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Seventy five years of potato in India

An inspiring success story

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India, celebrating seventy-five years of independence, aims to achieve Developed Nation status by 2047, relying heavily on its agriculture sector to fulfill Sustainable Development Goals (SDGs) such as eradicating poverty, eliminating hunger, and ensuring food health and well-being. With a burgeoning population expected to surpass 1.67 billion by 2050, the diversification and utilization of horticultural crops, particularly potatoes, emerge as vital strategies for ensuring food and nutritional security. This article traces the journey of potatoes from their origins in South America to their introduction and adoption in India. It highlights the pivotal role of research and development (R&D) interventions, notably by institutions like the Central Potato Research Institute (CPRI), in enhancing potato cultivation and productivity in India. Today, India stands as the second-largest producer of potatoes globally, with substantial contributions to the agricultural economy. The article delves into the drivers of growth in the potato sector, emphasizing the increasing demand for both fresh and processing-quality potatoes. It forecasts the future trajectory of potato consumption, driven by factors such as urbanization, changing dietary habits, and the rise of the agri-processing industry. As India looks towards meeting the projected demand for potatoes by 2050, the article underscores the need for concerted efforts to ensure the availability of high-quality seed potatoes and to further enhance productivity to meet global standards.

Keywords: CPRI, Drivers of growth, Potato, Production scenario, R&D interventions

INDIA has recently completed seventy-five years of its independence and aspires to be a Developed Nation in the next twenty-five years (i.e. 2047). For India, being agriculture-based country, and agriculture (along with its allied sectors) being the largest livelihood provider; for achieving: (i) No poverty, (ii) Zero hunger, (iii) Food health and well-being; the three of the seventeen Sustainable Development Goals (SDGs) adopted by the United Nations (to be achieved by 2030), much depends on growth and performance of agriculture sector. Further, India is expected to be most populous country in the world by 2050 with about 1.67 billion population. Diversification and utilization of horticultural crops would be the most important strategy to ensure food and nutritional security of the burgeoning population. This highlights the importance of horticultural crops in Indian agriculture and future thrust on research and development of horticultural crops.

Potato is one of the important horticultural crops and because of its ability to produce highest nutrition and dry matter on per unit area and time basis, among major food crops, FAO declared it the crop to address future global food security and poverty alleviation during 2008. Potato being '*Commodity for Class and Mass*', has immense potential to contribute for achieving the above stated three SDGs. Within just seventy-five years of its journey as independent nation, India has surpassed the total potato production of 60 million tonnes and the average yield of 25 t/ha. This is a remarkable and inspirational milestone for the whole nation in general and for the stake-holders associated with potato in specific. In the year 2021-22, potatoes contributed more than ₹ 67000 crore (Gross Production Value) in the Indian economy.

Potato journey from its place of origin to India

Potato (*Solanum tuberosum* ssp. *tuberosum*) is not a native crop of India. It was originally domesticated around 8,000 years ago by communities of hunters and gatherers in the Andes mountain range of South America, on the border between Bolivia and Peru. Though it is believed that conqueror of Peru, Francisco Pizarro was the first European to see potato in 1533. However, the

first record on potato is of 1537, when a band of Spaniards led by Jimenez de Quesada penetrated into the highlands of Colombia, followed by the accounts of Lopez de Gomara (1552) for potatoes in Southern Peru and by Pedro Cieza de Leon (1553) in the southern Columbia and northern Ecuador. In Chile, potatoes received first mention in 1578 by Sir Francis Drake. Following the conquest of Peru, the Spaniards introduced potato in Spain and further spread it to many European countries. However, potato remained a botanical curiosity till around mid 18th century. It was not until the late 18th and early 19th centuries, potato cultivation started on a large scale in Central and eastern Europe. Though potato was not readily accepted as a food by common Europeans, it became a favourite food of the sailors who took potato tubers for consumption on ocean voyages specifically to avoid scurvy since the tubers were a rich source of vitamin C. That was the time when Europe's 'Age of Exploration' had begun and many sea voyages were undertaken by Portugal, Spain, and England. Potato was carried as a preferred food in many of those journeys. In early 17th Century, it is generally believed that Portuguese sailors took the potatoes to India. Subsequently, Britishers took potato to the hills of northern India where it flourished in the colonial home gardens. The earliest reference of potato in India occurs in accounts of the voyage of Edward Terry (1655), who was chaplain to Sir Thomas Roe, British Ambassador to the court of the Mughal Emperor of that time. By late 18th Century or early 19th Century, potato was an important established vegetable crop in the hills and plains of India.

