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Introduction

Rice, wheat, sorghum, pearl millet and finger millet are the major cereal staples of Indian households but sorghum, pearl millet and finger millet are only consumed in the regions in which they are cultivated. Sorghum is the staple of central and western regions of Maharashtra and the northern regions of Karnataka and Andhra Pradesh and pearl millet is mainly consumed in the western states of India i.e. Gujarat and Rajasthan. Similarly, although wheat is consumed all over India, it is the main staple in the northern parts of India such as Punjab, Delhi, Haryana, Madhya Pradesh and Uttar Pradesh. Over the past decade, research studies that have analyzed household consumption data collected by the National Sample Survey Organisation (NSSO) have reported a long term historical decline in per capita consumption of all cereals and particularly nutritious cereals (Meenakshi 1996, Kumar P 1998, Hamumantha Rao 2000, Radha Krishna 2005, Mittal 2006). This is partially attributed to a shift in dietary patterns of consumption from cereals to a more balanced diet that includes livestock products, fruit and vegetables (Chand 2007) – a change driven by income growth and urbanization.

This paper is concerned with the production and consumption of the coarse cereal, sorghum, focusing on disaggregated data at the regional level in the major growing states of Maharashtra, Karnataka and Andhra Pradesh. The aim of this type of region-specific analysis is to provide insights into:

1. The importance of sorghum in the consumption basket in the main sorghum production regions of Maharashtra, Karnataka and Andhra Pradesh.
2. Differences in consumption of sorghum by various income groups in the regions.
3. Better insights into the gap between demand and supply of sorghum in these regions.
4. Inter-state and intra-regional trade in sorghum.

Data source and methodology

The main data source for this study was the National Sample Survey Organisation (NSSO), which publishes data on household consumer expenditure on food and non-food items for rural and urban consumers in India every five years. The household consumption data pertaining to the 61st round (2004-2005) was used to disaggregate the data for different regions of the states of Maharashtra, Karnataka and Andhra Pradesh. Disaggregation of the states into NSSO regions and the composition of districts in each region are presented in

Table 1. NSSO reports consumption expenditure of food items per capita for 30-day recall on the day preceding the survey. The survey was carried out in sub-rounds covering four seasons. The results, presented in this study, are based on the 30-day reference period and averaged for the four seasons. Per capita monthly consumption of sorghum was analyzed for all the regions in the selected states and across regions within a selected state.

Data on area, production and yield of sorghum at district level was obtained from publications of the Directorate of Economics and Statistics, Government of India, which provides such data for the principal crops grown in India. A three-year average of area and production of sorghum was considered to even out any sharp year-to-year fluctuations due to external factors. Sorghum production for both *rabi* (postrainy) and *kharif* (rainy) seasons obtained for the districts of Maharashtra, Karnataka and Andhra Pradesh were aggregated for different NSSO regions of the three states. The sorghum production thus obtained for these regions was used to arrive at an estimate of the gap between supply and demand at the regional level¹.

Table 1. NSSO regions and their district compositions in Maharashtra, Karnataka and Andhra Pradesh

Region	Districts composing the region
Coastal Maharashtra (CM)	Thane, Mumbai Suburban, Mumbai, Raigarh, Ratnagiri, Sindhudurg
Inland Western Maharashtra (IWM)	Pune, Ahmadnagar, Solapur, Satara, Kolhapur, Sangli
Inland Northern Maharashtra (INM)	Nandurbar, Dhule, Jalgaon, Nasik
Inland Central Maharashtra (ICM)	Nanded, Hingoli, Parbhani, Jalna, Aurangabad, Beed, Latur, Osmanabad
Inland Eastern Maharashtra (IEM)	Buldana, Akola, Washim, Amravati, Wardha, Nagpur, Yavatmal
Eastern Maharashtra (EM)	Bhandara, Gondiya, Gadchiroli, Chandrapur
Coastal & Ghats Karnataka (CK)	Uttara Kannada, Udupi, Dakshina Kannada
Inland Eastern Karnataka (IEK)	Shimoga, Chikmagalur, Hassan, Kodagu
Inland Southern Karnataka (ISK)	Tumkur, Kolar, Bangalore, Bangalore (Rural), Mandya, Mysore, Chamarajanagar
Inland Northern Karnataka (INK)	Belgaum, Bagalkot, Bijapur, Gulbarga, Bidar, Raichur, Koppal, Gadag, Dharwad, Haveri, Bellary, Chitradurga, Davanagere
Coastal Andhra Pradesh (CAP)	Srikakulam, Vizianagaram, Visakhapatnam, East Godavari, West Godavari, Krishna, Guntur, Prakasam, Nellore.

