



Potato Processing: Vital to Agribusiness in Gujarat

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Origin of Potato: Hawkes (1990) concluded that present day cultivated potato originated from the wild diploid species *Solanum leptophyes* some 7000-10,000 years ago. The first domesticated species was *S. stenotomum*. But there are stronger evidences in support of allotetraploid origin of *S. tuberosum* by hybridization between *S. stenotomum* and *S. spiliarsum*. A diploid cultivated species *S. phureja* evolved from *S. stenotomum* by human selection exercised for rapid maturity and lack of tuber dormancy to develop varieties to be grown 2-3 times a year in the lower Eastern frost free Andean Valleys. During the course of evolution, diploid species *S. megistacrolobum* and the tetraploid species *A. acaule* contributed frost resistance.

Landmarks in the History of Potato: The history of the potato provides a grim warning of the need to maintain genetic diversity in our staple food crops. In the 19th century, Ireland was heavily reliant on only a few varieties of potato, and those types contained no resistance to the devastating disease known as late blight. When late blight destroyed the 1845-1846 potato crop, widespread famine followed. An estimated one million people starved to death and more than a million were forced to migrate abroad.

Spread of Potato: Potato was introduced to **Europe** on two occasions firstly into Spain in 1570 AD and secondly into England 1590 AD (Hawkes, 1967). From Spanish introduction, it diffused throughout Europe and Asia. Its introduction into Spain led to an unimaginable growth and distribution of a new food crop with profound economical and historical results. From Spain potato was taken into neighboring European countries and in less than 100 years, it was being grown fairly extensively in many regions of Europe. Distribution beyond Europe soon occurred with the introduction into India in about 1610, China in 1700 and Japan in 1766.

Scotch Irish immigrants introduced potato in **North America** in early 1700s. After its origin in Peru Bolivian Region in Andes, it spread to the surrounding regions of South America like Columbia. The Incas spread the growing of potato throughout their empire. The first Virginia potato to reach North America continent was indeed brought to Virginia but they did not come from South America. In 1613, potatoes were carried

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to Bermuda from England, they were planted and soon became a major food crop for the colonists so when two chests full of provisions were sent in 1621 to the new colony in James Town Virginia, potatoes were naturally included and were cultivated in Virginia from that time onwards. But potato growing in American colonies did not start on a large scale until 1719 when Irish immigrants brought potatoes to their settlement in Londonderry.

The potato arrived in **Africa** much later. A few grew in South Africa as early as 1830 but British and German colonists and missionaries did not introduce potato in East Africa until about 1880. In North and East Africa the two world wars were the main stimulus for the crop introduction. While Africa is not a major producer in terms of volume, more African countries grow potato today, than any other continent.

History of Potato Processing: Potato processing is almost as old as potato itself. Even around 200 AD natives of Peru had found a way to dehydrate by allowing them to freeze at night and thawing during daylight. Juice was extracted from thawed potatoes by treading them with feet. This cycle was repeated several times and dehydration continued until the moisture content was reduced sufficiently to preserve the potatoes. A sample of potato flour meal was prepared in 1786 that keeps sound for “any length of time” (Fraser, 1794). In World War I, a number of dehydrated potato products were manufactured for military use. This war industry practically disappeared soon after the hostilities ceased, although considerable quantities of potato flour both for stock feeding and human consumption continued to be produced in Europe and to a lesser extent in England and US. Potato starch has been produced both in Europe and US for over 100 years.

Genetic Resources of Potato: All cultivated species of potato have been grouped under the of subsection potatoe. A considerable number of highly diverse species exist in genus *Solanum*. Because they can adapt to a broad range of habitats, potato wild relatives are promising sources of desirable agricultural traits. Historically, primitive forms of cultivated potato and its wild relatives have been used in breeding programs and there is still an enormous and unimaginable potential for discovering desirable characteristics, particularly in wild species. Different methods have been developed to incorporate useful alleles from these wild species into the improved cultivars. Potato germplasm comprising of useful alleles for different breeding objectives is preserved in various gene banks worldwide. These materials, with their invaluable information, are accessible for research and breeding purposes.

Potato Cultivation: Potato is a short duration crop and fits well in different multiple and intercropping systems. Realization of high yield potential is a function of better management practices. Some of the important aspects of potato cultivation are discussed below-

Soil and Climate: Potatoes can be grown in all types of soils having a pH range of 5.5 to 8. Deep, loose, alluvial soils of river flood plains and basins are most suitable for potato cultivation. Potato is crop of cooler climate. The crop is raised in India when

maximum day temperature is below 35⁰ C and night temperature is below 20⁰ C. Good tuber growth takes place when days are sunny and nights are cool.

