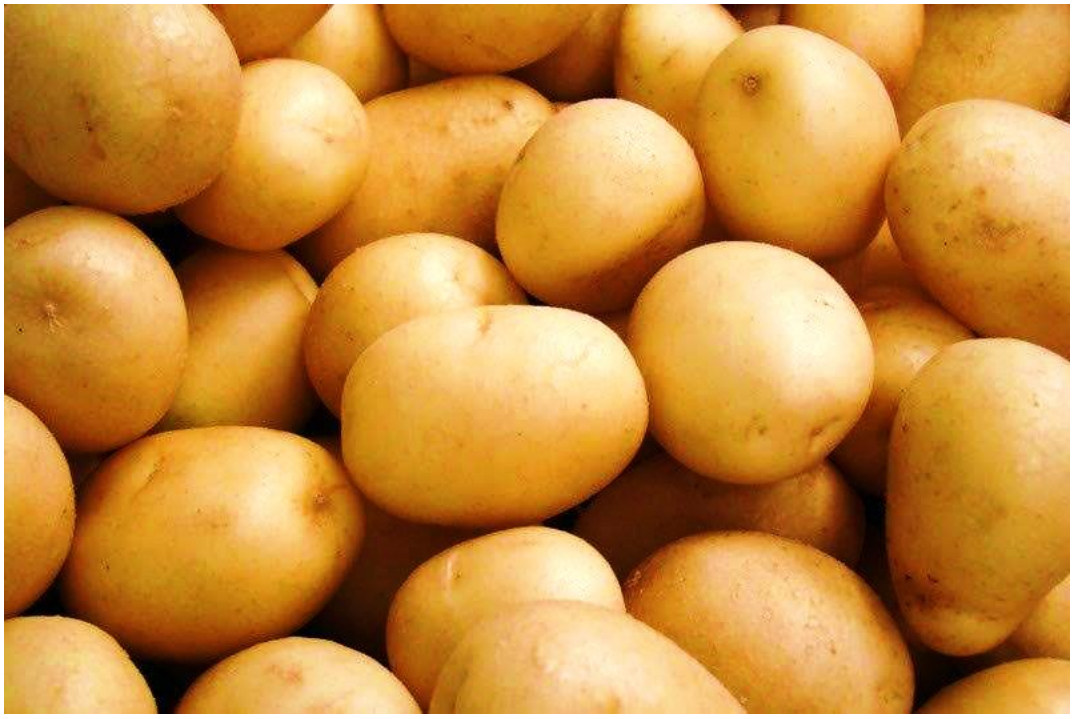
Post-Harvest Profile of Potato



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1.0 Introduction

Potato (*Solanum tuberosum* L.) is one of the most important food crops after wheat, maize and rice, contributing to food and nutritional security in the world. This tuber crop of the family *solanaceae* has about 200 wild species. Indian vegetable basket is incomplete without Potato. Because, the dry matter, edible energy and edible protein content of potato makes it nutritionally superior vegetable as well as staple food not only in our country but also throughout the world. Now, it becomes as an essential part of breakfast, lunch and dinner worldwide. Being a short duration crop, it produces more quantity of dry matter, edible energy and edible protein in lesser duration of time than cereals like rice and wheat. Hence, potato may prove to be a useful crop to achieve the nutritional security of the nation.

1.1 Origin

It originated in the high Andean hills of South America, from where it was first introduced into Europe towards the end of 16th century through Spanish conquerors. There the potato developed as a temperate crop and was later distributed throughout the world largely as a consequence of the colonial expansion of European countries. It was introduced to India by early 17th century probably through British missionaries or Portuguese traders.

1.2 Importance

India's potato consumption in last decade sees a sharp rise due its multiple applications in kitchen and value addition. In general potato is useful in making many Indian recipes. It is utilized in variety of ways, such as preparation of chips, wafers, flakes, granules, flour, starch, potato-custard powder, soup or gravy thickener, pan cakes as a process food.

The protein of potato has high biological value than proteins of cereals and even better than that of milk. The biological value of mixture of egg and potato is higher than the egg alone. Hence, potato can be supplement of meat and milk products for improving their taste, lowering energy intake and reducing food cost. Nutritional point of view, potato is a wholesome food and deserves to be promoted as a potential high quality vegetable cum food crop in the country.

With the improvement in the living standard of people in India, the dietary habits will shift from cereals to vegetables. Under such a situation, it is estimated that demand for potato in next couple of years is expected to rise in India. This target could be achieved only by improving the productivity level. The productivity of potato in India is quite low (183.3q/ha) as compared to that of Belgium (490q/ha), New Zealand (450q/ha), UK (397q/ha) and USA (383q/ha). This is due to shorter crop duration in India. There is a wide ranging variation in the agro-ecological setting of different parts of the country, which results in wide variations in the productivity levels of different states. Therefore, all our efforts may be put in to develop location-specific and problem-specific varieties and technologies.

Most of the people in India have either no knowledge or wrong notions about the nutritive value of potato. With low fat (0.1 per cent) and calorie contents, it does not cause obesity. Due to misconception, the per capita consumption of potato in India is only about 16 kg/year. On the other hand, the per capita consumption in Europe is 121 kg/year and as high as 136 kg/year in Poland. Hence, there is ample scope for improving the consumption of potatoes in India. For this purpose, a publicity campaign like eggs and milk needs to be launched through mass media such as television, radio and newspapers highlighting its nutritional value. Moreover, the possibility of using surplus potatoes as animal feed also needs to be explored.

The surplus potatoes in a season are stored in cold stores at 2-4°C in the country. This makes stored potatoes just unfit for processing and loses preference for table purposes due to accumulation of sugar content. To avoid sweetening, potato is required to be stored at 10-12°C. Only seed potatoes should be cold stored at 2-4°C. This would release at least 60 per cent of cold storage space that can be converted to store potatoes for processing and table purposes at 10-12°C with CIPC treatment leading to considerable savings on energy and storage costs.

Processing is a fast growing sector in the potato world economy. Due to increased urbanization, rise in per capita income and expanding tourism, the demand for processed potato products in India and international market has risen at a fast pace. However, in India, processing of potatoes constitutes less than 2 per cent of the total annual production as compared to 60 per cent in USA, 47 per cent in the Netherlands and 22 per cent in China. Hence, there is great scope to expand the potato processing industries in India and also to diversify the processing to produce flour, cubes, granules, flakes and starch.

Under the changed global scenario, the potato production and utilisation pattern is changing very fast. These changes harbour many opportunities which could be tapped through effective extension system. The use of modern information and communication technologies (ICT) to create awareness is highly pertinent in the contemporary times. This would enable us to reach directly to the end users by eliminating the intermediate channels which create distortion of information. Efforts are also needed to devise market-based extension strategies in order to promote entrepreneurship among potato growers with regard to potato production and marketing.

1.3 Nutritional value

Potato is a highly nutritious, easily digestible, wholesome food containing carbohydrates, proteins, minerals, vitamins and high quality dietary fibre. A potato tuber contains 80 per cent water and 20 per cent dry matter consisting of 14 per cent starch, 2 per cent sugar, 2 per cent protein, 1 per cent minerals, 0.6 per cent fibre, 0.1 per cent fat, and vitamins B and C in adequate amount. Thus, potato provides more nutrition than cereals and vegetables. Keeping in view the shrinking cultivable land and burgeoning population in India, potato is a better alternative to deal with the situation. It has low protein compared to meat but is the cheapest source of protein and minerals. The constituents of potato are indicated in Table 1.

Table 1: The constituents of potato per 100 gms.

S. No.	Constituents	Weight (grams)
1.	Water	74.70
2.	Carbohydrates (Starch and Sugar)	22.60
3.	Proteins	1.60
4.	Fibre	0.40
5.	Fat	0.10
6.	Minerals	0.60

Source: Potato in India, Central Potato Research Institute (CPRI), Shimla

Mineral value of potato is indicated in Table 2. Potato has more than 10 minerals and vitamins which are vital for balanced diet. It is among the major crop which supplies most of the essential minerals for metabolism.

Table 2: The Minerals and Vitamins as available in Potato is given below

S. No.	Minerals / Vitamins	Content (mg/100 gm of fresh weight)
1.	Calcium	7.7
2.	Copper	0.15
3.	Iron	0.75
4.	Magnesium	24.2
5.	Phosphorus	40.3
6.	Potassium	568.0
7.	Sodium	6.5
8.	Vitamin C	14.0 – 25.0
9.	Thiamine	0.18
10.	Riboflavin	0.01-0.07
11.	Niacin	0.4 –3.1
12.	Total Folate	5.0-35.0
13.	Pyridoxine	0.13-0.25

Source: Potato in India, Central Potato Research Institute (CPRI), Shimla

2.0 Potato Production Scenario

In Europe the potato crop is grown in summer having long photoperiod of up to 14 hours and the crop duration of 140-180 days. The potato in Indian plains is, however, grown in completely contrasting situations. Nearly 90 per cent of the crop is grown during winters having short photoperiod (with about 10-11 hours' sunshine) and the crop duration is also limited to 90-100 days because of short and mild winter. The season wise distribution of potato production in India is depicted in Table 3.

Table 3: Season wise distribution of potato production in India

Season	Sowing time	Harvesting time	Seasonal distribution (%)	Production in Million Tonnes (2020-21) (2nd Ad. Est.)
Rabi	End-Sep to Nov	Dec to Mar	98	**53.69**
Kharif	May to July	Sep to Nov	2	

Source: DA&FW

2.1 Major potato producing countries

Potato is grown in more than 100 countries globally with a production of around 360 million tonnes during the year 2020. China ranks first while India and Ukraine ranks second and third respectively. China, India, Ukraine, Russia and USA shared more than 50 per cent of total global production. The country wise production during 2016-20 is presented in Table 4.

Table 4: The country wise production of potato during 2016 to 2020 (in million tonnes)

Countries	2016	2017	2018	2019	2020
China	95.71	99.21	90.26	91.82	78.24
India	43.42	48.61	51.31	50.19	51.30
Ukraine	21.75	22.21	22.50	20.27	20.84
Russian Federation	31.11	29.59	22.39	22.07	19.61
United States of America	20.02	20.02	20.42	19.18	18.79
Germany	10.77	11.72	8.92	10.60	11.72
Bangladesh	9.47	10.22	9.74	9.66	9.61
Total Production	**354.19**	**370.10**	**365.32**	**370.44**	**359.12**

Source: FAOSTAT

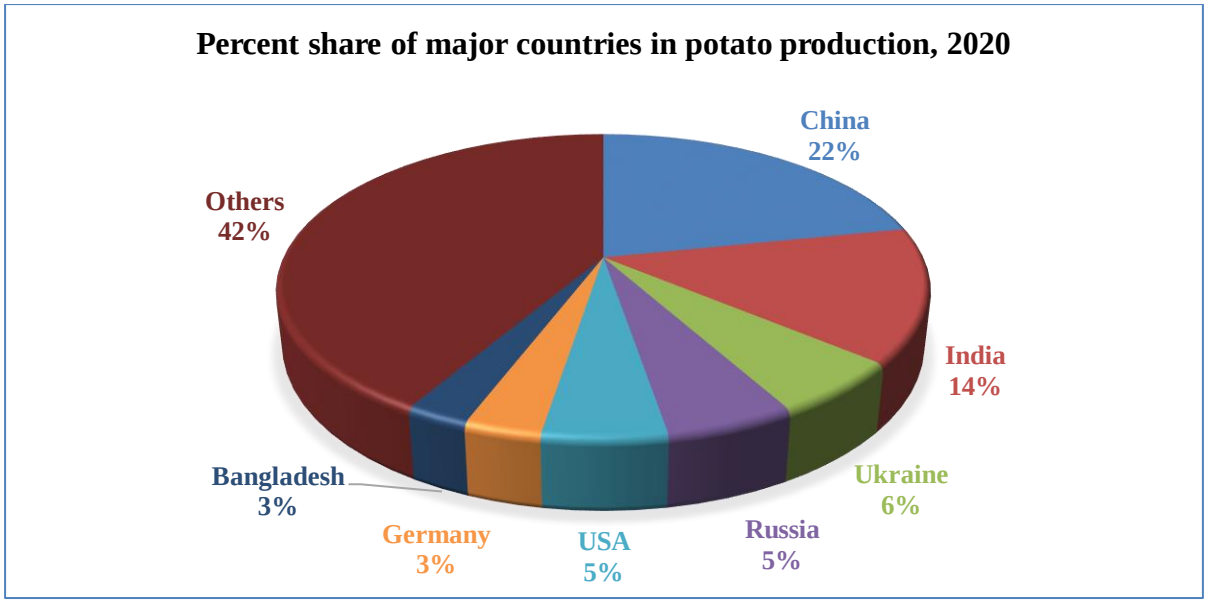


Figure 1: Share of major potato producing countries in potato production, 2020

2.2 Major potato producing states in India

In India, potato is cultivated in almost all states and under very diverse agro climate conditions. About 85 per cent of potatoes are cultivated in Indo-Gangetic plains of North India. The states of Uttar Pradesh, West Bengal, Bihar, Gujarat, Madhya Pradesh and Punjab accounted for more than 85 per cent share in total production. The state-wise production is furnished in Table 5.

