



A COMPARATIVE STUDY ON GROWTH AND INSTABILITY OF PRODUCTION AND PRODUCTIVITY OF RICE IN INDIA AND THAILAND

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Abstract

The majority of the people in both India and Thailand are directly or indirectly related to farming activities. Both nations are among the highest producers of rice of the world. The production of rice in India has been increasing since 2013-14 while in Thailand it has been decreasing since the last decade. Moreover, Thailand has been the highest exporter of rice in the world, but since 2013-14 the export of rice from Thailand has been decreasing. However, the export of rice has been increasing from India during the same period. In this research paper, we aim to compare the pattern of growth in the area used for production, production and productivity of rice in both nations. The study also examines the instability of growth of production, productivity, export and import. The finding shows that the change in climatic conditions has been the major factor for the decrease in production and productivity of rice in Thailand, while in India, the extensive use of fertilizers and pesticides results in increase of production of rice.

Keywords: Production, Productivity, Growth rate, CAGR, Instability.

Introduction

Rice (*Oryza sativa*) being one of the staple foods for more than half of world population provides global food security (Thongrattana, 2012). Rice contributes around 41 per cent of total food grains production and nearly 58 per cent households are directly or indirectly associated with agriculture (Bandumula *et al.*, 2022). Though, India is the second largest producers of rice in the world after China while its productivity stands at 2578 kg per ha (Skand *et al.*, 2020). India is the largest exporter of rice in the world followed by Thailand and Vietnam. Although with the increase in innovations of technology the production of rice has increased in the last two decades but instability in production increased distress to the cultivators (Singh *et al.*, 2021) and this instability in production leads to the fluctuations of the price in the market (Jainuddin *et al.*, 2017). Also the land reform operation has structurally impacted positively in growth of rice production in various states of the India (Prasanna *et al.*, 2009). But post the green revolution, the use of fertilizers has increased and adversely affected the fertility of the soil and altered the micro biota of the soil (Nelson *et al.*, 2019).

Singh et.al. (2021) in their studies found that the production and productivity of rice in India is influenced by climatic conditions. The production of rice has a significance effect with the use of fertilizers. Lakshmi (2009) in her research work found change in the production of rice in the area treated with fertilizers. However, excessive use of fertilizers caused the imbalance in the productivity (Jayanti, 2012). (Widjajanto et.al, 2021) studied the use of silicate fertilizer on namely Pandanwangi and Mentiksusu rice. But it found that it has no effect on its growth and productivity. Moreover, the rice production in the state is highly dependable on rain fed area and lack of fertilizer management system is the main cause of instability in growth of rice productivity (Daimary and Barman, 2023). Majority of the production of rice are from the Asian nations. But Thailand was the largest exporter of rice of the world since early 2000's. However, since 2013-14 the export of rice from Thailand has been decreasing and took over by India.

From 1960 to 2000, the Govt. of Thailand allocated 35. 74 % of all agricultural research budgets for which a turning point can be seen in the improvement of rice production since 1966 in Thailand (Jaroensathapornkul, 2007). The government policies and supporting production of rice through Green Revolution initiatives and commercialization has embedded into the chain of business both domestically and internationally and became the top exporter of rice of the world (Kerdnoi et. al, 2014). The efficiency and effectiveness of rice production impacts the policy decisions in Thailand (Sachchamarga and Williams, 2004). Kawasaki and Herath (2011) predicted the productivity of Suphanburi rice, Sanpathong rice, and Chainat rice varieties in North Eastern part of Thailand and these varieties will appear to decrease during the years 2050-2059 and 2090-2099, which was presumably due to unpredictability of climatic conditions. But Chang rice variety was considered to maintain rice productivity under future climatic conditions. Hom Mali rice of Thailand comprises eighty per cent of total rice exported from Thailand (Changkid, 2017).