R&D interventions for potato in India

Potato cultivation in India during initial 300 years after its introduction remained very restricted and the entire Indian subcontinent contributed less than 1% of world's potato area and production till 1941. This was primarily due to non-availability of locally adapted varieties and technologies for growing potato under sub-tropical climatic condition. To take care of those problems, an organized research programme on potato was initiated in April 1935 with the opening of three breeding and seed production stations at Shimla, Kufri and Bhowali (Kumaon hills), under the Indian (Imperial) Agricultural Research Institute, New Delhi. In 1945, a scheme for the establishment of Central Potato Research Institute (CPRI) was drawn up under the guidance of the then Agriculture Advisor to the Government of India, Sir Herbert Stewart and Sir Pheroz M. Kharegat, Secretary, Ministry of Agriculture. Dr B. P. Pal, Dr S. Ramanujam, Dr Pushkarnath, and Dr R. S. Vasudeva participated in the formulating the scheme and in establishment of the institute. Dr S. Ramanujam, who was then working as Second Economic Botanist at IARI, was appointed as an Officer on Special Duty for implementing the scheme in 1946. The institute (CPRI) was established in August 1949 at Patna and started functioning from an old single-story, barrack-type building provided by the Government of Bihar. In 1956, the headquarter was shifted to Shimla, Himachal Pradesh in order to facilitate hybridization work and better maintenance of potato seed health. Presently, CPRI has 6 regional stations in different potato growing areas of the country. These are located at; Modipuram (Uttar Pradesh), Jalandhar (Punjab), Gwalior (Madhya Pradesh), Patna (Bihar), Shillong (Meghalaya), and Ootacamund (Tamil Nadu). The institute played a key role in popularizing potato cultivation and utilization under sub-tropical agro-ecosystem. As a consequence, India emerged as the second largest potato producer in the world after China. Some of the key technologies developed by the institute are briefly listed below.

- Development of 72 high-yielding indigenous varieties including 9 processing varieties and 2 heat-tolerant varieties suitable for growing under different agro-climatic conditions.
- The Institute partnered with the Potato Genome Sequencing Consortium and deciphered the potato genome, which subsequently led to various global research initiatives on functional genomics.
- The 'Seed Plot Technique' made it possible to carry out disease free seed production in the plains and established a national disease-free seed production programme for hills and plains, utilizing the low aphid periods identified in the plains.
- The 'Breeder's Seed Production Programme' with annual production of about 3,000 tonnes of Breeder's seed, availability of quality planting material has been ensured.
- Standardization of tissue culture techniques for micro-propagation, *in vitro* microtuber production and rapid multiplication.
- Development and commercialization of aeroponics-based seed production technique has complemented the other systems of producing quality potato seed to meet the increasing demand of the quality seed potato in the country.
- Development of 'Package of Practices' for cultivation of ware and seed potato in different agro-climatic conditions.
- Identification of profitable potato-based cropping systems in different agro-climates, including inter-cropping of the potato with sugarcane, wheat and several crops.
- Development of agri-cultural implements for mechanizing potato cultivation, including an oscillating tray type potato grader, fertilizer

applicator-cum-line marker, potato culti-ridger, soil crust brakers, granular insecticide applicator, two/ four row automatic potato planter, and potato digger.

- Development of integrated package of practices for management of late blight, bacterial wilt, viruses, and soil and tuber-borne diseases.
- Development of Late blight forecasting model (Indo-blight cast) and Methodology for acreage and production estimation of potato using remote sensing, GIS and crop modelling.
- Development of sensitive virus detection techniques and DBT Accredited lab for testing of virus presence.
- Development of techniques for storage of table and processing potatoes at elevated temperature and on-farm storage structures.
- Technologies and technical support to industry for value addition including chips, french fries and other processed products.

