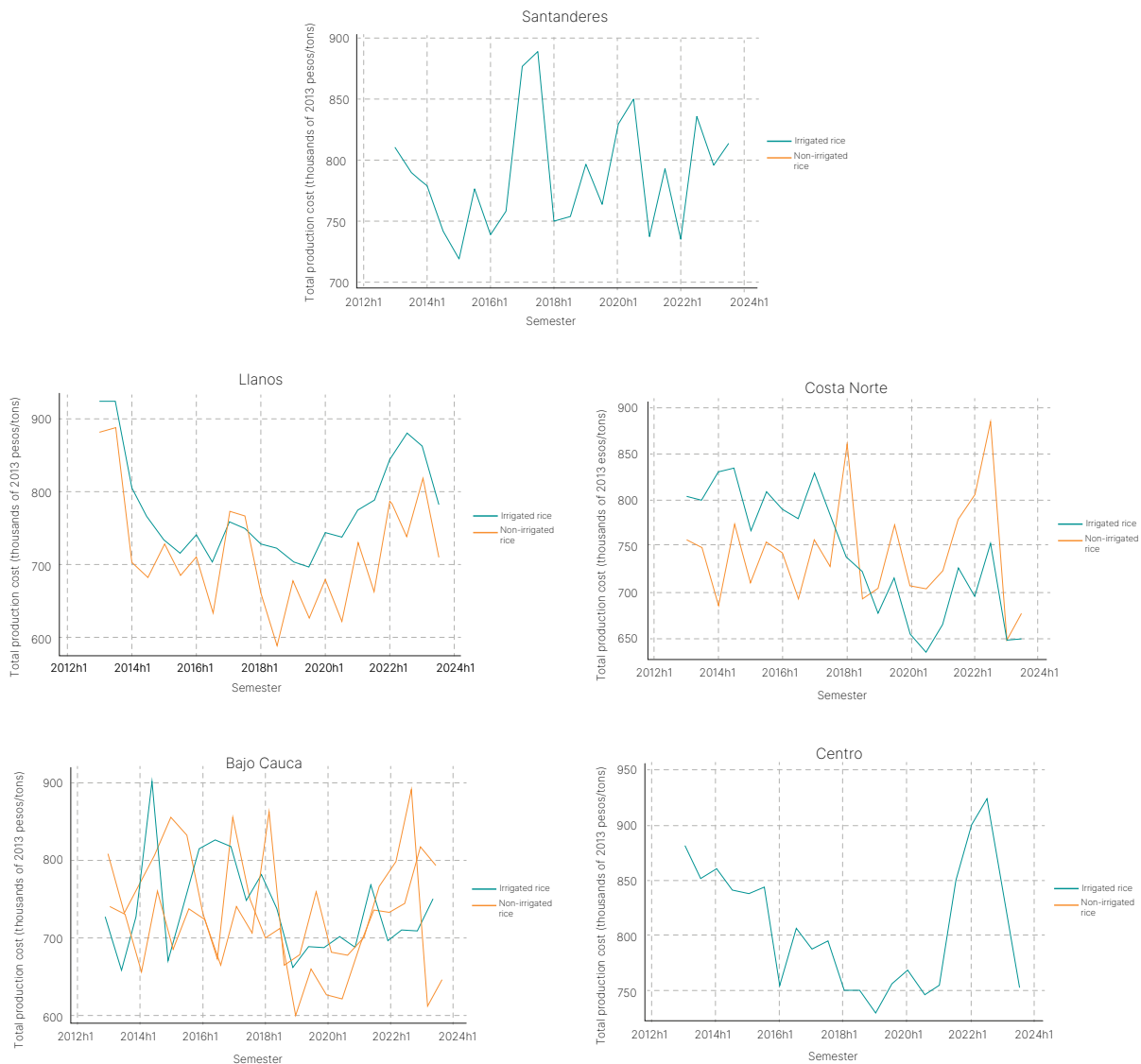
**Table 2. Planted area under irrigated and non-irrigated systems, by production zone, 2023**

Zone	Planted Area (Hectares)			share (%)	
	Total	Irrigated	Non-irrigated	Irrigated	Non-irrigated
Total	589.848	254.319	335.529	43,1%	56,9%
Bajo Cauca	65.786	6.203	59.583	9,4%	90,6%
Centro	144.059	141.643	2.416	98,3%	1,7%
Costa Norte	23.198	22.387	811	96,5%	3,5%
Llanos	316.061	45.611	270.450	14,4%	85,6%
Santanderes	40.744	38.475	2.270	94,4%	5,6%

**Source: Elaborated by authors based on data from (Fedearroz- FNA, DANE, 2024)**

Figure 7 presents the semiannual evolution of total production costs per ton, differentiated by rice-growing area and cultivation system (irrigated vs. rainfed), in constant 2013 pesos. In general, costs under irrigation are higher and more stable, in line with the greater use of inputs, technology, and infrastructure requirements. However, in areas such as Bajo Cauca and Costa Norte, there are cases where rainfed costs exceed those of irrigation, although, given the small irrigated and non-irrigated system usage in the Bajo Cauca and Costa Norte regions, respectively, it is hard to draw general conclusions about the difference in cost in these regions. In Santanderes and the Centro, data are only available for irrigation, with high volatility throughout the period. These results reflect technical and productive heterogeneity across regions and systems, with implications for the design of differentiated support instruments and profitability analysis.