In the last decade the production of rice in Thailand has been decreasing (Table 3) while a spike has been seen in case of India (Table 1). A comparative study was carried out to determine the pattern of production and instability in the export and import of rice in both the nations. The study also aims in analysing the reasons for growth in productivity of rice as well as its export in India, moreover, for decreasing in export of rice from Thailand and losing its spot as a rice exporter nation. However, both nations have seen increase in import of rice and so we aim to explore the reasons behind it.

Materials and Methods

The secondary data of area, production, productivity, export and import used for analysing are collected from Food and Agriculture Organization (FAO) of United Nations Organization from 2011 to 2021. Also the data and information are collected from the books, newspapers, research articles published in various journals and thesis. The collected data are used to assess the growth performance and instability of production of rice in India and Thailand.

Table 1: Area, Production and productivity of Rice in India

Year	Area	Production	Productivity
2011	44010000	157900000	35878
2012	42754000	157800000	36909
2013	44135950	159200000	36070
2014	44110000	157200000	35638
2015	43390000	156540000	36077
2016	43190000	163700000	37902
2017	43774070	168500000	38493
2018	44156450	174716730	39568
2019	43780000	177645000	40577
2020	45000000	178305000	39623
2021	46379000	195425000	42137

Source: Food and Agriculture Organization of United Nations; Area=in hectare, Production=in tonnes, Productivity= in hg/ha

Compound Annual Growth Rate (CAGR) calculates the average annual growth rate over a specific period of time. CAGR is used to estimate the growth analysis in area, production, productivity, export and import (Rani et. al., 2017). The CAGR is estimated using the following formula.

$$\text{CAGR (\%)} = (\text{Anti log } b - 1) \times 100$$

Where, b is the regression coefficient.

The deviation in the growth of area, production and productivity of rice refers the instability and so the coefficient of variations (C.V) is used as tool to measure its instability. But the simple coefficient of variation over estimates the instability in time series data. The Cuddy –Della Valle Index shows the better results of instability (Y Manohar et. al, 2017). The formula to measure Cuddy- Della Valle Index is as follows:

$$\text{Cuddy- Della Valle Instability Index (\%)} = \text{C.V} \times \sqrt{(1 - R^2)}$$

$$\text{And for CV} = \frac{\text{Standard deviation of the variable}}{\text{Mean of the Variable}} \times 100$$

Where, R^2 is the coefficient of determination of the time series.

The Pearson Co-efficient of correlation is calculated in order to find out the nature of relationship among the variables taken for the study.

Results and Discussions

The area used for production, its total production and productivity is shown in Table 1. The Table 2 indicates about the percentage change in area, production and productivity of rice in India with respect to its previous year. The area used for production in India increased at the rate of 3.23 per cent in 2013 which is the highest in the last decade. It might be because of increase in global demand and domestic consumption.

While it decrease for the next three years in India. But an increase in area of production can be seen in 2017 which increases at the rate of 1.35 per cent. Moreover, there is an increase of 3.064 per cent in 2021 from 2020 in the area used for production. The production of rice also increased from 0.37 per cent to 9.60 per cent in 2021. The increase in production of rice in 2021 results in increase in its productivity to 6.34 per cent from -2.35 per cent. While there is a marginal increase in the area used for production in 2012 but it decreases for next consecutive years till 2015 in Thailand shown in Table 4. However, in the last decade the area used for production increases at 10.45 per cent in 2016 which lead to increase in production of rice to 14.99 per cent with respect to its previous year. It may be due to unpredictable climatic changes and rise in water sea level that leads to instability in the production. Moreover, the productivity of rice increased to 2.76 per cent from -0.34 per cent in 2021.

