INSTABILITY AND GROWTH SCENARIO OF POTATO IN INDIA: AN EMPIRICAL STUDY

Abstract

Potatoes, a global food source in over 150 countries, witnessed significant growth in developing nations since the 1960s. In 2021, global production hit 376.11 million tonnes, with China and India leading. India's potato output soared over seven decades, but instability in Bihar, Gujarat, and West Bengal requires attention through research and technology. The Indo-Gangetic plains, including Uttar Pradesh, West Bengal, Bihar, Punjab, and Gujarat, play a crucial role. Despite fluctuations, these states contribute over 80% to India's potato production. Data from 1950-51 to 2020-21 highlights growth, but post-2000, productivity declined, urging renewed focus. The study advocates increased investment in research and technology for a stable potato industry, essential for India's vegetable production and farmers' income.

Keywords: potato cultivation and it’s growth, Production Profile, and Instability In Production.

Authors

Sonia Chauhan
Chief Technical Officer
ICAR-National Institute of Agricultural Economics and Policy Research
New Delhi, India.
sonia.chauhan@icar.gov.in

Subhash Chand
Principal Scientist
ICAR-National Institute of Agricultural Economics and Policy Research
New Delhi, India.
scchand46@gmail.com

Md. Ejaz Anwer
Research Associate (Market Intelligence)
ICAR-National Institute of Agricultural Economics and Policy Research
New Delhi, India.
dr.ejazanwer@gmail.com

Mangal Singh Chauhan
Chief Technical Officer
ICAR-National Institute of Agricultural Economics and Policy Research
New Delhi, India.
ms.chauhan@icar.gov.in

Arvind Kumar
Young Professionals-II
ICAR-National Institute of Agricultural Economics and Policy Research
New Delhi, India.
arvindkumar30697@gmail.com

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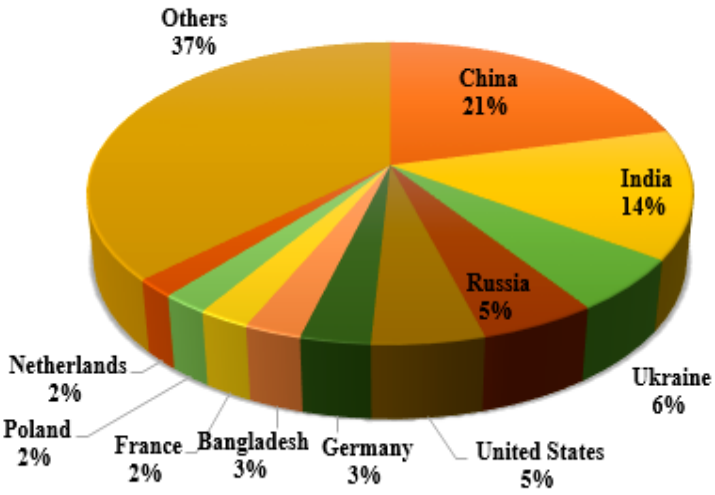
I. BACKGROUND

Potatoes serve as a fundamental dietary staple worldwide and are grown in more than 150 countries. Since the 1960s, the growth of potato cultivation has exceeded that of all other food crops in developing nations. Currently, over half of the global potato yield comes from these developing countries (cipotato.org). In 2021, the total global potato production reached 376.11 million tonnes, indicating a 1.34% increase from the 2020 total of 371.11 million tonnes (FAOSTAT, 2023).

On a global scale, China emerged as the primary contributor to potato production, constituting 21.07% of the world's output, closely followed by India at 13.82%. Ukraine, Russia, and the United States individually contributes around 5% to the overall global potato production. Bangladesh held a three percent share, while France, Netherlands, and Poland collectively represented a two percent stake on the international stage (Figure 1). Notably, China, India, Ukraine, Russia, the United States, and Germany jointly contributed to over 60% of the total global potato yield. The remaining 40% was produced by the rest of the world.

Figure 1: Top ten potato producting countires during 2020



Source: Computed by authors

The potato ranks as the third most vital dietary staple globally, coming after rice and wheat in terms of human consumption. More than one billion people worldwide include potatoes in their diet, contributing to a global crop production exceeding 300 million metric tons (cipotato.org). Potatoes are rich in carbohydrates and provide a valuable combination of protein, vitamins, and minerals, making them a recognized nutritious food source.