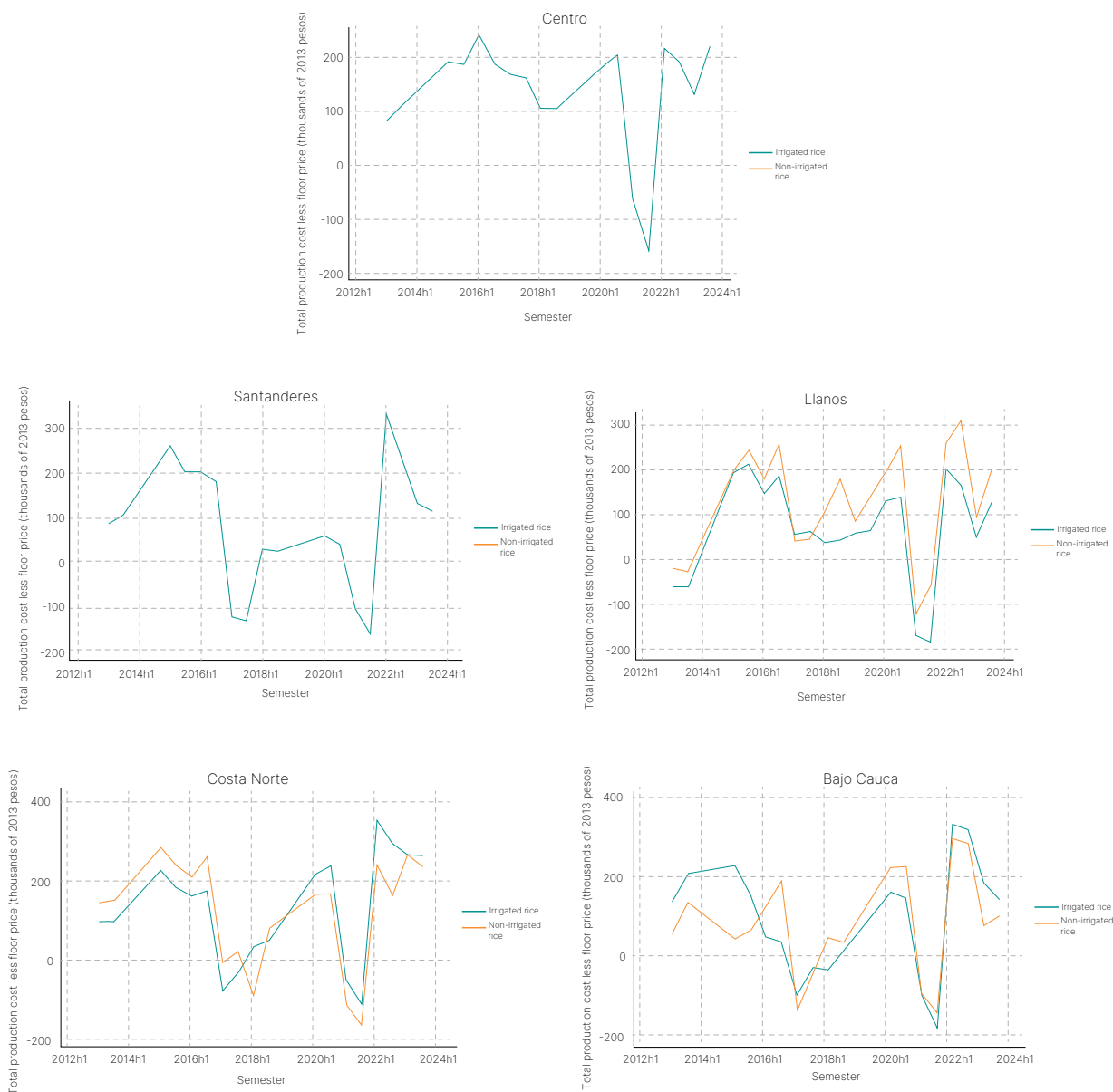
**Figure 7. Production costs in rice-growing areas by type of irrigation**



**Source: Elaborated by authors based on data from DANE – SIPSA and Fedearroz**

Figure 8 reveals the half-yearly evolution of estimated profit margins, calculated as the difference between the average price and the total production cost per ton, differentiating between irrigated and rainfed production in each rice-growing area. Overall, we observed positive margins, but with high volatility and episodes of negative margins in 2017 and 2021. In Llanos, rainfed producers tend to have higher profits, while in the other areas, the difference between systems is less clear. We perceive that crop profitability is neither constant nor homogeneous, which must be considered when evaluating the economic sustainability of producers in different regions.

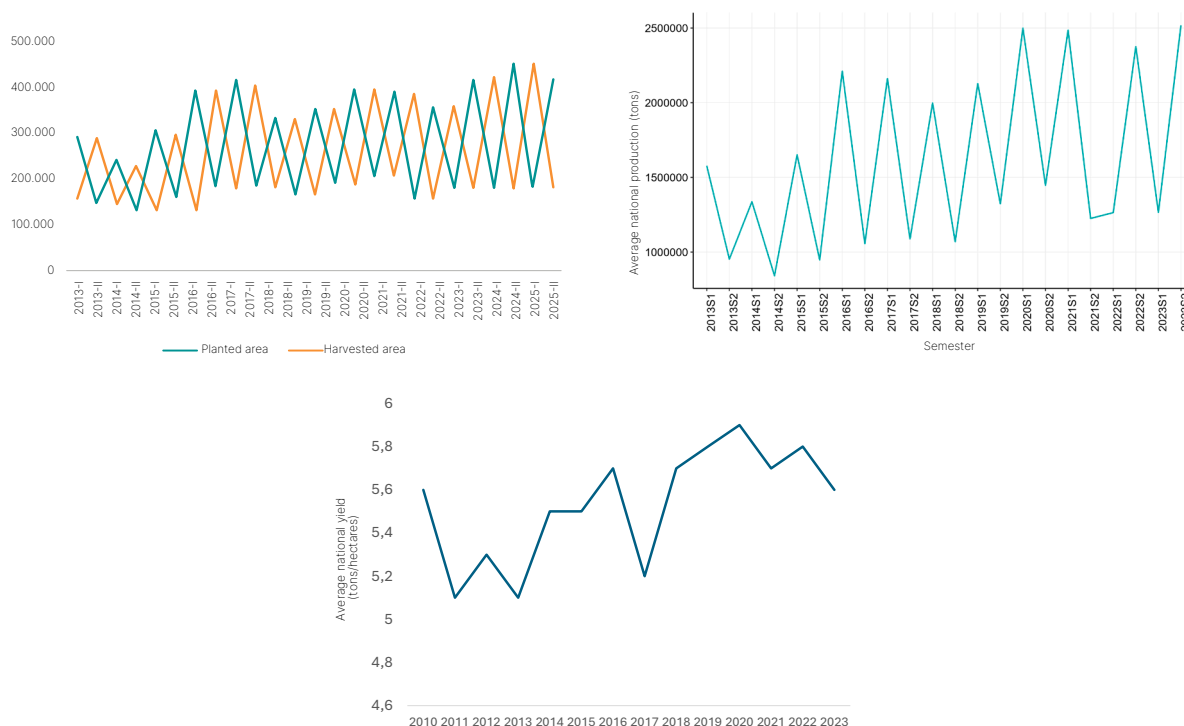
**Figure 8. Profit margins in rice-growing areas by type of irrigation**



**Source: Elaborated by authors based on data from DANE – SIPSA and Fedearroz**

Figure 9 presents the semiannual evolution of three key variables at the national level: total paddy rice production (tons), planted and harvested area (hectares), and average yield per hectare (tons/ha) between 2013 and 2023. First, we observe strong semiannual seasonality in production, with a pattern alternating between high and low semesters each year. This fluctuation reflects regional planting and harvesting schedules, as well as the concentration of supply in certain periods. Despite this intra-annual variability, production shows a marked upward trend.

**Figure 9. National dynamics of rice production, area and yield**



**Source: Elaborated by authors based on data from EVA**

Taken together, the indicators presented allow us to understand the structural and operational context of the rice storage incentive program and the price, cost, margin, and production conditions faced by sector stakeholders during the analysis period. The statistical information documented here constitutes an input for interpreting the quantitative results. The high variability observed across regions, farming systems, and time periods highlights the need for differentiated approaches in the design and implementation of sectoral policy instruments.

### **b. Econometric results**

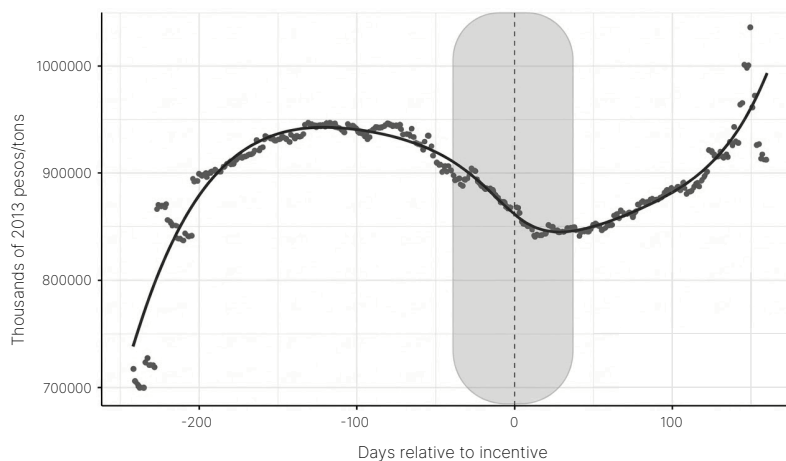
Below, we present an empirical evaluation of the impact of the Paddy Rice Storage Incentive Program on the price of green paddy rice and the income of rice producers. We base our analysis on four hypotheses: Hypothesis 1: The storage incentive stabilizes the market price; Hypothesis 2: The storage incentive smooths producers' income; Hypothesis 3: The storage incentive influences production decisions; Hypothesis 4: The storage incentive influences the prices of white rice that reach the final consumer.

