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Growth Performance of Potato in India vis-à-vis North East India

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ABSTRACT

There is a huge potato yield gap between India and developed countries and between regions within the country. This study examines the trends in potato area, yield, and production in India and North East India from 2000-01 to 2019-20, as well as the causes of the yield gap and the role of improved varieties in bridging it. Over two decades, all parameters showed positive trends in India and North East India, but growth rates were higher at the national level than in North East India. The growth in production was mainly attributed to an increase in area. During TE 2019-20, India produced 50.18 million tons (23.5 t/ha) of potatoes from 2.14 million ha, while North East India produced only 2.78 per cent (10 t/ha) from 8.15 per cent of national potato area. Low potato yield in the region is mainly caused by the lack of knowledge about and low adoption of quality seeds and recent varieties and other scientific potato technologies. State governments, research institutes, private seed companies, public policy bodies, and other potato stakeholders should facilitate the diffusion and adoption of improved varieties and other improved potato technologies to boost potato yield and farmers' income.

INTRODUCTION

The potato (*Solanum tuberosum* L.) is the world's most important vegetable crop and third important food crop, after rice and wheat (Jansky et al., 2019). In 2008, FAO designated potato as the crop to solve global food security in the future. India is presently ranked second in global potato production behind China; these two countries contributed to over a third of the world's potato production (Geetanjali et al., 2021). Potato is the most important vegetable crop, contributing to nearly one-third of the total vegetable production in India (Directorate of Economics and Statistics, 2021). Potato is an essential part of the Indian vegetable basket (Singh et al., 2009), and due to its short growing season and adaptability to a vast array of cropping patterns, potato has emerged as one of the important crops to diversify from cereals to horticultural crops in India (Yadav & Srivastava, 2015).

The country's production rose from about 1.5 million tonnes in 1950-51 to 48.5 million tonnes in 2019-20 (Kharumnuid et al., 2021). Despite this enormous breakthrough in potato production, India's present productivity remains a concern for research and development on potato cultivation. It is still relatively low compared to those of the developed countries and far below than 40 t/ha, which is the potential yield of the country. In addition, India will require around 125 million tons of potato by 2050 (CPRI, 2015) due to population growth, lifestyle changes, and economic growth. India is harvesting only 42-45 per cent of its potential yield at the current level of farm management, but this could be improved to 80 per cent with the effective and timely diffusion and adoption of scientific practices (CPRI, 2015).

Potato is an important food and commercial crop in North East India (NEI), where it is grown year-round in various parts of the region. However, there is a massive yield gap of more than 50 per cent between India and NEI (Yadav & Srivastava, 2015). Insufficient supply of good quality seeds of modern varieties suitable to the agro-climatic conditions of NEI was the main reason for the low potato yield gap (Tripura & Ghosh, 2017).

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There may be a number of other causes for the low potato yield in the region, which need to be critically identified. On this backdrop, the present study attempted to examine the performance of area, production and yield of potato in India vis-à-vis NEI. The study also attempted to identify the possible causes of yield gaps and the role of improved varieties in narrowing the gap in the region.

METHODOLOGY

Time-series data on potato area, production, and productivity over a 20-year period, i.e., 2000-01 to 2019-20, were collected from various sources, viz., websites of the National Horticultural Research and Development Foundation, and the Directorate of Economics and Statistics. For analyzing the growth performance of all selected parameters in India vis-à-vis NEI, the total period was split into three parts, viz., Period-I (2000-01 to 2009-10), Period-II (2010-11 to 2019-20) and the entire period under study as Period-III (2000-01 to 2019-20). The compound annual growth rates (CAGR) were estimated to analyze the changes in the parameters by using the Log Linear model as follows:

$$\ln Y = a + bt \quad ...(1)$$

where, Y defines potato production, area, and yield, 't' is the trend term, and 'a' is the constant coefficient. The slope coefficient 'b' quantifies the relative change in Y for a given absolute change in the explanatory variable 't'. Ordinary Least Square (OLS) was used to estimate equation (1). The CAGR formula is:

$$CAGR = [\text{antilog } b - 1] * 100 \quad ...(2)$$

To analyse the potato area, production and productivity across states of India, a three-year average i.e., triennium ending (TE) 2019-20 was used. The possible causes of the yield gap between India and NEI and the role of improved potato varieties in reducing the gap, were ascertained by an extensive review of related literatures published by various researchers, especially in the North East region and by discussions with experts in the related fields.

