Demand for Processed Potato Products and Processing Quality Potato Tubers in India

Rajesh K. Rana · Arun Pandit · N. K. Pandey

Abstract Potato processing in India has shown a tremendous growth in the recent past, creating a proportionate increase in demand for processing quality potatoes. Reliable annual demand estimates of processing quality potato tubers in India were not available; hence, the current study was undertaken to provide such estimates. The study was based on a survey of 442 households in the state Maharashtra in India, which was regarded to be representative for India in the consumption of processed potato products. The annual expenditure on potato products during 2006–2007 in Maharashtra was estimated to be INR 5,254 million (€ 93.82 million), which was equivalent to 28,148 Mg of physical processed potato products and 83,333 Mg of processing quality potato tubers (0.38% of national potato production during 2006–2007, i.e. 22.09 million Mg). When the estimates were generalised to a national level, the requirement of processing-quality potato tubers in 2006–2007 was equal to 4.04% of national potato production. The forecasted annual demand of potato products in Maharashtra during 2011–2012 was 75,375 Mg and the corresponding demand of processing quality potato tubers was 230,760 Mg (0.75% of the estimated national potato production during 2011–2012, i.e. 30.89 million Mg). When generalised at national level, the demand of processing quality potato tubers during 2011–2012 was found to be 8% of the estimated national potato production.

Keywords Demand · Forecasted demand · Processed potato products · Processing quality potato

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Abbreviations

ACGR(s)   Annual compound growth rate(s)
CPRI   Central Potato Research Institute
GDP   Gross domestic product
GOI   Government of India
HP   Himachal Pradesh
INR   Indian National Rupee(s); € 1=56 INR

Introduction

The food processing sector in India is commonly called the sunrise sector and its importance is not just limited to the simple contribution towards increasing the national gross domestic product (GDP). Many important socio-economic benefits which this sector provides in the form of increased employment opportunities and improvement in income and lifestyle of the rural people leading to reduction of migration of rural masses to cities are generally not accounted for. Mitigation of huge post-harvest and storage losses of fruits and vegetables in a tropical/subtropical country like India is another national benefit which is not reflected in the balance sheets of the food processors. However, the efforts of policy makers to compensate the food processing industry with various inceptives have started showing results.

Potato processing, which is a very important component of the overall food processing industry in India, has shown a tremendous growth during the recent past (Rana et al. 2004; Pandey and Sarkar 2005; Pandey et al. 2006). Early anticipation of this growth and timely diversification into breeding processing varieties by the Central Potato Research Institute (CPRI), Shimla, in the year 1990, ensured the availability of processing quality potato[1] tubers in India (Singh and Pandey 2003). As a result, many potato processors have ventured into this business and potato processing capacities have increased tremendously over less than one decade (Rana and Pandey 2007).

Transportation of potato—being a bulky and semi-perishable product—over longer distances is costly and inconvenient. Hence, the growth of the potato processing industry in any area depends to a very large extent on the availability of processing quality potatoes in nearby areas. An adequate supply of processing quality potatoes in commensuration with the industry's demand requires well planned and concerted efforts with research and development organisations like CPRI to develop new processing varieties of potato.[2] Estimates of current and projected demands for processed potato products serve as crucial information for policy makers.

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[1] Not every potato available in the market is fit for processing. Processing quality potatoes should have a dry matter concentration >20%, low reducing sugar concentrations (<150 mg per 100 g fresh weight), uniform size, appropriate shape (round for potato crisps and oblong for French fries) and fleet eyes on the tubers.

[2] Currently, all registered varieties of potato have been developed by the CPRI. Private companies have still not initiated potato varietal development programmes. Few private companies (such as TechniCo India; Mahindra Shubhlabh; KF Biotech etc.) are involved only in seed–potato production and marketing. Hence, CPRI has been addressed as the sole variety development agency in India.

Maharashtra is one of the largest and socio-economically diversified states of India (Government of Maharashtra 2004; Directorate of Economics and Statistics 2005; Mishra and Panda 2006). On the one hand, Mumbai represents the metropolitan and modern lifestyle of India; on the other hand, the rural population of Maharashtra has deep rooted traditional socio-cultural values. The consumption pattern also differs to a great extent and even for the urban population of Maharashtrians, consumption habits are strongly influenced by tradition. The current study was carried out to estimate the demand of processed potato products and processing quality potatoes in the state Maharashtra. The state was assumed to represent India with regards to the consumption of potato products, with the objective to derive national estimates of the demand for processed potato products and processing quality potato through generalisation.

Materials and Methods

In the absence of data from the National Sample Survey Organisation on the consumption of processed potato products, a household consumption survey was conducted in this study. The survey was conducted during March 2007 and a total of 442 families were covered. The sample was derived from Mumbai city and four districts of the state Maharashtra viz. Ahmednagar, Akola, Parbhani and Ratanagiri. Mumbai was representative of a metropolitan consumption pattern while the urban areas of the four selected districts represented the urban population of Maharashtra (Table 1). The number of urban households sampled in the study was higher than the rural ones due to a higher variability in consumption pattern of the urban population compared to the rural one. However, the sampled averages of the categories were generalised for the state population with the help of the estimated number of families in the respective category taking census 1991 and 2001 data into account.