Potato production scenario

Potato is the third most important food crop in the world after rice and wheat in terms of human consumption. As far as India is concerned, during initial years of its independence (1948,1949), India used to produce 1.54 million tonnes of potatoes from 0.234 million ha area at an average productivity level of 6.58 t/ha. From a total annual production of less than 2 million tonnes to touching 60 million tonnes (Fig. 1) in the post-independence era is an achievement to celebrate. Similarly, productivity has increased more than 3.9-fold (Fig. 3), with present yield above 25 t/ha (Fig. 2). Latest (2022) global annual production of potato is 375 million tonnes, with the average productivity of 21.1 t/ha. (2022; FAOSTAT), and thus average productivity of potato in India is higher than that of the world's average potato productivity. Presently, India is the second largest annual producer of potato after China. In 2022-23, India produced 60.14 million tonnes from 2.3 million ha area (Department of Agriculture & Farmers Welfare, Government of India). This is a remarkable achievement for the whole nation, as India surpassed the average yield of 25 t/ha and the total production of 60 million tonnes (Figs 2&3). Together, six states viz. Uttar Pradesh, West Bengal, Bihar, Gujarat, Madhya

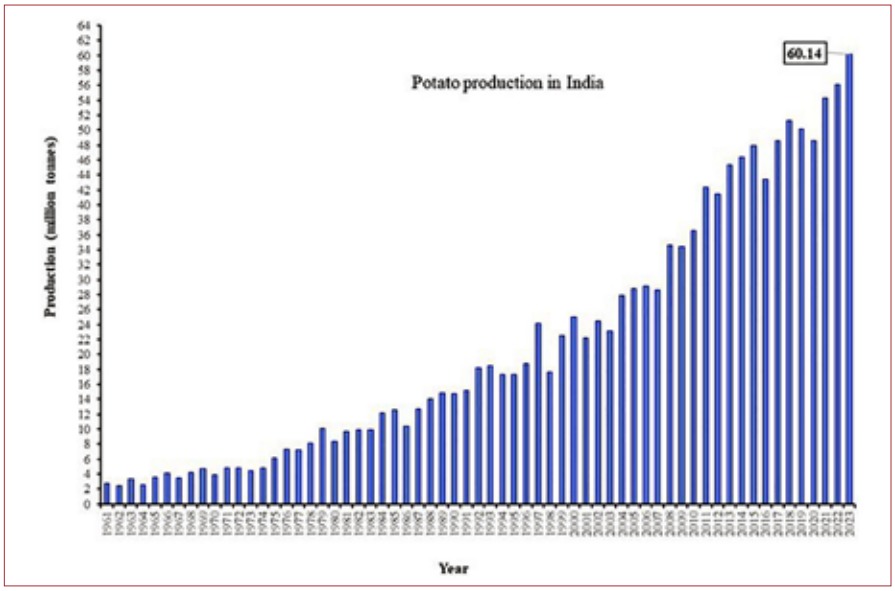

Fig. 1. Production of potato (million tonnes) in India, during 1961-2023 (*Sources*: https://agriwelfare.gov.in/ & https://www.fao.org/faostat/en/).

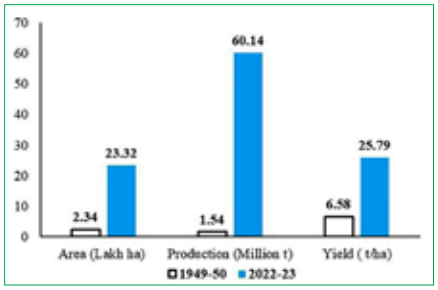

Fig. 2. Comparative production data of potato in 1949-50 *vis-à-vis* 2022-23

Fig. 3. Productivity of potato (t/ha) in India, during 1961-2023 (*Sources*: https://agriwelfare.gov.in/ & https://www.fao.org/faostat/en/)