## Hypothesis 1: The storage incentive stabilizes the market price

Initially, we used daily rice prices at the departmental level. Uncertainty about the specific timing of the treatment creates a quasi-experimental condition; the incentive acts as an exogenous shock around which it is possible to compare the price trajectory just before and after its implementation. We conduct a comparative analysis in three contexts: i) years with the incentive and mill participation, ii) years with the incentive without mill participation, and iii) years without the incentive (2024). This analysis allows us to identify structural differences in price formation and policy effectiveness.

During the years in which the incentive was in operation with active participation of the mills (scenario 1), prices exhibited a markedly negative slope before the intervention, consistent with the seasonal harvest pattern. After the program went into effect, this trend moderated considerably, leading to stabilization and even recovery of prices (Figure 10). This break in the slope is consistent with the policy mechanism: by subsidizing storage through actors with operational capacity, the program reduces immediate supply pressure, as well as binding them to the price band mechanism. In Table 2, we observe that the slope before the harvest is negative, while the change in slope afterward ( $\beta_2$ ) becomes positive and significant starting at 60-day windows. We also observe that in a 90-day window, the trend reverses, with a change in slope from  $-1,113$  to  $+1,051$  ( $\beta_1 + \beta_2$ ) pesos per day. We interpret this change as an endogenous price stabilization attributable to the incentive.

**Figure 10. Daily price of green paddy rice relative to the days the Storage Incentive started (years with incentive and mill participation)**



**Source: Elaborated by authors based on data from *Bolsa Mercantil de Colombia***

**Table 2. Results of discontinuous regression of daily green paddy rice price versus the effect of the incentive (years with incentive and mill participation)**

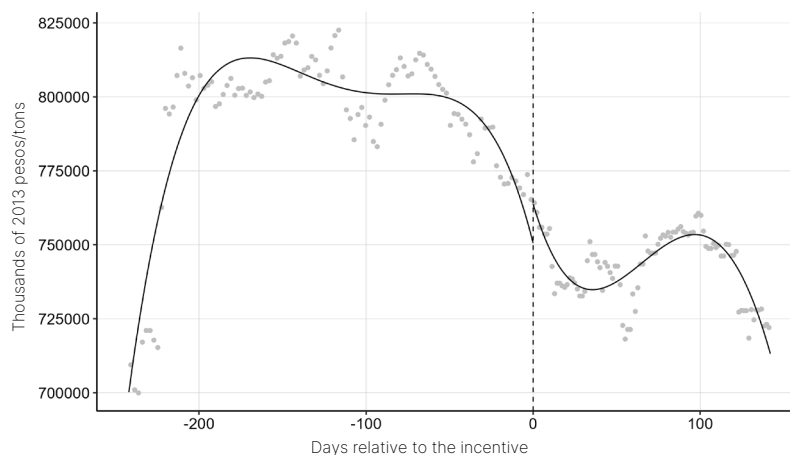
	Days related to the incentive		
	30 days	60 days	90 days
Pre-incentive trend ( $\beta_1$ )	-1524.424** (416.927)	-1035.250*** (201.950)	-1113.56*** (131.831)
Incentive effect ( $\tau$ )	-1392.232 (3256.720)	-12764.234** (4067.306)	-18393.54** (5288.485)
Change in trend ( $\beta_2$ )	627.375 (744.719)	723.375* (387.936)	1165.02*** (246.670)
<b>Observations</b>	4014	8184	12345
$R^2$	0.0297	0.0346	0.0469
$R^2$ adjusted	0.0261	0.0328	0.0458

Note: Standard errors in parentheses. \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ . Department-level fixed effects.

**Source: Own elaboration (2025).**

In contrast, when the program operates without mill participation (scenario 2), prices continue to follow a downward trajectory, with no statistically significant evidence of subsequent structural change (Figure 11). Similarly, we observe that the subsequent trend change is not statistically significant, suggesting that the incentive's transmission channel weakens (Table 3). These results indicate that, in the absence of purchasing agents with storage capacity, the program loses its ability to influence the market. The mere existence of the incentive is not sufficient if it is not linked to an effective collection and purchasing channel.

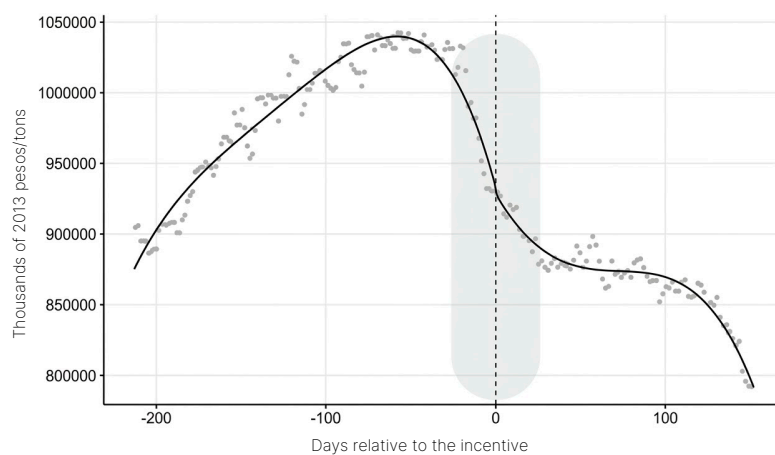
**Figure 11. Daily price of green paddy rice relative to the days the Storage Incentive started (years without mill participation, 2017 and 2018)**



**Source: Elaborated by authors based on data from Bolsa Mercantil de Colombia**

In 2024, the year without the incentive (scenario 3), we observe a sustained decline in prices after the theoretical comparison point (the time when the program would typically have started<sup>5</sup>). Unlike scenarios 1 and 2, there is no sign of stabilization, and the negative slope remains constant, reflecting the seasonal pattern without any market buffer. Table 3 shows that the negative trend before the intervention is steeper, and although the subsequent slope change is positive, its magnitude is not sufficient to reverse the downward trajectory. In the 90-day window, prices decline 1,326 pesos per day before the cutoff, and the change in slope is only 630 pesos. As a robustness check, Annex 1 shows this exercise considering different random dates for the start of the incentive in 2024 with consistent results.

**Figure 12. Daily price of green paddy rice relative to August 1 (non-incentive years)**



**Source: Elaborated by authors based on data from *Bolsa Mercantil de Colombia***

<sup>5</sup> We randomly took a date from previous years: August 1st.