Area, Production and Productivity of Potato: Statewise area, production and productivity of potato is given in table-1

Table-1: Statewise area, production and productivity of potato in India (2013-14)

State	Area (thousand ha)	Production (thousand tones)	Productivity (tones/ha)
Uttar Pradesh	564.3	13808.8	24.5
West Bengal	412.3	9030.0	21.9
Bihar	318.5	6535.0	20.05
Madhya Pradesh	110.0	2322.4	21.1
Gujarat	73.6	2267.4	30.08
Punjab	87.2	2189.2	25.1
Assam	98.0	700.1	7.1
Haryana	30.0	696.5	23.2
Jharkhand	49.1	653.1	13.3
Karnataka	40.7	539.7	13.3
Others	189.7	2813.2	14.8
Total	1973.2	41555.4	21.1

Source: National Horticulture Board Database 2014

Table-2 District wise area, production and productivity of Potato in Gujarat (2010-11)

S. No.	District	Area (ha)	Production (tones)	Productivity (tones/ha)
1	Anand	3100	52400	16.90
2	Banaskantha	25600	663000	25.90
3	Gandhinagar	5200	126800	24.38
4	Kheda	4700	92000	19.57
5	Mehsana	5100	122300	23.98
6	Panchmahal	200	3700	18.50
7	Patan	700	15700	22.43
8	Sabarkantha	8800	168200	19.11
9	Vadodara	300	6500	21.67
10	Jamnagar	1100	25600	23.27
11	Kutchh	300	6500	21.67
12	Total	55100	1282700	23.28

Source: Directorate of Agriculture, Gujarat State, Krishi Bhavan, Sector 10-A, Gandhinagar

Land Preparation and Planting: The soil is ploughed to a depth of 25-30 cm and brought to a fine tilth. Hot weather tillage by ploughing the field deep and giving one or two turnings of soil in the summer months of April-June in the plains and keeping it fallow, helps in checking the problem of pathogens and also perennial weeds. Potato is traditionally propagated through tubers which have a dormancy of 8-10 weeks. When the dormancy is over, axillary buds (eyes) start to produce sprouts. Sprouted tubers when planted in soil put up fast growth. Around 1200 kg of seed tubers are enough for planting in one hectare.

Manures and Fertilizers: Potato has a high nutrient requirement; a yield of 25 tones of tubers/ha depletes the soil of 119 kg of N, 50 kg of P and 225 kg of K. In light soils and places where organic manures are not easily available, green manuring is beneficial. Well rotten FYM at 30 t/ha should be incorporated into the soil three to four weeks before planting. Research on fertilizer requirements conducted in the Punjab and Sindh suggests that 100 kg N, 80-100 kg of P₂O₅, and 50 kg K₂O per hectare are sufficient to obtain good yields.

Irrigation: Potato requires 350-550 mm of water depending upon soil type, climate and crop duration. Pre-planting irrigation ensures uniform germination. Then the crop is irrigated around a week after planting. Watering should be light but more frequent. Critical stages are stolon formation, tuber initiation and tuber development. Irrigation is stopped 10 days before harvesting.

Cultural Practices: Mulching, weed management and earthing up are the main cultural practices carried out in potato cultivation. A brief account of these practices is given below-

Mulching prevents weed growth by obstructing sunlight. It conserves soil moisture and maintains conducive temperature. Maize or sorghum stalks, paddy straw, wheat husk etc are used as mulches in potato and are applied in ridges.

Weeds compete with the main plant for water, sunlight and nutrients. As a result, final yield comes down. Weeds may be removed manually or through the use of chemicals called weedicides. Weeds are also known to harbor many pests and act as host to many diseases. Losses due to weeds are considerable in potato. Main weeds found in potato fields in plain areas are *Anagallis arvensis*, *Chenopodium album*, *Poa* spp., *Trianthema monogyna*, *Vicia sativa*, *Cyperus rotundus*, *Spergula arvensis*, *Melilotus* spp., *Oxalis* spp., *Polygonum* spp., *Setaria glauca* etc. Pre-planting application of Fluchloralin and Pendimethalin and pre emergence application of Lasso, Nitrofen or Goal is helpful.

Earthing up is an important operation in potato. It should be done before potato tubers are exposed and turn green. Green potatoes are not fit for eating and they also lose their market value. One should keep an eye on potatoes over the coming weeks in case the earth has been washed away by heavy rain. To avoid this occurring, do not make the mounds too steep. As the plant continues to grow, repeat the process every time it reaches 10-15cm (4-6 inches) of new growth above ground. This could mean repeating the process 3 or 4 times per season.