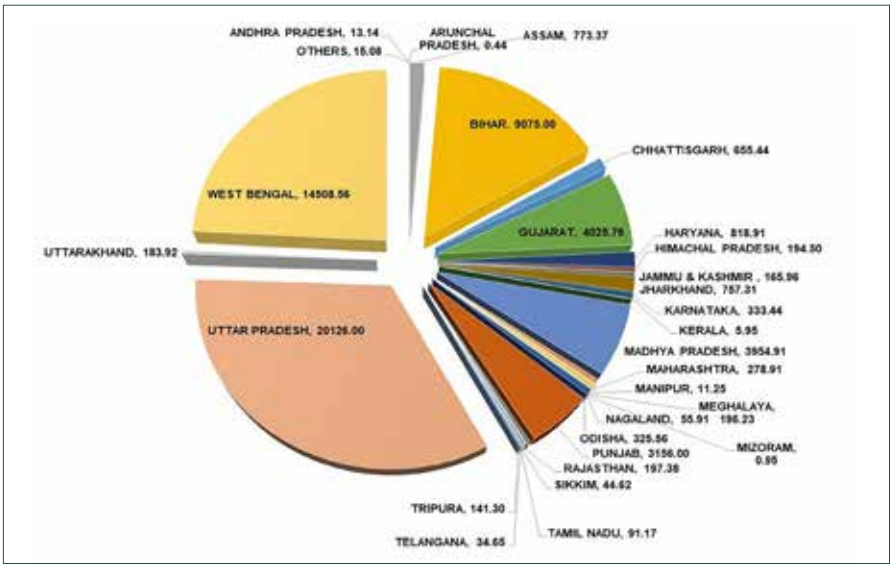

Fig. 4. State-wise potato production in India in 2022-23 (in '000' MT)

Pradesh and Punjab contribute more than 90% of total potato production in India (Fig. 4 & Table 1). In terms of total production, Uttar Pradesh, West Bengal and Bihar, occupy top three positions with the total annual potato production of 20.126 million tonnes (33.46%), 14.508 million tonnes (24.12%), and 9075 million tonnes (15.09%), respectively (Table 1).

Table 1. State-wise relative contribution (%) of potato production in India in 2022-23 (in '000' MT).

State	Potato production (000' tonnes)	% of total production
Andhra Pradesh	13.14	0.02
Arunachal Pradesh	0.44	0.001
Assam	773.37	1.29
Bihar	9075.00	15.09
Chhattisgarh	655.44	1.09
Gujarat	4025.76	6.69
Haryana	818.91	1.36
Himachal Pradesh	194.50	0.32
Jammu and Kashmir	165.96	0.28
Jharkhand	757.31	1.26
Karnataka	333.44	0.55
Kerala	5.95	0.01
Madhya Pradesh	3954.91	6.58
Maharashtra	278.91	0.46
Manipur	11.25	0.02
Meghalaya	196.23	0.33
Mizoram	0.95	0.00
Nagaland	55.91	0.09
Odisha	325.56	0.54
Punjab	3156.00	5.25
Rajasthan	197.38	0.33
Sikkim	44.62	0.07
Tamil Nadu	91.17	0.15
Telangana	34.65	0.06
Tripura	141.30	0.23
Uttar Pradesh	20126.00	33.46
Uttarakhand	183.92	0.31
West Bengal	14508.56	24.12
Others	15.08	0.03
Total	**60141.60**	**100.00**

Together, six states viz. Uttar Pradesh, West Bengal, Bihar, Gujarat, Madhya Pradesh, Punjab contribute more than 90% of total production in India

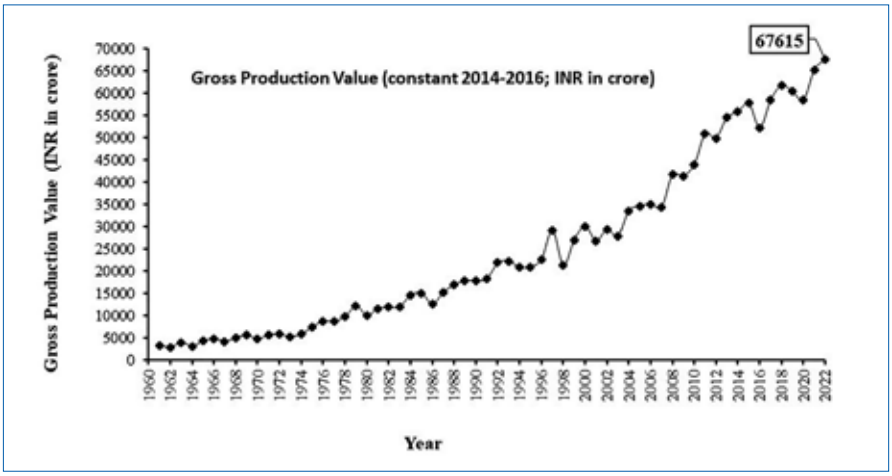

Fig. 5. Gross Production Value of potato (constant 2014-2016; INR in crore) (*data source*: fao.org).