Table 5: Major potato producing states during 2014-15 to 2020-21 (million tonnes)

State	Five-year average (2014-15 to 2018-19)		2019-20		2020-21 (2nd Ad. Est.)	
	Production	% share	Production	% share	Production	% share
Uttar Pradesh	15.03	31.11	13.00	26.77	15.84	29.50
West Bengal	11.06	22.89	12.56	25.86	13.20	24.59
Bihar	6.99	14.48	7.71	15.88	8.50	15.83
Gujarat	3.56	7.38	3.62	7.45	3.89	7.25
Madhya Pradesh	3.23	6.68	3.46	7.13	3.57	6.65
Punjab	2.47	5.12	2.87	5.91	2.95	5.49
others	5.96	12.34	5.34	11.00	5.74	10.69
Total	48.31	100.00	48.56	100.00	53.69	100.00

Source: State Departments of Horticulture & Agriculture

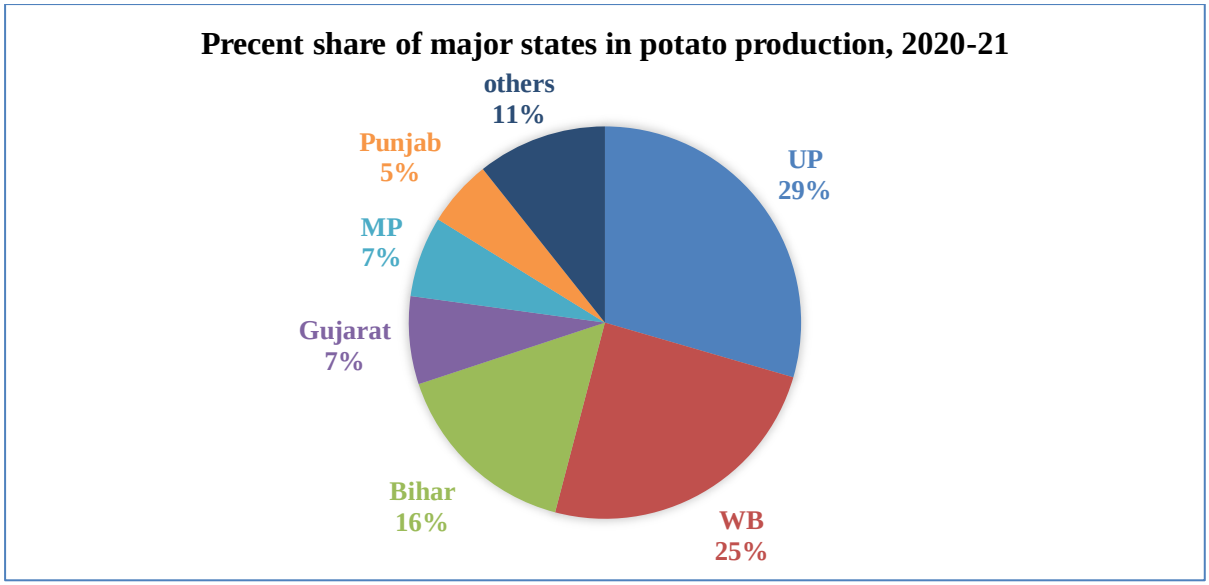


Figure 2: Major potato producing states in India, 2020-21

2.3 Region wise major potato varieties in India

Northern Indian plain is the major region where potato is grown successfully with satisfactory yield level. Majority of potato varieties are suited to northern plains. The potato varieties grown in this area are easy to cook and free from discoloration after cooking. The yield of potato in this region ranges from 200-350 q/ha. Potato growing regions have also extended to southern India and eastern plateau with considerable area and yield levels ranging from 200-350 q/ha. The region wise major varieties grown in India along with their characteristics are depicted in Table 6.

Table 6: Region wise major potato varieties in India

Zone	Variety	Yield (q/ha)	Characterstics
North Indian plains	Kufri Alankar	200-250	Easy to cook, texture floury, flavor mild, free from after-cooking discoloration
	Kufri Anand	350-400	
	Kufri Arun	300-350	
	Kufri Ashoka	250-350	
	Kufri Badshah	300-350	
	Kufri Bahar	300-350	
	Kufri Chamatkar	200-250	
	Kufri Khyati	250-300	
	Kufri Pushkar	200-350	
	Kufri Dewa	200-250	
	Kufri sindhuri	300-350	
	Kufri sutlej	300-350	
	Kufri lalima	200-250	
	Kufri safesd	200-250	
	Kufri Kumar	150-200	

	Kufri Chandramukhi	200-250	Easy to cook, texture floury, flavour mild, free from after-cooking discoloration, suitable for processing also
	Kufri Chipsona-1	300-350	Easy to cook, texture waxy, flavour mild, free from after-cooking discoloration. High dry matter, low reducing sugars and low phenols. Suitable for making chips and French fries
	Kufri Chipsona-2	300-350	
	Kufri Chipsona-3	300-350	
	Kufri Frysona	300-350	
North Indian plains and plateau	Kufri Jawahar	250-300	Cooks on prolonged boiling, texture floury, flavour mild, free from after- cooking discoloration
	Kufri kuber	150-200	
	Kufri pukhraj	350-400	Easy to cook, texture waxy, flavour mild, free from after-cooking discoloration. Coloration on exposure to light
	Kufri surya	250-300	Easy to cook, texture waxy, flavour mild, free from after-cooking discoloration, good for making French fries
North Indian Hills	Kufri Giridhar	300-350	Easy to cook, texture waxy, flavour mild, free from after-cooking discoloration
	Kufri kumar	150-200	
	Kufri shailaja	300-350	
	Kufri himalini	300-350	
	Kufri jeevan	150-200	
	Kufri kundan	150-200	Cooks on prolonged boiling, texture floury, flavour mild, free from after- cooking discoloration
	Kufri Himsona	150-200	Easy to cook, texture waxy, flavour mild, free from after-cooking discoloration. High dry matter, low reducing sugars and low phenols. Suitable for chip making
Uttar Pradesh, Bihar and West-Bengal	Kufri Garima	300-350	Easy to cook, texture mealy, flavour mild, free from after-cooking discoloration.
Karnataka, West-Bengal and Madhya Pradesh	Kufri Chipsona-4	300-350	Easy to cook, texture mealy, flavour mild, free from after-cooking discoloration. High dry matter, low reducing sugars and low phenols. Suitable for making chips.
Punjab, Haryana, Uttaranchal plains and Western Uttar Pradesh	Kufri Gaurav	300-350	Easy to cook, texture waxy, flavour mild, free from after-cooking discoloration
North-Bengal hills and Sikkim	Kufri Kanchan	250-300	Easy to cook, texture waxy, flavour mild, free from after-cooking discoloration.
	Kufri Sherpa	150-200	
North-eastern hills	Kufri Khasigaro	250-300	Easy to cook, texture floury, flavour mild, free from after-cooking discoloration
	Kufri naveen	200-250	
	Kufri Megha	250-300	
North eastern	Kufri Red	200-250	Cooks on prolonged boiling, texture

plains			waxy, flavour strong, free from after- cooking discoloration
North western plains	Kufri Sheetman	200-250	Easy to cook, texture waxy, flavour mild, free from after-cooking discoloration
Eastern plains	Kufri Lalit	300-350	Easy to cook, texture waxy, flavour mild, free from after-cooking discoloration
Uttar Pradesh	Kufri Sadabahar	300-350	Easy to cook, texture mealy, flavour mild, free from after-cooking discoloration
South Indian hills	Kufri Swarna	300-350	Easy to cook, texture floury, free from after-cooking discoloration

Source: Central Potato Research Institute

2.4 Potato varieties for different Agro-climatic regions

India is blessed with different ago climatic regions. Crops grown in one region very rarely adopts to other regions. Most of the crops are specific to certain region and some crops are modified to grow on other region. Potato is one such crop which can be grown in different regions. The decentralization of potato breeding from hills to plains in India through the seed plot technique enabled the development of varieties suited to different agro-climatic regions of the country. Hence various varieties of potato have been developed to suit the different agro-climatic regions of India to achieve high level of productivity.

Table 7: Potato varieties for cultivation in different agro-ecological zones

Agro-ecological zones	Duration	Recommended varieties
North-western plains	Early	Kufri Ashoka, Kufri Chandramukhi, Kufri Jawahar, Kufri Khyati, Kufri Pukhraj, Kufri Surya
	Medium	Kufri Anand, Kufri Arun, Kufri Badshah, Kufri Bahar, Kufri Chipsona-1, Kufri Chipsona-3, Kufri Garima, Kufri Gaurav Kufri Jyoti, Kufri Pukhraj, Kufri Pushkar, Kufri Sadabahar, Kufri Sutlej
West-central plains	Early	Kufri Chandramukhi, Kufri Jawahar, Kufri Khyati, Kufri Pukhraj, Kufri Lauvkar, Kufri Surya
	Medium	Kufri Anand, Kufri Arun, Kufri Badshah, Kufri Bahar, Kufri Chipsona-1, Kufri Chipsona-3, Kufri Frysona, Kufri Garima, Kufri Gaurav, Kufri Jyoti, Kufri Pukhraj, Kufri Pushkar, Kufri Sadabahar, Kufri Sutlej
	Late	Kufri Sindhuri
North-eastern plains	Early	Kufri Ashoka, Kufri Chandramukhi, Kufri Khyati, Kufri Pukhraj, Kufri Surya
	Medium	Kufri Arun, Kufri Bahar, Kufri Chipsona-1, Kufri Chipsona-3, Kufri Frysona, Kufri Garima, Kufri Gaurav, (In Table Row No. 7) Kufri Jyoti, Kufri Kanchan, Kufri Lalima, Kufri Lalit, Kufri Pukhraj, Kufri Pushkar, Kufri Sutlej
	Late	Kufri Sindhuri

Source: Central Potato Research Institute, Shimla

2.5 Indian potato varieties adopted by other countries

The potato varieties developed by CPRI, Shimla are grown not only in India but also in several neighbouring countries. The variety Kufri Chandramukhi is grown in Afghanistan, Kufri Jyoti in Nepal and Bhutan, and Kufri Sindhuri in Bangladesh and Nepal. Besides, five Indian hybrids are also commercially grown in Sri Lanka, Madagascar, Mexico and Philippines. The names of countries along with adopted Indian varieties are furnished in Table 8.