For selecting the sample households in Mumbai, four main regions out of the list of eight were randomly selected viz. Greater Mumbai, Panvel-Uran region, Navi Mumbai and Western region were the selected regions (Appendix 1). Out of each selected main region, one sub-region was selected at random. At least three wards were randomly selected from the list of wards in one urban area from each of the four selected districts. For selecting rural households, the selected district was stratified into three strata having distances from the nearest urban area of <5, 5–10 km, and >10 km. Finally, one village was selected from each of the three strata. This methodology was refined and standardised in an earlier study in the state Punjab (Rana et al. 2009). However Punjab's per capita and per family consumption of processed potato products was much higher than the national average, hence, results were not incorporated in this study.

Data were collected on household income and expenditure with the help of a schedule in a personal interview with the head or representative of each selected household. In addition to the product-wise expenditure on processed potato products the quantity of the consumption was collected. Home-scale processed potato

Table 1 Sample size, expenditure and income details of sampled households

District/state	Area	Sampled households (no.)	Expenditure (INR per month)			Income (INR per month)
			Potato products	Food	Total	
Mumbai	Rural	–	–	–	–	–
	Urban	141	44.5	3,023	8,333	19,018
	Total	141	44.5	3,023	8,333	19,018
Ahmednagar	Rural	51	7.3	2,911	6,035	16,087
	Urban	28	18.1	3,572	9,441	23,889
	Total	79	11.1	3,145	7,242	18,853
Parbhani	Rural	51	6.4	1,982	3,005	7,376
	Urban	21	20.9	2,602	6,380	17,619
	Total	72	10.6	2,162	3,989	10,364
Ratnagiri	Rural	49	5.6	2,539	4,370	12,724
	Urban	21	9.9	2,820	6,390	20,286
	Total	70	6.9	2,623	4,976	14,993
Akola	Rural	61	8.9	1,920	2,960	6,623
	Urban	19	22.2	2,568	5,318	16,605
	Total	80	12.1	2,074	3,520	8,994
Maharashtra	Rural	212	7.1	2,316	4,036	10,491
	Urban	230	34.1	2,995	7,863	19,400
	Total	442	21.2	2,670	6,028	15,127
Maharashtra total € per month			0.38	47.68	107.64	270.13

products are abundantly consumed in Maharashtra state during religious fasts. Therefore, also the quantity of various home-processed potato products was collected. Only those processed potato products were taken into consideration that has a shelf life of at least 1 month. Potato crisps, French fries,[3] *alu bhujia*[4], and other potato products (home processed potato products having exclusive or partial potato contents) were considered for this study. Simple arithmetic tools were used for analysis of the data.

Annual compound growth rates (ACGRs) of the number of rural and urban families during 1991 (Nanda 1994) to 2001 (Banthia 2004) were calculated.

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[3] French fries are par fried in the factories and are immediately deep frozen. They are transported in the frozen state and require to be immediately fried after taking them out from the freezer. They need to be fried at controlled temperature and are served hot. Hence, high-quality French fries are quite costly and are available only at specific outlets, mostly in urban areas. Rural people mostly consume them during their visits to urban areas.

[4] *Alu bhujia* is a potato product that contains only 35% potato contents and is not a traditional Maharashtrian snack. Because manufacturing companies are taking serious efforts to popularise this product all over India, *alu bhujia* is also becoming popular in Maharashtra. However, it is only present in urban areas; rural consumers still have less access to this product.

These ACGRs were used to estimate number of families during 2006–2007.[5] The ACGRs were computed with the help of the following expression:

$$r = \exp\left[\left(\ln\frac{Y_1}{Y_0}\right)/t\right] - 1$$

The ACGR across 15-year potato production values (1994–1995 to 2008–2009) was calculated and used for projecting potato production in 2011–2012. The following procedure was adopted to estimate this ACGR:

$$Y_t = Y_o(1+r)^t$$
$$\text{or } \ln Y_t = \ln Y_0 + \ln(1+r)t$$
$$\text{or } Y_t = A + B*t \qquad\qquad [A = \ln Y_0 \text{ and } B = \ln(1+r)]$$
$$r = \exp(B) - 1$$

In both the cases:

r	annual compound growth rate;
Exp	exponential value;
ln	natural log;
Y_1 or Y_t	value at end of the interval/period for which ACGRs are calculated;
Y_0	value at beginning of the interval/period for which ACGRs are calculated;
t	length of time interval/period in years for which ACGRs are calculated.
B	coefficient of t obtained after the application of "method of least square"

Values were forecasted/projected using the following expression:

$$Z_1 = Z_0(1+r)^t$$

Where:

Z_1	value at end of the interval for which figures are forecasted/projected;
Z_0	value at beginning of the interval for which figures are forecasted;
t	length of time interval in years for which figures are forecasted.

Results and Discussion

Expenditure on and Consumption of Processed Potato Products

The expenditure on processed potato products is highly influenced by the average family income of the household (Rana et al. 2005; Rana et al. 2008). The household income in urban areas of the state was nearly 85% higher than in the rural areas

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[5] Indian accounting year starts from April 1 and ends on March 31. About 95% of the potato production is harvested during December and March (spreading over two calendar years); hence, crop production statistics and several important data are available in this overlapping fashion. In fact, 2006–2007 refers to a single year of 12 months, i.e. April 01, 2006–March 31, 2007. The same applies for other figures written like this in the text and tables.