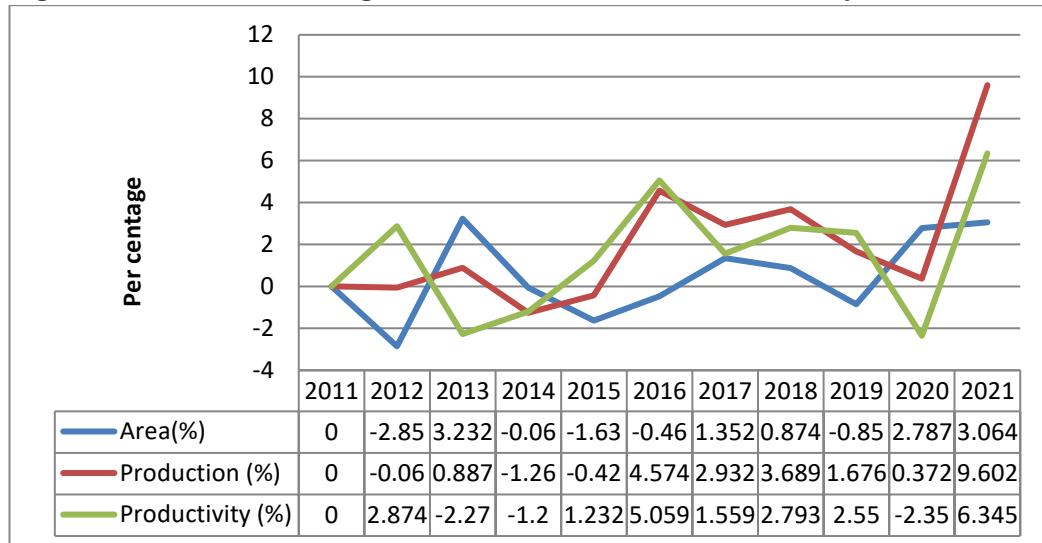
Table 2: Year-to-Year change in Area, Production and Productivity of rice in India

Year	Area(%)	Production(%)	Productivity(%)
2011	----	-----	-----
2012	-2.854	-0.063	2.874
2013	3.232	0.887	-2.273
2014	-0.059	-1.256	-1.198
2015	-1.632	-0.420	1.232
2016	-0.461	4.574	5.059
2017	1.352	2.932	1.559
2018	0.874	3.689	2.793
2019	-0.853	1.676	2.550
2020	2.787	0.372	-2.351
2021	3.064	9.602	6.345

Table 3: Area, Production and Productivity of Rice in Thailand

Year	Area	Production	Productivity
2011	11956638	38102720	31867
2012	11956781	38100189	31865
2013	11684315	36762277	31463
2014	10664923	32620160	30586
2015	9717975	27702191	28506
2016	10734279	31857000	29678
2017	10719698	32898903	30690
2018	10647941	32348114	30380
2019	9812614	28617948	29164
2020	10401653	30231025	29064
2021	11244000	33582000	29867

Source: Food and Agriculture Organization of United Nations; Area=in hectare, Production=in tonnes, Productivity= in hg/ha

Figure 1: Year-to-Year change in Area, Production and Productivity of rice in India**Table 4: Year-to-Year change in Area, Production and Productivity of rice in Thailand**

Year	Area (%)	Production (%)	Productivity (%)
2011	----	----	----
2012	0.001	-0.007	-0.006
2013	-2.279	-3.512	-1.262
2014	-8.724	-11.267	-2.787
2015	-8.879	-15.076	-6.800
2016	10.458	14.998	4.111
2017	-0.136	3.271	3.410
2018	-0.669	-1.674	-1.010
2019	-7.845	-11.531	-4.003
2020	6.003	5.637	-0.343
2021	8.098	11.085	2.763

The Table 5 shows the compound annual growth rate in both India and Thailand. The growth rate of area use for cultivation increases at the rate of 0.41 per cent over the period of time in India. But the area in Thailand decreases at the rate of 1.16 per cent during the same period. The area used for cultivation in India is fluctuating with a marginal increase in the last decade. The reason for this marginal increase is may be due to shifting of farmers to different cash crops and fetching higher income opportunities through export opportunities. While majority of rice in Thailand is cultivated in North-East region of Thailand (Kawasaki and Herath, 2011). The region is cultivated in rain fed conditions and due to erratic climatic conditions and heavy flooding often results in making unfavourable conditions for the cultivation of crops.(Kawasaki and Herath, 2011 ; Anuchiracheeva and Pinkaew, 2009).