The global consumption of potatoes has been steadily increasing, fuelled by its delightful taste and nutritional significance. The leading consumers of potatoes on a global scale are China, India, and the United States. Together, these three countries make up around 47% of the world's potato consumption, with the remainder being consumed by the rest of the world. As of 2020, China, occupying the top position, independently contributes to 27.0% of the total global potato consumption (helgilibrary.com). In India, potatoes are a versatile

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ingredient incorporated into almost every type of vegetable dish. They serve not only as a dietary staple in rural areas but also as a lucrative cash crop, generating substantial income for farmers (Agmarknet, Undated).

The Indo-Gangetic plains in North India are the predominant location for approximately 85% of total potato cultivation. Among these states, namely Uttar Pradesh, West Bengal, Bihar, Punjab, and Gujarat, there is a collective contribution of over 80% to the overall production. Over the past seventy years, India's potato production has shown remarkable growth. Notably, the annual compound growth rate for the potato area, production, and productivity has surpassed that of other major food crops. The potato area, production, and productivity experienced an annual growth rate of 3.23%, 5.32%, and 2.02%, respectively (Table 2).

Hence, the projections for the potato crop during the 2021-22 period have achieved unprecedented levels in both cultivated area and production (GoI, 2021). The cultivated area has expanded to 2.25 million hectares, with a production of 54.23 million tonnes in the 2020-21 fiscal year. This stands in stark contrast to the conditions in 1950-51 when India cultivated a mere 0.24 million hectares, resulting in a modest production of 1.66 million tonnes of potatoes. Potato production has surged since the '60s due to tech advancements, offering year-round opportunities. This chapter explores India's potato production trends, revealing fluctuations post-independence. Kumar et al. (2021) attribute instability to area and productivity changes. Interestingly, the latest decade showed reduced instability compared to 2000-2010. The '60s saw high production instability. To stabilize, focus on quality seeds, advanced tech, and reducing post-harvest losses is crucial. Increased investment in research and technology is essential. Results show state-wise variations, with Bihar and Gujarat having high area instability, while West Bengal leads in productivity but faces high instability, likely due to climatic conditions.

II. REVIEW OF LITERATURE

The assessment of growth and instability has consistently been a focal point in the agricultural economics literature in India. Numerous studies have endeavored to gauge the growth and instability of diverse agricultural commodities in the country (Hazell, 1982; Mahendra Dev, 1987; Saha and Swaminathan, 1994; Larson et al., 2004; Sharma et al., 2006; Chand and Raju, 2009; Kumar and Jain, 2013; Tewari et al., 2017).

While an increase in production is expected, instability in the agricultural sector is on the rise due to various factors. This instability elevates the risks associated with farm production, affecting farmers' income and influencing their decisions regarding the adoption of capital-intensive technologies and investments in farming (Chand and Raju, 2009).

In a 2020 study conducted by Pant et al. on potatoes in the Pithoragarh District of Uttarakhand, it was found that the greatest degree of variability occurred in production, followed by productivity and area. Additionally, the primary source of instability in potato production was attributed to the productivity effect, accounting for approximately 57% of the overall instability, whereas the interaction effect played a minimal role in causing production instability.

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The volatility of potato in the Kavrepalanchok district of Nepal was indicated by the highest coefficient of variation, which stood at 41.36% for production (Rijal et al., 2021).

In 2021, Sharma and Sham Singh conducted a separate examination of potatoes in Himachal Pradesh. Their findings revealed a notable instability in productivity, amounting to 18.87%, spanning the period from 1997-98 to 2017-18. This chapter now presents the empirical outcomes concerning the growth and instability of potato cultivation in the primary producing states of India.

III. DATA SOURCES AND METHODOLOGY

Information regarding crucial aspects like the extent of potato cultivation, production volume, and yield for the period 1950-51 to 2020-21 were collected from the Directorate of Economics and Statistics under the Ministry of Agriculture, Government of India, New Delhi, and the National Horticulture Board. The study's timeframe has been segmented into seven distinct periods, allowing for the observation of changes over decades. The compound annual growth rates of potato area, production and yield were calculated using a semi-logarithmic model. The Annual growth rate was used to assess the trends and pattern in area, production and yield of potato (Avinash et. al, 2018).