**Table 3. Results of discontinuous regression of daily green paddy rice price versus the effect of the incentive (years without incentive and without mill participation)**

	Years without mill participation			Years without incentive		
	30 days	60 days	90 days	30 days	60 days	90 days
Pre-incentive trend ( $\beta_1$ )	-559.087 (453.29)	-643.685* (342.682)	-644.28** (216.19)	-4937.25** (438.878)	-2425.7*** (154.153)	-1326.5*** (119.824)
Incentive effect ( $\tau$ )	-2832.32 (6518.2)	-10897.566 (10159.74)	-16304.5 (13000.4)	13368.55* (5506.666)	-22375.1** (7322.86)	-50628.1*** (10115.2)
Change in trend ( $\beta_2$ )	-778.071 (440.84)	178.639 (503.618)	456.727 (375.675)	3236.02** (596.603)	1320.16*** (299.164)	630.481** (283.089)
<b>Observations</b>	1403	2783	4163	793	1573	2353
$R^2$	0.4193	0.3792	0.3948	0.7863	0.7952	0.7785
$R^2$ adjusted	0.4135	0.3761	0.3928	0.7822	0.7932	0.7771

Note: Standard errors in parentheses. \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ . Department-level fixed effects

**Source: Own elaboration (2025).**

Finally, in 2024—without implementation of the program—prices show a sustained decline from the theoretical comparison point. Unlike in the years with intervention, no subsequent stabilization is evident. Table 4 shows that the slope prior to the cutoff is even steeper (up to -4,937 pesos per day in the 30-day window). Although the subsequent change in slope is positive and significant, its magnitude (+630 pesos per day in the 90-day window) is insufficient to reverse the downward trajectory.

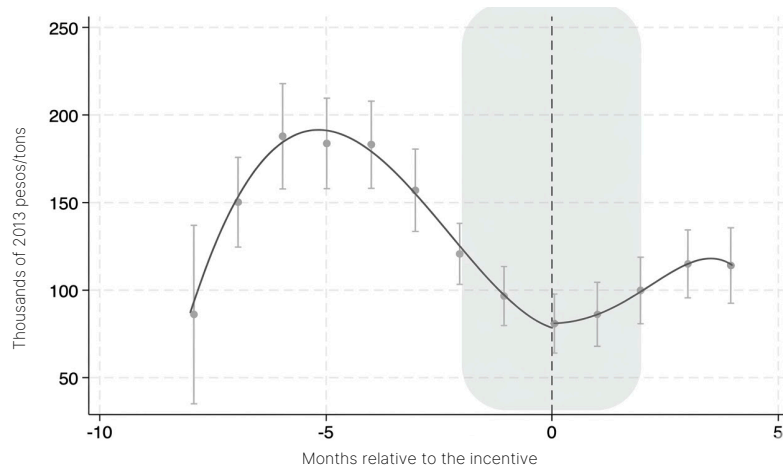
Overall, the results show that although the market may exhibit some self-regulation at the margin, the storage incentive accelerates stabilization when accompanied by effective operating capacity, which is consistent with the program's expected effect: smoothing the seasonal price decline. As a robustness exercise, Annex 2 shows this exercise considering monthly green paddy rice prices at mills by municipality (2013-2024) with consistent results.

### **Hypothesis 2: The storage incentive smooths producers' income.**

To infer the potential effect of the incentive on producers' income, we implemented a similar regression discontinuity model with the spread between the price of green paddy rice at the mills and total production costs as the dependent variable. Cost information is available at the rice-growing area level by semester and by irrigation system (irrigated and non-irrigated).

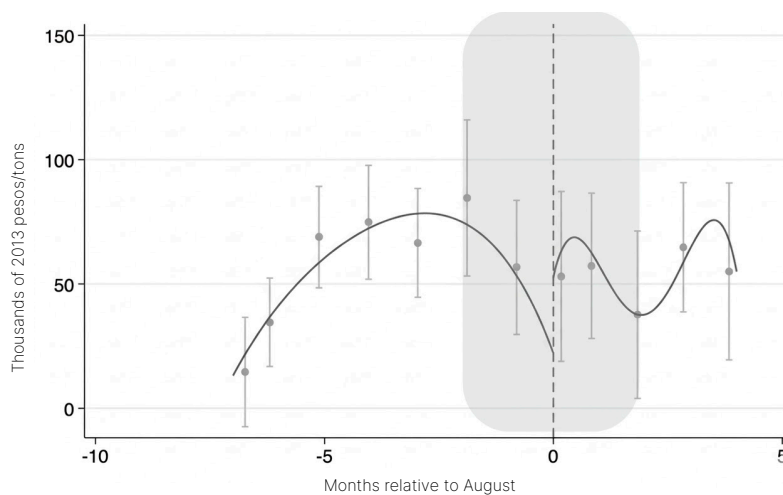
Figures 13 and 14 show the evolution of the spread in irrigated areas, in years with and without incentives, respectively. In years with incentives, the spread tends to stabilize more quickly after the program starts, in contrast to years without incentives, where the spread exhibits an inconsistent trajectory over the following months. This finding suggests that the program may be helping to smooth out producers' incomes at times when they would face steep seasonal declines in their margins.

**Figure 13. Green paddy rice price differential with total production costs relative to the program start month (years with incentive) - IRRIGATION**



Source: Elaborated by authors based on data from DANE – SIPSA

**Figure 14. Green paddy rice price differential versus total production costs relative to August (years without incentive) - IRRIGATION**



Source: Elaborated by authors based on data from DANE – SIPSA

In irrigated areas during years with incentives, the pre-program trend is negative and statistically significant after three and four months, indicating that margins had been deteriorating before the intervention. After the start of the incentive, we observed a statistically significant change in the trend: the coefficient of change in trend ( $\beta_2$ ) is positive and statistically significant at all cutoffs, implying a progressive recovery in net income after the program's implementation. However, the immediate effect of the incentive ( $\tau$ ) is not statistically significant, suggesting that the improvement in income is not instantaneous, but materializes in the following months.

As for the total value of the incentive, the estimator is negative and statistically significant, which implies that bigger programs are associated with lower profitability for producers. This speaks of the supply and demands dynamics of the market, as higher supply involves a higher need for resources to evacuate inventory and drives prices down, reducing profitability. This means that, while the Program can cut downward trends in prices after its implementation, the overall market trends still impact on the profitability of producers.

In contrast, in years without incentives, although there is a slight improvement in the trend after the reference month (August), it is not statistically significant. The immediate effect is also unclear. This finding reinforces the idea that the program could be functioning as an income stabilization mechanism. Table 4 presents the results of a discontinuous regression applied to the different time windows used in the green paddy rice mill price model.