Table 8: Indian potato varieties grown in other countries

Country	Varieties/Hybrids
Afghanistan	Kufri Chandramukhi
Nepal	Kufri Jyoti, Kufri Sindhuri
Bhutan	Kufri Jyoti
Bangladesh	Kufri Sindhuri
Mexico	I-654 as CCM-69.1
Sri Lanka	I-822 as cv. Khrushi, I-1085 as cv. Sita
Philippines	I-1035 as cv. Montanosa, I-1085 as cv. BSUP-04
Madagascar	I-1035 as Malaika
Bolivia	I-1039 as cv. India
Vietnam	I-1039 as cv. Red skin

Source: Central Potato Research Institute, Shimla

3.0 Post Harvest Management

3.1 Post-harvest losses

Post-harvest management plays key role in increasing the shelf life and utility of potato. It was observed from various studies that potatoes grown under tropical and sub-tropical conditions face a loss of 30-50 per cent due to poor handling and storage. The post-harvest losses of potatoes are defined as qualitative and quantitative losses. The qualitative losses greatly reduce the price of potatoes. The qualitative losses may be due to either physiological reasons or pathological reasons or may be due to both reasons. The physiological, pathological causes and their remedies are presented in the Table 9.

Table 9: Qualitative losses of potato

Types of Qualitative Losses	Reasons	Remedies
Physiological losses [Caused by the effect of environmental conditions]	1. Due to exposure to extreme temperatures, (high and low temperatures), both before and during storage. 2. Overheating of tubers due to direct exposed to sunlight or during high temperature and non-refrigerated storage. 3. Rough handling of tubers during harvesting.	1. Do not expose tubers to direct sunlight or high temperatures or freezing temperatures. 2. Do not harvest the crop before maturity. 3. Store potatoes at 2-4^{0}C in cold storage. 4. In case of processing and ware potatoes, store at 10-12^{0}C by using sprout inhibitors.
Pathological losses [Caused by the attack of pathogens e.g. fungi, bacteria, insects etc.]	1. Rotting and decay accounts for major losses caused due to attack of pests and diseases. It depends primarily on the condition of tubers stored and is linked with pre harvest factors and aggravated by storage conditions. Such types of losses are low in hills and negligible or small in cold Storage.	1. Careful attention to pre harvest management like harvesting, grading etc., is essential. 2. Sorting and removal of rotted and damaged tubers before and after storage.

Source: Post Harvest Manual for Exports of Potatoes, Agricultural and Processed Food Export Development Authority (APEDA), New Delhi.

The quantitative losses lead to loss in the quantity of the product. These losses occur at different stages of handling the product in the marketing of the produce. The quantitative losses vary across the stages of the handling and types of handling practices being used by the different intermediaries at the various levels of marketing. The adoption of good handling practices leads to considerable reduction in the losses. The quantitative losses of potato at different stages / levels in various states are given in the Table 10.

Table 10: Quantitative Losses of Potato state wise

Stages / level	States /U.T.	Percentage of Losses
Harvesting	Arunachal Pradesh, Himachal Pradesh, Meghalaya, Rajasthan	Upto 1 per cent
	Assam, Jammu & Kashmir, Karnataka, Manipur, Punjab, Tamil Nadu	Upto 2 per cent
	Bihar, Delhi, Haryana, Tripura, West Bengal	Upto 3 per cent
	Andhra Pradesh, MP, Orissa, Sikkim, UP	Upto 5 per cent
	Gujarat, Maharashtra	5-6 per cent
Village Traders	Assam	2-3 per cent
	Bihar	5-10 per cent
	Himachal Pradesh	1-2 per cent
	Karnataka	2 per cent
	Kerala	10 per cent
	Madhya Pradesh	1-2 per cent
	Manipur	1-2 per cent
	Meghalaya	0.5 per cent
	Orissa	1-2 per cent
	Sikkim	2-4 per cent
	West Bengal	3-6 per cent
Traders	Andhra Pradesh	1-2 per cent
	Assam	2 per cent
	Bihar	5-10 per cent
	Gujarat	5 per cent
	Himachal Pradesh	1-3 per cent
	Jammu & Kashmir	5 per cent
	Madhya Pradesh	10-15 per cent
	Manipur	3-5 per cent
	Meghalaya	0.5 per cent
	Orissa	2-5 per cent
	Punjab	6 per cent
	Sikkim	1 per cent
	Tripura	10-15 per cent
	Uttar Pradesh	10 per cent
	West Bengal	4-6 per cent

Source: Marketing of Potato in India, DMI

Table 11: All India Harvest and post-harvest loss of potato

Stages of loss	Level	Percent loss
Farm Operations	Harvesting	2.58
	Collection	0.25
	Sorting/ Grading	2.93
	Packing	0.06
	Transport	0.72
	Total loss in farm operation	**6.54**
Storage	Farm	0.15
	Godown/cold storage	0.17
	Wholesaler	0.34
	Retailer	0.11
	Processing units	0.02
	Total loss in storage	**0.78**
Overall total loss		**7.32**

Source: CIPHET

The Crop production undergoes series of harvest and post-harvest operations like harvesting, handling, storage and transportation before reaching to the consumers. Some food losses happen at each stage of harvest and post-harvest which results in reduction in food quantity. The reduction in the quantity of available production for human consumption is defined as quantitative food loss. These post-harvest losses result into decrease in food availability. The recent study by ICAR-CIPHET, 2015 (Table 11) has estimated losses in potatoes in the range of 7.32% in Potato, the overall total loss in different regions of India varied between 5.01%-7.96% (except for Assam where loss was only 3.92%). It indicated almost uniform kind of pattern in losses of potato in different regions of India. The loss of potato in farm operations at national level was 6.54%. The report also highlighted the fact that the total loss during storage of potato at national level has decreased significantly from 2.26% in 2005-07 to 0.78% in present study which may be attributed to better availability of cold stores and other infrastructures. The storage loss of potato has decreased almost in all channels.

3.2 Harvesting care

3.2.1 Harvesting

The following are the most commonly followed harvesting care:

a) Follow the practice of Dehaulming [cutting of haulms / aerial parts by sickle or killing by chemicals (e.g. Gramoxone) or destroying by machines] when the crop attains 80-90 days and when the aerial part of the plant turns yellow.
b) Always harvest in dry weather.
c) Stop irrigation about two weeks before dehaulming.
d) Avoid bruising and skinning of tubers otherwise tubers become susceptible to rot diseases.
e) Harvest the crop after 10-15 days of haulm cutting.

3.2.2 Drying and curing

A) The following care should be taken during drying:

(a) Always dry the harvested tuber quickly to remove excess moisture from the surface of tubers for improving their keeping quality.
(b) Always dry the harvested tuber in storage shed, expose to sun causes the greening of potatoes.
(c) Do not store the tubers immediately if they are exposed to rain after harvest.

B) The following care should be taken during curing:

(a) Always follow the curing process at 25 degrees centigrade with a 95 per cent relative humidity,
(b) For optimum suberization, curing is essential for healing the wounds of tubers resulted from cutting and bruising during harvesting.

C) The following care should be taken during sorting:

(a) All the damaged and diseased tubers should be removed during sorting.

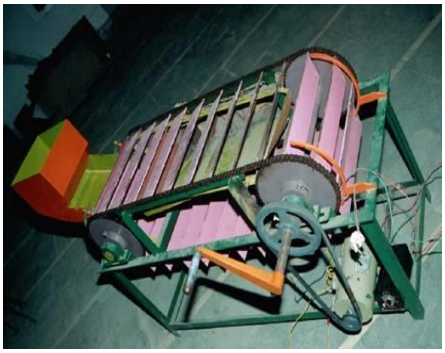
3.3 Harvesting and post harvesting equipment

1. **Manual potato peeler:** It is batch type hand operated equipment for peeling outer skin of potatoes of any size for further processing to produce value added products like chips, wafers etc. It consists of main frame, handle, rotating drum with notches, water inlet, top cover etc. A batch of 8 kg is fed in the drum and peeling is completed in 8 minutes (Image curtsy: Google)

2. **Pedal operated potato peeler:** The pedal operated potato peeler is developed for small entrepreneurs where electricity is not available. The perforated stainless steel drums during rotation remove skin of potatoes as in manual peeler. (Image curtsy: Google)

3. **Pedal operated potato slicer:** The pedal operated potato slicer is suitable for small entrepreneurs where electricity is not available. It consists of Main frame, feeding unit, stainless steel blade etc. (Image curtsy: Google).

4. **Farm fruit grader:** The machine can manually be operated by hand or can mount 1 HP single phase motor. Two labours are required for successful operation of the machine. It saves the time and labour cost. (Image and content curtsy: Vikaspedia)



5. **Farm level fruit and vegetable washing machine:** A stainless steel, portable, electric power (1 HP) operated vegetables washing machine has been designed, developed and evaluated. The inner rotary drum of the washer is made of stainless steel with 1.5 mm thickness, 760 mm length and 620 mm diameter. The periphery of the drum is provided with perforations of 6 mm diameter each @ 20 per 100 cm. The drum is mounted between two bearings through a hollow shaft and stainless steel pipe carrying water is placed inside

the shaft. Pressurized sprays of water with a water injection pump through the central, perforated inner shaft is provided for extensive washing. The machine is provided with a timer and an electronic device to regulate precisely the rotational speed of the drum up to 60 rpm. Proper arrangements for feeding water into machine and draining out dirty water and silt is provided. Rotating parts and moving belts are covered with guard for operational safety. (Image and content curtsy: Vikaspedia).

6. **Tractor Mounted Root Crop Harvester cum Elevator:** A root crop harvester-cum-elevator was developed by PAU, Ludhiana for digging onion and other root crops. The field capacity of the machine is 0.28, 0.24, 0.21 and 0.21 ha/h for digging of carrot, potato, garlic and onion crops, respectively at a forward speed of 2.78, 2.41, 2.10 and 2.10 km/h. The damage to tubers is 1.98, 1.92 1.22 and less than 1.0% for digging of carrot, potato, garlic and onion crops, respectively. The approximate cost of the machine is Rs. 60,000/-. The saving in cost of operation and labour for harvesting onion, carrot and garlic is 52.28, 46.71, 52.28%, and 69.05, 59.29 and 69.05%, respectively as compared to manual harvesting. (Image and content curtsy: icar.gov.in).

7. **Tractor Operated Potato Digger Elevator**: It consists of a frame, shovel type-digging blade of 550 mm width, endless rod chain conveyor, gearbox, two gauge wheels, idlers and driving sprockets. The elevator conveyor is made of mild steel rods of 12 mm diameter, which are riveted/bolted to two endless flat belts. The pitch of the conveyor links is 25 mm. The length of the conveyor is 1500 mm and makes an angle of 20 degrees with the horizontal. The machine is operated by a tractor of 26 kW. (Image and content curtsy: icar.gove.in).

3.4 Grading: Grading is an important factor in the marketing process of potato.

Benefits:

i) Grading helps the potato producer and seller to determine the price.
ii) It reduces the cost of marketing and helps the consumers to get standard potato at fair price.
iii) It facilitates the scope to widen the avenue for potato export.
iv) It has a direct influence on utilization point of view, as the small to medium sized tubers are prepared for 'seed tubers' and large sized tubers are preferred for processing purpose.