The growth was analysed using equation
$Y= ab^te$

Where, Y=area/ production/ productivity of potato, a= intercept, b=regression coefficient, t= time variable, e= error term

The compound growth rate was obtained from logarithmic form of the equation as follows:
$\ln y= \ln a +t \ln b + e$

The per cent compound growth rate (G) was derived as follows
G= (Antilog of b-1)*100

For calculating instability index the methodology used by Chand and Raju (2009) has been adopted. The instability index is given by:

Instability Index = Standard deviation of the natural logarithm (X_{t+1}/X_t)

Here X_t refers to Area (A), Production (P), Yield (Y) in the year "t"; and X_{t+1} denote the same for subsequent year. This index is unit free and robust and measures deviations from underlying trend (log linear in this case). When there are no deviations from the trend, the ratio of X_{t+1} and X_t remains the same and their standard deviation is zero.

IV. SIGNIFICANCE OF THE STUDY

Potatoes continue to maintain their significance as a notable vegetable crop in India. The ongoing shift from cereal to horticultural crops indicates that transitioning from wheat or barley cultivation to potato farming proves more lucrative for farmers (GoI Agmarknet, 2007). Potatoes claim a substantial share of the overall vegetable area and production, as illustrated in Figure 2. Although there has been a gradual decline in the proportion of potatoes

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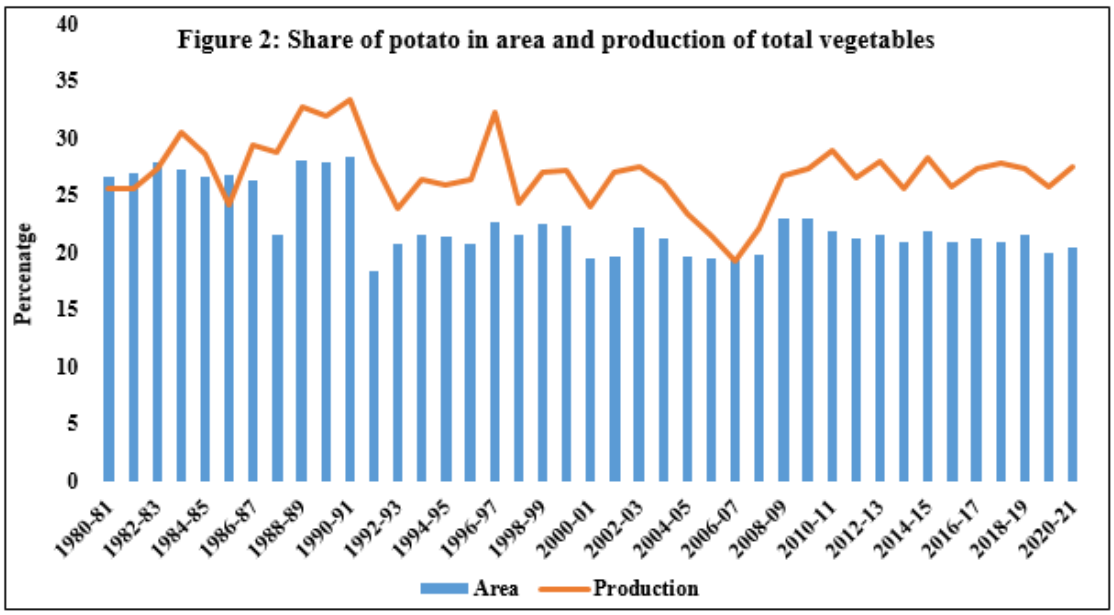
in the total area and production of vegetables from 1990-91 to 2020-21, in the latter period, i.e., 2020-21, potatoes occupied roughly 20 percent of the total cultivated area dedicated to vegetables and contributed around 28 percent to the overall vegetable production in India, as detailed in Table 1.



Source: Compiled from MoA&FW and computed by authors

Table 1: Share of potato in Total Vegetables

Year	Percent area under potato	Percent production of potato
1980-81	26.60	25.65
1990-91	28.34	33.38
2000-01	19.52	23.96
2010-11	21.90	28.89
2020-21	20.50	27.50

Source: Agricultural statistics at a glance, various issues, MoA&FW, GoI.