(Table 1). Similarly, the total expenditure,[6] food expenditure and expenditure on processed potato products in urban areas was, respectively, about 95%, 29% and 376% higher than in the rural areas. It can be concluded that due to higher proportionate cost of living in urban Maharashtra the proportionate saving on regular expenses was higher in rural areas of the state.

Processed potato products were divided for this study in four categories: potato crisps, *alu bhujia*, French fries and other potato products. Other potato products were mostly home-processed products like potato *papad*, *chakli* and *kish*.[7] Per family expenditure on potato crisps and other potato products in urban Maharashtra was, respectively, 198% and 629% higher than in rural areas (Table 2). Since *alu bhujia* and French fries are predominantly consumed in urban areas, the proportion of per family rural consumption of these products was negligible in comparison to the proportion consumed by urban families. The lower proportion of expenditure on *alu bhujia* and French fries by rural families was due to lack of popularity and un-availability of these products in rural areas. Rural households were spending about three quarters of their total processing potato products expenditure on potato crisps only while this proportion was less than half in urban families (Fig. 1). The proportionate expenditure on other potato products was higher in urban areas.

Physical consumption of processed potato products for an average Maharashtrian family was nearly six times more in urban areas than in rural areas (Table 3). The overall consumption of processed potato products in the state was nearly 1.4 kg per family per year. "Other" potato products were consumed in the highest quantity as compared to the remaining products categories. However, out of nearly 400 g per family potato products consumption in rural area, potato crisps constituted the highest followed by other products, French fries and *alu bhujia* (Fig. 2). In urban areas, the other products constituted the highest proportion of the nearly 2.3 kg annual potato products consumption of an average family.

The total expenditure on processed potato products in the state was computed by multiplying the per family expenditure by the estimated number of households in 2006–2007 (Table 4). Based on the number of families in rural and urban areas of Maharashtra in 1991 (Nanda 1994) and 2001 (Banthia 2004), ACGRs were computed. The number of families in 2006–2007 was estimated using these ACGRs, assuming that number of families would increase at the same rate. As the state had a very high proportion of urban population (45% of the families), nearly 80% of the physical quantity of processed potato products was consumed in the urban areas.

Depending upon the actual purchase made by the consumers for the packs of potato products carrying different prices[8] and the quantity of product in a particular pack, the weighted average prices of different potato products were computed. The

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[6] The total expenditure includes only the regular monthly expenses. One-time expense such as purchase and development of land, cost of litigations, expenses on marriages and illness, purchase of a house, vehicles, farm machinery, etc. are not included.

[7] *Papad*, *chakli* and *kish* are the local names for home made products having partial (first two products) or full (last product) potato contents. These are dehydrated products which are fried just before consumption.

[8] Fried potato products are packaged in nitrogen-filled packs of convenient prices mostly ranging from INR 5 to 20. In the case of change in input costs, manufacturers generally change quantity rather than the price of the pack.
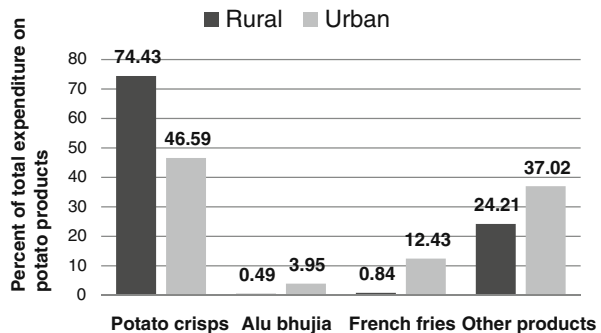
Table 2 Average expenditure on potato products during 2006–2007 (INR per family)

District/state	Area	Potato crisps	Alu bhujia	French fries	Others	Total
Mumbai	Rural	–	–	–	–	–
	Urban	213.1	26.4	76.6	218.2	534.3
	Total	213.1	26.4	76.6	218.2	534.3
Ahmednagar	Rural	61.5	1.8	0.0	24.0	87.2
	Urban	173.6	0.0	8.6	35.4	217.5
	Total	101.2	1.1	3.0	28.0	133.4
Parbhani	Rural	67.1	0.0	0.0	10.0	77.1
	Urban	203.6	0.0	9.3	37.9	250.7
	Total	106.9	0.0	2.7	18.1	127.7
Ratnagiri	Rural	33.4	0.0	3.1	31.2	67.7
	Urban	78.6	0.0	0.0	39.7	118.3
	Total	46.9	0.0	2.1	33.8	82.8
Akola	Rural	88.3	0.0	0.0	18.9	107.2
	Urban	161.9	0.0	25.3	78.9	266.0
	Total	105.8	0.0	6.0	33.2	144.9
Maharashtra	Rural	64.0	0.4	0.7	20.8	86.0
	Urban	190.9	16.2	50.9	151.7	409.7
	Total	130.0	8.6	26.9	88.9	254.4
Maharashtra total € per month		2.32	0.15	0.48	1.59	4.54

per kg prices for potato crisps, *alu bhujia*, French fries and other potato products were estimated to be Indian National Rupee (INR) 285 (€ 5.09)/kg; INR 125 (€ 2.23)/kg; INR 175 (€ 3.13)/kg and INR 120 (€ 2.14)/kg, respectively (Table 5). Using these prices, the annual physical quantity of potato products was calculated. The annual quantity of different potato products consumed by the people of Maharashtra was estimated to be highest for other potato products followed by potato crisps, French fries and *alu bhujia*. The annual demand for all potato products in the state thus was 28,148 Mg.