¹ The NSSO household consumption data on sorghum is not separated into *kharif* and *rabi* sorghum and hence the sorghum production data for the two seasons has been combined for the purpose of comparison.

Inland Northern Andhra Pradesh (INAP)	Adilabad, Nizamabad, Karimnagar, Medak, Hyderabad, Rangareddi, Mahbubnagar, Nalgonda, Warangal, Khammam
South Western Andhra Pradesh (SWAP)	Kurnool, Anantapur
Inland Southern Andhra Pradesh (ISAP)	Cuddapah, Chittoor

To analyze differences in the consumption pattern across income groups of the NSSO regions of the three states, the NSSO sample was divided into three broad groups of low, middle and high income, based on the distribution of sample households across different expenditure classes².

Results and discussion

Annual consumption trends of sorghum in rural and urban India

All-India

Between 1972-73 and 2004-05, the annual per capita consumption of sorghum at the all-India level has declined sharply by 68% (8.5 to 2.7kg) in urban areas and by 70% (19.1 to 5.2kg) in rural areas of India (Figure 1).

A closer examination of the data reveals that a steep decline in consumption started in 1978 and 1982 and reached a low in 1999-2000. Between then and 2004-05, the latest year for which data are available, the decline has flat lined. A number of factors have contributed to this trend and are discussed in the paper on the availability and utilization of sorghum grain in India by Parthasarathy Rao et al. (2010).

² The classification of households into low, middle and high income is based on distribution of households in each expenditure class. For urban areas, household expenditure (in Rs) is classified according to the following criteria: <580 = low, between 580 and 1880 = middle and > 1880 = high. For rural areas, the criteria are <432 = low, between 432 and 632 = middle and > 632 = high.

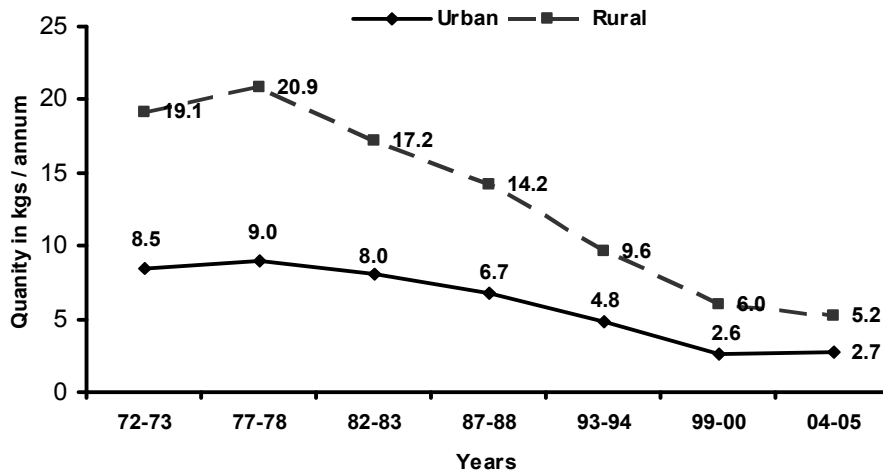


Figure 1. Trends in the annual per capita consumption of sorghum in rural and urban India, 1972 to 2005.