Methods of Grading

Grading of tubers is done both by hand as well as by graders. The different practices of grading of potato are as follows:

i) Grading of potatoes with a set of rectangular sieves having round holes of varying diameters, where a pair of such sieves placed one above the other are shaken to and fro by two persons and the third person continuously feds the upper sieve.

ii) Grading of potatoes through sieves hung on chains or ropes and move back and fore.

iii) Grading of potatoes by the mechanical grader, where the sieves are mounted on the oscillation of frame as operated mechanically by power. This grader can be operated with 1H.P. electric motor, engine or tractor.

iv) Grading of potato with power operated potato grader with conveyer attachment gives better grading efficiency (90 per cent) .The power requirement is 1.5 HP. It can grade four categories viz less than 10 gms, 10-25 gms, 25-60 gms, and more than 60 gms.

v) The rubber roller type of potato grader grades, six categories of grades viz. less than 10 gms, 10-25 gms, 25-50 gms, 50-75 gms, 75-100 gms, and more than 100 gms. The system consist of mainframe, grading rollers, conveyor belt and power transmission system. The grader is operated by 2 HP electric motor.

1. **Endless Screen Type Potato Grader:** Manually or engine operated grading machine with output capacity of 4.5 tonnes/hr (machine operation) and 2.5 tones/hr (manual operation). Manual operation needs 6-8 persons. (Image and content curtsy: Directorate of Cashew Research, Puttur)

2. **Expanding pitch rubber spool potato sizer:** It consists of two driving rollers with helical grooves of progressively increasing pitch that moves the rods with rubber spool. The advantage of such mechanism is that as many grades of potatoes can be obtained as desired. The rods are carried together with two link chains and rubber spools are carried on them. The machine can be operated by one horsepower motor and can grade 2-3 tonnes of potatoes in one hour. The mechanical damage to tubers is negligible. (Image and content curtsy: Directorate of Cashew Research, Puttur)

3.4.1 Grade specification

A. AGMARK specifications for domestic market

AGMARK specification plays important role in ensuring the quality of potatoes for marketing. It is provided with legal backing under the Agricultural Produce (Grading and Marking) Act, 1937.

The quality factors like size of tubers, conformity to the variety, tolerance limits for under sized and oversized tubers, percentage of diseased and damaged tubers, and dust and extraneous matters, etc. are taken into consideration. The Agmark grade standards of table potato are furnished in Table 12.

Table 12: Grade designations and definition of quality of table potatoes (oval or long varieties*)

Grade designation	General	Applicable to single tuber's size (Minimum diameter in) millimeters	Definition of quality				
			Applicable to quantities				
			Conformity to variety etc.	Tolerance			
				Under size or over-size	Disease + Damage etc	Earth and extraneous matter	Maximum aggregate of all defects under column 5,6 & 7
1	2	3	4	5	6	7	8
Extra special	Reasonably clean, healthy potatoes, free from serious defect and suitable for human consumption	41 mm**	At least 95% by weight must conform to the variety	Not more than 2% of the total weight may pass through sieve having circular holes with a diameter of the minimum size specified (in column 3) for the grade; included in this not more that 0.5% of the total weight may pass through a 25 mm mesh	Not more than 2% of the total weight may consist of appreciably diseased, damaged or unsightly potatoes and included in this amount	Not more than 2% may be total present, the percentage to be calculated on the net weight of screened potatoes.	4% of the total weight
Special	Reasonably clean, healthy potatoes, free from serious defect and suitable for human consumption	29 mm	At least 95% by weight must conform to the variety	Not more than 2% of the total weight may pass through sieve having circular holes with a diameter of the minimum size specified (in column 3) for the grade; included in this not more that 0.5% of the total weight may pass through a 25 mm mesh	Not more than 2% of the total weight may consist of appreciably diseased, damaged or unsightly potatoes and included in this amount	Not more than 2% may be total present, the percentage to be calculated on the net weight of screened potatoes.	4% of the total weight

* The word "Oval or Long" shall be marked following the grade name on the AGMARK label by means of a rubber stamp.

** When the potatoes have been passed over a riddle of greater mesh than 41 mm. the minimum size may at the seller's discretion be appended to the grade name, e.g. "Extra Special" (51 mm., 57 mm, 64 mm etc.) but potatoes which exceed 89 mm in their smallest diameter shall be excluded from grading.

\+ 1. Any disease or defect the presence of which may be established by cutting open the potato shall be taken into account, and potatoes having cuts worm and slug holes penetrating into the flesh shall be regarded as damaged.

2. Potatoes affected by greenness superficial disease or damage shall not be regarded as diseased or damaged unless more than 1/10 of the surface is so affected.

3. A potato shall only have regarded as being obviously affected with the soft rot, if at the time of inspection, it is squashy or the surface is at some part distinctly broken or wet owing to disease.

Table 13: Grade designations and definition of quality of table potatoes (round varieties*)

Grade designation	General	Applicable to single tuber's size (Minimum diameter in) millimeters	Definition of quality				
			Applicable to quantities				
			Conformity to variety etc.	Tolerance			
				Under size or over-size	Disease + Damage etc	Earth and extraneous matter	Maximum aggregate of all defects under column 5,6 & 7
1	2	3	4	5	6	7	8
Extra special	Reasonably clean, healthy potatoes, free from serious defect and suitable for human consumption	45 mm**	At least 95% by weight must conform to the variety	Not more than 2% of the total weight may pass through sieve having circular holes with a diameter of the minimum size specified (in column 3) for the grade; included in this not more that 0.5% of the total weight may pass through a 25 mm mesh	Not more than 2% of the total weight may consist of appreciably diseased, damaged or unsightly potatoes and included in this amount	Not more than 2% may be total present, the percentage to be calculated on the net weight of screened potatoes.	4% of the total weight
Special	Reasonably clean, healthy potatoes, free from serious defect and suitable for human consumption	32 mm	At least 95% by weight must conform to the variety	Not more than 2% of the total weight may pass through sieve having circular holes with a diameter of the minimum size specified (in column 3) for the grade; included in this not more that 0.5% of the total weight may pass through a 25 mm mesh	Not more than 2% of the total weight may consist of appreciably diseased, damaged or unsightly potatoes and included in this amount	Not more than 2% may be total present, the percentage to be calculated on the net weight of screened potatoes.	4% of the total weight

* Potatoes of round varieties shall be packed separately. The word "Oval or Long" shall be marked following the grade name on the AGMARK label by means of a rubber stamp.

** When the potatoes have been passed over a riddle of greater mesh than 45 mm. the minimum size may at the seller's discretion be appended to the grade name, e.g. "Extra Special" (51 mm, 57 mm, 64 mm etc.) but potatoes which exceed 83 mm in their smallest diameter shall be excluded from grading.

+ 1. Any disease or defect the presence of which may be established by cutting open the potato shall be taken into account, and potatoes having cuts worm and slug holes penetrating into the flesh shall be regarded as damaged.

2. Potatoes affected by greenness superficial disease or damage shall not be regarded as diseased or damaged unless more than 1/10 of the surface is so affected.

3. A potato shall only have regarded as being obviously affected with the soft rot, if at the time of inspection, it is squashy or the surface is at some part distinctly broken or wet owing to disease.

B. Grade specifications for export: For faster export and assure market access grade specifications is necessary. It was mandated by APEDA for any agro product to be exported needs to be specified with grade. AGMARK provide the grade specification to various exportable agro products. For potato it is provided as under with particular varieties.

Table 14: Grade designation and definition of quality of table potatoes of mettupalayam variety (oval or long or round or mixed*)

Grade designa-tion	General	Definition of quality				
		Applicable to single tuber's size (min. dia in mm)	Applicable to quantities			
			Conformity to variety etc.**	Tolerance		
				Under size or over-size	Disease, Damages, etc	Earth and extraneous matter
1	**2**	**3**	**4**	**5**	**6**	**7**
Extra special	Reasonably clean, healthy potatoes free from serious defect and suitable for human consumption.	46 @	At least 95% by weight must conform to the variety.	Not more than 3% of the total weight may pass through having circular with a diameter of a minimum size specified (in column 3) for the grade.	Not more than 2% of the total weight may consist of diseased, damaged or sprouted potatoes.	Not more than 2% may be present, the percentage to be calculated on the net weight of screened potatoes.
Special	Reasonably clean, healthy potatoes free from serious defect and suitable for human consumption.	35	At least 95% by weight must conform to the variety.	Not more than 3% of the total weight may pass through having circular with a diameter of a minimum size specified (in column 3) for the grade.	Not more than 2% of the total weight may consist of diseased, damaged or sprouted potatoes.	Not more than 2% may be present, the percentage to be calculated on the net weight of screened potatoes.
General	Reasonably clean, healthy potatoes free from serious defect and suitable for human consumption.	25	At least 95% by weight must conform to the variety.	Not more than 3% of the total weight may pass through having circular with a diameter of a minimum size specified (in column 3) for the grade.	Not more than 2% of the total weight may consist of diseased, damaged or sprouted potatoes.	Not more than 2% may be present, the percentage to be calculated on the net weight of screened potatoes.

*The word Oval Long or Round or Mixed" shall be marked, following the trade description, on the AGMARK label, by means of rubber stamp,

**Column 4 relating to conformation to variety will not apply to mixed lots.

@ In case when the potatoes have been passed over a riddle of greater mesh than 46 mm. the minimum size may, at the seller's discretion, be appended to the grade name e.g., "Extra Special" (51 mm., 57 mm., 64 mm, etc.) but potatoes which exceed 89 mm., in their smallest diameter shall be excluded from grading.

1. Any disease or defect, the presence of which may be established by cutting open the potato, shall be taken into account and potatoes having cuts, worm or slug holes penetrating into the flesh shall be regarded as damaged.
2. Potatoes affected by greenness, superficial disease or damage shall not be regarded as diseased or damaged unless more than 1/5 of the surface is so affected.
3. A potato shall only be regarded as being obviously affected with the soft rot, if at the time of inspection, it is squashy or the surface is at some part distinctly broken or wet owing to disease.

Table 15: Grade designation and definition of quality of katva or farukhabad table potatoes (round)**

Grade designa - tion	General	Definition of quality				
		Applicable to single tuber's size (min. dia in mm)	Applicable to quantities			
			Conformity to variety etc.	Tolerance		
				Under size or over-size	Disease, Damages, etc	Earth and extraneous matter
1	**2**	**3**	**4**	**5**	**6**	**7**
Extra special	Reasonably clean, healthy potatoes free from serious defect and suitable for human consumption	25 @	At least 95% by weight must conform to the variety.	Not more than 3% of the total weight may pass through having circular with a diameter of a minimum size specified (in column 3) for the grade.	Not more than 2% of the total weight may consist of diseased, damaged or sprouted potatoes.	Not more than 2% may be present, the percentage to be calculated on the net weight of screened potatoes.
Special	Reasonably clean, healthy potatoes free from serious defect and suitable for human consumption	20	At least 95% by weight must conform to the variety.	Not more than 3% of the total weight may pass through having circular with a diameter of a minimum size specified (in column 3) for the grade.	Not more than 2% of the total weight may consist of diseased, damaged or sprouted potatoes.	Not more than 2% may be present, the percentage to be calculated on the net weight of screened potatoes.

*The word 'Round' shall be marked, following the trade description, on the AGMARK label, by means of rubber Stamp.

@ When the potatoes have been passed over a riddle of greater mesh than 25 mm. the minimum size may, at the seller's discretion, be appended to the grade name eg., 'Extra Special' (51 mm., 57 mm, 64mm., etc.) but potatoes which exceed 89 mm, in their smallest diameter shall be excluded from grading.

1. Any disease or defect, the presence of which may be established by cutting open the potato, shall be taken into account and potatoes having cuts, worm or slug holes penetrating into the flesh shall be regarded as a damaged.
2. Potatoes affected by greenness, superficial disease or damage shall not be regarded as diseased or damaged unless more than 1/5 of the surface is so affected.
3. A potato shall only be regarded as being obviously affected with the soft rot, if the time of inspection, it is squashy or the surface is at some part distinctly broken or wet owing to disease.