About 29% of the total consumption of potato crisps was incurred by the rural households of the state while urban households were the major contributors towards

Fig. 1 Contribution of different potato products in the total expenditure on potato products in rural and urban areas of Maharashtra in 2006–2007

Table 3 Average consumption (kg per family per year) of processed potato products in Maharashtra during 2006–2007

District/state	Area	Potato crisps	Alu bhujia	French fries	Others	Total
Mumbai	Rural	–	–	–	–	–
	Urban	0.748	0.211	0.438	1.724	3.120
	Total	0.748	0.211	0.438	1.724	3.120
Ahmednagar	Rural	0.216	0.014	0.000	0.185	0.415
	Urban	0.609	0.000	0.049	0.281	0.939
	Total	0.355	0.009	0.017	0.219	0.601
Parbhani	Rural	0.235	0.000	0.000	0.078	0.314
	Urban	0.714	0.000	0.053	0.299	1.067
	Total	0.375	0.000	0.015	0.143	0.533
Ratnagiri	Rural	0.117	0.000	0.018	0.223	0.358
	Urban	0.276	0.000	0.000	0.296	0.572
	Total	0.165	0.000	0.012	0.245	0.422
Akola	Rural	0.310	0.000	0.000	0.135	0.445
	Urban	0.568	0.000	0.144	0.621	1.333
	Total	0.371	0.000	0.034	0.250	0.656
Maharashtra	Rural	0.225	0.003	0.004	0.154	0.386
	Urban	0.670	0.129	0.291	1.197	2.287
	Total	0.456	0.069	0.153	0.696	1.375

Average price of potato crisps = INR 285 (€ 5.09) per kg (branded) and INR 140 (€ 2.50) per kg (unbranded), *alu bhujia* = INR 125 (€ 2.23) per kg, French fries = INR 175 (€ 3.13) per kg and others = INR 120 (€ 2.14) per kg

this consumption (Fig. 3a). Similarly, urban households contributed more than rural households to the expenditure on *alu bhujia*, French fries and other potato products (Fig. 3b,c,d). The contribution of the rural households in the total expenditure was negligible for *alu bhujia* and French fries, and less than 14% for other potato products.

The ACGRs of potato products' consumption among sampled families were estimated to be 30% for potato crisps, 50% for *alu bhujia* and only 5% for other potato products. As other potato products are mostly home processed, they slowly

Fig. 2 Contribution of different potato products in the total consumption of potato products in rural and urban areas of Maharashtra in 2006–2007
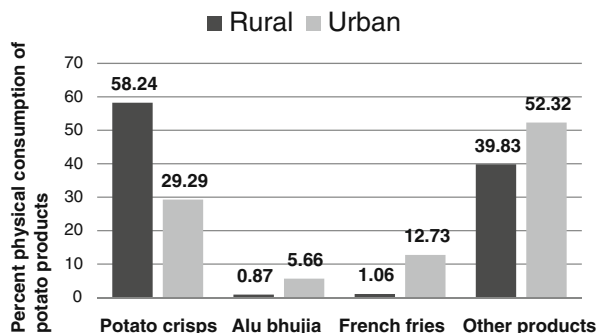
Table 4 Estimates of expenditure on processed potato products in the state of Maharashtra during 2006–2007

District/state	Area	Families (1991–1992)[a] (number)	Families (2001–2002)[b] (number)	ACGR	Estimated families (2006–2007) (number)	Estimates of expenditure	
						INR million	€ million
Mumbai	Rural	–	–	–	–	–	–
	Urban	2,051,216	2,515,589	0.02062	2,843,309	1,519.1	27.13
	Total	2,051,216	2,515,589		2,843,309	1,519.1	27.13
Ahmednagar	Rural	525,172	620,524	0.01682	685,840	59.8	1.07
	Urban	101,531	156,263	0.04406	202,399	44.0	0.79
	Total	626,703	776,787		888,239	103.9	1.86
Parbhani	Rural	299,253	196,170	−0.04135	152,263	11.7	0.21
	Urban	80,895	82,532	0.00201	83,532	20.9	0.37
	Total	380,148	278,702		235,795	32.7	0.58
Ratnagiri	Rural	296,869	336,040	0.01247	361,979	24.5	0.44
	Urban	27,167	41,326	0.04284	53,153	6.3	0.11
	Total	324,036	377,366		415,132	30.8	0.55
Akola	Rural	309,913	205,862	−0.04008	161,059	17.3	0.31
	Urban	110,100	114,085	0.00356	116,544	31.0	0.55
	Total	420,013	319,947		277,603	48.3	0.86
Maharashtra	Rural	9,259,441	11,173,512	0.01897	12,507,142	1,075.7	19.21
	Urban	6,084,994	8,403,224	0.03281	10,199,257	4,178.4	74.62
	Total	15,344,435	19,576,736		22,657,865	5,254.2	93.82

[a] Census of India 1991

[b] Census of India 2001

but gradually get out of favour with the new generations; hence, this 5% ACGR estimate is quite realistic. For estimating the ACGR of French fries, the estimates of the McCain Food India[9] were used. The estimated ACGR of French fries was 30%, and taking the expanding market for this product in India into consideration, it also seems to be quite realistic. With these ACGRs, the annual quantity of different potato products demanded after 5 years, i.e. in 2011–2012, was estimated (Table 6). The annual quantity demanded of all these potato products in the state Maharashtra in 2011–2012 was estimated to be 75,375 Mg[10]. Unlike the situation in 2006–2007 where more than half of the consumed processed potato products in the state are "other potato products", this proportion is expected to be approximately one fourth in 2011–2012 (Fig. 4). Potato crisps will constitute the highest proportion (nearly half) of processed potato products by the year 2011–2012.