Potato in Indian agricultural economy

Agriculture holds a significant place in the Indian economy, with over 70% of rural households relying on it for their livelihoods. As a critical sector of the Indian economy, agriculture contributes around 17% to the total GDP and provides employment for approximately 58% of the population. Indian agriculture has witnessed remarkable growth over the past seventy five years. The share of Gross value added (GVA) of agriculture and allied sectors in total economy (at current prices) and growth of GVA of agriculture and allied sectors (at 2011-12 prices) for the year 2022-23 is 18.3% and 3.3 %, respectively (as per the second advance estimates of National Income, 2022-23 released by Ministry of Statistics & Programme Implementation). As far as potato is concerned, its remarkable contribution to Indian economy can be clearly realized by its Gross Production Value (constant 2014-2016) of ₹67,615 crore for the year 2022-23 with more than 20-fold increase in the last six decades (Fig. 5).

Drivers of growth in India

Demand outlook

Potato is a predominant vegetable in India. At present, most of the domestic supply of potatoes is consumed as fresh (66.5%) followed by processing (10%) and as seed (8.5%). The rest 16% potatoes are wasted due as pre/post-harvest losses. However, the proportion of potato used/ wasted due to various reasons is expected to change in the medium and long-term scenario.

Fresh potatoes: Per capita consumption of fresh potatoes (FAOSTAT) increased from 1991 to 2010 at an ACGR of 2.34%. Will this consumption rise in the future at the same rate? The stagnating growth rates of cereals' productivity, large scale diversion of food grains to feed and bio-fuel and expected steep rise in per capita consumption of pulses, edible oil, fruits, vegetables, milk, sugar and non-vegetarian food in the regime of steadily rising population is bound to put pressure on existing cultivable land. Since, cultivable land is expected to remain more or less constant in the next 40 years, the role of crops like potato having higher production potential per unit land and time will become imperative. In this context, potato crop has very high probability of making crucial contribution to the future national food security agenda.

The perceived changes in Indian socio-economics in the medium and long term are expected to enhance per capita food consumption of fresh potatoes. Potato is an important ingredient of most of the fast foods in organised as well as unorganised sector. Rapid urban population growth from 375 to 840 million over next 40 years at an ACGR of 2.04% is expected against the overall national

ACGR of population at 0.78%. Faster rise of number of nuclear families, higher disposable incomes on account of fast economic growth resulting into higher tendency of out-of-home eating and rapid increase in the number of working women in the medium and long run are expected to maintain the ACGR of 2.34% in per capita consumption of fresh potatoes. Per capita food demand of fresh potatoes at this ACGR will be 48.5 kg in the long term. The corresponding national food demand for fresh potatoes will be 78.5 million tonnes in 2050.

Processing quality potatoes: Agri-processing sector experiences very fast growth rate when an economy transforms from developing to developed economy. The rise of Indian economy from $ 1.57 to between 13 and 34 trillion (under varied scenarios; NCAP estimates) is not possible without corresponding rise in agriprocessing industry. Further, potato is always the frontrunner when we take processing of agri-commodities into consideration. Analysis of past experience and pattern of Indian processing industry suggests that demand for processing quality potatoes over next 40 years will rise at the fastest pace for French fries (11.6% ACGR) followed by potato flakes/ powder (7.6%) and potato chips (4.5%). The actual demand for processing potatoes will rise from 2.8 million tonnes in 2010 to 25 million tonnes during the year 2050 at an ACGR of 5.61% (Table 2). Though in India only 7 – 8% of total produce is processed (compared to industrialized countries, this percentage is over 80), however, factors such as growing urbanization, and consumers' shift to convenient ready-to-eat foods, etc. foresee that that the Indian potato processing market will increase. Similarly, the Indian frozen potato products market size has already surpassed US$ 1.4 Billion in 2022 and is expected to reach US$ 2.8 Billion by 2028 (CAGR of 12.16% during 2023-2028). The major firms associated with Frozen Potato Products in India include: McCain Foods (India) Private Ltd, Hyfun Frozen Foods Private Ltd, Iscon Balaji Foods Private Limited, Golden Fries Limited, Bhanu Farms Limited etc. The main frozen products include French Fries, Smileys, Tikkis, Potato Wedges, Potato bites etc. Increasing consumer preference for these products is deriving the Indian market. In addition to this, convenience is a major driver, as frozen potato products offer a time-efficient solution for individuals and families seeking quick and easy meal options. Also, the versatility of these products, caters to diverse culinary preferences, and thus, further expanding their market appeal.

