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# Indian Farming

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# Potato for food and nutritional security in India

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*Availability, affordability and proper utilization of food are the important pillars of food security. Hence, surplus foodgrains in India don't ensure food security to all its people. 'Global Hunger Index 2012' report of the International Food Policy Research Institute depicts serious concerns about food security in India. Indian Hunger Index is worse than neighboring countries like Nepal and Pakistan. The only consolation that we are better than Bangladesh also has a disappointing side that we are improving slower than even Bangladesh. Most commonly set benchmark country for India's comparison, China, is about to achieve the target of less than 5% hunger index.*

The World food summit of 1996 defined food security as existing when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life. Even the other indicators of food and nutritional security, i.e. proportion of undernourished population, <5 years old underweight children and mortality of <5 years old children suggest similar situation (Table 1). Earlier in 2010 a UNDP survey had pointed out that in eight Indian states more poor people live than in 26 African countries. Experts opine that the so called food self-sufficiency in India was due to lack of food purchasing power of the poor for a long time.

## Falling per capita foodgrain production

India is primarily an agrarian nation where three-fourth of its population (800 million people) is directly or indirectly dependant on agriculture. However, now it is the time when we need to consider



Potato has been recommended by the FAO as a global food crop

agriculture beyond an employment generating sector, as the impending food insecurity issues are slowly cropping up in India. Per capita production of foodgrains increased from 183 kg during 1970s to 207 kg by mid 1990s, when country's population grew by more than 50% over the same period. After mid 1990s, foodgrain production has failed to keep pace with the

population growth in India. Per capita production of cereals fell by 17 kg and pulses production by 3 kg in next one decade. The demand of foodgrains in India is expected to grow from 235 million t at the end of 11<sup>th</sup> Five-Year-Plan to 281 million tonne by the year 2020-21. On the other hand per capita potato availability as food have steadily increased from 15.2 kg in 2003 to

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As a high-yieldig, short duration crop, potato has more edible energy, protein and dry matter percent area

21.5 in 2008 (FAOSTAT). Although the latest information on this aspect is lagging yet it is estimated that per capita potato availability in the country during 2012 (total provisional Indian potato production equal to 45 million tonne; FAOSTAT) might be more than 24 kg. The per capita net potato availability in India has increased at an annual compound growth rate of 2.5 during 1991 to 2012.

#### Potato as a Food Security Option

The Food and Agriculture Organization of the United Nations, Rome, in one of its prominent publication during 2008 has emphatically considered and recommended potato as a potential crop to ensure global food, nutritional and income security in future, to the poorest of the poor.

*Potato growth in India:* Comparison of triennium ending years 2008 and 2012 shows that potato compared to major cereals (maize, paddy and wheat) exhibited highest growth in terms of production and productivity (Table 2). It happened despite the fact that cereal crops got massive enhancement in support price during

this period. Moreover, there was robust export demand for maize in the international market during the said period. To be more precise the annual compound growth rates (ACGRs) of potato area, production and productivity in India during 2008 and 2012 were also computed (Table 3). Potato has shown much stronger ACGRs than maize, paddy and wheat in terms of potato area, production and productivity.

*Potential of potato as food:* The stagnating crop yields, exhausting

soils and ever increasing population in the country pose a serious food security problem in coming years. the government had to induce enhancement in foodgrains production in India through support price mechanism. However, potato provides a ray of hope in terms of highest per ha, per day production of edible dry matter and nutrition. Evidences are not required to substantiate that overproduction has been a much common problem associated with the potato crop than its low production. One can easily count the years of so called gluts (1975, 79, 82, 85, 87, 88, 97, 2000, 03, 08, 10) in potato. Policy makers have been very busy in exploring options for dealing with potato oversupply and alternative uses of potato. However, true potential of potato has not been realised as we are still using it as vegetable while in major part of the world potatoes are used as staple food substituting cereals.

*Potato a wholesome food:* More than 90% of potato dry matter is composed of carbohydrates. Besides, about 1 per cent of the weight of potato tubers consists of minerals. Potatoes contain a number of minerals, though many in relatively small amounts. Calcium, iron, magnesium, phosphorus, and



Value-added products prepared at CPRI



potassium are nutritionally important minerals, which occur, in significant quantities in potatoes. It is rich in potassium and a good source of phosphorus, as about 80 per cent of phosphorus is in the absorbable form. Potato tubers contain vitamin C and number of B-group vitamins. Potatoes also contain some Beta-carotene (pro vitamin A). Yellow fleshed potato varieties contain up to 100 mg of beta carotene per 100 gm fresh weight. History is replete of examples where people could survive for very long time exclusively on potato diet. Hence, potato can be a perfect substitute for other cereals where fast increase in production is not that easy.