1. **Production Scenario in India:** Over the course of the past seventy years, India has witnessed a substantial surge in its overall potato production, climbing from 1.66 million tonnes in 1950-51 to 54.23 million tonnes in 2020-21 (Figure 3). During this timeframe, the cultivated area for potatoes expanded threefold, productivity doubled, and the total output increased fivefold. Significantly, India achieved a notable growth of 5.32 percent in potato production from 1950-51 to 2020-21. The area dedicated to potato cultivation saw a growth of 3.23 percent, and there was a noteworthy 2.02 percent increase in productivity over the entire period (Table 2). This heightened productivity can be attributed to various factors, including research, technological advancements, and government initiatives. These initiatives encompass the introduction of genetically improved high-yielding and stress-resistant varieties, the adoption of certified quality seeds, and the implementation of micro-irrigation systems. Additionally, improved techniques for managing insects and pests have played a substantial role in boosting potato production (Rana and Anwer, 2018).

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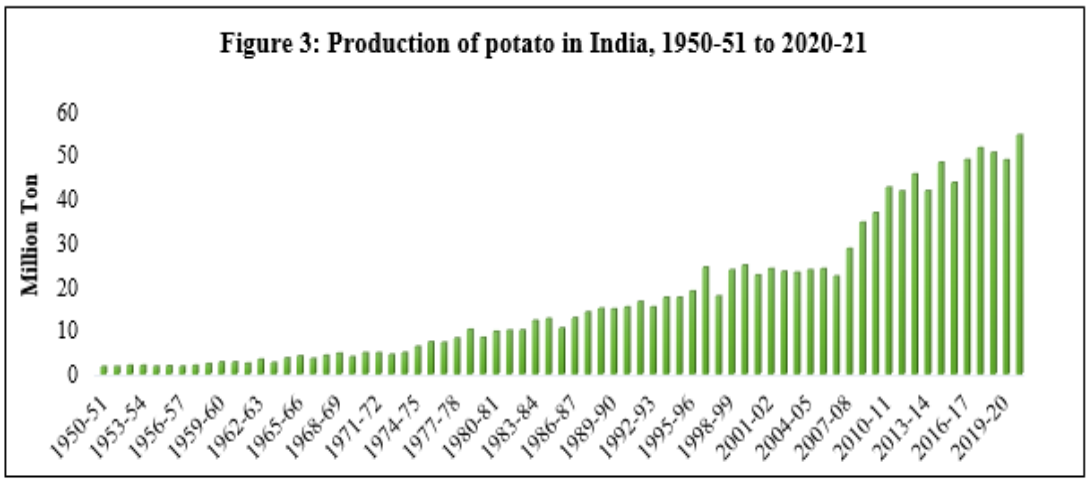
Table 2: Growth rates in area, production and productivity of potato in India (Percent)

Period	Area	Production	Productivity
1950-51 to 1959-60 (50s)	4.46	3.95	-0.56
1960-61 to 1969-70 (60s)	3.89 ↓	6.28 ↑	2.17 ↑
1970-71 to 1979-80 (70s)	5.36 ↑	9.17 ↑	3.71 ↓
1980-81 to 1989-90 (80s)	2.92 ↓	5.17 ↓	2.19 ↓
1990-91 to 1999-2000 (90s)	3.83 ↑	5.44 ↑	1.53 ↓
2000-01 to 2009-10 (20th)	4.81 ↑	4.86 ↓	0.04 ↓
2010-11 to 2020-21 (Recent)	1.56 ↓	2.40 ↓	0.83 ↑
1950-51 to 2020-21 (Overall)	3.23	5.32	2.02

Source: Computed by authors



Source: Agricultural Statistics at a glance, 2021, Department of Agriculture & Farmers Welfare, MoA&FW

Potato cultivation has experienced a significant expansion over the past seven decades (Figure 4). In 1950-51, India cultivated potatoes on 0.24 million hectares, a figure that rose to 2.24 million hectares by 2020-21. The period during the 1970s, following the adoption of the green revolution, witnessed the highest surge in both the area and production of potatoes. Productivity also saw an increase of nearly 4% during this time (Table 2). These trends underscore the prominent importance given to potato cultivation in the country.