Potato varieties suitable for processing: A brief description of Indian and foreign origin potato varieties suitable for processing is given below

Kufri Chipsona-1: It is a medium maturing variety suitable for cultivation in north Indian plains. It is resistant to late blight. It has white cream color flesh, ovoid tubers with shallow eyes. Its canopy is semi-compact and stem is green. Leaflet is ovate lanceolate, flowers are white and sprouts green. It has high dry matter and low reducing sugars and produces light colour chips.

Kufri Chipsona-3: It is a medium maturing variety suitable for cultivation in north Indian plains. It is resistant to late blight. It has white cream, ovoid tubers with shallow eyes and white flesh. Its canopy is semi-compact and stem is green with red-brown pigment only at base. Leaflet is ovate-lanceolate, flowers are white and sprouts red-purple. It is suitable for making chips as well as French Fries because it has high dry matter and low reducing sugars.

Kufri Chipsona-4: It is a medium maturing variety suitable for cultivation in Karnataka, West-Bengal and Madhya Pradesh. It is field resistant to late blight. It has white cream, round tubers with shallow eyes and white flesh. Its canopy is compact and stem green with red-brown pigment lightly scattered throughout. Leaflet is lanceolate, flowers are white and sprouts red-purple. It has high dry matter and low reducing sugars, and thus suitable for making chips.

Kufri Frysona: It is a medium maturing variety suitable for cultivation in north Indian plains. It is field resistant to late blight and immune to wart disease. It has white cream, long oblong tubers with shallow eyes and white flesh. Its canopy is open and stem green with purple pigment highly scattered throughout. Leaflet is ovate-lanceolate, flowers are red violet and sprouts red-purple. It has high dry matter and low reducing sugars and suitable for making French Fries.

Santana: An excellent variety for French fries with long to long oval tubers with cream flesh and white skin. It is used worldwide by different fast food chains. It shows medium long dormancy with a strong apical dominance. It requires high nitrogen fertilization and a balanced irrigation. It is widely distributed to farmers in India by Mc Cain under its contract farming programs and considered highly suitable for chip making.

Kennebec: Released by the United States Department of Agriculture (USDA) and the Maine Agricultural Experiment Station in 1948. The variety was selected from a cross between B127 and USDA 96-56. Kennebec is widely adapted and is grown in many parts of the world. At one time it was the primary variety used for potato chip processing in the U.S. and Canada. It was also important in French fry processing. In the table potato market its reputation for good culinary quality was well known. The variety produces a high yield of large tubers. This variety is widely distributed by Mc Cain India to its contract farmers.

Russet Burbank: This variety was developed by Luther Burbank as a blight-resistant variety. It is large, brown-skinned, white-fleshed potato and has become the world's

predominant potato in food processing and used by companies like Mc Donald's in French fries. It developed from a first generation seedling of an open-pollinated cultivar "Early Rose" in Massachusetts.

Lady Rosetta (LR): Good tasting variety used for boiling, baking and chipping. It is a high yielding variety of attractive appearance, very uniform in size; rather susceptible to internal bruising. It has short dormancy period and dry matter content is very high.

Primary Processing of Potato: After harvesting potatoes are kept in heaps in cool places for 10-15 days for drying and curing of skin. 3-4 meter long heaps and one meter wide, with one meter height at the centre are best. Before grading, all the cut, rotten and damaged tubers are removed. The tubers are then graded and packed in gunny bags according to sizes, preferably in four sizes – small (below 25 g), medium (25-50 g), large (50-75 g) and extra large (above 75 g). After grading potatoes meant for using as seed next year are treated with 3% boric acid solution for 30 minutes for protecting against soil borne pathogens eg. Black scurf, Common scab etc. before storing in the bags.

Before processing, potatoes are peeled. Peeling is an important preliminary step in the manufacture of various potato products, since the efficiency and effectiveness of peeling determine the yield of finished product, amount of waste and cost of disposing the waste. Various methods of peeling are employed. Some of the peeling methods of potato are described below:

Abrasion peelers: are designed to uniformly contact the surface of the tubers with abrasive discs or rollers so that while peeling losses are minimum. Abrasion peelers which might be batch or continuous type, use discs or rollers coated with grit to grind away. An important design feature is to ensure that all surfaces of the tuber are equally exposed to the rasping action. During peeling potatoes are sprayed with water in order to decrease the tendency of the tubers to darken as a result of the enzymatic action.