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[9] McCain is a Canadian multi-national corporation and is the largest producer of French fries in the world.

[10] The demand forecast figures for potato products and processing quality potato over the next five years may apparently seem to be on higher side, but taking into consideration the large expansion in processing capacity by the existing potato processors and many new entrants in this field, it looks realistic.

Table 5 Total consumption (Mg) of processed potato products during 2006–2007 in Maharashtra
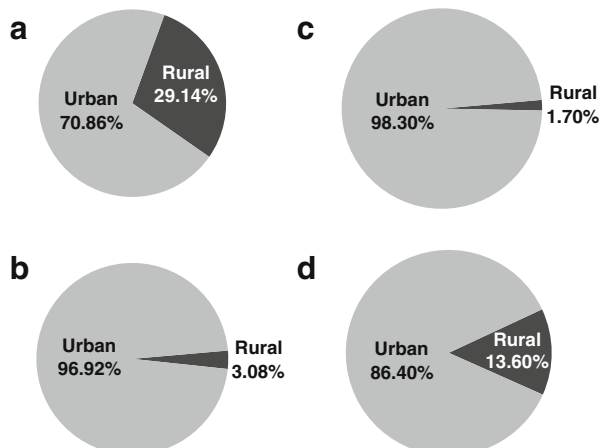
District/state	Area	Potato crisps	Alu bhujia	French fries	Others	Total
Mumbai	Rural	–	–	–	–	–
	Urban	2,125.6	599.8	1,244.4	4,900.8	8,870.6
	Total	2,125.6	599.8	1,244.4	4,900.8	8,870.6
Ahmednagar	Rural	148.0	9.7	0.0	126.8	284.5
	Urban	123.3	0.0	9.9	57.0	190.1
	Total	271.2	9.7	9.9	183.8	474.6
Parbhani	Rural	35.8	0.0	0.0	11.9	47.8
	Urban	59.7	0.0	4.4	25.0	89.1
	Total	95.5	0.0	4.4	36.9	136.9
Ratnagiri	Rural	42.4	0.0	6.3	80.8	129.5
	Urban	14.7	0.0	0.0	15.7	30.4
	Total	57.0	0.0	6.3	96.5	159.8
Akola	Rural	49.9	0.0	0.0	21.7	71.6
	Urban	66.2	0.0	16.8	72.4	155.4
	Total	116.1	0.0	16.8	94.1	227.0
Maharashtra	Rural	2,809.7	41.9	51.3	1,921.4	4,824.3
	Urban	6,831.2	1,319.3	2,969.0	12,203.9	23,323.4
	Total	9,640.9	1,361.2	3,020.3	14,125.3	28,147.7

Average price of potato crisps = INR 285 (€ 5.09) per kg (branded) and INR 140 (€ 2.50)/kg (un-branded), *alu bhujia* = INR 125 (€ 2.23) per kg, French fries = INR 175 (€ 3.13) per kg and other potato products = INR 120 (€ 2.14) per kg

Demand of Processing Quality Tubers

Reliable estimates of the requirement of processing quality potato tubers for the Indian potato processing industry are not available. Some of the studies, though not based on analysis, assumed potato tubers processed in India to be less than 1% of the national production (Khurana 2002; Singh and Pandey 2003; Khurana 2006). However, due to

Fig. 3 Contribution (%) of urban and rural areas in the total consumption of crisps (**a**), *alu bhujia* (**b**), French fries (**c**), and other potato products (**d**) in Maharashtra

a Urban 70.86% Rural 29.14%

c Urban 98.30% Rural 1.70%

b Urban 96.92% Rural 3.08%

d Urban 86.40% Rural 13.60%

Table 6 Projection of demand for processed potato products in Maharashtra in 2011–2012 (Mg)

District/state	Area	Potato crisps	Alu bhujia	French fries	Others	Total
Mumbai	Rural	–	–	–	–	–
	Urban	7,892.1	4,555.0	4,620.5	6,254.8	23,322.3
	Total	7,892.1	4,555.0	4,620.5	6,254.8	23,322.3
Ahmednagar	Rural	549.2	73.7	0.0	161.9	784.8
	Urban	457.7	0.0	36.8	72.7	567.2
	Total	1,006.9	73.7	36.8	234.6	1,352.0
Parbhani	Rural	133.0	0.0	0.0	15.2	148.2
	Urban	221.6	0.0	16.5	31.9	270.0
	Total	354.6	0.0	16.5	47.2	418.2
Ratnagiri	Rural	157.3	0.0	23.5	103.1	283.9
	Urban	54.4	0.0	0.0	20.1	74.5
	Total	211.7	0.0	23.5	123.2	358.4
Akola	Rural	185.2	0.0	0.0	27.8	213.0
	Urban	245.8	0.0	62.5	92.4	400.6
	Total	431.0	0.0	62.5	120.1	613.6
Maharashtra	Rural	10,432.3	318.2	190.4	2,452.3	13,393.2
	Urban	25,363.8	10,018.3	11,023.7	15,575.6	61,981.4
	Total	35,796.1	10,336.5	11,214.1	18,027.9	75,374.6