3.4.2 Codex Alimentarius Commission

The Codex Alimentarius Commission (CAC) was created in 1963 by Food and Agricultural Organization of the United Nations (FAO) and World Health Organization (WHO) to develop food standards, guidelines and related texts such as codes of practices

under the Joint FAO/WHO Food Standards Programme. Its main purpose is to protect the health of consumers and ensuring fair trade practices in food trade and promoting conditions of food and food standards work undertaken by International governmental and non-governmental organizations.

3.5 Packing

The different varieties of potatoes like Kufri Bahar, Kufri Locker and Kufri Badshah are exported. The potatoes are packed in Hessian bags (Jute bags) of having capacity of 25 kg. The bags used are generally hand stitched and the final stitching is done in such a manner that there is no space and scope for the movement of the product within the pack. Two corners of the open end of the bag when stitched are used as handles while loading and by application of pressure sensitive tape and reinforced with plastic shop unloading. The potatoes packed in these bags are exported by sea as container cargo in both general purposes as well as refrigerated containers.

Materials used for potato packaging

1. Jute bags
2. Leno bags
3. Net bags

3.6 Transportation

a. Tractor trolley: The use of tractor attached with a trolley is commonly used for transporting potatoes in many parts in the country. It is convenient for

i) Carrying large quantity of produce in lesser duration of time.

ii) Suitable in surplus producing areas than the trucks for carrying produce to the primary assembling markets in the absence of pucca roads.

b. Trucks

Large or bulk quantities of potatoes are carried by the trucks to the distant places throughout the country. It is convenient for**:**

i) Easy availability.

ii) Time saving.

iii) Quick movement of stocks.

iv) Door to door delivery.

v) Lower transit losses due to least handing of loading and unloading.

c. Railway transport

During harvesting season, considerable quantities of potato are transported by railway wagons. This is convenient for**:**

i) Suitable for carrying larger quantity of potatoes over long distances.

ii) Comparatively cheaper and safer mode of transport available through railways.

3.7 Storage

The purpose of storage is to maintain tubers in their most edible and marketable condition and to provide a uniform flow of tubers to market and processing plants throughout the year. Four variables to determine storage losses are the potato variety, pre-storage conditions, storage conditions and storage duration. It must be realized that storage losses cannot be avoided even by optimal storage. Good storage can merely limit storage losses in good product over relatively long periods of storage. Storage losses are often specified as weight losses and losses in the quality of potatoes, although the two cannot always be distinguished.

Storage losses are mainly caused by the processes like respiration, sprouting, evaporation of water from the tubers, spread of diseases, changes in the chemical composition and physical properties of the tuber and damage by extreme temperatures. These processes are influenced by storage conditions. All the losses mentioned above depend on the storage conditions and therefore can be limited by maintaining favourable conditions in the store. However, the storability of potatoes is already determined before the beginning of storage, by such factors as cultivar, growing techniques, type of soil, weather conditions during growth, diseases before harvesting, maturity of potatoes at the time of harvesting, damage to tubers during lifting, transport and filling of the store.

The four main outlets for stored potatoes are seed potatoes, household consumption, the processing industry and potatoes as raw material for the production of starch or alcohol. Choice of storage method must be considered by the requirements for each purpose, but for all uses wound healing is essential immediately after harvest. Good storage should prevent excessive loss of moisture, development of rots, and excessive sprout growth. It should also prevent accumulation of high concentration sugars in potatoes, which results in dark-coloured processed products. Temperature, humidity, CO_2 and air movement are the most important factors during storage.

In India potatoes are stored in cold store and used for both seed and table purposes. Seed potatoes are best stored in cold store maintained at 2- 4°C and at about 95% relative humidity. But cold stored potatoes are not suitable for table and processing purposes. Potatoes stored in cold store accumulate sugars and become sweet in taste and are therefore less suitable for consumption. Further, cold stored potatoes have poor keeping quality, once they are taken out of the cold store. When potatoes are used for preparation of chips, because of high accumulation of reducing sugars, they produce brown chips which are unacceptable both colour-wise and taste-wise. The storage requirements of potatoes should be in accordance with the purpose for which potatoes are stored (Table 17).

Table 17: Potato storage temperature and relative humidity (RH)

Intended Use	Temp (in ^{0}C)	RH (in per cent)
Seed purpose	2-4	95
Table purpose	7	98
Processing purpose	8-12	95

It is suggested that cold stores maintained at 2-4°C should be used exclusively for the storage of seed potatoes. Table and processing potatoes should be stored at 8-12°C, after treating the potatoes with a sprout suppressant. For short-term storage of table and processing potatoes,

non-refrigerated storage methods like evaporative cooled potato store and traditional, on-farm potato storage methods like heaps and pits can be used profitably.

It has been noticed that over the years, production of potato has increased manifold which led to glut situation in the market. The practice of storage helps to stabilize the prices in the market. Storing potatoes for longer period in normal temperature is not possible as it is a living material and through respiration, the changes occurs due to heat, resulting in loss of dry matter and ultimate deterioration of quality of tubers. At optimum condition, the quality of potatoes remains good in storage for 3-5 weeks.

Sprouting in stored potato is always a serious problem. To avoid sprout inhibition, suppressant like Isopropyl N-Chlorophenyl Carbamate (CPIC), TNCB, MH are used. The irradiation process has also been found effective for sprout inhibition. The condition and health of the tuber while in storage is important coupled with good management during storage also plays an important role.

Undoubtedly, cold storage forms the most vital post-harvest horticultural value chain for the downstream food processing industry. The current cold storage capacity in India is pegged at 37-38 million tonnes (MT). According to official statistics, there are about 8,186 cold storages in the country with 68 per cent of the capacity being used for potato, while 30 per cent is multi-commodity cold storage.

State wise distribution of Cold Storage capacity

Top potato producers of Uttar Pradesh and West Bengal make up 55-56 per cent of the overall domestic cold storage capacity (Table 18). Currently, 95% of the cold storages are owned by the private sector, 3% by cooperatives and the remaining 2% by the public sector undertakings. There is need to develop system to gather information regarding stock position on real time basis for efficient utilisation of capacity.

Table 18: State wise distribution of cold storage as on 31.08.2020

S. No.	State	No. of Cold Storage	Capacity (million Tonnes)	Percent Capacity
1.	Uttar Pradesh	2406	14.71	39.32
2.	West Bengal	514	5.95	15.89
3.	Gujarat	969	3.82	10.21
4.	Punjab	697	2.32	6.19
5.	Andhra Pradesh & Telangana	405	1.57	4.19
6.	Bihar	311	1.48	3.95
7.	Madhya Pradesh	302	1.29	3.46
8.	Maharashtra	619	1.01	2.70
9.	Haryana	359	0.82	2.19
10.	Karnataka	223	0.68	1.81
11.	Rajasthan	180	0.61	1.63
12.	Others	1201	3.17	8.46
	Total	**8186**	**37.43**	**100.00**

Source: National Horticulture Board (NHB), National Horticulture Mission (NHM), Horticulture Mission for North East & Himalayan (HMNEH) & Ministry of Food Processing Industries (MoFPI)

4.0 Marketing practices and constraints

4.1 Assembling of produce

Assembling is the first step in marketing of farm produce. It involves collection of small surpluses from number of small farms scattered over large areas and bulking the same for subsequent distribution in volume.

The agencies engaged in the assembling of potato are as below:

a) Producers
b) Village Merchants
c) Itinerant Merchants
d) Wholesale Merchants
e) Commission Agent
f) Producers Co-operative Societies

Major assembling markets

The major assembling markets are located in Uttar Pradesh, Punjab, West Bengal in which the assembling of potato is done along with other commodities. Some major assembling markets in major producing states in the country are listed in Table 19.

Table 19: Major assembling markets of potato in the country

S. No.	Name of State	Name of district	Name of major markets/mandies
1.	Uttar Pradesh	1) Kanpur	Kanpur
		2) Agra	Agra
		3) Farukhabad	Farukhabad
		4) Lakhimpur	Lakhimpur
		5) Kannuj	Kannauj, Chhibraman
		6) Firozabad	Shikohabad, Sirsaganj
2.	West Bengal	1) Murshidabad	Jangipur, Beldanga, Kandi
		2) North 24 Parganas	Barasat, Habra
		3) Birbhum	Sainthia, Rampurhat, Birbhum
		4) Darjeeling	Siliguri
		5) Hoogly	Champadanga, Kalipur
		6) Burdwan	Burdwan, Durgapur
3.	Gujarat	1) Surat	Surat
		2) Ahmedabad	Ahmedabad
		3) Rajkot	Rajkot, Gondal
		4) Porbandar	Porbandar
		5) Vadodara	Vadodara
		6) Banaskanth	Deesa
4.	Madhya Pradesh	1) Indore	Indore
		2) Bhopal	Bhopal
		3) Ujjain	Ujjain
		4) Gwalior	Gwalior
		5) Jabalpur	Jabalpur
		6) Morena	Morena

5.	Punjab	1) Ludhiana	Ludhiana, Khanna
		2) Jalandhar	Jalandhar
		3) Amritsar	Amritsar
		4) Hoshiarpur	Hoshiarpur
		5) Patiala	Rajpura, Patiala, Nabha
		6) Bhatinda	Bhatinda

Source: AGMARKNET

4.2 Market arrivals

The arrivals of winter crop potato contribute about 85 per cent of total production commencing from harvesting season stretching between Dec-Jan to March-April. The season of arrivals of potato in the major markets in different states are described in Table 20.

Table 20: State wise seasons of potato arrivals

S. No.	Name of State	Season
1.	Uttar Pradesh	November-April
2.	West Bengal	March-April , Sept-Nov (Plains) Jan-March, Jul-Aug (Hills)
3.	Punjab	Dec-April (Peak arrival), Oct-Nov (Average arrival), May-Sept (Lean period of arrival)
4.	Haryana	Dec-Jan (for early variety), Jan-March (for mid variety), March-April (Late variety)
5.	Himachal Pradesh	Sept-Oct (Seed potato varieties)
6.	Bihar	Dec-Jan (early variety), March-May (late variety)
7.	Gujarat	Feb-April
8.	Maharashtra	Feb-March
9.	Karnataka	Sept-Oct (Kharif crop), March-April (Rabi crop)
10.	Madhya Pradesh	Dec-April

Source: Potato commodity profile, AGMARKNET

4.3 Dispatches and distribution

Generally, most of the potato arrives in the markets are consumed within the state. However, in some cases, it has been noticed that a significant quantity of potato dispatched to other states also in the country. The percentages of quantity dispatched to other states from major assembling markets are given in Table 21.

Table 21: Percentage of potato dispatched to other states

S. No.	Name of Market	Percentage of potato dispatched to other states
1.	Ratlam	80.97
2.	Shimla	75.00
3.	Farukhabad	70.00
4.	Bangalore	60.00
5.	Delhi	50.00
6.	Mettupalayam	50.00
7.	Kamrup	43.66
8.	Amritsar	40.00

Source: Potato commodity profile, AGMARKNET

Interstate movements of potato

The interstate movement of potato mainly takes place by road, rail and to some extent by river. The movements of potato from surplus states to the deficit states take place throughout year in huge quantity especially during glut situation in peak season.