Lye peeling: It depends on the chemical action and thermal shock to soften and loosen the skin, eyes and blemishes of the potatoes so that they are readily worked off or rubbed off by pressure spray and washers. In this method, lye (sodium hydroxide solution) is used at high temperature.

Steam peeling: In this method, potatoes are subjected to high pressure steam for a short time. This treatment hydrates the potatoes and cooks their surface tissue which softens and consequently loosens the peel from underlying tissue. The softened tissue is removed by brushes or water sprays. However, steam peeling leaves a heat ring on the peeled potato surface. In many processed products, this is not objectionable. The exception is potato chips/wafers in which the ring is visible and affects market acceptance.

Brine peeling: Brine solution maintained near boiling and saturation points has been used for peeling potatoes. However, evaporation of water occurs constantly hence it is

necessary to prevent over saturation and crystallization. Immersion time required for adequate peeling may range from three to 10 minutes. Brine peeling is less expensive than lye peeling and is also less hazardous to operating personnel.

Flame peeling: Potatoes are exposed to high temperature which leads to charring or carbonation of skin. Potatoes are passed through a flame or a refractory oven which subjects all the surfaces of potato to approximately 2000⁰ F for 15-30 seconds. Since the tubers are exposed to such elevated temperature for such a short time, the depth of heat ring formed is much less.

Oil peeling: Oil heated at 300 to 400⁰ F can be used to remove the peel. Vegetable and mineral oil can be used. If mineral oil is used, it must be completely removed otherwise undesirable oily odors will spoil the product.

Secondary Processing of Potato: Potatoes can be processed into a number of products as follows-

Potato Powder/flour is one of the oldest commercially processed vegetable products. It is very widely used in the baking industry all over Europe, USA, far Eastern countries and Middle East, although its growth has not kept pace with other processed products of potato. In India it is used in baking industry and as a thickening agent in the soups. It can be prepared by grinding sun dried potato slices, grinding kiln dried potato shreds, dehydrated potato slices by grinding in a hammer mill, grinding dried, boiled and mashed potatoes.

Chips are the most commonly consumed first generation snack foods. They are used as snack food both in domestic as well as in fast food centres and restaurants as side dish and garnishers. Moreover, the product can be safely stored for upto six months without any change in quality. The process flow diagram for preparation of chips/wafers is given below

Potatoes (fully mature) → Washing → Sorting (removal of defected and small tubers) → Peeling (by abrasion peelers) → Trimming (removal of residual skin, discolored and green portion) → Slicing (1/15 to 1/25 inches thick slices using rotary slicer) → Drying (optional process, may be done by drum driers) → Frying (in continuous or batch fryer) → Salting and addition of flavoring materials (just after frying) → Cooling and inspection → Packaging and Storage

French fries (frozen potato chips): French fries are allummete cut potatoes that are normally deep-fried. French fries are served hot, either soft or crispy, and generally eaten as part of lunch or dinner, or by itself as a snack, and they commonly appear on the menus of fast food restaurants. French fries are generally salted and are often served with ketchup; in many countries they are topped instead with other condiments or toppings, including vinegar, mayonnaise, or other local specialties. The process flow diagram for making French fries is given below-

Potatoes (fully mature) → Washing → Sorting (removal of defective and small tubers) → Peeling → Trimming (removal of residual skin, discolored and green) → Cutting (into

strips by strip cutters)→ Sorting of strips (removal of broken, discolored and defective pieces) → Blanching (removal of excess moisture)→ Frying→ De-fatting→ Cooling and inspection→ Packaging→Freezing→ Storage (at zero degree F for at least 2-4 months).

Drying/Dehydration: A home drier for fruits and vegetables (including potatoes) was fabricated in which best dried product was obtained when the potatoes were peeled, sliced and blanched for 3-5 minutes at 81-100⁰ C. The slices could be dried in 9-11 hrs. The dehydrated slices could be rehydrated to normal shape, appearance and flavor if they were soaked in water for 24 hours. Peeling and trimming losses were less in new potatoes but the yield of the dried product was higher in old potatoes. The flow diagram for dehydrated potatoes is given below-

Potatoes→ washing→ Peeling→ Trimming→ Cutting (dicing/slicing)→ Blanching (in steam/water)→ Rinsing (to remove surface gelatinized starch and prevent sticking during dehydration)→ Sulphiting as a spray (may also be applied in blanching water)→ Dehydration→ Screening and inspection→ Sweating→ Sorting→ Packaging→Storage