Figure 2: Year-to-Year change in Area, Production and Productivity of rice in Thailand

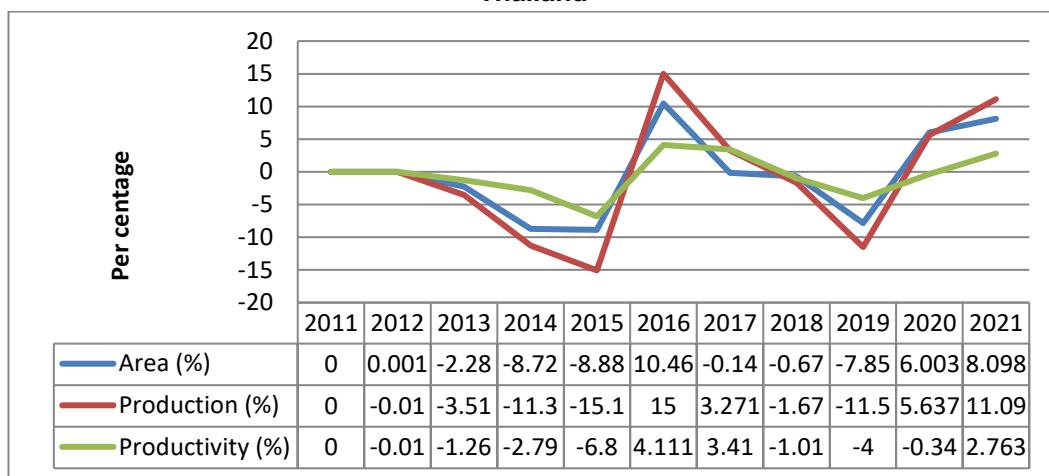


Table 5: CAGR of Area, Production and Productivity of Rice in India and Thailand

Country	Area	Production	Productivity
India	0.41**	1.99*	1.57*
Thailand	-1.16***	-1.93**	-0.77**

* , ** , *** indicates level of significance at 1%, 5% and 10% level of significance respectively

The production of rice in India increases at the rate of 1.99 per cent over the years while Thailand shows a decrease at the rate of 1.93 per cent over the same period. The increase in use of HYV seeds and extensive use of fertilizers and pesticides results in positive growth in production of rice in India. While in Thailand due to change in climatic conditions, change in patterns of rainfall and lack of irrigation facilities in north-east Thailand, and also increase in sea level that brings soil salinity impact the production of rice.

With the increase in production in India, the productivity also increases at the rate of 1.57 per cent over the same period while in Thailand its productivity decreases at the rate of 0.77 per cent. The analysis indicates that with the marginal increase in area used for production and its 1.99 per cent increase over the years in production has positive impact in the overall increase of its productivity in India. While in Thailand increase in drought leads to decrease in its productivity.

The instability of area used for production in India (1.79) is comparatively much more stable than that of Thailand (6.26) as indicated in Table 6. The erratic climatic change in Thailand has adversely affected the area used for production. The data also shows instability in production of rice in India (3.25) and that of Thailand is 8.89 which indicate higher instability in the production of rice since 2011 in the country. This is because of

change is government policies since 2014-15 and direct payment to rice producers with other input subsidies affected the income of the farmers overall (Pilavong, 2012). The policy was not able to achieve the purpose effectively to support producers' income and rather distort the market because somebody other than rice producers has to bear the burden at the end of the day (Kobayashi, et.al, 2016). But overall the instability in productivity of rice in both the nations is relatively less than its rate of production. While the instability in the productivity of rice India at the rate of 2.49 (India) and that of Thailand at 2.90.