Regional level

Annual consumption of sorghum across different regions of the states of Maharashtra, Karnataka and Andhra Pradesh in rural and urban areas is presented in Table 2. Inland Central Maharashtra (ICM), Inland Northern Karnataka, (INK), Inland Eastern Maharashtra (IEM), Inland Western Maharashtra (IWM), South Western Andhra Pradesh (SWAP) and Inland Northern Andhra Pradesh (INAP) are the major sorghum consuming regions. These seven regions account for nearly 60% of consumption of the total production of the three states. Geographically, they are located in close proximity to each other and hence it is not surprising that the consumption habits exhibit a similar pattern.

Inland Central Maharashtra (ICM), consisting of the districts of Nanded, Hingoli, Parbhani, Jalna, Aurangabad, Beed, Latur and Osmanabad and which comprise the traditional sorghum consuming belt of Maharashtra has the highest per capita annual consumption of 54kg in rural areas and 34kg in urban areas. Similarly, Inland Northern Karnataka (INK) which consists of the districts of Belgaum, Bagalkot, Bijapur, Gulbarga, Bidar, Raichur, Koppal, Gadag, Dharwad, Haveri, Bellary, Chitradurga and Davanagere has per capita per annum sorghum consumption of 50kg in rural areas and 33kg in urban areas.

Apart from cultural practices and the eating habits of these regions, other plausible reasons for such high consumption of sorghum include prevailing climatic conditions. These regions are prone to erratic rainfall and the soils are infertile and fragile. Hence sorghum, which is tolerant to drought and other adverse climatic conditions, is cultivated and forms one of the

main staples for food and feed security. Another reason for high sorghum consumption is that it is thought to keep the body cool during the hot months (anecdotal evidence).

In contrast, coastal regions of these states consume small amounts of sorghum. Rice is largely preferred here, and other typical coastal habits such as fondness for fish, which is easily available, are characteristic of these regions.

Table 2. Annual consumption of sorghum (rural and urban) across regions of Maharashtra, Karnataka and Andhra Pradesh (kg/person).

Region	Rural Consumption Kg/person/annum	Urban Consumption Kg/person/annum
Inland Central Maharashtra (ICM)	54.24	33.01
Inland Northern Karnataka (INM)	49.96	33.98
Inland Eastern Maharashtra (IEM)	45.41	9.89
Inland Western Maharashtra (IWM)	31.76	18.26
Inland Northern Maharashtra (INM)	22.37	8.26
South Western Andhra Pradesh (SWAP)	13.9	8.18
Inland Northern Andhra Pradesh (INAP)	11.04	3.54
Inland Eastern Karnataka (IEK)	4.22	0.51
Eastern Maharashtra (EM)	3.24	0.24
Costal Karnataka (CK)	2.97	2.93
Inland Southern Karnataka (ISK)	0.59	0.52
Costal Andhra Pradesh (CAP)	0.38	0.1
Inland Southern Andhra Pradesh (ISAP)	0.33	8.18

Consumption pattern across income groups

State level

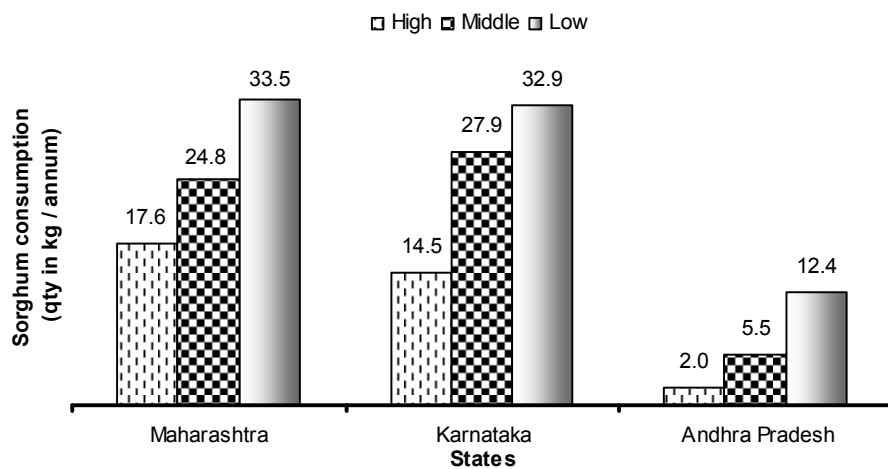


Figure 3. Annual consumption of sorghum (kg) in rural areas of Maharashtra, Karnataka and Andhra Pradesh.