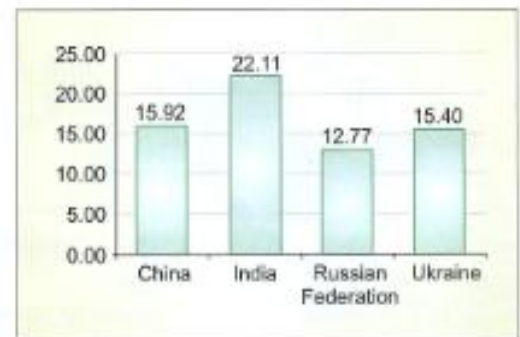
**Low calorie food:** Potatoes contain a very small quantity of fat (in traces) and major proportion of it consists of unsaturated fatty acids, which are nutritionally superior. Potato produces about 97 kcal per 100 g weight, which is much less than cereals and pulses (about 350 kcal per 100 g). An adult male's total daily requirement (2550 calories) could be met by consuming about 3kg boiled potato without causing obesity. However excessive consumption of processed products such as chips and French fries that contain up to 40% oil or fat is not free from this risk.

**Higher biological value of proteins:** Potatoes have about 2 percent

protein. The net protein utilizations or biological values of potato protein (about 71 per cent that of whole egg), is better than that of wheat (53 per cent), peas (48 per cent), beans (46 per cent), and is comparable to cow's milk (75 per cent).

**Higher production per unit area and time:** Potato is high yielding short-duration crop. Due to high protein-calories ratio (17g protein: 1000 Kcal) and short vegetative cycle, potatoes yield substantially more edible energy, protein and dry matter per unit area and time than many crops. Potato allows farmer to harvest up to 80% of biomass as edible, nutritious food. Only 50 percent of a cereal crop can be harvested as grain. This difference accounts for the high potential yield of potato. Crop physiologist estimate the potential yield of potato at about 120 tonnes per hectare or 30 tonnes per hectare grain equivalent, nearly twice that of cereals.

The importance of potato in agriculture economy can be judged from the fact that, in 1970-71, potato was cultivated in 0.3% of total cropped area in the country that contributed 1.4 per cent of total value of agriculture output. In contrast, paddy and wheat widely known to be responsible for green

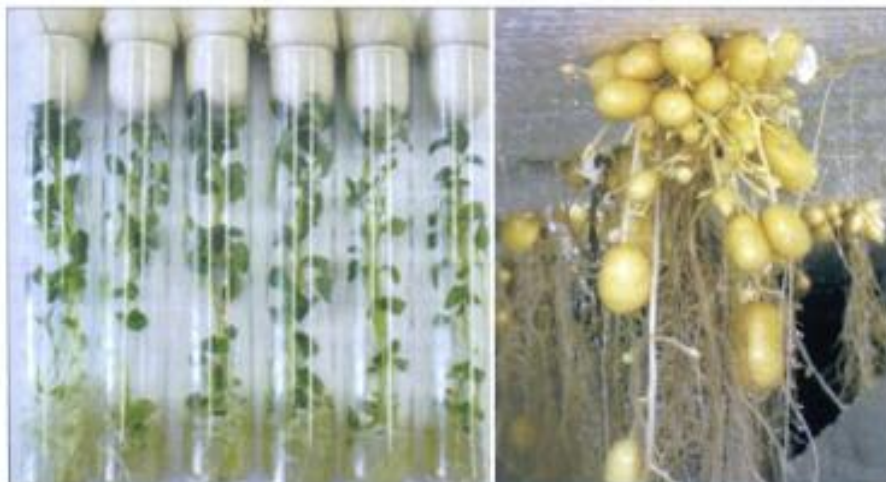


Potato productivity (t/ha) of leading potato producing countries (FAOSTAT, 2012)

revolution occupied 22.7 and 11.0 per cent of total crop area and contributed only 26.2 and 10.4 per cent of total value of agriculture output, respectively. The picture has not changed over the time and potato has continued to contribute significantly to the national economy. It was cultivated on 0.6 per cent of the total cropped area in 1995-96 and contributed 1.8 per cent of the total value of the agriculture output. In the same year contribution to value output by wheat and paddy was 12.2 per cent from 30.5 per cent area and 21.4 per cent from 23.1 per cent area, respectively. The average ratio of per cent value output to the per cent cropped area for potato, wheat and paddy during three decades were 3.3:1, 0.92:1, and 0.96:1, respectively. This indicates that potato contributes about 3.5 times more than both wheat and paddy from unit area to the national economy in agricultural sub-sector.

