Resurgence of sorghum foods in urban areas and alternate uses of sorghum grain

Ravinder Reddy Ch, Vilas A Tonapi, Ashok S Alur, Belum VS Reddy, CLL Gowda, P Parthasarathy Rao and KN Rai

Background

Sorghum (Sorghum bicolor), maize (*Zea mays*), pearl millet (*pennisetum glaucum*) and other millets are classified as coarse grain cereals, perhaps because of their hard grain texture. While sorghum and pearl millet are important staple food grains in Asia and Africa, they are used as the main component in feed formulations in other parts of the world. Grown generally in non-irrigated and rainfed lands, with very little agricultural inputs as compared to wheat (*Triticum aestivum*) and rice (*Oryza sativa*), they are important for food security in Asia and Africa

Both sorghum and pearl millet complement well with lysine-rich vegetable (Leguminous) and animal proteins and form nutritionally balanced composite foods of high biological value. Carbohydrates of sorghum and pearl millet comprise a large proportion of starch (65-70%) and a good amount (16-20%) of non-starchy polysaccharides (NSP). The NSP, which constitute nearly 95% of the dietary fiber of the grain, are derived not only from bran but also from the endosperm cell walls. There are no reports of any adverse effects of regular consumption of sorghum and millet, especially in the Indian subcontinent. On the other hand, incidence of diabetes mellitus and gastro- intestinal disorders are minimal among the population using these grains as staple food.

Although sorghum and pearl millet are nutritious and staple foods for millions in the under-privileged section of the society, their increased utilization and diversification is impeded by problems mostly related to milling and storage characteristics . These grains are known for their high (3-7%) fat content; the kernel, bran and germ contain a major portion of the lipid material .

Various foods from sorghum and pearl millet are traditionally prepared and consumed over centuries in the Indian subcontinent, Africa and in Central America. Majority of them are made from flour, either from the whole grain or partially decorticated grains. These include unleavened pancakes from fermented or

unfermented dough, stiff or thin porridges, snack foods, deep-fried products, sweet or sour opaque beer, non-alcoholic beverages and boiled (as for rice) decorticated grains Table 1 gives the list of these foods with specific names prevalent in the countries where they are normally consumed

Sorghum (*Jonna* (Telugu), *Jowar* (Hindi), *Jowar* (Marathi), *Jola* (Kannada), *Cholam* (Tamil and Malayalam) is commonly called as a camel among crops because of the low moisture environment and marginal lands on which it is grown with insignificant amount of farm inputs. Incidentally, it is also known as a poor man's crop because of non-exclusivity of its culture and use by the common working people. Sorghum is traditionally consumed as food in the form of *roti*, *sankatti* and *porridge* type preparations. In India, this crop is predominantly grown in the states of Maharashtra, Karnataka, Andhra Pradesh, Gujarat, Rajasthan, and Madhya Pradesh.

Table 1. Traditional foods made from sorghum and pearl millet.

Type of food	Common names	Countries/ Region
Sorghum/pearl millet		
Unfermented	Roti	India
pancake		
Thick (Stiff) Porridge	Ugali, tuwo, saino,dalaki, aceda, atap, Bogobe, ting, tutu, kalo, karo , kwon , Nshimba, nuchu, to tuo, zaafi, asidah, Mato, sadza, sankati	Africa, India , Central America
Thin porridge	Uji, ambali, edi eko, kamo nasha bwa, kal, obushera, ogi, oko, akamu, kafa, koko, akasa	Africa, India, Central America
Steamed cooked Products	Couscous, degue	West Africa
Snack foods	Popped, sandige, papad, chakli	India
Sorghum		
Nixtamalized Pancake	Tortilla	Mexico, Central America
Boiled rice-like Foods	Annam, acha	Africa, India, China, Mexico
Sweet/sour opaque beers	Burukutu, dolo, pito, talla	West Africa
Sour opaque beers	Marisa, bussaa,merissa,urwage, mwenge, Munkoyo, utshwala utywala, ikigage	Sudan, South Africa, India
Non- alcoholic beverages	Mehewu, amaheu, marewa,magou, letting,abrey,husawa	Cameronnn, south Africa, Sudan, Uganda, Zambia, parts

		of Tanzania.
1.Nixtamalization is an Aztec word that refers to the cooking of maize and sorghum in lime solution or leachate of wood ash. The resulting product is called masa, which is pressed into circles and cooked into flat unleavened breads. It originated in southern part of North America. This process increases the bioavailability of calcium and niacin. Source: CFC Technical paper no.34, 2003		