Canned Potatoes: Canning of potatoes is not a preferred form of processing because the cost of cans is extremely high which adds to the total product cost and weight and bulk of the canned potatoes is many times that of the raw potatoes, making it costly to transport. However, small quantities of potatoes are canned mainly to meet the requirement of armed forces. The process diagram for canning of potatoes is given below-

Potatoes→ Grading→ Washing→ Peeling→ Cutting→ Blanching for 3 minutes→ Cooling→ Filling in cans→ Brining (addition of 2% brine) → Exhausting (exhaust cans at 90-100⁰ C for 6-10 minutes or until temperature at the centre of the can reaches about 79⁰ C) → Sealing→ Processing→ Cooling→ Storage

Major Players in Potato Processing: As Gujarat is one of the leading states in potato production, a number of potato processing units have come up in Gujarat. Most of these units are located in big cities however, few of them find presence in small towns as well. A brief description of the indicative players is enumerated below-

Gopal Namkeen: The journey of Gopal Namkeen started in the year 1965 by the members of the Vithalbhai Haribhai Hadvani and family for supplying snacks and namkeen to local market at Rajkot. By the huge retail success they were inspired to set a Gruh Udyog (home scale industry) plant at Mavdi Plot, Amar nagar in Year 2001 to 2009. Instead of preparing Snack and namkeens by the traditional frying method this semi automatic plant boosted at Vajadi (Vad) - Rajkot in year 2009-2010 for the quality, taste and more sales also. In December 2009 the Gopal Gruh Udyog was converted to Gopal Snacks Pvt. Ltd. From May, 2010 it was transferred at GIDC Metoda with 2000, sq. meter land and 75000 sq. feet of buildings. The fame of taste reached to the whole Gujarat hence it was time to takeover the whole Gujarat market so that biggest automatic plant of Gujarat came in to the picture. Gopal Namkeen is now looking forward to march over India.

The main potato product from Gopal Namkeen is fryums (chips) which is available in packs of 55 gms for Rs. 5 and 120 gms for Rs. 10.

Balaji Wafers and Namkeen: Entrepreneurship was thrust in Virani brothers at a young age, when drought forced their father to sell ancestral agricultural land and give his sons a mere Rs. 20,000, with the advice to go forth and start a business. The road ahead saw Bhikhubhai, Chandubhai and Kanubhai fail at their first venture of fertilizers and then take up working at a boarding mess in Rajkot. Two years later, the brothers got associated with Astron Cinema and performed all necessary jobs with immense sincerity. This led the owner to offer them a profit sharing deal for running the canteen. The Viranis initially bought prepackaged snacks for patrons. Subsequently, the brothers got into sourcing unpackaged wafers and finally started making them themselves at their residence.

This was their first own production and soon, the brothers decided to sell their product “Balaji Wafers” not just to the Astron visitors, but also to customers outside. This was easier said than done, due to a harrowing experience of half-eaten packets returned by shopkeepers and soiled notes being paid. However, the Viranis persisted and ultimately created a name that was so deeply respected, that it nearly wiped off all other competition. The moped, which carried the wafers to the market, soon gave way to an auto and then to a tempo taking financial support through a nationalized bank.

Realizing that the key to constant success and profits was quality, The brothers ensured that if cooks failed to show up, they personally made the wafers and insisted on the best quality raw material to make Balaji wafers a premium product. Taking inspiration from the bittersweet experiences in life, the Viranis went on to create different snacks that were then sold under the same brand name of ‘BALAJI’. The turnover of Balaji was around 350 crores in 2010-11 and today it has crossed over Rs. 1000 crores. Balaji sources potatoes from farmers in North Gujarat and partly also from agent suppliers. Started as micro retail enterprise in 1974, today Balaji is the market leader in Gujarat with around 70% market share. In Maharashtra also it controls over 60% of market share. It is also coming up with a new facility in Indore which would be operational in 2016 itself. It has two facilities in Valsad and Rajkot with a capacity of 1 lakh kg of potato wafers and 5 lakh kg of savouries per day. It employs over 1800 personnel. The company has a network of 600 dealers in Gujarat and Maharashtra.

The product portfolio of Balaji is divided in three categories- youth, kids and family. Technically they could be divided into wafers and namkeen. Wafer is the main product that uses potato. Its wafers come in flavors of simply salted, masala pizza and Nimbu chatka. Alu sev though comes under Namkeen category but uses potato as its main raw material.