Table 2 illustrates that over the span of seventy years, there was positive growth in area, production, and yield, with the exception of the initial period. Notably, after the 2000s, there was a decline in productivity growth (0.04), and the increase in area played a predominant role in boosting production. This underscores the need for increased emphasis on research and development concerning potato varieties, initiatives, policies, and technologies to enhance potato production in the country. Overall, the data reveals a growth of 3.23 percent in area, 5.32 percent in production, and 2.02 percent in productivity (Table 2).

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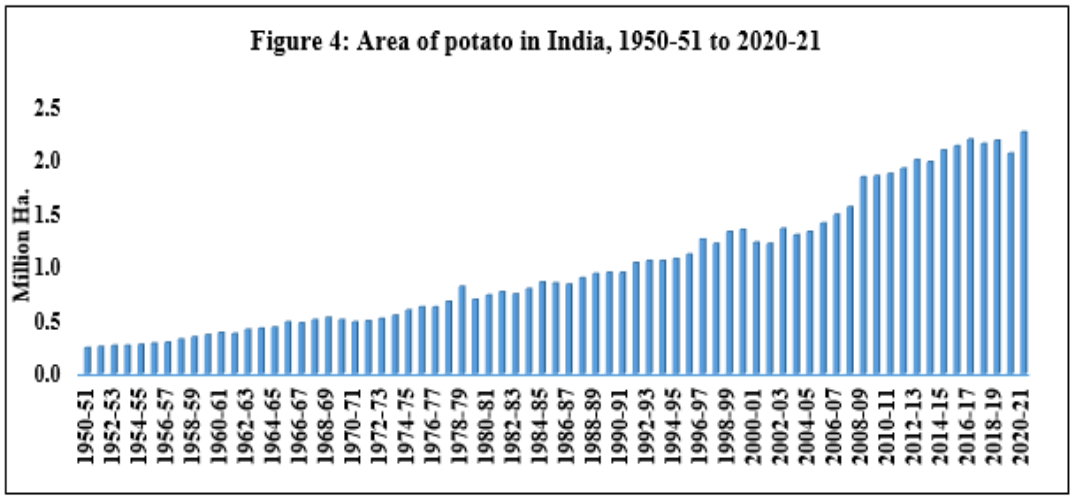
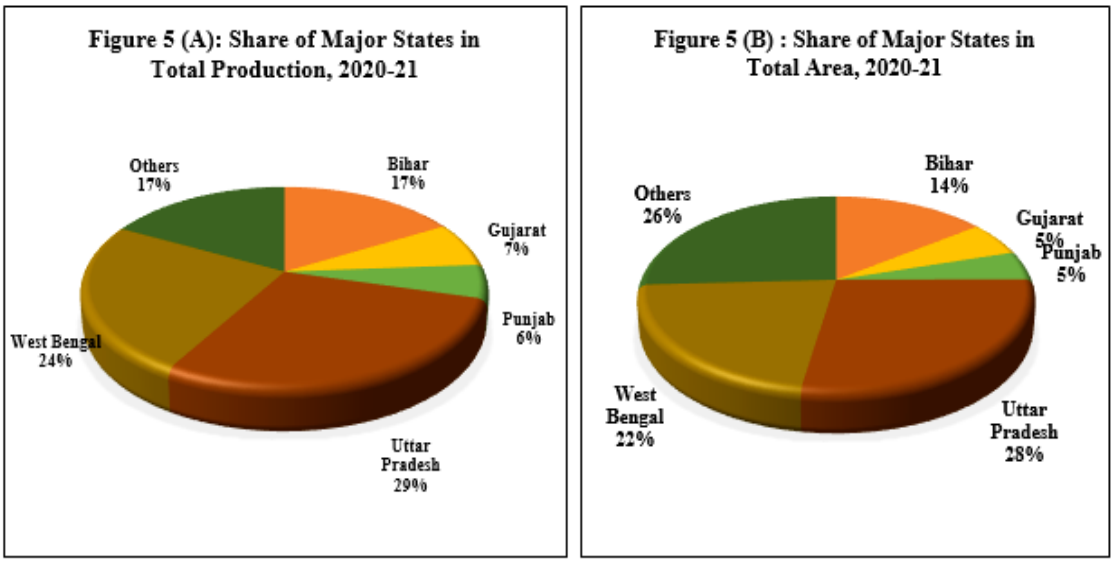