Of late, sorghum has garnered a great deal of acceptance in the form of unleavened bread (*roti, bhakri*) - a nutritious ready-to-eat food amongst all classes of the society. In fact it is slightly tricky to master the preparation of *jowar roti* than the *rotis* prepared with wheat and *maida* flour. This is mainly because of absence of gluten (responsible for stickiness in wheat derived flours). But this is a blessing in disguise for sorghum eaters, as gluten is hard to digest and significant proportion of people around the globe have gluten allergy. Hence sorghum *roti* is not hard to digest like gluten based preparations.

Presently, the commercial segment of *roti* is with wheat and *maida* flour. Our surveys on various food outlets serving *jowar roti* and the *roti* eaters across cross section of the society has indicated significant shift from wheat *roti* consumption towards eating *jowar roti*. The shift in demand is steadily increasing towards the commercially available ready-made and ready-to-eat *jowar rotis*. There seems to be a ready acceptance from all the group of people: youngsters consume it as a novel dish and middle-aged and oldies people as health food as it is very good for people suffering from diabetes. Jowar consumption in any form is good for health and highly advised to the diabetics due to the fact that it has high amount of fiber and has low digestibility character. It means that it gets digested slowly and thus releasing slow and intermittent sugar in the energy stream as needed in diabetics.

The concept of commercializing *jowar rotis* through local market was initiated by M/s. Nandi Group from Nandyal in Andhra Pradesh. The vision was to provide food to the needy and economically challenged group at a very reasonable rate (*jowar rotis* for Rs. 1/- each and Rs.1/- for *dal)* whereby a common man can have his meal and at the same time is fully nourishing too.

This concept has sown the seed of commercialization in preparation and supply of *jowar rotis* with big hoteliers, who conceived the basic idea of making and supplying *jowar rotis* in bulk at much cheaper rates than the *rotis* made from wheat and *maida*. Now, there are 3 – 4 main distributors in the Hyderabad city and are doing a brisk business on commercial scale by employing experienced "*roti* makers" from adjoining places like Bidar, Sedam Udgir and other places. One wholesale dealer confessed the fact that he is having a regular *jowar roti* supply order to almost 15 hotels around the city. He uses around 20 t of *jowar* flour a month. The preferred variety is white *jowar* from Sedam, Bijapur, Barshi; yellow *jowar* from Tandur (called as Tandur local). In the early stages, the entrepreneur would supply the *jowar rotis* to outlets cheaper rates and had to offer buy back facility. These had caught the attention of many hotliers and have started selling *jowar rotis* without any financial

risk at the moment. Now most of the retail outlets are making brisk business without leaving any *rotis* on the shelf as a carry over stuff. Today, even 5- Star hotels are happy to include *jowar roti* in their menu because of the demand among the young and older generation alike.

SORGHUM CONSUMPTION: PRESENT SCENARIO

The consumption of nutritious cereals is fast declining. However, still they are the most preferred cereals in the areas where cultivation of cereals are done. Most of the cereals are rich source of several nutrients. Policy option like inclusion of coarse cereals in Public Distribution System, subsidies to the cultivation of cereals, value-addition through processing, etc., would ensure that these cereals to provide enhanced food and nutritional security to millions of poor on sustainable basis.

Concerned research is under way to explore alternative uses of sorghum in bakery items (bread, cake and biscuits), malt, glucose, natural syrup (honey), jaggery, etc. Efforts are also made to explore new germplasm whereby the storability of the ready to eat foods prepared from sorghum can be stored for longer periods. If a breakthrough is made in this direction, sorghum will certainly become one of the main staple foods because of its high nutritive value and other added advantages such as poor digestibility.