Laxmi Snacks: The company was founded in 1989 with name “Laxmi Food Products” at Anand under ‘REAL’ brand name with an intention to provide people of Kheda District quality namkeen, wafers and bakery products with ultimate taste and relishing freshness. After a phenomenal growth in a decade, in 2001 ‘Laxmi Food Products’ had been

formulated in 'Laxmi Snacks Pvt. Ltd'. Since its establishment, the company has experienced a rapid growth, thus, becoming one of the leading snacks producers in Gujarat. To meet the requirements, a fully automatic plant was set up at Nadiad in 2008.

Laxmi Snacks Pvt. Ltd has quickly built up a reputation for manufacturing quality snacks at a competitive price. Its innovative and daring approach to product development as well as to marketing communication constitutes a solid ground for sustainable development. Today, the products of the company receive wide recognition throughout the state and it nourishes the company's ambitions to expand its success across a large number of neighboring states with a wider range of products. 'REAL' has carved a niche of its own in the regional namkeen market. They maintain the original flavor of traditional Indian snacks with primary focus on quality, hygiene and affordability. It has a network of 200 distributors across Gujarat. Main potato products of Laxmi Snacks are Alu sev (Bites), Masala punch, Tomato treat, and Tasty salty (Krunch), Farali wafers (Farali).

Apricot Foods: Evita is the brand name for Apricot foods and their head office is situated at Rajkot. Their potato product range includes Chips (tomato), Chips (crispy salted), Chips (masala), Chips (chili chat), Alu sev, Nimbu sev (contains dry potato powder), Farali chevdo. It has a staff strength of 380 people in office and plant and 72 people in field mainly in sales function. It has a factory area of 1,70,000 sq ft. It has fully automated plants with high tech labs. It has a turnover of Rs. 120 Crores. Production capacity per day is 19 lakh pouches (24 hours). It has markets outside Gujarat as well.

Samrat Namkeen: Turnover was 30 crores (from Gujarat market only) in 2008-09. Its potato product range includes Alu wafers (salted), Alu wafers (masala), Alu Sev. Samrat Namkeen began as a small home-made eatables unit at Swaminarayan temple at Narayan Ghat, Ahmedabad, Gujarat in 1979 by Mr. Jayashankar Vaid. In the following years, company has evolved consistently. Today, it manufactures 32 products. Samrat team includes taste scientists, food industry veterans, management experts, experienced chefs, recipe makers and plant engineers. Samrat's future endeavor is to bring more exotic taste into extended number of homes around the world, to develop enhanced series of methods for long term storage and freshness retention. With more number of foreign and domestic distribution outlets, Samrat brand will expand itself to newer markets. It has a very strong distribution network consisting of 200 distributors and 35,000 retailers.

Beehive Foods International: Play-O is the brand name of Beehive Foods based out of Dahod in Gujarat. It is one of the reliable manufacturers, exporters and suppliers of Play-O Snacks. The range of products includes Play-O Fryums and Play-O Namkeen. They have well-established infrastructure owing to which they can meet order requirements of various sizes. Besides investing in advanced infrastructure, they have laid down policies and procedures that help in faster completion of work. That's why they are able to make timely delivery of the products. They can also efficiently cater to urgent requirements of buyers. Its products come in two categories i.e. fryums and

namkeens. Among the namkeens, potato containing ones are alu sev, mitha farali chevda namkeen and tikha farali chevda namkeen. It has a staff strength of around 30 people and exports to UAE apart from selling domestically. In India, its main markets are Gujarat, Madhya Pradesh and Rajasthan. Its total turnover is around Rs. 2.5 crores.

Umiya FMCG Private Limited Rajkot: Umiya FMCG Private Limited is a part of the Umiya Tea Group. Among the potato products, the company manufactures fryums (Aeroplanes, Alphabets, Rings, Chowkdi, Moon Chips, Noodles, Pasta and Wheels). It started operations in 2013.

Sushma Namkeen Pvt Ltd.: Sushma Namkeen is an Ahmedabad (Changodar) based firm with major business stakes in Gujarat and a little quantity is also going to other states. The company was established in the year 2003. The company manufactures among others potato wafers, alu sev and mixed namkeen. The company follows modern methods of manufacturing and quality assurance like Hazard Analysis at Critical Control Points (HACCP) and ISO 9001:2000. It is a supplier to Adani Shopping Centre, Big Bazar, Star Bazar, Rajpath Club, Karnavati Club, Grand Bhagwati and all bus stops of Gujarat State Transport Corporation (GSTC). It has a network of 180 dealers and 1800 retail counters. Turnover of the company is around Rs. 5 crores and the staff strength is around 10 people.