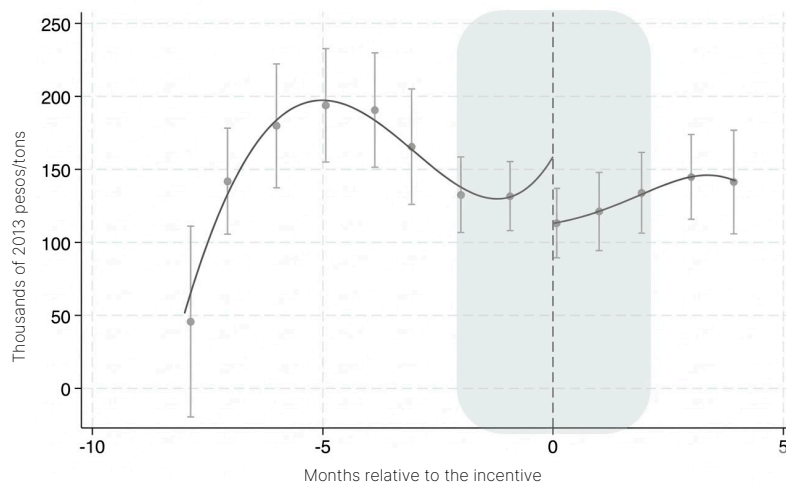
**Table 4. Results of discontinuous regression of the effect of the incentive on the price differential less production costs of green paddy - IRRIGATION**

Dependent variable: Green paddy price differential less rice production cost (thousands of 2013 pesos/ton)						
	Years with incentive			Years without incentive		
	2 months	3 months	4 months	2 months	3 months	4 months
Pre-incentive trend ( $\beta_1$ )	-20.26 (12.61)	-23.03*** (5.096)	-27.31*** (3.217)	-16.92 (22.58)	-11.89 (11.16)	-3.909 (6.801)
Incentive effect ( $\tau$ )	3.823 (14.12)	5.926 (7.827)	10.45 (6.474)	14.10 (25.09)	9.678 (17.00)	-0.938 (13.79)
Change in trend ( $\beta_2$ )	25.82** (13.12)	32.23*** (5.619)	38.05*** (3.702)	21.73 (23.37)	10.46 (12.24)	3.070 (7.841)
Incentive value (Millions COP 2013)	-.00154** (0.00016)	-.00158*** (0.00015)	-.00174*** (0.00015)			
Constant	135.0*** (15.80)	127.6*** (10.08)	121.4*** (8.915)	-75.14*** (25.28)	-55.65*** (17.19)	-35.46** (13.94)
<b>Observations</b>	1116	1534	1918	118	161	208

**Source: Own elaboration (2025).**

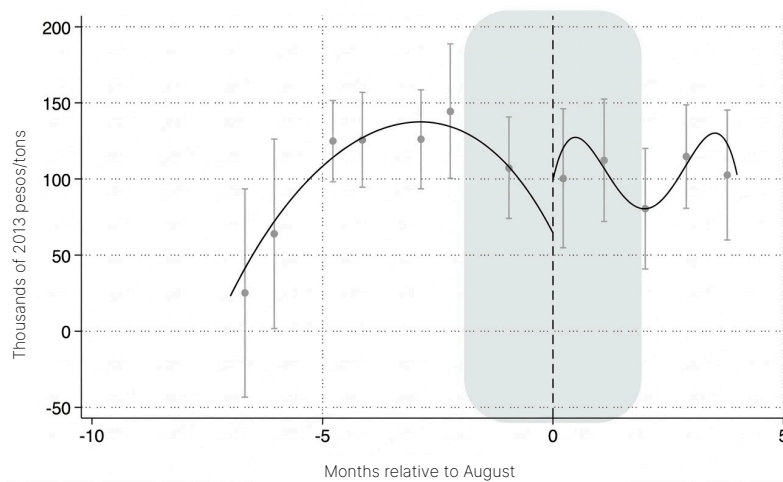
We analyze a similar pattern in Figures 15 and 16, but for non-irrigated areas. While visually, there also appears to be a stabilization of net income in the years with incentives, the results in Table 5 show that in rainfed areas, the program's impact is less clear. The pre-program trend is more erratic, and although we observe a positive change in the trend  $[\beta]_2$  at four months, this is only significant in that time window.

**Figure 15. Green paddy rice price differential versus total production costs relative to the program start month (incentive years) - NON-IRRIGATED**



**Source: Elaborated by authors based on data from DANE – SIPSA**

**Figure 16. Green paddy rice price differential versus total production costs relative to August (years without incentive) - NON-IRRIGATED**



**Source: Elaborated by authors based on data from DANE – SIPSA**

In terms of the immediate effect ( $\tau$ ), the program does not appear to have a significant impact either in years with or without incentives, suggesting that, as with irrigation, the benefits of the program on producers' net income accumulate over time and are not immediately observed. As for the impact of the total value of the Program, we observe the same tendency as with the irrigated system, which suggests that the market dynamics are consistent across systems.

**Table 5. Results of discontinuous regression of the effect of the incentive on the price differential less production costs of green paddy - NON-IRRIGATED**

Dependent variable: Green paddy price differential less rice production cost (thousands of 2013 pesos/ton)						
	Years with incentive			Years without incentive		
	2 months	3 months	4 months	2 months	3 months	4 months
Pre-incentive trend ( $\beta_1$ )	7.717 (19.88)	0.998 (7.950)	-11.27** (5.014)	-33.74 (39.79)	-23.54 (15.45)	-9.342 (8.386)
Incentive effect ( $\tau$ )	-25.97 (21.94)	-18.95 (11.80)	-4.096 (9.684)	28.46 (43.32)	20.03 (22.57)	2.694 (16.48)
Change in trend ( $\beta_2$ )	-0.127 (20.57)	8.895 (8.674)	21.54*** (5.684)	43.03 (40.87)	21.73 (16.73)	7.525 (9.576)
Incentive value (M. COP 2013)	-.00260*** (0.00024)	-.00259** (0.00022)	-.00272** (0.00021)			
Constant	160.3*** (23.98)	148.9*** (14.59)	134.5*** (12.67)	2.019 (43.19)	18.59 (22.06)	39.07** (15.73)
<b>Observations</b>	591	799	995	63	84	109

**Source: Own elaboration (2025).**

In summary, the results of the second hypothesis suggest that the storage incentive has a smoothing effect on rice producers' net income, especially in irrigated areas, where production conditions are more stable and market signals may be more effective. In these areas, the program's implementation reverses the negative trend in margins typically observed in the months prior to the start of the incentive. In non-irrigated areas, the effect is weaker and less consistent, possibly due to greater climate and productivity variability, which may limit the program's effectiveness as an income stabilization mechanism. In both cases, a higher total value of the Program is associated with a decrease in profitability for the producers.

### **Hypothesis 3: The storage incentive influences production decisions**

To approach the influence of the storage incentive on producers' decisions, we ran the following model and obtained the results described in Table 6. Note that in the regression we took the total value of the incentive in the previous semester.

$$Y_{i,t} = a_i + \lambda_t + \beta_1 \cdot \text{Incentive}_{i,t-1} + \beta_2 \cdot \text{Price}_{i,t-1} + \beta_3 \cdot \text{Cost}_{i,t-1} + \varepsilon_i$$

**Table 6. Linear regression results for production, yield, and planted/harvested area**

	Production	Harvested Area	Planted Area	Yields
Incentive <sub>t-1</sub>	2.4463**	0.3777*	0.4948	0.000083
	(0.9055)	(0.1667)	(0.2703)	(0.00007)
Price <sub>t-1</sub>	0.0120*	0.0017*	0.0001	0.0000
	(0.0057)	(0.0007)	(0.0008)	(0.0000)
Cost <sub>t-1</sub>	11.4468	1.1773	-2.7889	0.0075
	(10.013907)	(1.2832)	(2.1938)	(0.0023)
N	385	385	385	385

**Source: Own elaboration (2025).**

The results show that the storage incentive provided in the previous semester is associated with changes in farmers' decisions, particularly through increased production. The results show that, on average, for every additional million pesos of incentive provided in a semester, production in the following semester increases by 2.45 tons per municipality, a statistically significant result. This effect is not associated with yield improvements, but rather with an increase in the area harvested: the incentive is associated with 0.38 additional hectares harvested, suggesting an extensive response on the part of producers.