Source: Agricultural Statistics at a glance, 2021, Department of Agriculture & Farmers Welfare, MoA&FW

2. **Share of Major States in Potato Production:** In the realm of Indian states, Uttar Pradesh, West Bengal, Bihar, Gujarat, and Punjab stand out as the frontrunners in both the production and cultivation area of potatoes (Figure 5(a) & (b)). These five states collectively contributed over 80% to the total potato production in the country and constituted more than 70% of the total cultivated area during the 2020-21 period.



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Although, the potato cultivation area in significant states such as Bihar and Uttar Pradesh has decreased in the past decade compared to the preceding one, there has been notable growth in productivity during the same period. This increase in productivity is likely attributed to technological advancements, improved inputs, and effective government policies in these states. Bihar exhibited the highest productivity growth of 6.94% over the last two decades, with Gujarat experiencing the most substantial expansion in the area under potato cultivation (Table 3). In terms of potato production growth in the last two decades, Bihar demonstrated the highest increase, closely followed

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by Gujarat. However, Uttar Pradesh recorded the least growth in production among all the major potato-producing states in the country.

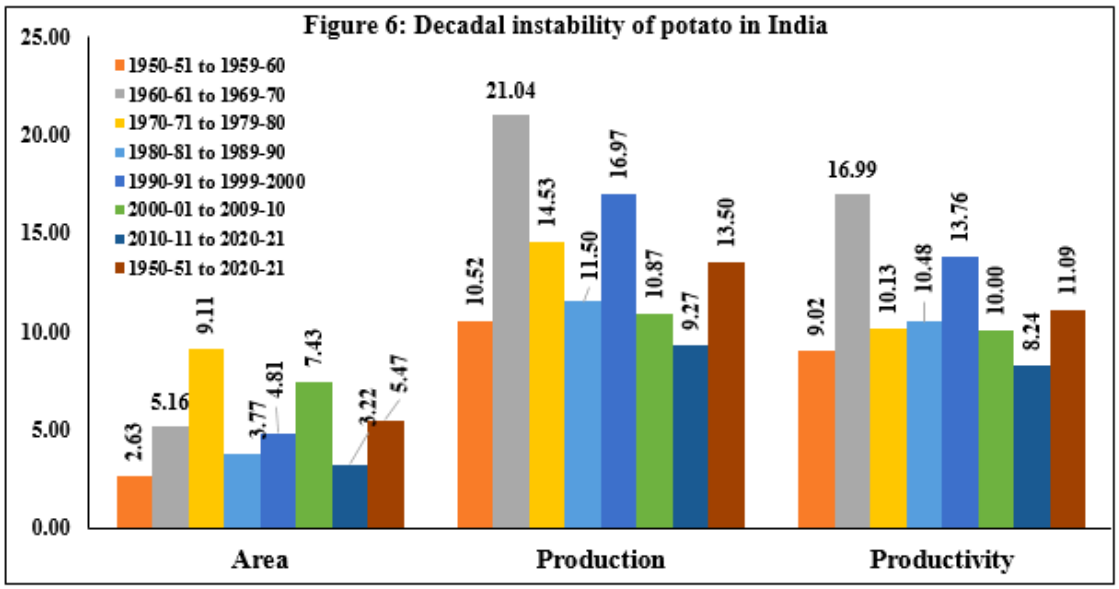
Table 3: Growth in area, production and productivity in major potato producing states, 2000-01 to 2020-21 (%)

States	Period	Bihar	Gujarat	Punjab	Uttar Pradesh	West Bengal	Others
Area	Period-I	8.12	8.92	4.2	3.67	3.43	5.13
	Period-II	-0.62	7.03	2.82	0.71	1.78	2.44
	Overall	5.27	8.26	2.93	2.42	1.96	4.23
Production	Period-I	12.7	11.15	5.62	3.7	2.2	5.3
	Period-II	3.82	7.29	3.79	0.81	1.3	3.81
	Overall	12.58	9.95	4.96	3.1	3.15	7.9
Productivity	Period-I	4.24	2.05	1.36	0.03	-1.19	0.16
	Period-II	4.47	0.24	0.94	0.11	-0.47	1.33
	Overall	6.94	1.57	1.97	0.66	1.17	3.52