Mc Cain Foods India: McCain Foods Limited is world's largest producer of French fries and Potato specialties. It has a state of the art manufacturing plant in Mehsana. McCain partnered with McDonald's to work with farmers in Gujarat to interact with agronomists and field assistants to demonstrate the best practices – right from better agronomy techniques like irrigation system, sowing, seed treatments, planting methods, fertilizer application programmes and better storage methods for the produce. As a result of such dedication and investment in Gujarat, McCain came out as a biggest success in food processing sector of Gujarat. Since 1998, McCain has been engaged in agriculture R&D and in development of frozen food market in India and subcontinent countries. McCain products are used by leading fast food chains, hotels, restaurants, catering companies and are popular for in-home consumption. Mc Cain sources 85% of its potatoes from Gujarat mainly through contract farming arrangements.

Hyfun Foods: has a corporate office in Ahmedabad and a modern, hitech plant with installed capacity of 25,000 tons annually for producing French Fries and other Potato Specialties in Mehsana. It has 1000 MT cold store with primary processing facilities like air cooled grading and sorting. It also has a storage capacity of 800 MT of finished products. It has a number of temperature controlled reefer vehicles for efficient transport of potato. The company manufactures products like French fries, Aloo tikki, Burger patty, Smoky bites, Super wedges, Hash brown, Batata wada and Veggie stix. HyFun Foods is a unit of M/s Asandas & Sons, engaged in the trade of potato and onion since last five decades. The firm was founded in the year 1962 by Mr. Asandas J. Karamchandani at Mehsana, a town in North Gujarat which is a potato growing region. The firm is managing an integrated supply chain of onion and potato, right from providing inputs to farmers, sorting, grading, packaging, storage and supply to

wholesale market as well as organized retail. The group enjoys respectable relations with the growers in North Gujarat and therefore can organize best of the chosen potato varieties for its processing plant by means of contract farming.

Issues and Challenges in Potato Processing and Possible Solutions:

- a. *Technical* : The major challenge is processing of potato is unavailability of quality raw material in terms of potato with high dry matter content and low reducing sugar. Earlier till about 1975, only table potato varieties were bred in the public sector. Kufri Chipsona-1 and Chipsona-2 came as late as 1998 and Chipsona-3 followed in 2005. Sprouting of potato in storage is another problem. After the registration of CIPC as sprout suppressant in India in 1998, processing potatoes were stored at 10-12°C with CIPC, and that resulted in production of satisfactory chips after 4-5 months of storage. However, the non-availability of processing potatoes in desired quantities throughout the year remained the major bottleneck for the growth of the processing industry even after the development of suitable indigenous processing varieties. However, after July, these varieties also start accumulating higher amounts of reducing sugars and the potatoes become unsuitable for processing. This is a very crucial period for the industry, since fresh potatoes are not available anywhere. So, there is an acute shortage of processing potatoes from August to December in the vicinity of existing processing industries except some little quantity coming from Hassan in Karnataka.

Unavailability of frying medium presents another acute challenge in the potato processing industry. All types of edible oil including mustard oil are in short supply in India and we have to import large quantities of edible oils. Today, the edible oils produced in the country are not even sufficient to meet the requirement of house wives. A ray of hope has emerged when talks are going on for commercialization of genetically modified mustard.

- b. *Business*: Outselling by contract farmers has been a major problem in potato contract farming. The problem is more so with smaller companies. Bigger companies like Mc Cain have devised a solution to this problem. If the prices in the open market are higher than the contract prices, then 50% is bought by the company at agreed price and 50% is sold by farmer in the open market. Farmers had bad experiences contracting with individual vendors. When prices in the open market are low, the vendors buy from the open market and disobey the contracts with the farmers. As a result more and more progressive potato farmers in Palanpur, Vadgam and Deesa blocks of Banaskantha Districts are entering into contracts with processing companies like Mc Cain and Pepsi.

Potato Processing as Linked to other Sectors of Economy: Potato production and processing has a significant bearing on the other sectors of the economy. A number of support industries have developed as a result of potato production and processing in

Gujarat. These support industries include transport, cold chain, cold storage, agrochemicals industry, agricultural farm machinery, tools and implements, potato seed production and tissue culture, finance (credit), insurance, fast food chains, export of potato and its processed products, retailing and street vending etc. Potato processing also has number of bi-products which are used in other industries like animal feed industry. Potato Industry provides employment to a large number of people in the agri input industry (seeds, pesticides, fertilizers, farm machinery etc), potato farming, processing itself, potato sourcing, marketing like aggregators, traders, commission agents, wholesale buyers, cold store establishments, potato transporters etc.