RESULTS AND DISCUSSION

Figure 1 indicated that the potato area had increased from 1.22 million ha in 2000-01 to 2.05 million ha in 2019-20, and production rose from 22.50 million tons to 48.56 million tons. During the same period, the area in NEI had increased from 1.21 lakh ha to 1.56 lakh ha, and the production from 10.45 lakh tons to 12.38 lakh tons (Figure 2). It is also observed from the figure that over the two decades, the productivity had increased from about 18.00 t/ha to about 24.00 t/ha at national level; however, there was no significant change in productivity in NEI, which hovered between 7-10 t/ha. The linear trend lines showed positive slopes for all parameters in both India and NEI. However, the increase in yield slope was less than that of production and area in both India and NEI.

Table 1 indicated that over the period of 2000-01 to 2019-20, the CAGR of all parameters was higher at national level than in NEI. During the overall period, the CAGR in area, production and productivity in India were 3.5, 5.2 and 1.8 per cent per annum, respectively, as compared to 2.3, 2.9 and 0.6 per cent, respectively, in NEI. It is evident from the table that the rise in production was primarily attributable to area expansion rather than yield during the entire period. It is further revealed that, though India recorded the higher growth rate in terms of area (India=4.7%, NEI=1.0%) and production (India=4.1%, NEI=1.3%) during the Period I (2000-01 to 2009-10), however, it experienced negative growth rate in terms of productivity (India=-0.6%, NEI=0.3%). During the Period-II (2011-2020), the CAGR in area in NEI is higher than the national level (NEI=2.4%, India=1.5%). However, the CAGR in production (India=2.2%, NEI=1.1%) and productivity (India=0.7%, NEI=-1.3%) is higher at national level. For both Period-I and Period-II, the production growth rate was largely attributable to positive area growth rather than yield growth.