ACGR assumed for projection: potato crisps=30%, *alu bhujia*=50%, French fries=30% and other potato products=5%

the rapid growth of the potato processing industry and the availability of processing quality potato tubers in India (Rana et al. 2004), other researchers have the opinion that the actual potato processing in the country is much higher (Pandey and Sarkar 2005; Pandey et al. 2006). Based on secondary information and a survey of potato processing plants, Rana and Pandey (2007) reported the processing quality tuber demand in India during 2005–2006 to be 0.97 million Mg, which was 4.06% of the national potato production (23.91 million Mg) in the same year.

Based on the results of our survey the requirement of processing quality potato tubers for the production of processed potato products for Maharashtra was computed (Table 7). As potato crisps have 25% recovery (Kaur and Ghuman 2002), the processing quality

Fig. 4 Contribution (%) of different potato products to the current (2007–2008) and projected (2011–2012) physical consumption of potato products in Maharashtra
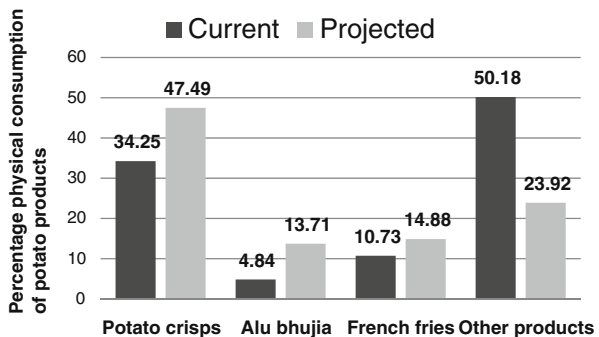
Table 7 Processing quality potato tuber requirement for the processed potato products in Maharashtra in 2006–2007 (Mg)

District/state	Area	Potato crisps	Alu bhujia	French fries	Others	Total
Mumbai	Rural	–	–	–	–	–
	Urban	8,502.3	839.8	3,111.1	12,252.0	24,705.1
	Total	8,502.3	839.8	3,111.1	12,252.0	24,705.1
Ahmednagar	Rural	591.7	13.6	0.0	317.1	922.3
	Urban	493.1	0.0	24.8	142.4	660.3
	Total	1,084.8	13.6	24.8	459.4	1,582.6
Parbhani	Rural	143.3	0.0	0.0	29.8	173.1
	Urban	238.7	0.0	11.1	62.5	312.3
	Total	382.0	0.0	11.1	92.4	485.4
Ratnagiri	Rural	169.5	0.0	15.8	201.9	387.2
	Urban	58.6	0.0	0.0	39.4	98.0
	Total	228.1	0.0	15.8	241.2	485.2
Akola	Rural	199.6	0.0	0.0	54.4	253.9
	Urban	264.7	0.0	42.0	181.0	487.8
	Total	464.3	0.0	42.0	235.3	741.7
Maharashtra	Rural	11,238.9	58.7	128.2	4,803.5	16,229.3
	Urban	27,324.8	1,847.0	7,422.5	30,509.8	67,104.1
	Total	38,563.8	1,905.7	7,550.7	35,313.3	83,333.4
Percent of Indian potato production in 2006–2007 (22.09 million Mg; GOI 2010)						0.377%

Recovery rate of potato crisps (100% potato contents)=25%, alu bhujia (35% potato contents)=25%, French fries (100% potato contents)=40%, and other potato products (50% potato contents)=20%

potato requirement was calculated be to four times the potato crisps' quantity demanded. The processing quality potato requirement for *alu bhujia* was estimated taking into consideration that it contains 35% potato and that the potato contents present in it has 25% recovery. *Alu bhujia* is a fried and salty product like potato crisps; hence, the recovery is equivalent. The recovery for French fries was assumed to be 40% of the raw material as the product is made exclusively from potatoes. The percentage recovery for French fries in India is lower than the world average of 52% due to smaller sized tubers produced in shorter crop growing period (about 100–110 days). The other potato products were assumed to contain 50% potato contents having 20% recovery from the raw material (processing quality potato). Other potato products are largely the dehydrated potato products where peeling losses are more or less compensated by the moisture retained in the final product. The estimates are based on personal observations and no studies were found in this area.

The annual processing quality potato tuber demand in Maharashtra in 2006–2007 was estimated to be 38,564 Mg for potato crisps, 35,313 Mg for other potato products, 1,906 Mg for *alu bhujia*, and 7,551 Mg for French fries (Table 7). The annual requirement of processing quality potato tubers to meet the demand of processed potato products in Maharashtra was 0.38% of the national potato production during 2006–2007 (GOI 2010). As Maharashtra has been considered the representative of processing potato products' consumption in the country, the requirement of processing quality

potato tubers of India for processed potato products in 2006–2007 was estimated[11] to be 4.04% of the national potato production (Table 8). This estimate is slightly below, but quite close to the 4.06% processing quality tuber requirement, a supply side estimate for the Indian potato processing industry, made for in 2005–2006 by Rana and Pandey (2007) using secondary information and a survey of potato processing plants.