Energy and protein from one ha land in a period of just 90 days is  $170 \times 10^5$  kcal and 280 kg, respectively. These values for wheat, rice and maize are  $89 \times 10^5$  kcal, 303 kg;  $64 \times 10^5$  kcal, 126 kg; and  $55 \times 10^5$  kcal, 180 kg, respectively. Thus, potato has higher potential and nutritional superiority for fighting hunger and malnutrition in developing world.

**Flexible planting and harvesting:** High yield of potato per unit land area and time is an especially valuable trait in developing areas where the



Based on extensive research and water management, CPRI has developed zone-wise agro-techniques for potato production





Applying the latest tools in the field of biotechnology, CPRI has been able to develop basic seed as well as many varieties

climate permit more than one crop to be grown in the same field each year. In Indian tropics and sub-tropics, it is a short-duration crop that can be grown in wide range of climatic conditions and soil types with wide flexibility in planting and harvesting time. It can be harvested while tubers are still immature and also if the

tubers are left un-harvested for some time, they continue to increase in size and thereby, improve yields. This wide flexibility in its planting and harvesting dates makes the crop most suitable for inclusion in intensive cropping system including inter-cropping prevalent in different regions of the country. There is thus, a great

opportunity to increase the area and production of potato along with the other crops.

*Wider adaptability:* In India, potato can be grown throughout the year in one part or the other. Its adaptability is so wide that traditional agricultural seasons don't restrict its cultivation; for example in Punjab, early crop of potato can be taken during September-November, main crop during October-January and spring crop during January-April/May. A similar trend is now emerging in some parts of Haryana and western Uttar Pradesh. In North-eastern hills and Southern tropical hills potato is grown throughout the year. In fact, it can grow and give economic returns under any climate, provided the night temperatures during tuberization remain around 20°C or below.

*High response to inputs:* Potato responds well to inputs and give high returns. The residual potash and phosphorus of the crop is generally adequate to the subsequent crop, and the nitrogen requirement is reduced by half, for good growth of succeeding cereal crop. The possibility

**Table 1.** Indicators linked to food and nutritional security

Country	Undernourished population (%)				<5 years old underweight (%)				<5 years old mortality (%)			
	90-92	95-97	00-02	06-08	88-92	94-98	99-03	05-10	1990	1996	2001	2010
Azerbaijan	n/a	27	11	2*	11.8*	8.8	5.9	8.4	9.3	7.9	6.5	4.6
China	18	12	10	10	12.6	10.7	7.1	3.4	4.8	4.1	3.1	1.8
Sri Lanka	28	25	20	20	31.3*	27.5	23.3	21.6	3.2	2.6	2.2	1.7
Pakistan	25	20	24	25	39.0	34.2	31.3	25.4	12.4	11.1	9.9	8.7
Nepal	21	20	18	17	45.5*	42.9	43.0	38.8	14.1	10.4	8.0	5.0
India	20	17	20	19	59.5	41.1	44.4	43.5	11.5	9.7	8.3	6.3
Bangladesh	38	41	30	26	61.5	56.7	45.4	41.3	14.3	10.7	8.1	4.8

Source: 2012 Global Hunger Index report

Note: \*-IFPRI estimates

**Table 2.** Rate of change of area, productivity and production of selected crops in India (triennium ending average 2008 to 2012)

Crop(s)	Area (ha)			Productivity t/ha			Production (Million t)		
	TE 2008 average	TE 2012 average	% Change	TE 2008 average	TE 2012 average	% Change	TE 2008 average	TE 2012 average	% Change
Maize	8.06	8.55	6.11	2.22	2.52	13.27	17.93	21.52	20.01
Potatoes	1.70	1.87	9.60	18.10	22.11	22.17	30.81	41.31	34.06
Paddy	44.42	43.11	-2.95	3.24	3.51	8.45	143.91	151.49	5.26
Wheat	27.51	29.14	5.95	2.71	3.00	10.73	74.58	87.52	17.35

Data source: FAOSTAT

TE: triennium ending (year)

**Table 3.** Five year ACGRs of selected crops in India (2008 to 2012)

Crop(s)	Area	Productivity	Production
Maize	1.08	2.90	4.01
Potatoes	1.32	6.17	7.58
Paddy	-0.90	3.07	2.15
Wheat	1.76	2.80	4.62

Data source: FAOSTAT

of higher yield with higher inputs is an important potential that can be realised in crisis situation.