Table 2 revealed that India produced about 50.18 million tons

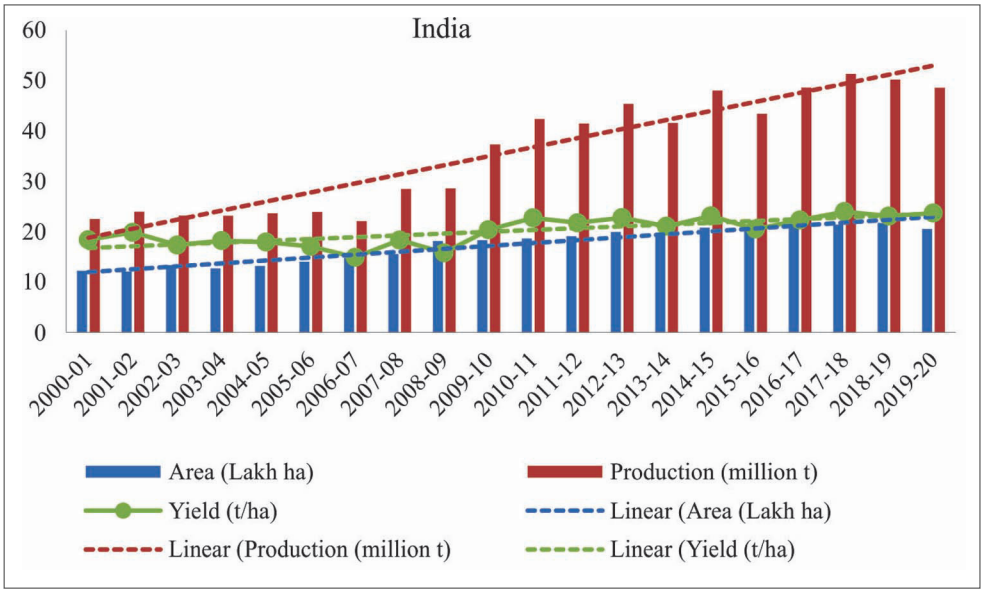

Figure 1. Trends in potato area, production and productivity in India

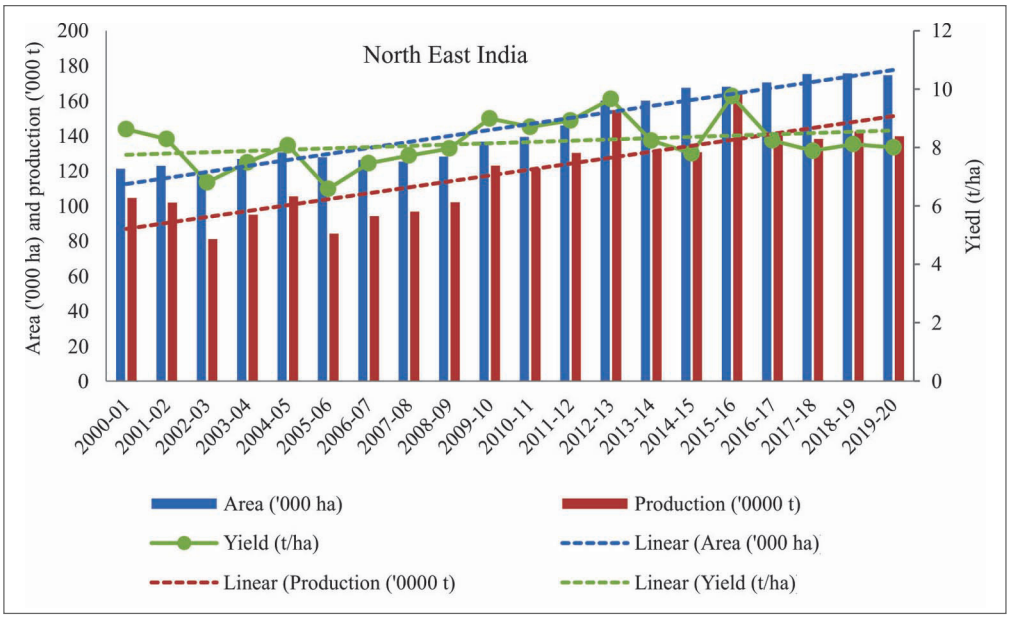

Figure 2. Trends in potato area, production and productivity in NEI

Table 1. CAGR of potato area, production and yield in India vis-à-vis NEI

Year	Area (%)		Production (%)		Yield (%)	
	India	NEI	India	NEI	India	NEI
2000-01 to 2019-20	3.5	2.3	5.2	2.9	1.8	0.6
2000-01 to 2009-10	4.7	1.0	4.1	1.3	-0.6	0.3
2010-11 to 2019-20	1.5	2.4	2.2	1.1	0.7	-1.3

Table 2. Potato area, production and productivity across India's states (TE 2019-20)

State	Area ('000 ha)	Share (%)	Production ('000 t)	Share (%)	Yield (t/ha)
Uttar Pradesh	598.43	27.94	14626.36	29.15	24.40
West Bengal	432.85	20.21	12115.17	24.14	28.00
Bihar	294.89	13.77	7868.23	15.68	26.87
Gujarat	125.31	5.85	3709.82	7.39	29.65
Madhya Pradesh	144.10	6.73	3305.65	6.59	22.94
Punjab	102.53	4.79	2721.83	5.42	26.54
Haryana	31.49	1.47	807.14	1.61	25.58
Assam	103.61	4.84	750.22	1.49	7.24
Jharkhand	48.71	2.27	697.11	1.39	14.31
Chhattisgarh	46.12	2.15	692.85	1.38	14.97
Others	214.14	10.00	2889.53	5.76	14.74
All India	2142.16	100.00	50183.91	100.00	23.57
NEI	174.62	8.15	1397.39	2.78	9.91

Source: Author's calculation

potatoes during TE 2019-20 from about 2.14 million ha area, with productivity of about 23.57 t/ha. During the same period, the production of potato in NEI was only 13.97 lakh tons; only about 2.78 per cent of the total potato production in India, from an area of about 1.74 lakh ha (~ 8.15% of national potato area). The yield of potato in the region was abysmally low at about 9.90 t/ha, when compared to whole India at about 23.60 t/ha, despite the fact that potatoes in the hilly regions are grown for longer duration than those in plain areas. Thus, there exists a huge yield gap between India and NEI, which could be attributed to many factors as discussed in the next section.

Table 2 also shows that during TE 2019-2020, Uttar Pradesh was the leading potato producing state in India, which produced about 14.63 million tons of potato, which was about 29 per cent of the total potato production. West Bengal was the second top state with almost 12.00 million tons of potato (~24% of total potato production) from 0.43 million ha area. The third largest potato producer was Bihar which produced about 8.15 million tons of potato and accounted for about 16 per cent of total potato production. These three states together contributed more than two-third of the total potato production in India. Other major potato producing states are Gujarat, Madhya Pradesh, Punjab,