Source: Data compiled from Dacnet and computed by authors

Where: Period-I: 2000-01 to 2009-10, Period-II: 2010-11 to 2020-21 and Overall Period: 2000-01 to 2020-21

3. **Instability of Potato in India Production:** Table 4 illustrates the volatility in the potato sector concerning area, production, and yield since gaining independence. The instability in potato production is attributed to fluctuations in both cultivation area and productivity, as noted by Kumar et al. in 2021. A noteworthy observation is the decrease in instability in both area and productivity during the latest period (2010-11 to 2019-20) compared to the preceding decades (2000-01 to 2009-10). The heightened instability in area and productivity in the earlier decades corresponded to an increase in production instability.



Source: Computed by authors

As depicted in Figure 6, production exhibited high instability during the 1960s. The instability index for cultivated area was approximately six percent, and productivity was around eleven percent throughout the entire period. To mitigate production instability, there is a potential avenue through the adoption of quality seeds, implementation of improved technologies, and reduction of post-harvest losses in all states involved in potato cultivation. Consequently, there is a pressing need to prioritize increased investment in research and technological innovations.

Table 4 illustrates the fluctuation in potato cultivation across states in India. Over the past decade, Bihar has experienced the greatest instability in the area dedicated to potato farming, closely followed by Gujarat. In terms of productivity instability, West Bengal took the lead with a recorded rate of 28.05%, followed by Bihar (Table 4). West Bengal boasts the highest productivity, with Bihar following closely. The climatic conditions in these states may be a contributing factor to the observed high instability.

Table 4: Instability index for major potato producing states, 2000-01 to 2020-21 (%)

States	Period	Bihar	Gujarat	Punjab	Uttar Pradesh	West Bengal	Others
Area	Period-1	24.6	20.07	10.93	6.97	9.32	8.37
	Period-II	10.58	11.81	1.62	5.04	5.2	5.45
	Overall	18.3	15.85	7.45	5.88	7.27	6.97
Production	Period-1	47.8	18.93	15.58	12.19	26.85	21.05
	Period-II	7.78	11.62	2.36	9.55	26.44	10.63
	Overall	32.72	15.14	10.58	10.63	25.98	16
Productivity	Period-1	25.03	9.16	12.41	9.59	31.74	16.12
	Period-II	9.21	3.87	2.36	6.35	25.82	8.46
	Overall	18.03	6.75	8.52	7.85	28.05	12.5

Source: Computed by authors

V. CONCLUSIONS & POLICY SUGGESTIONS

In summary, potatoes are a fundamental dietary staple grown in over 150 countries, with significant growth in developing nations since the 1960s. In 2021, global potato production reached 376.11 million tonnes, with China and India being the leading contributors. India's potato production has shown remarkable growth, with the annual compound growth rate exceeding that of other major food crops. However, there are signs of increasing instability, particularly in states like Bihar and Gujarat, impacting farmers' income and decision-making.

To address this instability, it's essential to invest in research, technological innovations, and policies to ensure a stable and thriving potato industry in India. Potatoes continue to maintain their significance in India, with a shift from cereal to horticultural crops, making potato farming more lucrative for farmers. Despite a decline in the proportion of potatoes in total vegetable production, they still occupy a substantial share and contribute significantly to India's vegetable production.

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Over the past seven decades, India has witnessed substantial growth in potato production, driven by increased area and productivity. The role of research, technological advancements, and government initiatives is highlighted in achieving this growth. Uttar Pradesh, West Bengal, Bihar, Gujarat, and Punjab are leading potato-producing states, contributing over 80% of the total production. Notably, Bihar and Gujarat have shown notable growth in productivity, although there has been a decrease in the cultivation area in some states.

Instability in potato production is linked to fluctuations in cultivation area and productivity, with a potential avenue for mitigation through the adoption of quality seeds, improved technologies, and reduction of post-harvest losses. Increased investment in research and technological innovations is crucial to address these issues and ensure a stable potato industry in India.

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