*Superior dietary fibre:* Most of the potato fibre is accounted for by the potato peel and the intracellular cementing material. It has been demonstrated that potato peeling, as a source of dietary fibre are superior to wheat-bran and can be incorporated in bread and other processed products with advantage.

#### Potato R and D to address food security

The Central Potato Research Institute (CPRI) was established in 1949 with the mandate of undertaking basic and applied research in the field of potato. Development of potato varieties, other technologies for enhancing productivity and utilization of potato and production of disease-free basic seed to fulfill country's needs were the prime focus areas at CPRI. However, research and development efforts were concentrated in many other areas as well. This is only due to these efforts that at present our national potato productivity is better than the world average and even better than the other top three potato producing countries in the world, i.e. China, Russian Federation and Ukraine.

*Potato varieties:* Most of the potato varieties in the world were best suited for long day conditions of temperate climates. CPRI laid special emphasis on developing indigenous potato varieties and as a result of the extensive breeding programme, CPRI has so far released 50 potato varieties

**Table 4.** Details of potato varieties released by the CPRI

Variety	Year of release	Maturity	Target areas	Purpose
Kufri Kisan	1958	Late	North Indian plains (NIP)	Table
Kufri Kuber	1958	Medium	NIP and plateau region (PR)	Table
Kufri Kumar	1958	Late	North Indian Hills (NIH)	Table
Kufri Kundan	1958	Medium	NIH	Table
Kufri Red	1958	Medium	Plains of WB and Bihar	Table
Kufri Safed	1958	Late	NIP	Table
Kufri Neela	1963	Late	South Indian hills (SIH)	Table
Kufri Sindhuri	1967	Late	NIP	Table
Kufri Alankar	1968	Medium	NIP	Table
Kufri Chamatkar	1968	Late	NIP	Table
Kufri Chandramukhi	1968	Early	NIP and PR	Table
Kufri Jeevan	1968	Late	NIH	Table
Kufri Jyoti	1968	Medium	All Indian hills and plains	Table
Kufri Khasigaro	1968	Late	North Eastern hills (NEH)	Table
Kufri Naveen	1968	Late	NEH	Table
Kufri Neelamani	1968	Late	SIH	Table
Kufri Sheetman	1968	Medium/late	North Western plain (NWP)	Table
Kufri Muthu	1971	Medium	SIH	Table
Kufri Lauvkar	1972	Early	PR	Table
Kufri Dewa	1973	Late	NIP	Table
Kufri Badshah	1979	Medium	NIP and PR	Table
Kufri Bahar	1980	Medium	NIP	Table
Kufri Lalima	1982	Medium	NIP	Table
Kufri Sherpa	1983	Medium	North Bengal hills	Table
Kufri Swarna	1985	Medium	SIH	Table
Kufri Megha	1989	Late	NEH	Table
Kufri Ashoka	1996	Early	NIP	Table
Kufri Jewahar	1996	Early	NIP	Table
Kufri Suttlej	1996	Medium	NIP	Table
Kufri Pukhraj	1998	Early	NIP, Western plains and PR	Table
Kufri Chipsona-1	1998	Medium	NIP	Processing
Kufri Chipsona-2	1998	Medium	NIP	Processing
Kufri Giriraj	1999	Medium	NIH	Table
Kufri Kanchan	1999	Medium	NIH	Table
Kufri Anand	1999	Medium	NIP	Table
Kufri Shalja	2005	Medium	NIH	Table
Kufri Arun	2005	Medium	NIP	Table
Kufri Pushkar	2005	Medium	NIP	Table
Kufri Surya	2006	Early	NIP and peninsular India	Processing
Kufri Chipsona-3	2006	Medium	NIP	Processing
Kufri Himalini	2006	Medium	All Indian hills	Table
Kufri Sadabahar	2007	Medium	UP and adjoining areas	Table
Kufri Himsona	2007	Late	NIH	Processing
Kufri Khyati	2008	Early	NIP	Table
Kufri Giridhari	2008	Late	NIH	Table
Kufri Frysona	2009	Late	NIP	Processing
Kufri Neelima	2009	Medium	SIH	Table
Kufri Gaurav	2010	Early	NIP and Western plains	Table
Kufri Chipsona-4	2010	Medium	NIP and PR	Processing
Kufri Garima	2011	Medium	NIP	Table



for different areas and growing conditions (Table 5). These varieties can be grouped in table purpose varieties, processing varieties, potato varieties with resistance to diseases and insects and varieties with heat tolerance. Besides this the True Potato Seed (TPS) technology was also developed and standardised at CPRI.