Based on processing quality potato tuber requirement estimates of 2005–2006 (0.97 million Mg) and 2011–2012 (2.68 million Mg) the ACGR was estimated to be 18.46%. Using this ACGR, the estimated figure for 2006–2007 processing quality potato tubers requirement was 1.15 million Mg which was 5.21% of national potato production in the year (22.09 million Mg). However, the supply side estimate does include the demand for processing quality potato tubers for potato products exported from India. Some traditional products like *alu bhujia*, dehydrated potato crisps and other dehydrated potato products have considerable demand from non-resident Indians, which results in export of these products from India (Singh and Rana 2005). Hence, these two estimates derived from two different approaches tend to agree and it can be concluded that Maharashtra state is a right representative of India in case of the consumption of processed potato products.

Using the ACGRs, the demand for processing quality potato in Maharashtra in 2011–2012 was projected to be 230,760 Mg (Table 9), which is 0.75% of the estimated Indian potato production in 2011–2012. Assuming that the ratio of the population of Maharashtra to India in 2011–2012 will remain the same as it was in 2006–2007, the generalisation of results at national level suggests that 8% of the estimated Indian potato production in 2011–2012 will be needed as raw material for potato processing in 2011–2012 (Table 8). The projected estimate for processing quality potato tubers in 2011–2012 in the current study (only the domestic demand) is 2.47 million Mg. Taking into consideration the exports of potato products from India (Singh and Rana 2005), this estimate is consistent with the supply side estimate of 2.68 million Mg processing quality potato tubers requirement in 2011–2012 in India (Rana and Pandey 2007).

Conclusions

In addition to the established players in the field of Indian potato processing like Frito Lay, Haldiram, McCain Foods India and Balaji Wafers; new entrants like ITC, Gee Pee Foods, Merino group, Satnam Agro, Parle Agro and Vimal Oil & Foods Limited have also joined the race to chasing important business opportunities in the field of potato processing during the last few years. In addition, the huge expansion of the capacity and establishment of new plants by the existing players, confirms the rapid growth of this industry in the recent past and near future in India. Not every potato tuber available on the market is fit for processing, and the availability of processing quality tubers is an important and decisive factor of success for a potato processing plant manager. The development and release of processing potato varieties[12] by the CPRI has induced confidence of raw material availability among potato processors. However, most of the developments in the potato processing field are still based on personal judgements of the

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[11] Estimates are based on forecasted population figures by the Census of India (http://www.censusindia.gov.in).
[12] CPRI released Kufri Chipsona-1 and Kufri Chipsona-2 in 1998 for potato crisp manufacturing, followed by Kufri Chipsona-3 (potato crisps, 2005), Kufri Surya (French fries, 2005) and Kufri Himsona (potato crisps, 2007).

Table 8 Generalisation of Maharashtra estimates to the whole India

		Processing quality potato tuber estimates (% of national production)	
State/country	Population (2006–2007)[a]	2006–2007[b]	2011–2012[c]
Maharashtra	10.40	0.377	0.747
India	111.42	4.04	8.00

[a] Census of India

[b] Percent of national potato production in 2006–2007, i.e. 22.091 million Mg

[c] Assumed that ratio of Maharashtra population to India during 2006–2007 (0.09334 or 9.334%) will remain the same in 2011–2012

Table 9 Projections of processing quality potato tuber requirement for processed potato products in Maharashtra during 2011–2012 (Mg)

District/state	Area	Potato crisps	Alu bhujia	French fries	Others	Total
Mumbai	Rural	–	–	–	–	–
	Urban	31,568.4	6,376.9	11,551.2	15,637.0	65,133.5
	Total	31,568.4	6,376.9	11,551.2	15,637.0	65,133.5
Ahmednagar	Rural	2,196.8	103.3	0.0	404.7	2,704.7
	Urban	1,830.8	0.0	92.1	181.7	2,104.6
	Total	4,027.6	103.3	92.1	586.4	4,809.3
Parbhani	Rural	532.0	0.0	0.0	38.1	570.1
	Urban	886.2	0.0	41.2	79.8	1,007.2
	Total	1,418.2	0.0	41.2	117.9	1,577.3
Ratnagiri	Rural	629.3	0.0	58.8	257.7	945.7
	Urban	217.6	0.0	0.0	50.2	267.8
	Total	846.9	0.0	58.8	307.9	1,213.6
Akola	Rural	741.0	0.0	0.0	69.4	810.4
	Urban	983.0	0.0	156.1	231.0	1,370.1
	Total	1,724.0	0.0	156.1	300.3	2,180.4
Maharashtra	Rural	41,729.3	445.5	476.0	6,130.7	48,781.4
	Urban	101,455.2	14,025.5	27,559.3	38,939.1	181,979.1
	Total	143,184.5	14,471.0	28,035.3	45,069.8	230,760.5
Percent of Indian potato production in 2011–2012 (30.89 million Mg[a])						0.747%

[a] The latest data on potato production from the Directorate of Economics and Statistics, Ministry of Agriculture, GOI is for the year 2008–2009 (28.58 million Mg). The 15-year (1994–1995 to 2008–2009) ACGR of potato production in India was estimated to be 2.63%. Based on this ACGR the projected potato production during 2011–2012 is 30.89 million Mg

ACGR assumed for projection: potato crisps=30%, alu bhujia=50%, French fries=30% and other potato products=5%

entrepreneurs and available examples in the industry due to the absence of any published, scientific estimate of the demand of processed potato products and processing quality tubers. Some private companies are carrying out studies on demand of potato products, but the results are kept highly confidential.