Table 6: Instability indices of area, production, productivity of rice in India and Thailand

Country	Area		Production		Productivity	
	CV	CDVI	CV	CDVI	CV	CDVI
India	2.19	1.79	7.40	3.25	5.73	2.49
Thailand	7.10	6.26	10.64	8.89	3.78	2.90

Table 7: Export and Import of Rice in India and Thailand

Year	Export		Import	
	India	Thailand	India	Thailand
2011	5004280	8905751	1093	5269
2012	10470312	10671194	539	10630
2013	11300105	6704304	1323	25742
2014	11092731	6787796	1727	21306
2015	10953469	10951021	1308	6964
2016	9869281	9781624	995	26875
2017	12060844	9870079	1874	14627
2018	11579628	11616113	6502	19500
2019	9731549	11073000	5753	14946
2020	14462834	7751119	4435	29637
2021	21034658	6065097	3650	25211

Source: Food and Agriculture Organization of United Nations; Export= in tonnes, Import= in tonnes

Table 8: Year-to-Year change in Export and Import of Rice in India and Thailand

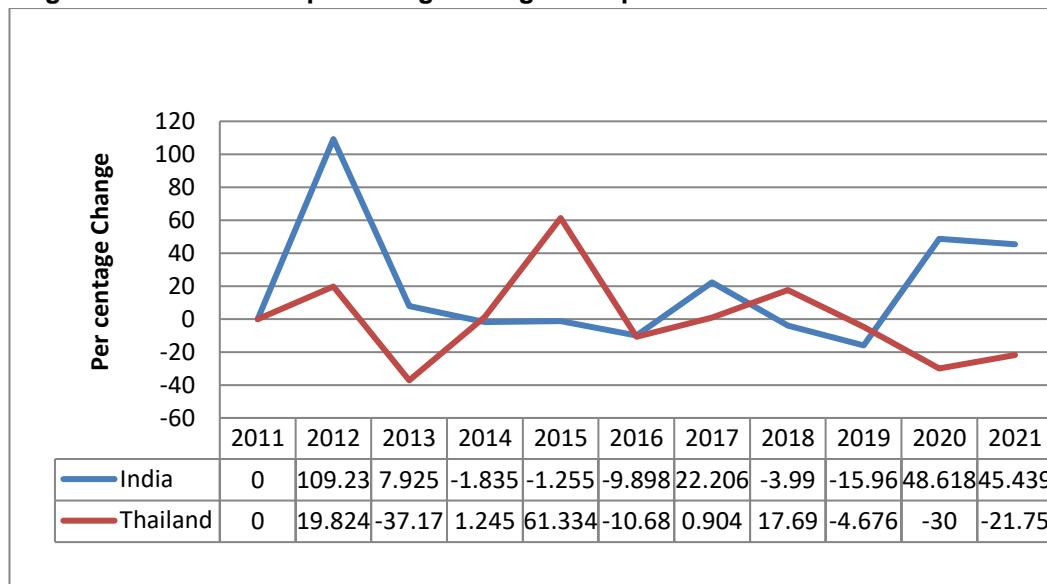
Year	Export (%)		Import (%)	
	India	Thailand	India	Thailand
2011	----	----	----	----
2012	109.227	19.824	-50.686	101.746
2013	7.925	-37.174	145.455	142.164
2014	-1.835	1.245	30.537	-17.233
2015	-1.255	61.334	-24.262	-67.314
2016	-9.898	-10.678	-23.930	285.913
2017	22.206	0.904	88.342	-45.574
2018	-3.990	17.690	246.958	33.315
2019	-15.960	-4.676	-11.520	-23.354
2020	48.618	-30.000	-22.910	98.294
2021	45.439	-21.752	-17.700	-14.934