SUMMARY

Rising number of working couples, rapid rate of urbanization, enhanced tendency of eating out of home, higher disposable income levels of people and important place of potato in fast food items, create an ideal situation for expansion of potato consumption in the near and distant future. As stated in the Vision 2050 document of ICAR-CPRI, estimated domestic demand of potatoes in India is 122 million tonnes during 2050. Demand for processing quality potatoes will increase from current level of 2.8 million tonnes to 25 million tonnes in the year 2050. It implies that the demand is expected to increase by

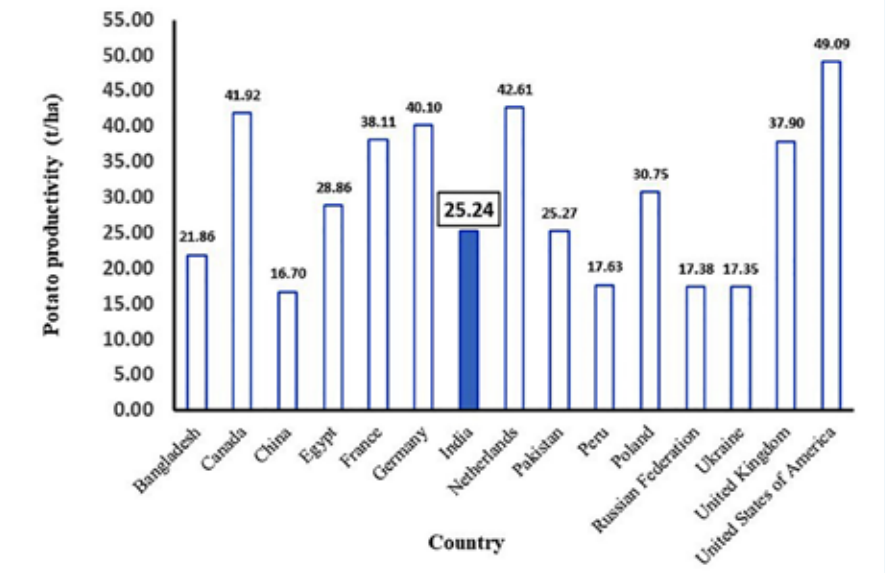

Fig. 6. Productivity of potato (t/ha) in fifteen major potato growing countries (year 2022) (*Data Sources:* https://agriwelfare.gov.in/ & https://www.fao.org/faostat/en/).

Table 2. Per capita consumption of potato (kg/capita/year) dynamics in India *vis-a-vis* global scenario during 2010-2021 *(Source: fao.org).*

Year	Country/Region						
	Belarus	Ukraine	Latvia	United Kingdom	United States of America	India	World
2010	178.5	129.9	112.1	82.9	51.7	22.6	31.7
2011	178.3	140.2	108.8	83.7	52.6	23.0	32.1
2012	181.7	140.6	118.9	84.6	55.6	23.2	32.2
2013	174.9	135.2	114.2	82.4	52.0	23.5	32.0
2014	173.3	124.7	113.3	81.2	51.7	23.9	32.2
2015	166.6	115.6	112.2	77.9	49.6	24.6	31.3
2016	167.1	130.4	111.2	76.0	51.3	24.8	31.1
2017	168.2	138.6	120.7	83.8	51.1	25.2	31.5
2018	166.5	131.5	108.4	68.7	50.8	25.7	31.3
2019	170.8	129.0	97.0	51.1	49.1	25.3	30.9
2020	156.8	127.4	63.3	57.8	49.7	24.8	30.8
2021	154.3	129.0	56.9	50.6	45.8	25.2	30.5

6% ACGR up to 2050, where frozen potato products will have the highest ACGR (11.6%) followed by potato flakes/ powder (7.6%) and potato chips (4.5%). On similar lines, the food demand for fresh potatoes will increase to 78 million tonnes during 2050 at an ACGR of 2.34%. Although, the demand for seed potato will grow nearly 2.1 times (2.96 to 6.1 million tonnes) by the year 2050, yet, highly concerted efforts need to be directed towards providing desirable quality seed potatoes to all farmers at affordable price. Though, it is heartening to have achieved the potato productivity of 25 t/ha, but still there is ample potential to further increase it substantially as the productivity of countries like USA, Canada, Netherlands, Germany etc. are already above 40 t/ha (Fig. 6). Similarly, keeping in view the per capita consumption dynamics of potato in India vis-à-vis global level (Table 2), there are strong indications that in India, per capita consumption of potato will further increase substantially and thus, in turn will drive the increased potato demand in the future.