As expected, the average per annum consumption of sorghum across income groups both in rural and urban areas shows an inverse relationship with income. Low income groups in rural areas in all the three states consume larger quantities of sorghum compared to middle and high income groups (Figure 3). In urban areas too, a similar inverse relationship holds except for Andhra Pradesh where consumption levels are low (Figure 4). Urban consumers of all three income groups in Karnataka consume more than twice the quantity of sorghum compared to consumers in urban Maharashtra. As both states are in the traditional sorghum-consuming belt, the reasons for this large variation in consumption within urban areas needs further investigation.

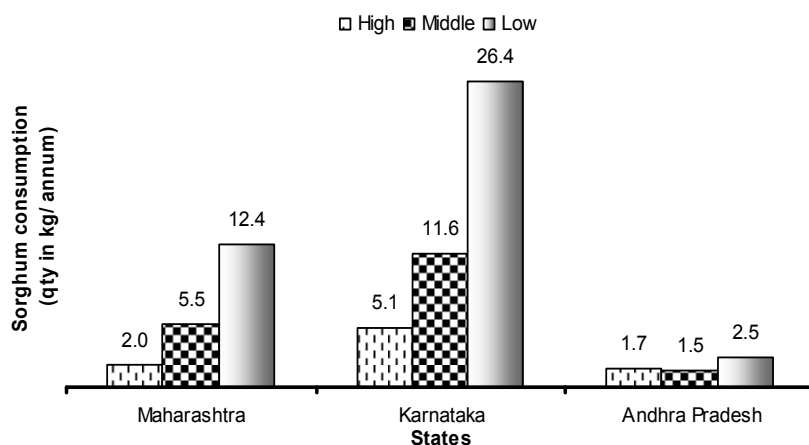


Figure 4. Annual consumption of sorghum (kg) in urban areas of Maharashtra, Karnataka and Andhra Pradesh.

One possibility is that sorghum has penetrated well into the urban areas of Karnataka because of the availability of wide range of ready-to-eat sorghum products which cater to the urban population. In addition to this diversity, people may be more health consciousness owing to surges in medical problems such as diabetes and coronary heart diseases. Field investigations may provide better explanations for the variation in consumption levels across these states, particularly in urban areas.

Regional level

Across the regions of Maharashtra, Karnataka and Andhra Pradesh in rural areas, Inland Central Maharashtra (ICM) has the highest average annual per capita consumption of sorghum by lower income group at 55kg. For urban areas however, Inland Northern Karnataka (INK) has higher levels of sorghum consumption across all regions and income groups (Table 3).

Table 3. Annual consumption of sorghum by region across income groups (2004-05) in rural and urban areas of Maharashtra, Karnataka and Andhra Pradesh (kg/person).

Region	Rural			Urban		
	High (>632) ^a	Middle (432-632) ^a	Low (<432) ^a	High (1880) ^a	Middle (580-1880) ^a	Low (580) ^a
ICM	34 ^b	52	55	12	26	34
IEM	33	29	48	3	8	11
IWM	23	31	32	4	11	21
INM	20	18	23	4	6	9
EM	0	0.1	4	0.0	1	0.2
INK	49	51	44	25	33	37
IEK	1	6	3	0.0	1	0.7
ISK	0	1	1	0.1	1	0.1
INA	12	9	11	4	2	4
SWA	12	12	14	0.0	6	9
ISA	3	0.4	0.2	0.0	0.3	0.3

^aFigures are Indian Rupees

^bkg/person/annum

Higher and middle income groups in rural areas of INK region consume more sorghum compared to lower income groups. Thus, sorghum in INK is consumed irrespective of income groups, i.e. the inverse relationship between consumption and income for sorghum does not

hold good, perhaps because this is the staple of the region. Thus even with an increase in income in rural areas, sorghum is not likely to be considered an inferior food in this region in the medium term. Similarly in ICM, IEM and IWM regions, sorghum is the staple in rural areas as reflected in high levels of per capita consumption across all income groups.

