Evidence of Climate Change Impact on Quantity of Rice-Planted Areas in Panama

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Abstract

This paper provides statistical evidence of a positive correlation between anomaly precipitation and the variation of planted hectares of rice. Panamanian farmers reduce planted areas of rice when they experience lower levels of rain.

Introduction

In 2023, the Panama Canal experienced an unprecedented drought that made international news headlines due to its impact on ship transit and global trade.

"El Niño" phenomenon lengthened the dry season and reduced rainfall in 2023, affecting the agricultural sector, too. Specifically, the rice sector recorded a 7.1% reduction in the hectares of rice planted, decreasing from 95,182 hectares in 2022 to 88,401 hectares in 2023.[1]

This paper is organised as follow: The first section presents how climate threats can affect rice production. The second section describes the results obtained for the relationship between abnormal rainfall and the variation of hectares planted with rice in the country. The last section provides conclusions.

Rice Production and Climate Treats

Rice cultivation depends on climatic conditions such as temperature, precipitation, and water availability; extreme temperature variations and lack or excess rainfall impact crop productivity.

Greater frequency and intensity of droughts and floods reduce rice production, [2] and temperature rise reduces growth duration and grain filling duration, resulting in lower yield and lower quality rice grain.[3]

Between 1971 – 2020, Panama experienced a mean temperature increase of 1.1°C and a decrease in precipitation of 140.9 mm. [4]

If temperature increases continue and there are reductions in accumulated precipitation, the rice production levels will decline; if farmers do not adapt to climate change, the country will have a deterioration of future rice harvests.[5]

Statistical Evidence

With the agricultural closure information from the Ministry of Agricultural Development (MIDA), we evaluate the percentage change in the number of hectares of rice cultivated for the period 2010-2023 and its correlation with the anomaly precipitation levels of each year obtained from the MeteoBlue.com site.

The following table shows the data for the analysis period that generated a correlation coefficient of 0.705. This coefficient shows us that there is a positive relationship between precipitation and variation of rice-planted areas. The higher the amount of rainfall, the higher the level of rice-cultivated hectares, and vice versa, the less amount of rainfall, the lower the level of hectares that farmers proceed to plant with rice.

Agricultural Closure			Hectares planted	Variation	Anomalous Precipitation
2010	-	2011	64,218		
2011	-	2012	67,048	4.4%	-82.1
2012	-	2013	63,754	-4.9%	-255.5
2013	-	2014	67,073	5.2%	-237.3
2014	-	2015	52,428	-21.8%	-407.6
2015	-	2016	57,066	8.8%	103.4
2016	-	2017	66,231	16.1%	-219.0
2017	-	2018	70,937	7.1%	-3.0
2018	-	2019	72,033	1.5%	-377.2
2019	-	2020	74,635	3.6%	-88.2
2020	-	2021	87,635	17.4%	279.8
2021	-	2022	95,182	8.6%	170.3
2022	-	2023	88,401	-7.1%	-328.5
			Correlation Coefficient (r):		0.705

To validate the statistical significance of the obtained Pearson Correlation Coefficient, a Student's T-test is applied given the following steps:

- Step One. Statement of the Null Hypothesis and the Alternative Hypothesis:

[1] Ministry of Agricultural Development (MIDA). (2024). Agricultural Closure 2022-2023.

[2] Serey, S. et. al. (2021). Climate Change Impacts on Rice Cultivation: A Comparative Study of the Tonle Sap and Mekong River. *Sustainability.* Vol. 13(16).

[3] Jagadish. K., et.al. (2009). Regional vulnerability of climate change impacts on Asian rice production and scope for adaptation. *Advances in Agronomy.* Vol. 102.

[4] Climate Change Knowledge Portal. (2024). Climate Risk Profile: Panama. World Bank.

[5] Mora, J. et al. (2010). Panama: Effects of climate change on agriculture. CEPAL.

H_o: r=0 There is no relationship between the level of rainfall and the variation in the number of hectares cultivated with rice.

H_1: r≠0 There is a relationship between the level of rainfall and the variation in the number of hectares cultivated with rice.

- Step Two. We calculate the Student's T-statistic:

$$\frac{r\sqrt{n-2}}{\sqrt{1-r^2}} = \frac{0.705\sqrt{12-10}}{\sqrt{1-0.705^2}} = 3.14$$

- Step Three. We establish the Student's T-Table Value:

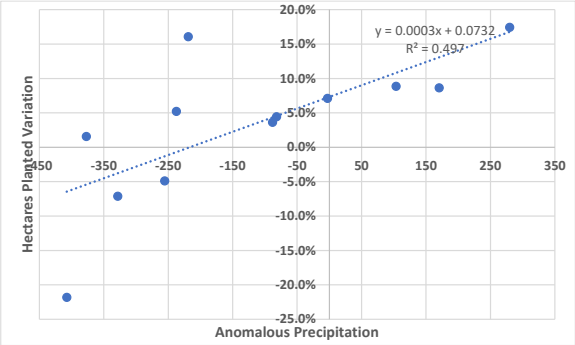
At a significance level of 2.5% (two-tailed), for ten (10) degrees of freedom, the Student's T-Table Value is -2.22. [Excel Function INV.T (2.5%;10)]

- Step Four. We make a decision:

As the Student's T-statistic is less than the Student's T-Table Value (-2.22 < 3.14), we reject the Null Hypothesis; thus, we conclude that at a significance level of 2.5%, there is a relationship between the variation of planted hectares and the level of anomaly precipitation of the year.

Conclusions

The next graph shows the positive correlation between anomaly precipitation and the variation of planted hectares of rice.



Therefore, a lower rainfall level in the country and the higher presence and intensity of droughts can reduce rice production through crop loss, lower yield per hectare, and lower sowing of cultivated areas.

Panama produces 88% of national rice using the rainfed system. Rainfed production depends on rainfall levels. Consequently, farmers anticipating or suffering from low availability of rainwater tend to reduce their rice-planted areas.