Table 22: Trend of interstate movement of potato in India

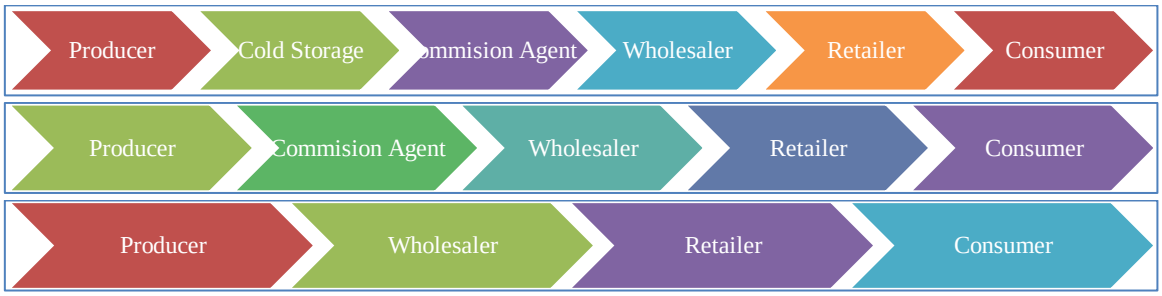
S. No.	Despatched from	Despatched to
1.	Punjab	Maharashtra, Bihar, West Bengal
2.	Haryana	Maharashtra, Bihar, West Bengal
3.	U.P.	Bihar, West Bengal, M.P.
4.	H.P	Bihar, Maharashtra

Source: Potato commodity profile, AGMARKNET

4.4 Marketing Channels

Private

The different private agencies such as Producers, Commission agent, Wholesaler, Retailer and consumers are involved in the route of marketing channels of potato. These are:



Institutional

Due to price fluctuations and glut situation in the market, some institutions like National Agricultural Co-operative marketing Federation (NAFED), different state govt. agencies, co-operative societies are intervening in the domestic market and Agricultural and Processed Food Export Development Authority (APEDA) for export purpose to stabilize the prices.

4.5 Marketing costs and margins

Marketing costs

Marketing costs are the actual expenses required for bringing potato from farm gate to the consumers. It includes the following:

- ✓ Handling charges at local points
- ✓ Assembling charges
- ✓ Transportation and storage costs
- ✓ Handling charges by wholesalers and retailer to consumers
- ✓ Expenses on secondary services like financing, risk taking and market intelligence
- ✓ Profit margins taken out by different agencies.

Market fee: It is collected from buyers and not from sellers. The rates of market fees are determined by respective Agricultural Produce Market Committees in some states like Gujarat, Maharashtra, and while in most of the states these are fixed for the entire state under the respective State Marketing Regulation Acts.

Commission charges: In some regulated markets, the commission agents exist and they

collect the charges.

Market charges: These are the charges, which are incurred towards loading, unloading, weighing, brokerage, cleaning, etc. These charges are fixed by the market committee and vary from market to market. The operational charges starting from unloading, cleaning, preparation lot for sale and sometimes weighing charges are borne by farmers /sellers. From weighing, the subsequent operational charges are borne by the buyers/ traders. In case of some regulated markets, entry fee is charged for the vehicle.

Marketing Margins

The marketing margins of potato are the difference between the actual price paid by the consumer and the price received by farmer for an equivalent quantity and quality of potato. It may be explained in terms of price spread applied for a particular situation. Studies on marketing margins or price spread reveals that as the number of market functionaries' increases, they add cost to the commodity in the marketing channel which results in the fall of producers share in consumer's rupee.

4.6 Marketing Constraints

Potato marketing in the country suffers from following constraints:

i) High marketing costs & margins: There is a need for promoting producer's co-operative in potato growing areas to reduce the price gap between growers and consumers.

ii) Wide price fluctuations: The major potato growing states should arrange advance forecasting of area under potato and plan to divert the potatoes to the deficient areas or by export to avoid glut situations and price crashes in the markets.

iii) Bottlenecks in storage facilities: About 90 per cent of total cold storages in the country used for potato storage and most of them are situated in big towns and markets. Hence it is needed to have new cold storage units in deficient areas particularly rural areas.

iv) Lack of long term Indian potato export policy.

v) Lack of avenues of utilization of potato: There is a need to utilize larger quantities of potatoes in the processing industries to improve and enhance the efficiency of processing and to reduce the cost of processing and processed products. Developed technologies for dehydrated potatoes will not only ensure proper return to the farmers but also boost the processing industry.

5.0 Demand, supply, price behaviour and trade

5.1 Demand and supply of potato in India

The annual demand of potatoes in India hovers around 42 to 47 million tonnes which is being met by the domestic production. Our domestic production is sufficient to meet the required quantity of potatoes in the country.

Table 23: Total annual production and demand of potato during 2012-13 to 2017-18

Year	Production (Million Tonnes)	Annual demand (Million Tonnes)
2012-13	45.3	42.2
2013-14	41.6	41.5
2014-15	42.2	42.2
2015-16	43.4	43.2
2016-17	48.2	45.7
2017-18	51.3	47.5

Source: NSS Report No. 558: household consumption of various goods and services in India, 2011-12
Note: Annual demand includes personal consumption, bulk consumption in hotels, marriages etc., exports, seeds, losses, processing etc.

5.2 Trend of potato arrivals and prices

Arrivals and prices

The monthly all India arrivals and average wholesale prices of potato in different markets of the country for the year 2019 to 2021 are given in Table 24. The arrivals in the markets are higher from December to March which coincides with the harvesting season. The wholesale prices of potatoes are generally low during December to March. During this period arrival in the markets are at the peak level which led to the dampening of the prices.

Table 24: State-wise arrivals and average wholesale prices of Potatoes

State	Sept 2018 to Aug 2019		Sept 2019 to Aug 2020		Sept 2020 to Aug 2021	
	Arrivals (Tonnes)	Weighted Avg. Price (Rs./Qtl.)	Arrivals (Tonnes)	Weighted Avg. Price (Rs./Qtl.)	Arrivals (Tonnes)	Weighted Avg. Price (Rs./Qtl.)
Uttar Pradesh	6145481	739	4244487	1182	3872683	1129
Gujarat	899419	980	729950	1543	616654	1293
Maharashtra	805503	1215	568458	1656	622501	1651
West Bengal	1075755	846	519503	1610	529267	1502
Karnataka	455347	1271	374207	1732	322791	1814
NCT of Delhi	513531	869	374044	1459	386309	1268
Haryana	451187	719	302250	1213	74825	929
Rajasthan	301662	763	288811	1305	266719	1191
Punjab	360486	729	267804	1015	326493	961
Odisha	232696	1164	206690	1878	135439	1925
Madhya Pradesh	232671	776	191924	1078	187932	1158
All India	12008124	865	8553206	1362	7819175	1310

Source: AGMARKNET

State wise trend of potato prices

The monthly state-wise average wholesale prices of potato are depicted in the Table 25. It

shows that there are lot of spatial and temporal variation in the prices of potato.

Table 25: State-wise monthly wholesale prices (Rs/Quintal) of potato in India, 2020

States/UT	Centres/Varieties	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Assam	Guwahati (FAQ)	1650	1600	1250	NA	NA	2350	2350	3000	3400	3650	3600	2500
Bihar	Patna (Red)	1700	1640	1720	1900	1700	1920	2400	2500	2980	3350	3650	1890
Delhi	Delhi (Punjab spl.)	1400	1200	1300	NA	1450	1575	1975	2450	2600	3000	3050	900
Haryana	Hisar	1400	1000	1200	NA	1550	1750	2150	2350	2550	2850	3550	1100
	Karnal (White)	1600	1100	1700	NA	NA	NA	1835	2080	2215	1925	2615	1025
Himachal Pradesh	Shimla	2500	1500	2500	2050	2200	2520	3200	4000	3000	4800	4000	1600
Karnataka	Bangalore	2500	2100	1500	1900	1850	1900	2300	2000	2600	2600	3200	2750
Maharashtra	Mumbai	1600	1500	1850	1750	1700	1800	1900	2350	2550	3250	3000	1950
	Nagpur	1450	1400	1700	2050	1700	1950	2450	2650	2750	3750	3900	2300
Punjab	Hoshiarpur (Kufri)	800	870	1075	NA	NA	NA	1500	1900	2300	2600	2900	900
Tamil Nadu	Chennai	2500	1800	2200	2300	2200	2500	2800	2600	3000	3400	3000	2200
Telangana	Hyderabad	1800	1800	1600	NA	1800	2000	2400	2800	2800	3200	3000	2000
Uttar Pradesh	Kanpur (White)	1100	925	1800	1650	1350	1725	2400	2365	2600	3260	3460	1080
	Mainpuri (White)	1100	850	1160	1400	1340	1500	1825	2150	2500	2700	2825	930
West Bengal	Kolkata (Desi)	1700	1100	1300	1900	1840	2090	2350	2900	2740	3200	3660	1800

Source: Indiastat

5.3 Export of potatoes

Indian potatoes have immense export potential. It has a price advantage over its European counterpart because of lower production cost and due to short crop duration and cheap labour. The king of vegetables, Indian potato has the quality for its savoury taste with exuberant varieties. The country is also blessed with natural abode of some of the best varieties of potatoes in the world. Besides, it has the potential to emerge as one of the largest suppliers of seed potato. The potatoes from India are mainly exported to Nepal, Sri Lanka, Oman, Mauritius, Indonesia, Malaysia etc. The annual quantities and values of potatoes exported from the country are given in Table 26.

Table 26: Export of potatoes from India

Year	Quantity (000' tonnes)	Value (Rs. in crores)
2011-12	193.09	133.45
2012-13	163.19	148.72
2013-14	220.93	251.14
2014-15	373.93	835.06
2015-16	279.65	361.55
2016-17	396.34	661.48
2017-18	395.75	411.82
2018-19	367.39	440.78
2019-20	427.08	580.09
2020-21	323.69	549.46

Source: APEDA

6.0 Marketing Information and Extension

6.1 Marketing Information

Agricultural Marketing Information comprises of collection, analysis and compilation of agricultural marketing related information as well as dissemination of right information to the people in need, at right place, at right time and in right form. In a marketing system, market information is an important function which facilitates the marketing decisions and regulates the competitive market processes and mechanisms. It is helpful to the farmers for planning, production and marketing of their commodities. It is also the key to achieve operational and pricing efficiency in a marketing system. In the present context of global agricultural scenario, the small and marginal potato farmers should change the habit of traditional farming to modern market / export oriented farming by improving the quality and productivity of the produce.

Farmers / traders/ processors should reorient their potato enterprises by using facilities of market information and information technology (IT) for the following purposes**:**

- Planning for market oriented production.
- Preparation of produce for marketing.
- Adoption of modern storage techniques.
- Availing suitable transport facilities.
- Availing market intelligence for remunerative prices.

For effective dissemination of market-led information, almost all the state / U.T. Govt. organizations have some activities for the benefit of the producers, traders, processor, exporters and consumers, which are of conventional nature. Hence, to improve this entire system, Govt. of India started "Market Research and Information Network" (MRIN) Scheme through the Directorate of Marketing and Inspection (DMI) and its website i.e., AGMARKNET. Besides, there are also other organizations involved in the dissemination of market information of agricultural commodities.

6.2 Marketing Extension

Marketing extension is a tool to educate the farmers, traders, consumers and other beneficiaries regarding the latest knowledge on post-harvest management, marketing, value addition, and exploring new market opportunities. It aims to bring desired changes in their skill, attitude and behaviour towards post-harvest management and marketing practices of agricultural produce. In the present context of globalization of agricultural trade, it is essential to grow awareness among the producers and other beneficiaries regarding proper harvesting, grading, packaging, transportation, storage, maintaining proper quality standards and sanitary-phytosanitary requirements, etc.

Benefits

- To provide up-to-date information on the prices and arrivals.
- To orient producers/traders about price trends, demand and supply position, etc.
- To guide the producers/farmers about when, where and how to market the produce.
- To educate farmers about different aspects of post-harvest management / operations.
- To guide the farmers about benefits of direct / contract marketing and future trading.