This study is a unique attempt to assess the demand of processed potato products using household consumption data in Maharashtra, which is one of the largest states of India. Maharashtra was found to be a highly representative state of India as far as consumption of potato products in the country is concerned. Consumers in the state spent highest amount of potato products' expenditure on potato crisps as compared to other categories of processed potato products viz. French fries, *alu bhujia* and other potato products. It was estimated that the people in the state were annually spending INR 5,254 million (€ 93.82 million) on processed potato products. This expenditure was equivalent to 28,148 Mg in terms of physical quantity of potato products, which required 83,333 Mg of processing quality potato tubers. This raw material demand was equal to 0.38% of the potato production in India during the season 2006–2007.

When generalised at a national level, the estimated processing quality potato tuber requirement of India for processed potato products during 2006–2007 was 4.04% of the national potato production. This estimate is consistent with the estimate by Rana and Pandey (2007), using supply side estimation. With the help of ACGRs of different categories of processed potato products, i.e. potato crisps, *alu bhujia*, French fries and other potato products, the demand of processed potato products and their processing quality tuber requirement after 5 years was estimated. For the season 2011–2012, the forecasted figure of potato products' annual demand for the state of Maharashtra was 75,375 Mg requiring 230,760 Mg of processing quality potato tubers which was equal to 0.75% of the estimated Indian potato production during 2011–2012. When generalised at the country level, 8% of estimated Indian potato production in 2011–2012 is expected to be required as raw material requirement for the potato processing industry in 2011–2012. The projected figure of the potato tuber requirement of the industry is 2.47 million Mg which is again consistent with the estimates (2.68 million Mg) of Rana and Pandey (2007). The latter figure was derived from supply side estimation and includes the possible exports of processed potato products while the former estimates only the domestic consumption.

More than 8% of potato area in the country is expected to come under processing varieties of potato by 2011–2012. The country currently has six processing quality potato varieties out of the 47 varieties released by the CPRI[13] so far. Taking into consideration the rapidly rising trend of processed potato products in India, there is need of more processing quality varieties having a higher dry matter concentration, lower reducing sugar concentrations and shorter time to maturity[14] in India. Hence,

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[13] Kufri Jyoti, K. Lauvkar and K. Chadramukhi were the table purpose Indian potato varieties found suitable for processing. However, K. Chipsona-1, K. Chipsona-2, K. Chipsona-3, K. Surya, K. Himsona and K. Frysona are Indian processing varieties of potato. The CPRI has so far 47 released potato varieties. In addition to Indian varieties McCain Foods India Ltd. and PepsiCo are supporting contract farming of exotic potato varieties too. Shepody, Kennebec, Santana and Innovator are such varieties liked by McCain while PepsiCo prefers Atlantic, Frito Lay collections (FL-1533; most common) and Lady Rosetta among exotic potato varieties. However, exotic varieties are not registered in India.

[14] Warmer sub-tropical/tropical climate in India and the increasing threat of global warming are gradually reducing the length of favourable potato cultivation span in the country. Therefore, short-duration potato varieties having processing attributes are urgently needed.

the national potato research and development institutes like CPRI need to further expedite their efforts in this area of urgent attention.

Limitation of the Study   Due to shortage of required manpower and time, the study could not be extended to more states for a better national representation. However, the results of the state Maharashtra generalised at a national level were quite close to the supply-side estimates of the demand of processing quality potato in India (Rana and Pandey 2007) which validated the assumption that Maharashtra highly represented India in the field of potato products' consumption.

Appendix 1

Table 10 List of areas and sub-areas used for selecting the respondents in Mumbai

Main regions	Sub-regions
Greater Mumbai	Island city
	Western suburb
	Eastern suburb
Western region	Mira-Bhayander sub-region
	Vasai-Navghar sub-region
	Nallasopara sub-region
	Virar sub-region
	VVNA-coastal sub-region
	VVNA rural sub-region
	Rest Vasai tehsil sub-region
North-East region	Thane sub-region
	K.M.C. sub-region
	Ulhasnagar sub-region
	Ambernath sub-region
	Badlapur sub-region
	Bhiwandi sub-region
	Rest of Bhiwandi tehsil
	South Kalyan Ulhas
	North Kalyan Ulhas
Navi Mumbai	NMMC (excl. 15 villages)
	NMMC (15 villages)
	Panvel sub-region

Table 10 (continued)

Main regions	Sub-regions
	Uran sub-region
Neral-Karjat sub-region	Karjat sub-region
	Khalapur sub-region
Panvel-Uran region (outside New Bombay)	Rasayani–Panvel sub-region
	Rest of Panvel sub-region
	Kopta sub-region
	Rest of Uran sub-region
	Karnala sub-region
Pen region	
Alibag region	

Source: http://www.regionalplan-mmrda.org/N-3.pdf

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