In this sense, the incentive is not only related to post-harvest market conditions but also appears to influence farmers' production decisions. This finding implies that its implementation can induce adjustments in the magnitude of available supply in the following cycle, through the continuation or expansion of areas designated for cultivation due to the reduction in perceived market risk.

**Hypothesis 4: The storage incentive influences the prices of white rice that reach the final consumer.**

To explore whether the storage incentive influences the final consumer, we evaluated the relationship between the price of white rice at wholesale centers and the average price of green paddy rice at mills in previous semesters, with and without the incentive. To do this, we estimated the following model and obtained the results presented in Table 7. Since green paddy price data are only available in municipalities with mills, where there are not necessarily wholesale centers, we explored this effect at the municipal, departmental, and rice-growing area levels.

$$Y_{i,t} = \alpha + \beta_1 \cdot \text{PriceGreenPaddy}_{i,t-1} + \beta_2 \cdot \text{PriceGreenPaddy}_{i,t-1} \cdot \text{Incentive}_{t-1} + \beta_3 \cdot \text{PriceGreenPaddy}_{i,t-2} + \beta_4 \cdot \text{PriceGreenPaddy}_{i,t-2} \cdot \text{Incentive}_{t-2} + \varepsilon_i$$

**Table 7. Linear regression results of white rice price versus green paddy price lags**

<b>Dependent Variable: Price of premium rice at wholesale centers (COP/kg)</b>			
	<b>Municipality</b>	<b>Department</b>	<b>Rice-growing area</b>
Price Green Paddy rice <sub><i>t-1</i></sub>	-0.417** (0.201)	-0.456** (0.188)	-0.373 (0.311)
Price Green Paddy rice <sub><i>t-1</i></sub> * Incentive <sub><i>t-1</i></sub>	0.593 (0.421)	0.901** (0.374)	0.434 (0.522)
Price Green Paddy rice <sub><i>t-2</i></sub>	0.803*** (0.195)	0.618*** (0.172)	0.616** (0.289)
Price Green Paddy rice <sub><i>t-2</i></sub> * Incentive <sub><i>t-2</i></sub>	-0.713* (0.410)	-0.353 (0.366)	-0.619 (0.513)
incentive value	0.0277** (0.0113)	0.0344*** (0.0120)	0.0266* (0.0150)
Constant	1611.0*** (282.7)	1700.7*** (277.7)	1838.4*** (392.6)
<b>Observations</b>	115	151	90

**Source: Own elaboration (2025).**

The results indicate that, in the absence of the incentive, the price of green paddy rice at the mills in the previous semester has a negative and statistically significant effect on the price of white rice. This suggests that, without intervention, an increase in the harvest price of raw rice translates into a decrease in the price received by the final consumer in the following semester. However, this effect disappears when the storage incentive is introduced. The interaction between the price of paddy rice and the incentive in the previous semester shows a positive relationship, significant at some levels of aggregation, indicating that the incentive alters the original relationship between the two prices. In other words, the existence of the incentive neutralizes or reverses the impact that the price of green paddy rice would have on that of white rice.

## 5. Discussion and Conclusion

The empirical evaluation of the Paddy Rice Storage Incentive Program's impact on the price of green paddy rice and the income of rice producers, as shown above, yields four relevant results regarding the hypotheses raised. We must discuss these findings considering the effectiveness of public policy instruments for rice in Colombia.

As mentioned above, this document analyzes the effectiveness and efficacy of the main rice agricultural policy instruments, considering competitiveness, sustainability, scope, and relevance, to identify opportunities for improvement in Colombian rice policy, specifically for the Dry Paddy Rice Storage Incentive Program.

In this regard, we plan the effectiveness and efficacy analysis using an approach based on the OECD Development Assistance Committee (DAC) Quality Standards for Development Evaluation, which aims to improve the quality and, ultimately, consolidate the contribution of evaluation processes to improving development outcomes (OECD & Organization for Economic Co-operation and Development, 2010). That is, we will consider the criteria of relevance, efficiency, impact, and sustainability in the discussion regarding compliance with rice public policy instruments.

Thus, considering the results of the evaluation of the first hypothesis, we can confirm that the storage incentive smooths the price decline in oversupply scenarios, contributing to a more rapid stabilization of the green paddy rice market. This outcome is evident when using daily data by department and monthly data by municipality.

We find that in the 90 days before the incentive begins in scenario 1, the green paddy price falls at an average rate of \$1,113 COP per ton per day. After the incentive begins, this trend reverses, and the price begins to increase at a rate of approximately \$51 COP per ton per day after 90 days, as the change in slope was \$1,165 COP per ton per day. Meanwhile, in scenarios 2 and 3, there is no sign of stabilization, as the negative slope remains constant, reflecting the seasonal pattern without any market buffer.

Softening the fall in prices in the face of oversupply scenarios was the main objective for which the program was created. Therefore, we can say that this policy instrument is relevant, since its implementation responded to the need to stabilize the market, avoid income crises for producers, and guarantee supply. However, this same result shows that the program's effects related to price stabilization were associated with containment outcomes. This contradiction is because prices were also stabilized because of external price fixing associated with the incentive. This duality of effects makes the incentive perceived as an inconsistent instrument, disconnected from the goals of competitiveness

and modernization of the sector, and closer to a logic of social and political containment. As the milling industry mentioned in the discussion of these results, "The incentive solved short-term problems, but it failed to stem the market reaction".

On the other hand, the lack of results in scenarios 2 and 3 shows that the effect of the Program is dependent on the participation of the mills, the biggest buyers of rough rice, and the ones with the highest storage facilities. Since the program involved a commitment on the buyer's end to respect the price range for all purchases in order to be eligible for the Program, it is unclear whether the price stabilization mechanism really came from a reduction in supply driven by the higher storage incentive, or if the main driver of the market reaction was the de-facto establishment of a price floor. In either case, the relevance of the program depends on giving the buyers the right incentives to participate in the program, store the rice and acquire the price compromises involved with it.

Analyzing the results of hypothesis 2, we observe that the storage incentive also contributes to stabilizing producers' income (margin relative to their production costs). However, its effect is heterogeneous between irrigated and non-irrigated systems, raising the need for differentiated policy design according to the type of production system.

For irrigated producers, whose cost structure is more stable, the incentive softens the drop in profitability by mitigating price volatility, which translates into more stable incomes (four months after the incentive, margins went from falling COP \$27,310 per ton to rising COP \$10,740, representing a complete reversal in the economic trajectory of the product). However, in non-irrigated systems—with greater variations in costs and productivity—we did not observe a significant trend before the incentive, so there is no clear evidence of a structural decline in margins before the treatment, and it is not possible to detect the program's effect on income dynamics.

Considering this stabilization of margins for producers, we observe a second duality in terms of evaluating its effectiveness. Although the incentive is effective because it not only contains price declines but also helps stabilize margins for some types of producers, we identified gaps in coverage and access, especially for small producers without their own infrastructure or specifically non-irrigated producers.

On the other hand, the negative relationship between the total value of the Program and the producer's income suggest that, while the program is somewhat effective to mitigate the immediate drops in income for producers, the effects of higher supply correlated with a higher need for storage cannot be fully mitigated by the Program.