Table 3. Major causes of low potato yield in NEI reported in published resources

Causes of low potato yield	Reporting resources
Lack and low adoption of quality seeds of modern varieties	Dubey et al., 2010; Kadian et al., 2010; Srivastava et al., 2012; Biswas & Nath, 2013; Yadav et al., 2014; Borah et al., 2016; CPRI, 2016; Jamatia et al., 2016; Chulet et al., 2017; Nath et al., 2017; Tripura & Ghosh, 2017; Nath & Shil, 2019; Rajavardhan et al., 2020; Umdor et al., 2020
Lack and high cost of improved potato technologies	Sah et al., 2007; Burman et al., 2007; Kadian et al., 2010; Srivastava et al., 2012; Biswas & Nath, 2013; Yadav et al., 2014; Jamatia et al., 2016; Borah et al., 2016; Roy et al., 2016; Tripura & Ghosh, 2017; Umdor et al., 2020
Lack of awareness and knowledge of scientific potato cultivation	Roy et al., 2009; Dubey et al., 2010; Kadian et al., 2010; Srivastava et al., 2012; Biswas & Nath, 2013; CPRI, 2016; Roy et al., 2016; Chulet et al., 2017; Tripura & Ghosh, 2017
High disease and pest incidence	Sah et al., 2007; Kadian et al., 2010; Yadav et al., 2014; CPRI, 2016; Jamatia et al., 2016; Chulet et al., 2017; Rajavardhan et al., 2020
Lack of efficient storage, processing, and marketing facilities	Saikia, 2001; Kadian et al., 2010; Sah et al., 2011; Borah et al., 2016; Chulet et al., 2017; Tripura & Ghosh, 2017
Rainfed cultivation and lack of irrigation	Burman et al., 2007; Sah et al., 2007; Kadian et al., 2010; Sah et al., 2011; Yadav et al., 2014
Shifting (*Jhum*) cultivation and other traditional methods of production	Kadian et al., 2010; Yadav et al., 2014; Chulet et al., 2017
Small land holding and subsistence agriculture	Sah et al., 2007; Burman et al., 2007; Sah et al., 2011; Borah et al., 2016; Roy et al., 2016

Haryana, Chhattisgarh and Assam. With regards to NEI, Assam state with a production of 7.50 lakh tons, which was about 60 per cent of the NEI's potato production, was the top producer from an area of about 1.03 lakh ha. The second top producer was Meghalaya which produced about 1.87 lakh tons of potato (~13.5% of the total potato production in NEI). Tripura was the third major producer with about 1.45 lakh tons of potato (~10.20% of total potato production in NEI). Tripura state had the highest productivity of about 18.00 t/ha. More than 85 per cent of NEI's potato production came from these three states in TE 2019-20.

The existence of yield gap in horticulture crops, including potato is a significant concern in India where farmers' yields are significantly lower than the potential yields. Studies conducted in Bihar and Meghalaya revealed that huge yield gaps of about 43.4 and 48.6 per cent of the potential yield existed in potato in Bihar and Meghalaya, respectively, which were largely due to wide scale adoption of low-quality seeds and obsolete and local varieties (CPRI, 2020; Singh et al., 2020). The major causes of the low potato yield in the region, as reported by multiple researchers, have been identified and presented in Table 3. Low adoption of modern varieties and a lack of quality seeds are the major causes of the region's low potato productivity. Due to a dearth of quality seeds, farmers are driven to use low-quality farm-saved seeds that have been cultivated over several generations, and cheap and disease-infected seeds available at the local market (Nath et al., 2017). Lack of awareness and lack of and low adoption of scientific potato technologies are also the major causes. The prevalence of serious diseases throughout the crop season, especially late blight, which caused heavy damage to the crop and other diseases and insects, also contributed to the region's low productivity. The lack of efficient potato transportation, marketing, and processing facilities in the North Eastern region, along with the region's hilly terrain and prevalence of shifting *(Jhum)* cultivation have negative impacts on potato production. As this region's agricultural production system is primarily rainfed, mono-cropped, and at subsistence level, potato yield is quite low (Burman et al., 2007; Sah et al., 2007). These major causes should be taken into consideration by policymakers, researchers, and extension agencies for the formulation and implementation of strategies to reduce the yield gaps of potato in the region.

CONCLUSION

Systematic growth performance and yield gap analyses are important to generate more resources for R&D to boost crop productivity and sustainability. The study found that the growth rates of all selected parameters were higher at the national level than in NEI, and the potato yield was far below the national yield. The major causes of the large yield gap between India and NEI are the lack of quality seeds and low adoption of recent varieties, as well as a lack of knowledge about and adoption of improved potato technologies. Thus, farmers should be facilitated to enhance their awareness and adoption of recent varieties and other scientific technologies through various extension strategies in the region.

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