Table 27: Organizations providing the services on marketing information and extension

S. No.	Organization	Services
1.	Directorate of Marketing & Inspection (DMI)	• It is at present implementing a plan scheme i.e. 'Market Research and Information Network' (MRIN) through NIC for establishing a network for speedy collection and dissemination of market information for its effective utilization. • Under the scheme, important agricultural markets, state agricultural marketing boards/departments are being linked through computerized internet services. Under this scheme, DMI has also created a website namely, AGMARKNET. • By this website, the user or beneficiary may collect the detailed information on various aspects of agricultural commodities including potato.
2.	Directorate of Economics and Statistics, Ministry of Agriculture & Farmers Welfare	• Compilation of statistical data on agricultural commodities for planning and development. • Dissemination of data/information on agriculture through publication and internet.
3.	National Horticulture Board	• Collection, compilation and dissemination of market intelligence, market related information / data on horticultural commodities including potato.
4.	Central Potato Research Institute (CPRI), Shimla	• This institute is part of Indian Council of Agricultural Research (ICAR). It works on all aspects of potato.
5.	Agricultural Produce Market Committees (APMCs)	• Providing market information on arrivals, prevailing prices at different markets through display boards, public address system, etc. • Providing information of other markets. • Organising training programmes, tours, exhibitions for farmers and other beneficiaries.
6.	State Agricultural Marketing Departments	• Provide agricultural marketing related information. • Arranging publicity programme through demonstration, farmers' meetings etc. • Dissemination of information through literature, Radio and T.V. Programmes
7.	State Agricultural Marketing Boards	• Providing market related information by co-ordinating all market committees in the state. • Arranging training facilities to farmers and other beneficiaries. • Organizing seminars, workshops and exhibitions on agricultural marketing.

Kisan call centre

The Department of Agriculture and Farmers Welfare (DA&FW), Ministry of Agriculture & Farmers' Welfare, Government of India launched Kisan Call Centres on January 21st, 2004 throughout the country. It has the objective of affording instant solution to the problems faced by the farmers during crop cultivation under diverse challenging situations and facilitating their full comprehension by the use of local language. The call centres are acting as composite help centres which consist of a complex telecommunication infrastructure, computer support and human resources organized to manage effectively and efficiently the queries raised by farmers instantly in local languages. The subject matter specialists using telephone & computer are used to interact with farmers to understand their problems and answer their queries as soon as possible. This is a new dimension in agriculture extension management which makes the full use of on-going information and communication revolution by connecting the farming community in the remotest areas of the country with the experts of agricultural field. By tackling the difficulties of the farmers, a close linkage is established among the key stakeholders in extension system, agricultural scientist, extension functionaries, farmers and marketing agencies. Potato farmers are availing this facility through a nationwide toll free number 1800-180-1551.

7.0 Alternative System of Marketing

7.1 Direct Marketing

The direct marketing system enables the farmers to meet the specific demand of wholesalers, traders, consumers according to their preferences from the farmers' inventory of graded and certified produce on one hand and on other hand helps the farmers to take advantage of favourable prices. This system encourages the farmers to undertake sorting, grading and quality marking at their farms. This model has been introduced in the name of Apni Mandi in Punjab and in the name of Rythu Bazars in Andhra Pradesh for fruits and vegetables.

7.2 Contract Farming

The "Contract marketing" is a system in which the commodity is marketed by farmers under a pre-agreed buy-back contract with an agency engaged in trading or processing. In contract marketing, a producer will produce and deliver to the contractor, a quantum of required quality of produce, based upon anticipated yield and contracted acreage, at a pre-agreed price. In this agreement, agency contributes input supply and renders technical guidance. The company also bears the entire cost of transaction and marketing. By entering in to contract, farmer's risk of price reduces and the agency reduces the risk of non-availability of raw material. The inputs and extension services provided by the agency include improved seed, credit, fertilizers, pesticides, farm machinery, technical guidance, extension, marketing of produce etc. In present scenario, Contract marketing is one of the way by which producers, especially small farmers, participates in the production of good quality potato to get higher return. Contract Farming enables producers to adopt new technologies to ensure maximum value addition and access to new global markets. It also ensures efficient post-harvest handling and meeting specific needs of customers.

In such arrangement, the purchaser, may be exporter or processing unit, generally provides inputs, technical know-how and financial support. Thus sharing the risk by both the, buyers and sellers. It is an approach that can contribute to increased income to farmers, avoidance of risk of adverse price fluctuation, and higher profitability to sponsors. Many companies have entered into contracts with farmers for production and marketing of agricultural produce including potato.

Table 28: Benefits to farmer and contracting agency

Types of benefits	To farmer / producer	To contracting agency
Access	Access to inputs	Access to required quality of produce.
Risk	Minimizes price risk	Minimizes risk of scarcity of consistent supply of raw materials
Quality	Use of good quality of inputs like seeds, fertilizers.	Supply of desirable quality and quantity of produce.
New skills of post-harvest management	Facilitates the adoption of new skills of post-harvest at low cost.	Adopt more efficient and better post-harvest handling / practices.
Mutual Relationship	Strengthen long term relationship with buyer for mutual interests.	Strengthen long term relationship with farmer for mutual interest.
Profit	Increases	Increases.

7.3 Co-operative Marketing

The Co-operative marketing is the system by which a group of farmers join together to carry on some or all the processes involved in bringing goods from producer to consumer. In other words, it is the association of cultivators / farmers for the purpose of helping them to market their produce in a more profitable way than private trade system.

Functions

The members of a potato co-operative society sell their surplus produce to the society and they get an advance. After collecting the potato from the member, the society either processes it or sells it in the markets or to the processors. Sometimes, considering the unfavourable prices prevailing in the market, the society stores the produce and sells later at favourable price. As soon as the produce is sold, the society makes payment to the farmers. Thus, the co-operatives play a key role in the agricultural marketing process and they protect the interest of the farmers from exploitation of middlemen and secure better returns for their produce.

7.4 Forward and Future Markets

In terms of price discovery and risk management the forward and future markets have been identified as an important tool for price stabilization. Presently, forward and future market system is followed in certain agricultural commodities including potato.

The forward market supports two economic functions namely price discovery and price risk management which enables the traders and stockiest to protect against the risk of adverse fluctuation of prices.

The future market facilitates the trading of potato for the purchase or sale of the commodity for future delivery where contracts are made on a future exchange on the basis of standard quality, quantity, delivery time, locations and the price. This makes the supply chain efficient and provide better price to the farmers.

The benefits of future trading

- Management of price risk an agricultural commodity.
- Facilitates production, as per recognized quality standards of produce.
- Acts as a price barometer to farmers and other trade functionaries.
- It facilitates indirectly to the exporters / farmers through better information.
- It gives an idea of prices to the consumer which enables them to enter forward contract markets.

7.5 E-NAM

National Agriculture Market (eNAM) is a pan-India electronic trading portal which networks the existing APMC mandis to create a unified national market for agricultural commodities. Small Farmers Agribusiness Consortium (SFAC) is the lead agency for implementing eNAM under the aegis of Ministry of Agriculture and Farmers' Welfare, Government of India. The pupose of eNAM is to promote uniformity in agriculture marketing by streamlining of procedures across the integrated markets, removing information asymmetry between buyers and sellers and promoting real time price discovery based on actual demand and supply.

8.0 Institutional Facilities

8.1 Marketing Related Schemes

The marketing systems and post-harvest marketing infrastructure have not been able to keep pace with the growing production and marketable surplus. This has brought to the fore, the need for providing farmers with access to competitive markets with adequate infrastructure including cold chain logistics, to enable them to realise better prices on the one hand and providing nutritious food to consumers at stable and affordable prices on the other. With this objective in view, all the Central Sector Schemes to strengthen this sector have been brought under one umbrella namely "Integrated Scheme for Agricultural Marketing (ISAM)" The ISAM is having following five sub schemes:

1. Agricultural Marketing Infrastructure (AMI) [the schemes of Grameen Bhandaran Yojana (GBY) and Development/ Strengthening of Agricultural Marketing Infrastructure, Grading and Standardization (AMIGS) merged as AMI]
2. Marketing Research and Information Network (MRIN)
3. Strengthening of Agmark Grading Facilities (SAGF),
4. Agri-Business Development (ABD) through Venture Capital Assistance (VCA) and Project Development Facility (PDF) and
5. Choudhary Charan Singh National Institute of Agriculture Marketing (NIAM).

Objectives

1. To promote creation of agricultural marketing infrastructure by providing backend subsidy support to State, cooperative and private sector investments.
2. To promote creation of scientific storage capacity and to promote pledge financing to increase farmers' income.
3. To promote Integrated Value Chains (confined up to the stage of primary processing only) to provide vertical integration of farmers with primary processors.
4. To use ICT as a vehicle of extension to sensitize and orient farmers to respond to new challenges in agricultural marketing.
5. To establish a nation-wide information network system for speedy collection and dissemination of market information and data on arrivals and prices for its efficient and timely utilization by farmers and other stake holders.
6. To support framing of grade standards and quality certification of agricultural commodities to help farmers get better and remunerative prices for their graded produce.
7. To catalyze private investment in setting up of agribusiness projects and thereby provide assured market to producers and strengthen backward linkages of agri-business projects with producers and their groups.
8. To undertake and promote training, research, education, extension and consultancy in the agricultural marketing sector.

8.2 Credit Facilities

Agricultural credit is considered as one of the most basic inputs for conducting all agricultural development programmes. In India there is an immense need for proper agricultural credit as Indian farmers are very poor. From the very beginning the prime source

of agricultural credit in India was moneylenders. After independence the Government adopted the institutional credit approach through various agencies like co-operatives, commercial banks, regional rural banks etc. to provide adequate credit to farmers, at a cheaper rate of interest.

Considering the period and purpose of the credit requirement of the farmers of the country, agricultural credit in India can be classified into three major types:

(a) Short Term Credit: The Indian farmers require credit to meet their short term needs viz., purchasing seeds, fertilisers, paying wages to hired workers etc. for a period of less than 15 months. Such loans are generally repaid after harvest.

(b) Medium Term Credit: This type of credit includes credit requirement of farmers for medium period ranging between 15 months and 5 years and it is required for purchasing cattle, pumping sets, other agricultural implements etc. Medium term credits are normally larger in size than short term credit.

(c) Long Term Credit: Farmers also require finance for a long period of more than 5 years just for the purpose of buying additional land or for making any permanent improvement on land like sinking of wells, reclamation of land, horticulture etc. Thus, the long term credit requires sufficient time for the repayment of such loan.

Sources of Agricultural Credit in India

Non-Institutional Sources: Moneylenders, Traders and Commission agents, Relatives and Landlords.

Institutional Sources: Commercial Banks (CBs), Regional Rural Banks (RRBs) and Co-operatives.

Table 29: Credit facility to farmers

S. No.	Credit facility	Quantum of assistance
1.	Interest Assistance	Crop loan upto Rs.3 lakhs at 7% rate of interest. This interest rate becomes 4% due to 3% interest subvention incentives provided to those farmers who repay crop loan on time.
2.	Kisan Credit Card	Farmers can avail crop loan through Kisan Credit Card. Loan /credit limit is fixed on the basis of crop sown and area under cultivation. Kisan Credit Cards are valid for 3-5 years. Farmers are also provided risk coverage in the event of accidental death/ disability. Crop coverage loans are covered under the Crop Insurance Scheme.
3.	Investment Loan	Loan facility to the farmers is available for investment purposes in the areas viz. Irrigation, Agricultural Mechanization, Land Development, Plantation, Horticulture and Post-Harvest Management.