Contribution of Potato Processing to Economy of Gujarat: As has already been elaborated above, Gujarat produces around 2267.4 thousand MT of potato every year. Averaging, annual average prices of three major markets in Gujarat (Ahmedabad, Surat and Deesa), comes out to be Rs. 12070/MT. This pegs the annual fresh potato trade figure at Rs. 2740 crores. Total GDP of Gujarat in 2014-15 was 9.15 lakh crores. This indicates that contribution of potato to state GDP is 0.3% which is quite significant (being contributed by a single commodity).

Coming to the processing side, Mc Cain alone sources around 50,000 MT of processing potatoes from Gujarat, while other players source around 11000 MT, bringing the total figure to 61,000 MT. The average prices offered are around Rs. 9 per Kg, the total value comes to around 55 crores which is quite high.

A comparison of contribution of leading potato processors in Gujarat

S. No.	Name of the company	Years into business as of 2016	Total turnover (Rs. Crores)	Employee strength (field, plant and offices)	Turnover as percentage of industry turnover (1500 cr)
1	Gopal Namkeen	51	02	10	0.13
2	Balaji Wafers and Namkeen	42	1000	1800	66.67
3	Laxmi Snacks	27	0.50	25	0.03
4	Apricot Foods	11	120	452	8.00
5	Samrat Namkeen	37	35	250	2.33
6	Beehive Foods International	2	2.50	30	0.17
7	Umiya FMCG Private Limited	3	NA	NA	NA
8	Sushma Namkeen Pvt Ltd.	13	5	10	0.33
9	*Mc Cain Foods India	19	300#	400	20.00
10	Hyfun Foods	54	30	200	2.00
11	Others	--	5	--	0.33
12	Total	259	1500	3177	100.00

*Caters to markets of India, Bangladesh, Nepal, South and South East Asian countries as well as Middle East countries from its plant located in Mehsana, Gujarat

#Estimated Gujarat turnover only

Summary: Gujarat is a leading agricultural state in India and has achieved a double digit growth rate of agriculture in Gujarat. Thanks to bt-cotton revolution and greening of desert areas of Kutch and North Gujarat (Banaskantha region mainly) through the reach of Narmada canal recently. Credit also goes to well thought out strategy, meticulously planned and co-ordinated scheme of action, sheer hard-work and sincere implementation of programmes, political will to take bold decisions and commitment to economic policy reforms by the state Government. Entrepreneurial nature of Gujarat farmers has also contributed significantly towards this.

The productivity of potato is highest in Gujarat which is around 30 MT/ha. This is because of the sandy loam soils particularly in Northern parts of the state and cool dry weather in rabi season which favours better tuberization and hinders growth of many fungal diseases. As a result, a large number of cold stores and many potato processing units have come up in Gujarat including some of the international entities like Mc Cain foods, few of which are in contract farming arrangements with potato farmers of Gujarat. Off late, a number of processing varieties have been bred in the public sector like Kufri Chipsona series but established private players like Mc Cain prefer their own varieties bred elsewhere and multiplied in India in cooler locations. Some of the examples are Santana, Cannebec, Saphody etc. Companies like Pepsi use varieties like Lady Rosetta (LR).

Potato processing in Gujarat is supporting a number of ancillary industries like cold stores, potato seed tuber production and trading, starch industry, agricultural inputs industry like plant protection chemicals, fertilizers, anti sprouting agents like CIPC, potato tissue culture production of seed tubers, aeroponics, transportation, frozen potato products and their exports. These industries provide employment to a large number of people. Today potato processing industry in Gujarat directly employs around 3500 people and caters to a network of around 500 distributors and 5000 retailers/dealers. Balaji wafers is the market leader with around 70% market share in Gujarat. This is followed by Mc Cain with 20% market share, though it is a leading player on pan India basis. Raw potato business contributes to around 0.3% of the state GDP of Gujarat. Potato contract farming brings an income of Rs. 55 crores annually to around 5000 farmers in Gujarat.

Potato processing industry in Gujarat also faces a number of challenges. First is the unavailability of a frying medium in sufficient quantities. India has to import large quantities of edible oils including mustard oil. Other problems include sprouting of potatoes in cold storage. Yet another challenge in potato contract farming is outselling by farmers when open market prices are high and out-buying by companies when open market prices are low. Companies like Mc Cain have overcome these challenges by agreeing on a mid path with the farmers that 50% may be sold to company and rest 50% in open market by the farmers when the open market prices are higher and vice versa.

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