A number of Indian potato varieties and hybrids developed by the CPRI are grown in different countries including Afghanistan, Nepal, Bhutan, Bangladesh, Sri Lanka, Philippines, Madagascar, Bolivia and Vietnam either under Indian names or modified local names, e.g. Kufri Chandramukhi (in Afghanistan), Kufri Jyoti (in Nepal and Bhutan) and Kufri Sindhuri (in Bangladesh and Nepal). Five Indian hybrids, I-654 (as CCM-69.1 in Mexico); I-822 (as cv. Krushi in Sri Lanka); I-1035 (as cvs. Montanosa in Philippines and Mailaka in Madagascar); I-1039 (as cvs. India in Bolivia and Red Skin in Vietnam); and I-1085 (as cvs. Sita in Sri Lanka and BSUP-04 in Philippines) are being officially grown.

*Forecasting and surveillance systems:* A late blight warning service was started since 1978 for Shimla hills and successful warnings were issued through All India Radio, Shimla every year. Besides, a late blight forecasting system has been developed for western UP. The system was successfully tested for two consecutive years (1997 and 1998). It successfully forecasted the late blight appearance in UP during 1998 crop season and has since been in operation. Recently such systems have been developed for different regions of the country. These fore-warning and forecasting systems are of great help to the potato growers who can take precautionary measures and can minimize the losses. Moreover, these have been instrumental in reducing the labour and cost on plant protection by avoiding unnecessary and untimely

use of fungicides. Besides, Wart the dreaded disease of potato was managed due to the efforts of CPRI in terms of imposing timely quarantine regulation. As a result this disease is confined only to Darjeeling. Moreover, wart situation is also being monitored regularly through joint surveys with Government of West Bengal. Besides, CPRI has also developed several wart immune potato varieties. As a result more than 90% of area under potato in summer crop of the district has been covered with wart immune varieties and the losses due to this disease gets reduced. Similar efforts have been made to contain cyst nematode.

*Package of practices:* Based on the extensive research on nutrient and water management (through many applications, such as field trials, radio-tracer studies and statistical analysis), the CPRI developed zone-wise agro-techniques for potato production during 1970-71. During 1986-1988 package-of-practices for seed and table potato production were brought out for Western Indo-Gangetic Plains, Central Indo-Gangetic Plains, Eastern Indo-Gangetic Plains, North-western Hills and Plateau regions of the country. Later on package-of-practices for potato cultivation in Nilgiri Hills and North-Eastern region were published during 1988-1990. The package-of-practices were distributed free of cost to the farmers and were up-dated from time to time. Adoption of these package-of-practices by farmers has led to tremendous increase of potato in area and production in the country during subsequent years. Earlier, farmers used to apply fertilizers according to availability and in wrong combinations but now farmers are better informed and concerned about appropriateness and doses of chemical fertilizers and pesticides.

*Mechanization:* Potato farming is a specialized job which needs lot of operations to be performed in a short duration (under Indian conditions).

Mechanization not only increases the speed of operations but also enhances efficiency and precision of costly inputs such as seed, fertilizers and pesticides etc. As potato farm machinery developed by the advanced countries is not suitable in India, the CPRI started its indigenous potato farm machinery development programme. Now, they have their own tractor operated fertilizer drills, semi-automatic potato planters (audible ring planter; revolving magazine type planter; and belt-up type planter), automatic potato planters (cup-type planters; picker wheel planter; and multi belt-fed type planter), channel maker, crust breaker, ridger, chemical sprayers, granular insecticide applicator, potato diggers (elevator digger; vibratory digger; and potato combine), potato graders (screen grader; wire-belt grader; roller grader and differential belt type grader) and potato seed treatment devices of different sizes and capacities to suit different requirements. As a result, 80% of the potato cultivation in India is partially or fully mechanised leading to reduction in human drudgery and enhancement of farm efficiency.