Table 9: CAGR of Export and Import of Rice in India and Thailand

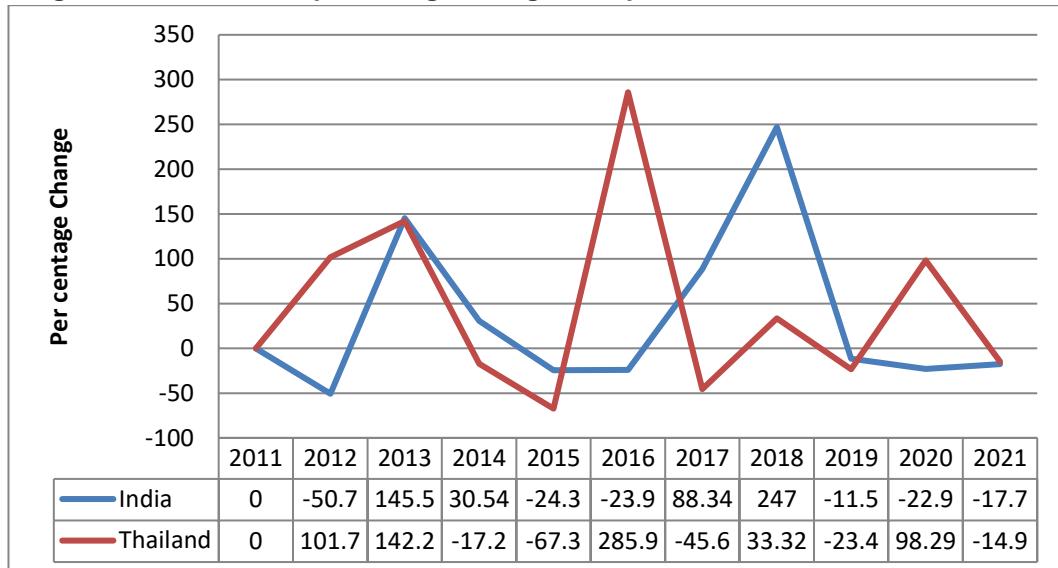
Country	Export	Import
India	7.74**	22.01*
Thailand	-0.65	10.37***

* , ** , *** indicates level of significance at 1%, 5% and 10% level of significance respectively

The export of rice from India increased to 109.22 per cent in 2012 while in the same year the import of rice in Thailand increased to 101.74 per cent. However, in the following year the import of rice in India increased to 145.45 per cent followed by Thailand to 142.16 per cent. The above data shows that export of rice from India increases to 48.61 per cent and 45.43 per cent in 2020 and 2021 respectively while for Thailand its export decreases since 2019.

Figure 3: Year-to-Year percentage change in Export of Rice in India and Thailand

Since 2011 the export of rice in India has been increasing at the rate of 7.74 per cent. This is because of high domestic stocks and comparative cost advantage against other exporting nations allowed India to offer at high discount over the years and that leads to increase in export. However, the import of rice in India is higher than its export due to increase in its domestic consumption. While the export of rice from Thailand have been decreasing at the rate of 0.65 per cent over the years. Droughts and unpredictable rainfall in the tropics where agricultural activities are practiced becomes vulnerable to temperature rise and leads to low productivity in the region (Kawasaki and Herath, 2011). Moreover, the appreciation of Thai Baht in the last decade and costly freight charges leads to decrease in export of rice from Thailand (Pilavong et.al., 2012). But the import of rice in both the countries has been increasing over the years. The import of rice in India is increasing at the rate of 22.01 per cent since 2011. While in Thailand import has been increased at the rate of 10.37 per cent.

Figure 4: Year-to-Year percentage change in Import of Rice in India and Thailand

Conclusion

The study finds that with the increase in production, the export of rice from India has been increasing at a positive rate. The export of rice from Thailand has been decreasing since 2013-14. Due to erratic climatic conditions and heavy flooding often results in making unfavourable conditions for the cultivation of crops in Thailand, which leads to negative growth rate in production over the years. With the increase in its domestic consumption, the import of rice has been increasing with each passing year. Moreover, the growth rate of import of rice is higher than its export in India. The government of India should set a proper strategy to balance the export and import of rice, so that it won't have to import from other nations. Moreover, the government of Thailand should focus on other parts of country also rather than only in north east region for cultivation of rice. Proper irrigation system in both nations will have a major role in its production as major portion of the production depends on rain fed area.

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