This outcome reaffirms the need for the Colombian agricultural system to have an inclusive, interoperable, and representative agricultural information system to reduce historical gaps that have particularly affected small and medium-sized producers, such as those in the rice sector.

The lack of disaggregated, updated, and connected data across entities has limited the design of differentiated policies. The consolidation of this type of system—as proposed by the Comprehensive Agricultural Risk Management Strategy (SIGRA) would also make it possible to highlight lagging territories, avoid duplication of institutional efforts, and incorporate social variables such as gender, land tenure, and climate vulnerability, thus strengthening rural equity and sectoral resilience (MADR, 2018).

When analyzing hypotheses 3 and 4, we find that the storage incentive has a positive relationship with rice production, as the results suggest an anticipated response from producers, who adjust their harvesting decisions based on the program's expectations. We find that for every additional million pesos delivered through the incentive in the previous semester, production increases by approximately 2.4 tons, and the harvested area increases by 0.37 hectares. This could affect the efficient decision-making process of producers, as it no longer responds mainly to the expectations of what is going to happen in the market, but also to the expectations of future market interventions, as mentioned by (World Bank, 2022).

We also find that the existence of the incentive erases the effect that the price of green paddy rice at mills has on the future price of white rice at wholesale centers. By covering storage costs, the incentive may reduce the effect of green paddy rice on white rice.

These two results have several considerations in terms of effectiveness and efficiency according to OECD criteria. Although the incentive was able to smooth price volatility, it also led to greater oversupply due to excessive increases in production, increased fiscal costs, and dependence on subsidies. This finding would reinforce the idea that the incentive functioned more as a containment policy than as a structural policy for the rice sector.

Furthermore, there has been much discussion among members of the rice production chain regarding the financial inefficiency of the incentive. Many stakeholders suggest that the invested resources could have generated greater value if they had been allocated to infrastructure or production technologies. There has also been discussion about whether the year-over-year allocation of the incentive budget seemed more like a matter of policy decisions and negotiations with major players than a rigorous process in terms of economic stability.

Thus, through an evaluation of the storage incentive, the study identified structural problems in the Colombian rice sector, such as weaknesses in the competitiveness of the primary sector (production link), marked seasonality of production, high price volatility, and increasing vulnerability to climate events.

The results show that, while the incentive contributed to stabilizing prices in the short term, it also generated significant market distortions. This instrument has promoted overproduction, sustained artificially high prices, and reduced incentives to improve the sector's productivity and competitiveness, perpetuating a dependence on subsidies and emergency intervention mechanisms.

In this context, it is essential to analyze the fiscal cost associated with these policies, highlight their reactive nature and their impact on the sector's efficiency, and design a transition plan that gradually eliminates distorting incentives and prepares the chain to be competitive, especially in light of the complete elimination of tariffs by 2030, as established in the FTA with the United States.

## 6. References

- Fedesarrollo. (2022). *La cadena del arroz en Colombia: diagnóstico y perspectivas*. Bogotá, Colombia: Fedesarrollo.
- Abokyi, E., Strijker, D., Asiedu, K., & Daams, M. (2022A). *Buffer Stock Operations and Well-Being: The Case of Smallholder Farmers in Ghana*. *Journal of Happiness Studies*, 23(1), 125-148. <https://doi.org/10.1007/s10902-021-00391-4>.
- Abokyi, E., Strijker, D., Asiedu, K., & Daams, M. (2022B). *Buffer Stock Operations and Well-Being: The Case of Smallholder Farmers in Ghana*. *Journal of Happiness Studies*, 23(1), 125-148. <https://doi.org/10.1007/s10902-021-00391-4>.
- Arfini, F., Antonioli, F., Cozzi, E., Donati, M., Guareschi, M., Mancini, M., & Veneziani, M. (2019). *Sustainability, Innovation and Rural Development: The Case of Parmigiano-Reggiano PDO*. *Sustainability*, 11(18). <https://doi.org/10.3390/su11184978>.
- Cadena Torres, J., Cuello Pérez, D., Romero Ferrer, J., & Pérez Cantero, S. (2021). *Caracterización del sistema de producción de arroz criollo en La Mojana, Colombia*. *Cien. Agri.*, 18(2): 67-82. <https://doi.org/10.19053/01228420.v18.n2.2021.11610>.
- Card, D., Lee, D., Pei, Z., & Weber, A. (2015). *Inference on Causal Effects in a Generalized Regression Kink Design*. *Econometrica*, 83(6), 2453-2483. <https://doi.org/10.3982/ecta11224>.
- Dana, J., & Gilbert, C. (2009). *Managing Agricultural Price Risk in Developing Countries*. En *Risk Management in Commodity Markets* (pp. 207-237). John Wiley & Sons, Ltd. <https://doi.org/10.1002/9781118467381.ch13>.
- DANE. (2014). *Censo Nacional Agropecuario 2014. Estadísticas por tema*. <https://www.dane.gov.co/index.php/estadisticas-por-tema/agropecuario/censo-nacional-agropecuario-2014>.
- DANE. (2024). *Quinto Censo Nacional Arrocerero (5° CNA) 2023 Primera entrega*. <https://www.dane.gov.co/files/operaciones/CNA/bol-5toCNA-2023.pdf>.
- Dong, Y. (2011). *Jumpy or Kinky? Regression Discontinuity without the Discontinuity*. University of California–Irvine. <http://www.economics.uci.edu/files/economics/docs/workingpapers/20112012/dong-07.pdf>.

- Escobar Fernandez, J. (2025). *Colombia dejaría de producir arroz en el primer semestre de 2025 debido a estas preocupantes razones*. <https://www.infobae.com/colombia/2025/03/06/colombia-dejaria-de-producir-arroz-en-el-primer-semester-de-2025-debido-a-estas-preocupantes-razones>
- FAO. (2023). *Food Balance Sheets*. FAOSTAT. Obtenido de <https://www.fao.org/faostat>.
- Fedearroz. (2023). *Incentivo al almacenamiento: Una herramienta inspirada ante todo por el bien común*. Fedearroz. <https://fedearroz.com.co/es/publicaciones/editoriales/incentivo-al-almacenamiento-una-herramienta-inspirada-ante-todo-por-el-bien-com%C3%BAn/>.
- Fertó, I. (1995). *Methods for Stabilizing Agricultural Prices in Developing Countries*. *Acta Oeconomica*, 47(1/2), 155-169.
- Galtier, F., Vindel, B., & Timmer, P. (2013). *Managing food price instability in developing countries: A critical analysis of strategies and instruments*. *Agritrop*. <https://agritrop.cirad.fr/568954/>.
- Ibrahim, H. (2018). *Postharvest Loss in Rice: Causes, Stages, Estimates and Policy Implications*. *Agricultural Research & Technology: Open Access Journal*. 15. 10.19080/ARTOAJ.2018.15.555964.
- Imbens, G., & Lemieux, T. (2008). *Regression discontinuity designs: A guide to practice*. *Journal of Econometrics*, 142(2), 615-635. <https://doi.org/10.1016/j.jeconom.2007.05.001>.
- Juganas, T., Regalado, M. J., & Ramos, J. (2023). *Improving Rice Quality and Minimizing Losses through Effective Postharvest Management*. .
- MINAGRICULTURA. (2021). *Resolución 000221 de 2021. Normatividad*. <https://www.minagricultura.gov.co/Normatividad/Resoluciones/RESOLUCI%C3%93N%20NO.%20000221%20DE%202021.pdf>.
- MINAGRICULTURA. (2022). *Resolución 00243 de 2022*. <https://www.minagricultura.gov.co/SIG/DocumentosNormograma/RESOLUCI%C3%93N%20NO.%20000243%20DE%202022.pdf>.
- Novikova, M. (2021). *Transformative Social Innovation in Rural Areas: Insights from a Rural Development Initiative in the Portuguese Region of Baixo Alentejo*. *European Countryside*, 13(1), 71-90.