Farmers also prefer growing sorghum because this crop provides highly nutritive food and good quantity and quality fodder for cattle when compared to other cereals. The importance of fodder for livestock particularly during drought increases manifold. During drought, it will help in generating employment in low rainfall areas where crop alternatives are limited and an assured source of income as a buffer at times of distress.

WHY SORGHUM AND MINOR MILLETS ARE HEALTH FOODS?

The nutritious cereals are represented by sorghum, pearl millet, finger millet, maize and minor millets. They are excellent source of nutrients to the millions of economically challenged society in India, and these cereals have become synonymous with health and nutrition.

However, malnutrition and under-nutrition are evident not only in the lowest bracket of the society, but in every class of the society. The main reason for this is the shifting of consumption pattern from a balanced diet to inadequate and faulty diets, The widespread prevalence of nutritional deficiencies such as protein energy malnutrition, vitamin-A deficiency, iron-deficiency, anemia and iodine-deficiency (referred to as big four problems) are prevalent among children and women of all class of the society. The idea of inclusion of less expensive nutritious cereals in the food basket will greatly help in averting severe chronic disabilities in future.

Sorghum has a starch content of 65-70 %. The protein content of sorghum is comparable with that of wheat. It is rich in iron and phosphorous and high in ash content. The whole grains are rich in vitamin B-complex while deficient in vitamin A and vitamin-C and contains 3% crude fat which is higher than in rice and wheat. Lysine is an important amino acid (71 to 212 mg per gm of nitrogen), while rice lacks

it. Sorghum is a rich source of vitamin B-complex especially niacin (vitamin B6), thiamin and riboflavin. Sorghum contains 7.6 to 9.2 % of dietary fiber along with slow digestibility good for diabetics. Many chronic nutritional disorders like anemia (iron deficiency), vitamin B-complex deficiency like stomatitis, glossitis and cheilosis (riboflavin deficiency) and pellagra (nicotinic acid deficiency) can be effectively tackled with the consumption of food grains like sorghum and millet. Sorghum (3490 k.cal per kg) and pearl millet (3610 k.cal per kg) are better energy suppliers than rice (3450 k.cal per kg) and wheat (3460 k.cal per kg). In fact, sorghum acts as a health food due to its slow digestibility and is most useful for diabetic patients. Preparations from sorghum are useful for people suffering from hyper acidity.

However, there are some hurdles for widespread of marketing of sorghum *rotis*. Most of the *urban peasants* are in the habit of eating *rotis* made by the dough of wheat or *maida* which are softer when compared with that of sorghum. So, most of the bulk sorghum *roti* marketers are making sincere efforts to see that the sorghum *rotis* are lighter and softer and they are successful with traditional white and yellow sorghums. The present shelf life of the rotis prepared from sorghum are of two types 1) The rotis which are prepared for fresh and immediate consumption are not over baked and are smooth and soft which can be stored for two to three days without any deterioration.2) Secondly the rotis can be over baked till they are completely dry and brittle so that it enhances the keeping period and quality for a long time .Such of the rotis can be stored for more than 30 days without any deterioration in quality and taste when compared to that of wheat rotis.This method is usually followed when the rotis are prepared for big functions such as marriages. Last but not the least, preparation of making *jowar rotis* is not easy.

A large scale awareness campaign about the nutritive value of the trendy *jowar roti* should be taken to inform the general public about the nutritional value of sorghum over other fine cereals. The barrier of low social status attached to the consumption of nutritious cereals should be removed by terming them as “health foods”. The sorghum rotis may be used extensively for mid-day meals programme of schools sponsored by various state governments. New recipes of sorghum are also in the offing but need to be popularized.