*Seed production:* Potato is largely a vegetatively propagated food crop and hence it is subjected to a large number of fungal, bacterial, viral and nematode infestations which gradually affect the quality of seed and subsequent yield potential of the crop. Replacement of seed after every three-four years becomes very important in order to maintain good yield of potato crop. Healthy seed potato production, particularly nucleus and breeder seed production is a specialized task that needs extensive infrastructural requirements along with a large number of head counts to perform the operations. India is the only sub-tropical country in the world that has its own seed potato production programme and it is run by the CPRI. More than 3000 tonne breeders seed is produced at



CPRI every year. About 2000 tonnes potato breeder seed is distributed by the CPRI to different states and central seed multiplication agencies. The modern bio-technological tools are used in order to produce disease free potato seed. CPRI has developed sensitive virus detection methods such as ELISA, ISEM and NASH, which are of great help in eliminating quarantine pathogens from any kind of potato material. Successful design and operation of the indigenous areoponics system for healthy seed potato production at various locations has been another feather in the cap of ICAR and CPRI in this direction.

**Remote Sensing/GIS:** 'Remote Sensing' and 'Geographical Information System' application in potato was also carried out at CPRI in collaboration with the ISRO, Ahmedabad. The impact of this research has come in the form that now it has been estimated potato acreage through remote sensing and GIS in the major potato producing states of India. With the help of GIS, many new places where potato cultivation is possible have been identified for special diversification.

**Expert System:** CPRI developed an expert system with the name 'Potato Pest Manager' which is capable of diagnosing the cause through sequential arrangement of symptoms and related photographs; and suggesting the required management practices for insects and diseases at its own. The system is gaining high popularity among the farmers that have personal computer with them or have an access in any other form. CSK Agricultural University, Palampur, Himachal Pradesh has already adopted this model for modifying it to suit their requirements. Another expert system 'CASP' can help farmers to choose suitable potato varieties for their

region along with date of planting and harvesting.

**Bio-technology:** CPRI has applied the latest tools in the field of Bio-technology for production of basic seed as well as development of potato varieties. The institute has developed potato transgenics for virus resistance (CP-PVY gene), cold clipping (invertase inhibitor gene) and late blight resistance. These await clearance from the government of India for multi-location testing.

### CONCLUSIONS

Impending food security issues are becoming clearer by every passing day. Stagnating yields of cereals and pulses leave very little potential to deal with these issues. However, some desirable qualities of potato crop such as wholesome nature of food, low calorific value of food, higher biological value of potato proteins, higher food production per unit area and time, flexible planting and harvesting, very wide geographical adaptability, high response to inputs and superior dietary fibre; position potato at the right place to address these issue in a more efficient manner.

The research impact of CPRI is manifold and can't be assessed in parts. At the time of inception of CPRI potato was considered to be a part of luxury and exclusive food in India but nowadays many poor people in the country survive exclusively on potato during production season. At present our potato productivity is better than China, the largest potato producer in the world. CPRI started research work at a time when every potato field used to be a museum of diseases but now it is very difficult to find diseases with naked eye on most of the potato farms. The high yielding potato varieties have replaced more

than 95% conventional and un-registered potato varieties in India.

At the time of inception of CPRI (1949), India used to produce 1.54 million tonnes potato out of 0.234 million ha with an average yield of 6.58 t/ha. The latest data shows that India produced 45 million tonne potatoes during 2012 (FAOSTAT) from 1.9 million ha with an average yield of 23.68 t/ha showing an increase of 812, 2922 and 360% in area, production and yield of potato, respectively. It has led to potato revolution in India.

Potato is basically a temperate plant grown under long day conditions but, the breeding programmes at CPRI could make possible that in India more than 90% potato is grown in sub-tropics. The non-conventional potato states such as Andhra Pradesh, Karnataka and Maharashtra have brought additional areas under potato cultivation. With the higher attention of Indian government on solving infrastructural problems potato exports are gradually increasing in spite of our very high domestic demand.

### SUMMARY

Potato is very popular all over the world and is either used as vegetable or made into a number of products for use as snacks. In some countries it has become the staple food. But whatever, or in whichever way it is being used, potato has become an inseparable part of people's diet all over. Potatoes are rich in minerals though relatively in small amounts and also contain nutritionally rich minerals like calcium, iron, magnesium, phosphorous and potassium. It is felt, that in time to come potato can be a perfect substitute for other cereals in a big way. ■

***It pays to advertise in Indian Farming***