In the urban areas of all regions, lower income groups consume more sorghum than higher income groups. Across all regions of the three states and all income groups, INK has the highest levels of consumption. Some of the possible reasons for higher consumption in urban areas have been alluded to earlier and the matter needs further investigation.

Production patterns of sorghum

State level

Among the major sorghum producing states in India, Maharashtra has the highest production with 47% of all India production, followed by Karnataka (20%) and Andhra Pradesh (9%) (Table 4). Maharashtra produces almost equal proportion of both *kharif* (rainy) and *rabi* (postrainy) sorghum while the states of Karnataka and Andhra Pradesh produce more *rabi* than *kharif* sorghum.

Table 4. Sorghum production (*kharif* and *rabi*) in major sorghum-producing states during 2004-05 ('000 tons).

State	Production (thousands of tons)			State's share of all-India production (%)	State's share of all-India <i>rabi</i> production (%)
	<i>Rabi</i>	<i>Kharif</i>	Total		
Maharashtra	1519	1889	3408	47	53
Karnataka	912	506	1418	20	33
Andhra Pradesh	331	285	615	9	12
All India	2865	4320	7185		

Regional level

Within Maharashtra, Inland Western Maharashtra (IWM) has the highest area under *rabi* sorghum while Inland Central Maharashtra (ICM) has the highest area under *kharif* sorghum (Table 5). *Rabi* sorghum production accounts for 79% of total sorghum production within the IWM region, while it is 48% in the ICM region (Table 6). The two regions (IWM & ICM) together account for 92% of *rabi* and 47% of *kharif* sorghum production in the state.

Price and non-price factors such as resource endowments, climate and consumption patterns of the regions, besides relative profitability explain the wide variation in cropping patterns across regions within a state. Inland Central Maharashtra (ICM), which consists of the districts of Nanded, Hingoli, Parbhani, Jalna, Aurangabad, Beed, Latur and Osmanabad are predominantly rainfed parts of the state and hence both *rabi* and *kharif* sorghum are cultivated there, the latter being in demand from industrial users for poultry, livestock feed and alcohol. Inland Western Maharashtra (IWM) consists of the districts of Pune, Ahmadnagar, Solapur, Satara, Kolhapur and Sangli and is endowed with better resources. As this is predominately a sorghum-consuming region it consequently has a larger proportion of cultivation under *rabi*. Similarly, Inland Northern region of Karnataka (INK) and Inland Northern region of Andhra Pradesh (INAP) have large proportions of area under *rabi* sorghum. Because of the geographical proximity of the regions of IWM, ICM, INK and INAP, cropping and consumption patterns are similar.

Table 5. Area occupied by region in major sorghum producing states of India, 2004-05 ('000 hectares).

Region	<i>Kharif</i> area	Share of <i>kharif</i> to total regional area (%)	<i>Rabi</i> area	Share of <i>rabi</i> to total regional area (%)	Total area
IWM	164	8	1864	92	2028
ICM	636	36	1111	64	1747
IEM	520	95	28	5	549
CM	0	0	0	0	0
EM	11	26	31	73	43
INM	200	71	80	29	281
CK	0	97	0	3	0
IEK	8	46	9	54	17
ISK	47	97	1	3	48
INK	295	19	1230	81	1526
CAP	9	35	16	64	25
INAP	181	49	188	51	370
SWAP	24	19	103	81	127
ISAP	6	54	4	40	10

Table 6. Production by region of sorghum in major producing states of India, 2004-05 ('000 tons).