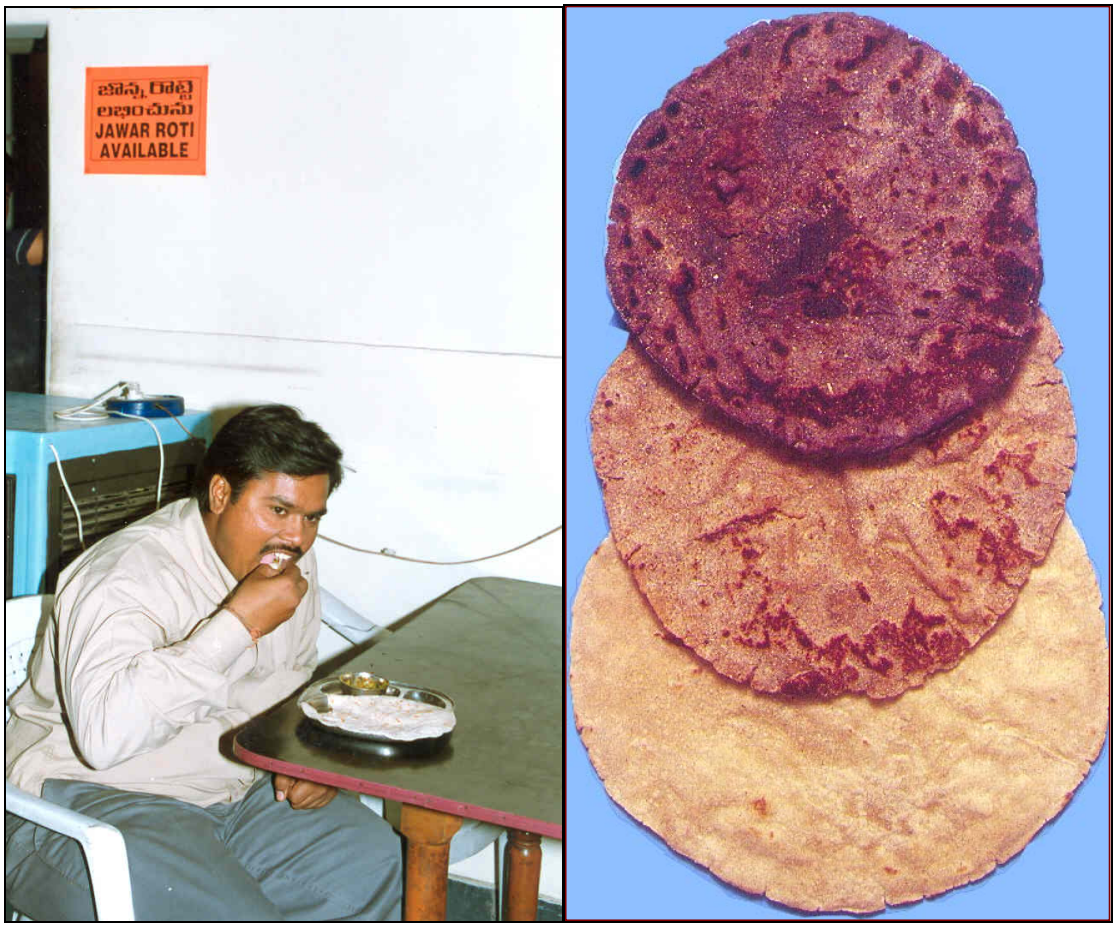

Fig 1. A customer relishing the jowar roti in a hotel; Rotis prepared from red, yellow and white sorghums

Fig 2. View of one of the hotels among hundreds displaying the availability of Jowar Roti

Alternate uses of sorghum grain

With rise in production of good quality rabi sorghum, there is a decreasing demand for the Kharif (rainy season) grain is anticipated from food sector. However, Kharif grain by virtue of its low price may remain as a more accessible staple food for the economically weaker group and an alternative on feed and industrial uses. It is expected that any further decline in Kharif area may get stabilised around little over 3-4 m ha and its production, depending on demand, but could rise up to 5-8 m t by 2020 AD (projections based on current trend basis and alternatively existing area continuation basis). Demand of sorghum in feed and industrial sectors is largely decided by its relative cost advantage over maize as well as shortfall in the production of the latter. While the minimum support price(MSP) of sorghum is usually less than that of maize .

There is scope to enhance this price advantage of kharif sorghum through productive optimisation of yield at increased cost efficiency and value addition.