Reutlinger, S. (1976). *A Simulation Model for Evaluating Worldwide Buffer Stocks of Wheat*. American Journal of Agricultural Economics, 58(1), 1-12.

Reutlinger, S. (1976). *A Simulation Model for Evaluating Worldwide Buffer Stocks of Wheat*. American Journal of Agricultural Economics, 58(1), 1-12.

Schut, M., Leeuwis, C., Sartas, M., Andrade, L., Van Etten, J., Muller, A., . . . Thiele, G. (2022). *Scaling Readiness: Learnings from Applying a Novel Approach to Support Scaling of Food System Innovations*.

Shpykuliak, O., & Sakovska, O. (2020). *AGRICULTURAL COOPERATION AS AN INNOVATION FOR RURAL DEVELOPMENT*. Baltic Journal of Economic Studies, 6, 183-189. <https://doi.org/10.30525/2256-0742/2020-6-3-183-189>.

Thistlethwaite, D., & Campbell, D. (1960). *Regression-discontinuity analysis: An alternative to the ex post facto experiment*. Journal of Educational Psychology, 51(6), 309-317. <https://doi.org/10.1037/h0044319>.

UPRA. (2022). *Riego en arroz: un reto urgente para la investigación agropecuaria*. <https://www.agronet.gov.co/Noticias/Paginas/Riego-en-arroz-un-reto-urgente-para-la-investigaci%C3%B3n-agropecuaria.aspx>

Varangis, P., Gilber, C., & Dehn, J. (2004). *Agricultural Commodity Price Volatility*.

Wright, B., & Williams, J. (1982). *The Economic Role of Commodity Storage*. The Economic Journal, 92(367), 596-614. <https://doi.org/10.2307/2232552>.

## 7. Annexes

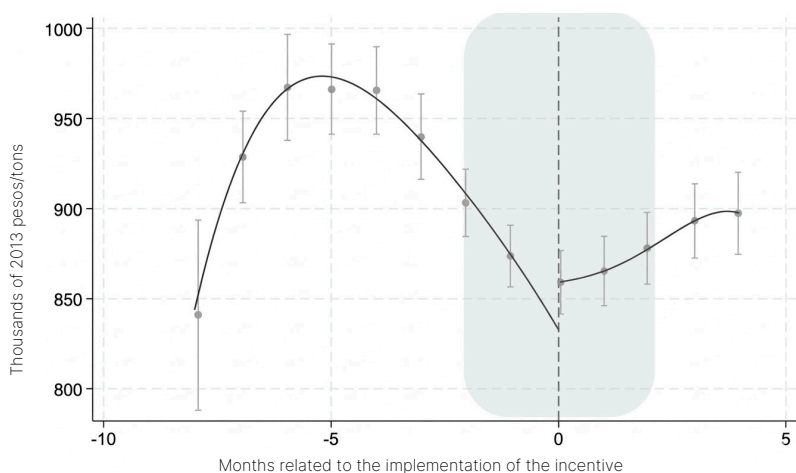
### Annex 1: Robustness test with alternative dates for 2024

Since the Storage incentive program was not implemented in 2024, we assumed the counterfactual date of August 1 for the principal analysis of scenario 3, which approximates the midpoint of the program's historical implementation range. As a robustness check, we estimated the RKD models using two alternative dates: August 15 (the incentive implementation date in 2020) and September 4 (the latest date on record, 2015). The results of this sensitivity test indicate that the conclusions regarding the absence of the incentive in 2024 remain robust under different assumptions about the counterfactual implementation date.

### Annex 2: Monthly green paddy rice price at mills by municipality (2013-2024)

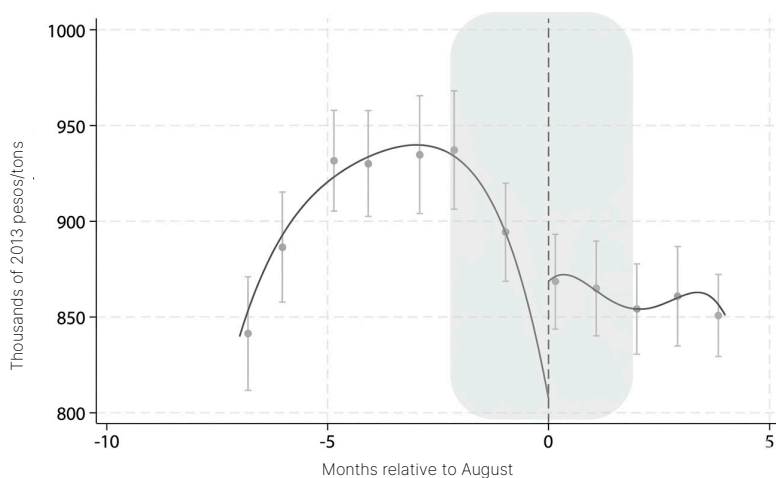
When we analyze green paddy rice prices at mills at the municipal level, we find consistent results. Below is the monthly average price trajectory for 2014 and 2024, years in which the storage incentive was in effect and years in which it was not. In both cases, we observe a pattern like the daily price data. During years with the incentive, the seasonal decline in prices prior to its implementation stabilizes more quickly than in years without the program.

#### Monthly price of green paddy rice at mills relative to the month in which the incentive began (years with incentive)



Source: Elaborated by authors based on data from DANE – SIPSA

### Monthly price of green paddy rice in mills relative to August (years without incentive)



Source: Elaborated by authors based on data from DANE – SIPSA

Dependent variable: Price of green paddy rice at mills (thousands of 2013 pesos/ton)						
	Years with incentive			Years without incentive		
	2 months	3 months	4 months	2 months	3 months	4 months
Pre-incentive trend ( $\beta_1$ )	-21.10** (9.276)	-23.48*** (3.991)	-27.20*** (2.691)	-35.07 (28.90)	-29.02** (11.33)	-18.42*** (6.602)
Incentive effect ( $\tau$ )	4.606 (10.39)	6.133 (6.130)	9.840* (5.415)	9.618 (32.39)	2.957 (17.50)	-10.58 (13.47)
Change in trend ( $\beta_2$ )	26.21*** (9.649)	32.49*** (4.401)	38.00*** (3.096)	32.40 (30.03)	24.60** (12.50)	14.07* (7.629)
Incentive value (M. COP 2013)	-.00024** (0.00012)	-.00033** (0.00012)	-.00051*** (0.00012)			
Constant	842.4*** (11.85)	842.9*** (8.217)	842.7*** (7.825)	762.7*** (33.09)	768.2*** (18.36)	779.0*** (14.34)
<b>Observations</b>	1116	1534	1918	222	304	391



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