Region	<i>Kharif</i> production	<i>Rabi</i> production	<i>Kharif</i> share to total regional production (%)	<i>Rabi</i> share to total regional production (%)	Total production
IWM	204	764	21	79	968
ICM	696	638	52	48	1334
IEM	631	15	98	2	646
CM	0	0	0	0	0
EM	12	11	51	49	24
INM	346	91	79	21	437
CK	0	0	0	0	0
IEK	8	6	57	43	15
ISK	53	1	98	2	54
INK	444	905	33	67	1350
CAP	17	32	34	66	50
INAP	178	141	56	44	320
SWAP	85	155	36	64	240
ISAP	5	3	63	37	8

Sorghum supply and demand

State level

In all three of the major sorghum producing and consuming states, there is surplus production over household consumption. During 2004-05, Karnataka had the highest consumption to production ratio of 83% followed by Andhra Pradesh and Maharashtra (Table 7). Between 1999-2000 and 2004-05 the surplus of production over consumption decreased by 16% in Maharashtra and by 5% in Andhra Pradesh while in Karnataka there was a marginal increase of 3% (Table 8). However, there was a decline in consumption of sorghum between 1999-2000 to 2004-05 in Maharashtra and Karnataka. Thus, the overall increase in consumption to production ratio from 1999-2000 to 2004-2005 is due to falls in production in Maharashtra and Karnataka by 27% and 20%, respectively (Table 8).

Table 7. Annual production and consumption of sorghum across the states of Maharashtra, Karnataka and Andhra Pradesh in 2004-05 ('000 tons).

State	Maharashtra	Karnataka	Andhra Pradesh
Production	3408	1419	615
Household consumption	2245	1181	399
Surplus over household consumption	1163	238	216
Household consumption to production (%)	66	83	65
Surplus production (%)	34	17	35

Table 8. Differences in annual production and consumption of sorghum in the states of Maharashtra, Karnataka and Andhra Pradesh between 1999-2000 and 2004-05 ('000 tons).

Supply/demand	Maharashtra		Karnataka		Andhra Pradesh	
	1999-2000	2004-05	1999-00	2004-05	1999-2000	2004-05
Production	4693	3408	1791	1419	535	615
Household consumption	2645	2245	1538	1181	324	399
Surplus over household consumption	2048	1163	253	238	211	216
Household consumption as percentage of production (56	66	86	83	60	65
Surplus production (%)	44	34	14	17	40	35

As indicated earlier, separate data for consumption of *rabi* and *kharif* sorghum were not available. However, based on field observations and literature we find that *kharif* production of sorghum is generally from hybrids and is susceptible to grain mold. Consequently, the produce is of poor quality and less preferred for human consumption (Parthasarathy Rao et al. 2004). The best quality *kharif* grain is mainly consumed by low income consumers because of its lower price than that of *rabi* sorghum, wheat and other grains. On the other hand, 90% of the production of *rabi* sorghum is used for human consumption and a small proportion goes to the processed food sector (field observations; Dayakar et al. 2010). Hence, the surplus production in all the three states available after meeting the consumption demand is mainly *kharif* sorghum, *Kharif* sorghum tends to be used more as feed ingredient in the poultry and

livestock industries and as raw material for the alcohol industry and is traded across regions and states in India to meet these demands (Kleih et al. 2000; Marshland & Parthasarathy Rao 1999).

Surpluses of *rabi* sorghum are reflected in inter-state and inter-regional trade from surplus to deficit regions, mainly to meet food demand for household consumption and sorghum *rotis* in restaurants. *Rabi* sorghum is also traded for seed purposes and mainly used to grow the plant as a fodder crop in neighboring states such as Gujarat.

The majority of the restaurants in the Marathwada region and southern parts of Maharashtra and northern Karnataka include sorghum *rotis* on their menus. They are also obtainable in a few other big cities in these states where they are promoted as a novel delicacy. Hence *rabi* sorghum requirement by hotels and restaurants has been increasing over time; however, this demand has not been captured by NSSO data and it needs to be made clear that a portion of the surplus production, particularly *rabi* sorghum, would be accounted for by this sector. The fact that food consumed outside the home is not included or allowed for has been a major shortcoming of household consumption data collected by NSSO.