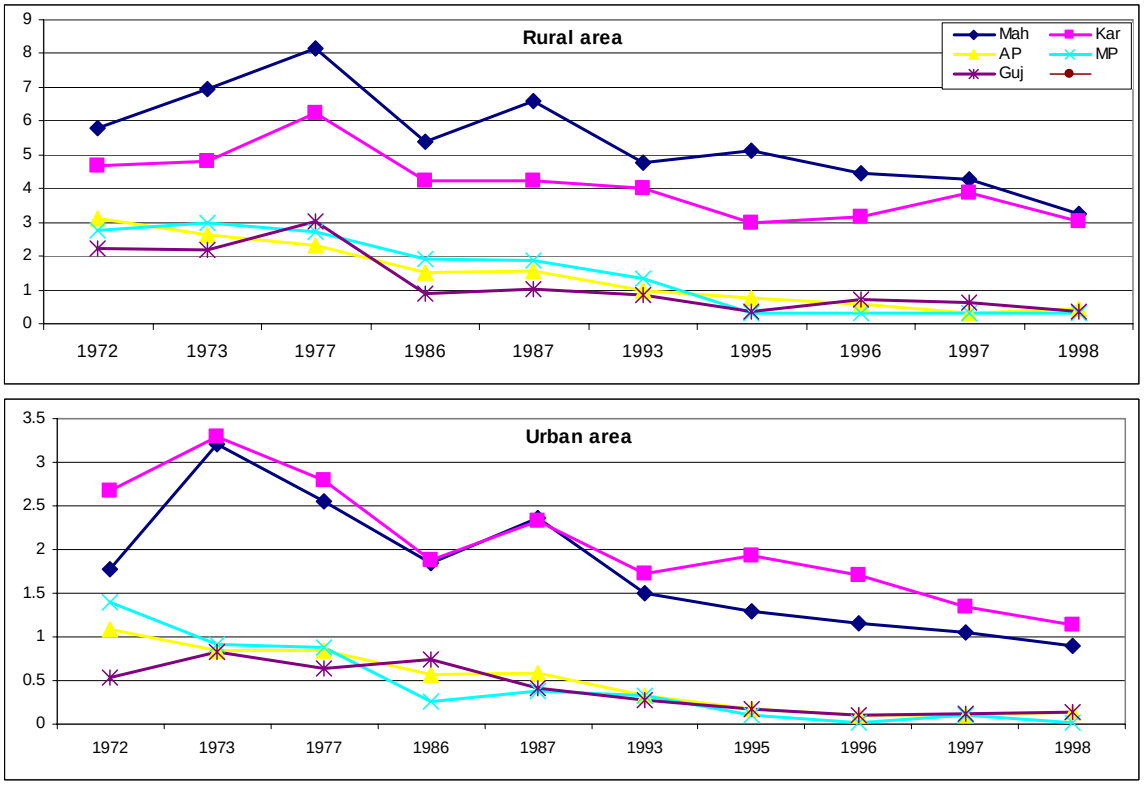

Fig. 3: State-wise per capita consumption of sorghum in rural and urban areas

The current utilization of Kharif sorghum grain as a raw material in various industries and its future prospects given the limited prospects of rainy season (Kharif) sorghum for human consumption was computed based on industrial survey that has been carried out in the states of AP, Madhya Pradesh, Gujarat, Rajasthan, Delhi, Maharashtra and Tamil Nadu during 2002-2003 (NRCS, 2005) (fig 3). According to main industries currently using sorghum in India are the poultry feed, animal feed and alcohol distilleries while its usage is quite sporadic in starch industry. At present poultry feed sector using approximately 1.3 m t, animal feed sector about 0.45 million tones followed by alcohol distillers about 0.092 million tones of sorghum. Poultry feed sector largely depends on maize which constitute 30-35% of poultry ration.

Sorghum is used when maize is in short supply and priced higher than sorghum. Sorghum is used when prices are 20% lower than that of maize. The estimation for the future demand shows that poultry feed industry is going to be the major industry which will absorb huge quantity of sorghum (2.7-3.1 m t), followed by dairy feed industry (0.6 m t) in 2010 A.D.