8.3 Organization Involved in Marketing Services

The following Govt., Semi-Govt. and State Govt. organizations provide and assist in marketing services like procurement, grading, storage, and processing in the field of potato.

Table 30: Service providers for agricultural marketing

S. No.	Organization	Services provided
1.	Directorate of Marketing and Inspection (DMI)	➢ To promote grading of agricultural produce under the Agricultural Produce (Grading & Marking) Act, 1937. ➢ To facilitate the construction of marketing infrastructure of agricultural produce. ➢ To render advice on statutory regulation, development and management of agricultural markets by states / U.Ts. ➢ Marketing research, surveys and planning ➢ To train personnel in agricultural marketing
2.	Agricultural and Processed Food Export Development Authority (APEDA)	➢ Promote export of agricultural commodities including potato and its products to foreign countries. ➢ Adopting standards and specifications for the purpose of export of schedule products.
3.	National Horticulture Board (NHB)	➢ To develop post-harvest infrastructural facilities of horticultural commodities including potato.
4.	Ministry of Food Processing Industries(MOFPI)	➢ Grant and support for food park component which in turn also help in setting up of Agri Export Zone.
5.	National Agricultural Cooperative Marketing Federation of India Ltd. (NAFED)	➢ To act as a nodal agency for implementing the market intervention scheme to avoid glut situation and price craze of potato.
6.	State Marketing Boards	➢ Regulation management and development of marketing in concerned state. ➢ To implement different schemes on agricultural marketing including potato. ➢ To co-ordinate functioning of all market committees. ➢ Grading of agricultural produce. ➢ Publicity on regulated marketing of agro produce.
7.	Agricultural Produce Market Committees (APMCs) at different regulated markets of different states.	➢ For better marketing of agricultural produce the APMC provide the following facilities : ➢ Facilitates drying of produce. ➢ Providing grading, weighing and storage facilities of produce, brought to APMC complexes.

9.0 Processing and utilization

9.1 Processing

Potato is a perishable commodity and its harvesting time (March/April) coincides with the rise in temperature in Indo- Gangetic plains which contributes about 85 per cent of total production in India. Therefore, the potato produced requires shifting in cold storage.

It has been observed that all varieties of potato are not suitable for processing. The dry matter and reducing sugar content are two important parameters for selecting raw materials for processing. The varieties namely Chipsona-1 and Chipsona-2 released by Central Potato Research Institute (CPRI), Shimla, have been found fit and beneficial for potato processing. The following are the characteristics of potato meant for processing purposes.

Table 31: Characteristics of potato fit for processing

Characteristics	Type of Potato Products			
	Dehydrated	**French Fries**	**Chips**	**Canned**
Tuber size	30	50	40-60	35
Specific gravity	1.080	1.080	1.085	1.080
Dry matter (percentage)	22-25	20-234	22-25	18-20
Starch (percentage)	15-19	14-16	15-18	12-24
Reducing Sugar (percentage)	0.5	0.5	0.25	0.5
Shapes / Sizes preferred	Medium to large sized tubers	Long oval shaped tubers	Round to oval shaped tubers	Small sized tubers

Source: Post Harvest Manual for Export of Potatoes, APEDA, New Delhi.

The processed potato products are classified as follows:

Fried Products	Potato chips, Frozen French Fries, other frozen fries.
Dehydrated Products	Dehydrated chips, dices, flakes, granules, flour, starch, potato custard, powder soup or gravy thickener and potato biscuits.
Non-Fried Products	Potato jam, Potato murraba, Potato candy, Potato biscuits, Potato cakes.
Canned Products	

9.2 Uses

As vegetable	Potato is utilized as major vegetable throughout the world and in preparation of number of recipes either by using potato alone or by combining it with other vegetables, pulses, cereals etc.
As seed	Medium sized tubers are used normally in the northern plains. In the northern and eastern hills, is used as seed.
As processed food	It is utilized in variety of ways such as dehydrated potato products like chips, dice, flakes, granules, flour, starch, potato powder and potato biscuits. It is also used to prepare frozen foods like potato patties, puffs, wedges, pancake, dehydrated mashed potatoes etc.

9.3 Do's and Don't

Do's	Don't
✓ Harvest the crop, when the weather is dry.	✗ Harvest the crop, when the weather is moist.
✓ Stop irrigation two weeks before dehaulming.	✗ Continue irrigation two weeks before dehaulming.
✓ Avoid bruising and skinning of tubers during harvesting.	✗ Neglect bruising and skinning of tubers during harvesting.
✓ Dry the harvested tubers in storage shade.	✗ Dry the harvested tubers in sun.
✓ Separate the damaged and diseased tubers before storing.	✗ Mix the damaged and diseased tubers before storing.
✓ Store always the matured tubers.	✗ Store the matured tubers with immature tubers.
✓ Store potatoes at 2-4 degree centigrade in cold store for the purpose of preventing sprouting.	✗ Store potatoes above 2-4 degree centigrade in cold store for the purpose of preventing sprouting.
✓ Use sprout inhibitors (e.g., CIPC) to store potatoes at 10-12 degree centigrade in cold store.	✗ Store potatoes at 10-12 degree centigrade in cold store without using sprout inhibitors (e.g. CIPC).
✓ Grade the potatoes manually or mechanically before marketing.	✗ Market the potatoes without grading either manually or mechanically.
✓ Sale potato to the co-operative society or at regulated markets for getting better prices.	✗ Sale the produce to local traders or itinerant merchants at low prices.
✓ Avail benefit of contract farming with any agency to ensure better marketing of the produce.	✗ Produce potatoes without assessing & assuring its market demand for that year.
✓ Get the market information on potato regularly from newspaper, TV, concerned APMC offices, websites of different organizations namely Agmarknet website.	✗ Sell potatoes without collecting/ verifying any marketing information.
✓ Avail the system of future trading to avoid price risk arising due to wide fluctuation in commodity prices.	✗ Sell the produce at fluctuating prices or in glut situation.
✓ Contact the expert agency for availing the procedure of phytosanitary measure for export of potatoes.	✗ Export potatoes without any phytosanitary measure.

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Appendices

State-wise Progress of AMI (Storage Infrastructure) including Erstwhile GBY

Since inception w.e.f. 01.04.2001& up to 31.03.2022

S. No.	State	No. of projects	Storage Capacity (in MT)	Subsidy Released (Rs. Lakh)
1	Andhra Pradesh	1444	5816670	29303.71
2	Arunachal Pradesh	1	945	6.30
3	Assam	346	1067157	6659.78
4	Bihar	1089	715539	3018.15
5	Chhattisgarh	600	1953611	7372.00
6	Goa	1	299	0.94
7	Gujarat	11970	4964855	27995.05
8	Haryana	2284	6818374	38871.69
9	Himachal Pradesh	88	30826	180.77
10	Jammu & Kashmir	15	88027	709.79
11	Jharkhand	37	183708	814.92
12	Karnataka	4674	3941516	19387.07
13	Kerala	209	105903	539.55
14	Madhya Pradesh	4617	13749757	71724.49
15	Maharashtra	3698	7035176	29225.43
16	Meghalaya	16	21012	186.75
17	Mizoram	1	302	2.52
18	Nagaland	36	32814	354.38
19	Odisha	695	1019830	4191.55
20	Punjab	1761	6814459	23516.33
21	Rajasthan	1594	3123742	10585.51
22	Tamilnadu	1202	1436730	5205.06
23	Telangana	857	5023442	25292.72
24	Tripura	5	28764	296.61
25	Uttar Pradesh	1182	5600154	18074.01
26	Uttarakhand	291	786272	3467.72
27	West Bengal	2565	1619834	5093.98
Total		**41278**	**71979718**	**332076.78**

State-wise Progress of AMI (Other than storage infrastructure) including Erstwhile AMIGS SchemeSince inception w.e.f. 20.10.2004 & upto 31.03.2022

S. No.	State	No. of projects	Subsidy Released (Rs. Lakh)
1.	Andhra Pradesh	379	7102.90
2.	Assam	13	573.52
3.	Chhattisgarh	339	6688.92
4.	Delhi	1	30.41
5.	Goa	1	50.00
6.	Gujarat	8815	22844.76
7.	Haryana	7	137.70
8.	Himachal Pradesh	62	1640.18
9.	Jharkhand	1	0.00
10.	Karnataka	835	8975.19
11.	Kerala	372	6254.84
12.	Madhya Pradesh	1264	33761.78
13.	Maharashtra	1568	43965.50
14.	Manipur	17	0.00
15.	Mizoram	1	2.52
16.	Nagaland	72	1422.33
17.	Odisha	20	852.13
18.	Punjab	2074	26920.31
19.	Rajasthan	557	9853.39
20.	Sikkim	1	15.52
21.	Tamil Nadu	1811	5361.95
22.	Telangana	711	11489.05
23.	Uttar Pradesh	3	872.00
24.	Uttarakhand	7	1002.26
Total		**18931**	**189817.16**

Details of mandis and traders registered on eNAM, in different States/UTs

State/ UT	*Mandies*	Traders	FPOs	Farmer	No. of Unified licenses issued by State
Andhra Pradesh	33	3483	177	1445806	3,483
Chandigarh	1	114	0	7106	0
Chhattisgarh	14	3126	22	135253	36
Gujarat	122	9444	110	869102	9,444
Haryana	81	14486	243	2725243	35
Himachal Pradesh	19	2015	56	124506	0
Jammu and Kashmir	2	237	4	957	0
Jharkhand	19	2315	120	247554	104
Karnataka	2	662	13	1455	662
Kerala	6	354	7	2792	35
Madhya Pradesh	80	22378	104	3007337	1,070
Maharashtra	118	21548	268	1217277	0
Odisha	41	7504	208	285380	7,504
Puducherry	2	181	2	13529	0
Punjab	37	2611	10	217427	1
Rajasthan	144	82924	189	1500993	82,924
Tamil Nadu	63	6375	108	312051	3,768
Telangana	57	5803	62	1823790	5,803
Uttar Pradesh	125	35157	271	3315390	90
Uttarakhand	16	4738	44	54329	4,738
West Bengal	18	3994	171	49819	33
Total	1000	229,449	2189	17,357,096	1,19,730

Source: https://enam.gov.in/

State wise progress of market reforms

State/ UT	Limiting regulation within APMC Yard	Separation of Powers between Dir(Mktg.) & MD, Mandi Board	Single unified trading license	Single Point levy of Market fee	Private Wholesale market	Direct marketing (Outside mandi)	Declaring warehouse, silos / cold storages, as deemed market	e-trading	Deregulation of marketing of F&V
Andhra Pradesh	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Arunachal Pradesh	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Assam	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bihar	No APMC Act								
Chhattisgarh	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Goa	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Gujarat	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Haryana	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
HP	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Jharkhand	No	No	Yes	Yes	Yes	Yes	Yes	No	Yes
Karnataka	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Kerala	No APMC Act								
MP	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Mah.	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Manipur	No APMC Act								
Meghalaya	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mizoram	No	No	Yes	Yes	Yes	Yes	No	Yes	No
Nagaland	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Odisha	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Punjab	No	No	Yes	Yes	Yes	Yes	No	Yes	No
Rajasthan	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Sikkim	No	No	Yes	Yes	Yes	Yes	No	Yes	No
Tamil Nadu	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Telangana	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No
Tripura	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
UP	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Uttarakhand	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
West Bengal	No	No	Yes	Yes	Yes	Yes	No	Yes	Yes
Delhi	No	No	No	No	No	No	No	No	Yes
Chandigarh	No	No	Yes	Yes	Yes	Yes	No	Yes	No
Puducherry	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
J&K	No APMC Act								
Laddakh									
A&N Islands									
DNH									
Daman & Diu									
Lakshdeep									

Source: DMI (updated on 14.07.2020)