Regional level

As with the state level picture, there is surplus production over consumption in most of the sorghum growing regions. However, if household consumption needs are accounted only from *rabi* sorghum production in most of the regions would fall short of meeting the demand (Table 9). This shortfall is presently met from *kharif* sorghum of good quality. Increasing production of *rabi* sorghum through productivity or increasing the area sown to the crop would bring down the price of *rabi* sorghum and make it affordable for low income consumers.

Table 9. Production and consumption of sorghum by region in major sorghum-growing states ('000 tons).

Region	Production	Consumption	Surplus (%) (total sorghum)	Rabi Production	Surplus/Deficit - (rabi sorghum production only)
ICM	1334	807	527	638	-169
IWM	968	692	276	764	71
IEM	646	509	137	15	-493
INM	437	218	219	91	-127
EM	24	15	9	11	-3
CM	0	4	-4	0	-4
INK	1349	1140	209	905	-235
ISK	54	11	43	1	-10
IEK	16	17	-2	6	-11
CK	0.37	13	-13	0	-13
INAP	320	280	40	141	-139
SWAP	240	94	146	155	60
CAP	49	10	39	32	22-
ISAP	8	14	-6	3	-12

Conclusion

Regional level disaggregation of sorghum consumption in important producing and consuming states has shown that sorghum is still important in the consumption basket particularly in rural central, eastern and western Maharashtra and northern Karnataka regions. This is further corroborated by household consumption data analyzed at the state level that indicates sorghum is still able to compete with rice and wheat in Maharashtra and with wheat in Karnataka.

A further disaggregation of the data by income groups has shown that in sorghum-growing and consuming regions, sorghum is consumed by all income groups but more so by lower income consumers. In the urban areas of Inland Northern Karnataka (INK) region, consumption of sorghum by the high income group is unexpectedly more than that of their peers in the low income group. Most of this consumption can be attributed to *rabi* sorghum. Hence, the evidence suggests that in sorghum growing regions where sorghum forms a staple food, purchasing power determines the consumption habits as *rabi* sorghum prices are 1.5 to 2 times higher than those of *kharif* sorghum. The evidence also suggests that even with

increase in income in the medium term, sorghum as a food is not going to be seen as an inferior dietary component in these regions.

The higher consumption of sorghum in urban regions by higher income groups in the INK region of Karnataka shows better penetration of sorghum value-added products such as, for example, *dry rotis, dosa, vermicelli* and, *upma*. Availability of such diversified products acts as one of the factors that drives home consumption. Field level findings suggests that there is scope to arrest the declining demand for sorghum in urban centers by promoting value-added and ready-to-eat products as they are much in demand in hotels and restaurants. Though consumers are aware of the health benefits of sorghum in their diets, lack of availability of processed products comparable to those available for wheat has contributed to the decline in consumption of sorghum. Hence, keeping in view of the potential benefits of sorghum, research efforts should be focused on release of varieties to cater to the demand from the processing sector as this should result in better value-added products which would meet the demand of the growing urban population.

There is surplus production of sorghum available from most of the regions of the producing states but most of this is *kharif* production which is used for industrial processes and only about 40-45 % is used as food. *Rabi* sorghum is traded for food use to the non-producing regions in these states.

As sorghum is still a staple, and an important commodity for food consumption in Maharashtra, Karnataka and Andhra Pradesh, efforts should be made at the policymaking level to include sorghum in the Public Distribution System (PDS) in these states³. This would, in the long run, help both the producers and consumers. It would provide incentives for producers to grow sorghum and would make the product available more cheaply. Research efforts, particularly for *rabi* sorghum, should be in the direction of increased productivity, in order to make the crop affordable for the poorer sections of communities.

³ Alternatively food stamps could be issued enabling consumers to buy the grain of their choice.

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