Poultry industry:

The demand for sorghum and pearl millet in poultry feed largely depends on price and availability of maize. Inclusion of sorghum up to 10% for layers and 15% for broilers in poultry ration is a common practice with commercial poultry farmers**.** The rainy season sorghum can replace the maize in poultry feed to a great extent because of its low price compared to maize (lower by 7 to 37%). At present with the inclusion rate of 12-15% in the poultry feed ration, about 1.3 m t of sorghum is required by the poultry industry. It is believed that with the better qualities of sorghum and improved information dissemination, the inclusion of sorghum in poultry feed may be increased to the tune of 25% and hence the increase in sorghum demand.

Dairy industry:

With the average consumption of 200-250 grams of grain per day per dairy animal, approximately four million tons of dairy feed is required and the same was produced by commercial sector during 1998-99. Based on the prevailing trend and at an average inclusion rate of 10%, about 0.6 million tons of sorghum is required, to produce around 6.04 million tons of dairy feed by 2010 AD. Some poultry co-operatives in Gujarat were using sorghum grain up to 20%.

Alcohol industry

Potable alcohol: Molded sorghum grain is being used in the production of potable alcohol. Quality of this alcohol is good and hence may find ready foreign market for blending purpose compared to that produced from sugarcane molasses which is not preferred for potable alcohol in developed countries. Some of the sorghum cultivars are closer to barley in their ability to produce malt. This property offers potential for breeding high yielding cultivars for malting. Sorghum malt is cheaper than barley malt and would be acceptable for lager beer brewing and production of malt syrup, baby food and non-alcoholic beverages. There are about 295 alcohol distilleries in India with installed capacity of 3198 m litres of alcohol. Nearly 52% of total alcohol production is used for potable purpose (Indian Manufactured Foreign Liquor-IMFL) and remaining 48% is used for industrial purpose.

The decision of Government of India to blend ethanol with petrol will tremendously increase the requirement of anhydrous alcohol in the near future and keeping this in view, potentiality of sorghum as a raw material for alcohol production can be greatly exploited. If the government policies on grain based alcohol production become more favorable, there is a possibility of expected growth beyond 10% in case of potable alcohol, as a result of which the demand for raw material (sorghum grains) will be around 0.25 to 0.35 m t by 2010 AD.

Starch industry:

Demand for industrial starch and starch bye-products is continuously rising (Table 2). Currently preferred raw materials are maize and cassava. Content and quality of starch are similar in sorghum and maize. Advantage of maize is its grain size, high extraction and return from bye-products like corn oil and residue. Specifically bred sorghum cultivars with larger grain size and starch extractability can promote the prospect of sorghum as a competitive raw material in this industry.

Table 2. Production of starch based derivatives (in metric tones)

Year	Starch	Liquid glucose	Dextrose Monohydrate	Analysis Dextrose	Sorbital
1983	135,001	43,683	13,992	2,091	4,300
1984	142,000	55,000	27,000	4,400	11,000
1985	145,000	57,589	26,500	4,500	11,900
1986	147,000	58,000	27,500	4,600	12,250
1987	150,000	52,500	25,500	4,400	-
1988	157,500	52,760	26,827	4,700	-
2005P	250,000	90,000	30,000	6,000	24,000
Av. growth rate (%)	3.3	4.2	18.3	1.7	61.6

P- projected figure *Source : CMIE, Mumbai*

Thus, the demand for sorghum for various industrial sectors is depicted in Table 2. The revised demand by industries for sorghum shows that poultry feed industry (especially layer feed) is going to the major buyer which will absorb huge quantity of sorghum followed by dairy feed industry. It also shows that alcohol industry too will place a fair demand for sorghum. But the starch industry may reduce its demand in the future.

Table 3 . Summary of industrial demand for sorghum in India('000 tonnes)

Industry	Estimates[3]	
	2001-2002	*Projected for 2010*
Poultry feed (Total)	1078^{+}-1270^{++}	2668^{+}-3085^{++}
Broilers	240	840
Layers	768-960	1668-2085
Others (grower & parent stock)	70	160
Diary feed	440-450	600
Alcohol	92	216
Exports	11	-
Total	1621-1823	3484-3901

Note:
1. The poultry and starch industries use sorghum only when maize is expensive or not readily available; 2. Figures are projections;
3. Figures are the estimates based on industrial survey conducted as a part of RNPS-6 NATP projects.