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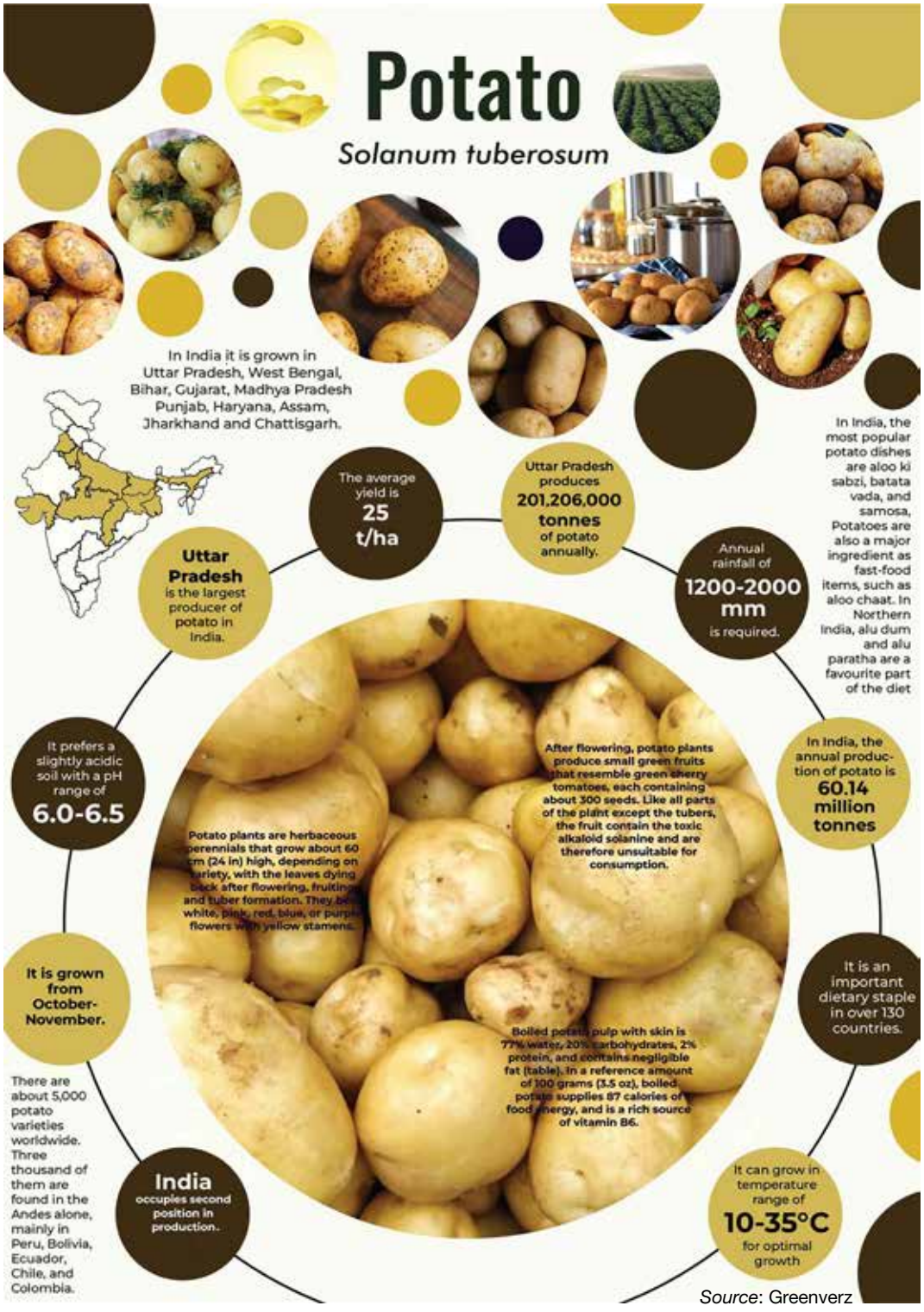

Source: Greenverz