Figures reflect the average sorghum utilization during 2002 based on inclusion rates and current requirement of raw material. The starch industry figures are not readily available. The annual growth rates considered for the projection are 8% in layer; 15% in broiler; 5% grower and parent stock, 3.5% in dairy and 10% in alcohol industry. Sorghum inclusion rate in feed considered for the estimation are 12%+ to 15%++ in layer; 10% in broiler; 5% in grower and parent stock; 10% in dairy.

Feed industry: Poultry feed industry in the country is progressing well. Several independent feeding trials conducted on layer and broiler birds could conclusively demonstrate that sorghum is as good as maize (Table 3) although, the latter is marginally superior in total energy value. Sorghum based feed in layer birds has to be supplemented with carotene to ensure yellow colour to egg yolk. With the current price advantage over maize, sorghum is used more and more in poultry feed.

Table 4 . Production of animal and poultry feed (In lakh metric tonnes)

Year	Total feed	Poultry feed	Share of sorghum in feed **
1983	10.13	3.49	7.5
1984	11.57	4.07	7.5
1985	13.7	5.03	5.03
1986	14.92	5.67	6.5
1987	17.29	6.09	6
1988	18.25	7.09	10
1989	19.23	7.73	10
1990	21.61	8.34	-
1991	24.18	9.43	-
1992	22.6	8.06	-
1993	22.47	8.77	-
2005*	47	19.7	17.4

** Projected on the basis of CARG % . Grains constitute 40-50 % of the feed produced in the organized sector.*

*** FS & D view, Economic Research Service. USDA (1991);* Source: CMIE, Mumbai

Malt: Another potential area could be the use of sorghum malt and as an adjunct in brewing industry. Malted sorghum is used for brewing beer in Ghana and Nigeria(fig 4). Sorghum's comparative advantage would be its low output price, especially in production regions of rainy sorghum in India over that of existing raw material.

Fig 4. sorghum beer and potable alcohol

Sorghum for bio-energy harvest (bio-fuel production)

Sweet stalked and high energy sorghum has the potential to emerge as a major bio-energy crop for production of industrial alcohol (ethanol), and even electricity. While the national trials on sweet sorghum had shown its potential productivity as 50-60 t stalk and 2-3 t grain/ha in 125-130 days, reports from China indicate a far high productivity to the tune of 90 t stalk and 6 t grain/ha from the crop in 140-150 days. This productivity potential places the crop at an undoubtedly advantage over sugarcane or molasses at their ruling prices for ethanol production. As a bio-energy crop sweet sorghum is more efficient than sugarcane because of its high productivity with relatively low levels of fertilisation and irrigation.

A future policy to blend ethanol to gasoline at 10-20% proportion may create enormous demand for alcohol which could not be met from the indigenous molasses production. Sweet sorghum, in this context, could be effectively exploited as an energy crop. The economic benefit to the nation is saving of more than 10% of the annual fossil fuel import bill. This would grow into a huge saving when the energy use raises many-fold with economic growth from its current low per capita use. A part of the Kharif area having most favourable soil and rainfall could be appropriate region for growing sweet or high energy sorghum. The grain of value added high energy sorghum could become a most competitive source for feed or industrial uses.

Foods

Production of jaggery and brown or colourless syrup or high fructose syrup are other opportunities from sweet sorghum (fig 5). These diversifications could be done at village or farm level as small scale enterprises. These agri-businesses possible from sweet sorghum may bring in increased employment and economic growth in the traditionally poor sorghum growing region. Common bakery products such as bread, cakes and biscuits were prepared by finely ground sorghum flour to the consistency of fine wheat flour (maida) was prepared from pearled rainy season sorghum grain using 300 u m sieve. This flour in combination with maida was used for the preparation of various bakery products like bread, cakes and biscuits (fig 6).

Fig 5. Syrup and jaggery from sweet sorghum

Fig 6. sorghum bakery products-bread, cake and biscuits