Study of Farmers Preference for different Varieties, Production and Consumption trends and Export Competitiveness of Sorghum in SAT India

Report Submitted to

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)

By

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DECLARATION

I do hereby declare that the dissertation entitled upon **"Study of Farmers' Preference for Different Varieties, Production and Consumption Trends and Export Competitiveness of Sorghum in SAT India"** is an original and independent record of project work undertaken by me under the supervision of **Dr. N. Nagaraj (Principal Scientist) at Markets, Institution and Policies, International Crop Research Institute for Semi Arid Tropics (ICRISAT), Patencheru, India**, during the period of my study as part of curriculum of Master in Agri Business Economics at Gokhale Institute of Politics and Economics, Pune.

HYDERABAD By,

Date: 12th July , 2013 **Writi Bagchi**

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Abstract

Title	**:**	**Study of Farmers' Preference for Different Varieties, Production and Consumption Trends and Export Competitiveness of Sorghum in SAT India**
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Abstract

The alarming trends in production and consumption of sorghum have been studied and the factors affecting the trends have been tried to be addressed. Participation of both public and private sector is needed for the improvement of the production and consumption of sorghum. In this respect the adoption pattern of improved varieties by the farmers has been studied. A sample of 5 farmers was selected and their preferences, constraints in adoption and the rate of adoption were listed and ranked and accordingly the problems have been tried to be addressed in the end.

Also an endeavour has been made to study the alternative uses of sorghum which are slowly but steadily gaining popularity among the consumers as they are increasingly getting aware of the lifestyle-related disorders and sorghum's ability to deal with them. The private sector is also taking a deep interest in the processing of sorghum products. Their cost-to-returns ratio has been calculated to find out the viability of sorghum as a processed good. Also the export competitiveness of the crop has been calculated to analyse the potential of sorghum as an export commodity

These studies were conducted at International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India.

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1. INTRODUCTION

In India, more than 60% of the area is cultivated in arid and semi-arid regions which are characterised by long dry seasons, inadequate rainfall which again turns out to be quite unpredictable and also the infertility of the soil is another major problem. Owing to the climatic conditions and the infertile soil there is pretty much less choice in the type of crop that can be grown there. Hence the wise choice generally is to grow hardy crops like Sorghum, Pearl Millets, Chickpea, Guar etc which can survive the adverse agro climatic conditions. Thus these crops occupy a place of importance in the farming systems of the arid and semi-arid regions and also form the staple diet of a majority of the poor consumers. Rainfall there is as low as 600mm with frequent dry spells coupled with recurrent droughts. The farmers in these regions are exposed to such harsh agro-climatic conditions thus facing a lot of problems as their cropping choice gets quite restricted owing to the moisture stress, saline and dry soils and lack of irrigation and hardly any efficient use of the available moisture level. (Nagaraj et al, 2012).

Adaptation to poor habitats, poor resource base and production and consumption by the poorer sections of the society has made sorghum crop an indispensable component of dryland agriculture. It is a drought hardy crop, can withstand water-logging and thus excels over maize; it is also ecologically sound and environment friendly demanding little pesticide use for crop management. Notwithstanding the moderate contribution of sorghum to the national food basket, this crop offers enormous advantages such as early maturity, wide adaptation, ease of cultivation and good nutritive value of both grain and fodder with the green revolution and availability of fine cereals in remote places, proper disposition by value addition and establishing food, feed, beverages, sugars and alcohol industries will not only generate employment potential but also improve the regional economy. Sorghum is a valuable food grain for many of the world's most food insecure people. Much of Africa and India is characterized by semi-arid tropical climatic conditions. Sorghum is undoubtedly and uniquely adapted in the Afro-Asian regions. Sorghum in Africa and Asia is processed into a very wide variety of nutritive food products. Documentation, standardization, popularization and commercial exploitation of traditional products need attention. A large number of accessions are available. Continuing focused fundamental and applied research is essential to unleash sorghum's capacity to be the cornerstone in food, feed, fuel and fibre sectors in Afro-Asian countries. The future for sweet sorghum or high energy sorghum is also bright. Combined

efforts of research institutions, private seed sector, industry and the government are necessary for its commercial exploitation. So far, there was a concept of developing agro-based industry. However, we now have to think of industry-based agriculture.
In India, sorghum is being grown in rainy and post-rainy seasons. A reasonable level of stability in grain yield has been reached in the last decade in the state of Maharashtra, India. Unless substitute for cattle fodder is suggested, sorghum has to be grown irrespective of market price of grain. Therefore, diversification of its uses for making this crop more remunerative is essential. The fall in consumption even in remote areas could be attributed to price factor, status of the grain, easy availability of fine cereals such as wheat and rice through Public Distribution System (PDS) and fine road network.

Asia alone contributes 30% of world sorghum production. The sorghum area total cereals area is a meagre 3.69%; however, it is the fifth important cereal in Asia. Sorghum production in Asia is concentrated mainly in India and China, which together contribute 86% of Asia's total sorghum production. However the relative importance of sorghum as food grains in Asia is decreasing in terms of cultivated area and production. Generally the above changes can be explained in terms of increasing incomes, change in consumers' preferences and tastes, subsidized supply of wheat and rice through Public Distribution System (PDS), etc. Despite the decline in their consumption, food use still accounts for major share, especially of pearl millet. Sorghum is passing a transition stage from mere food and fodder crop to a valued industrial raw material such as feed (in India), sweet sorghum alcohol (in China and Thailand) and forage (in Pakistan). Cotton, groundnut, pulses and castor are the major crops replacing sorghum in many areas. Soybean is the competing crop, especially in central and western India replacing sorghum. Cotton, sunflower, maize, groundnut, pulses and soybean are replacing pearl millet. Some factors responsible for replacement of sorghum by these competing crops are low productivity and profitability of sorghum and pearl millet vis-a-vis competing crops, increased irrigation availability and price support to other cash crops. The net returns from irrigated sorghum are up to five times that of dryland sorghum in India, making a pathway for its future commercialization.

The investment in R&D and outcome of research from private sector is growing at a faster rate than the public sector. Industrial uses such as animal feed, alcohol production (grain and sweet sorghum), jaggery and syrup (sweet sorghum), processed foods, malt/brewing and red sorghum exports will be the driving forces for commercialization of sorghum and pearl millet. Productivity enhancement (maximization of yields) is the

alternative in the absence of prospects of any increase in real prices of output. This will result in lowering per unit cost of production. Thus, yield improvements and value-addition through industrial utilization may enhance the profitability and alleviate rural poverty. Marketing, contract farming and farmer-industry linkages are the niches for commercialization of these crops

1.1 Relative Importance of sorghum

Sorghum is one of the most important dryland cereal crop supporting both food and nutrition security of the poor in semiarid marginal areas of India. In addition, it also supports the larger livestock in the economy in terms of fodder security.In India, it was one of the major cereal staple during 1950's andoccupied an area of more than 16 million ha. But, of late its area dipped (48 per cent)to 7.67 million ha by 2009-10 (5% of GCA). However, it is still contributes about 6.98 milliontons (3.2%) to India's total food production and around 12.7% to the world's sorghumproduction(FAO, 2009-10).Globally USA is the highest producer of sorghum followed by Nigeria and India. Over 10.13% of the world produce, approximating at around 7 million tonnes, comes from India.

In India, rabi sorghum occupies a slightly higher acreage than Kharif Sorghum. Kharif sorghum However the total acreage under sorghum is facing a declining trend for the past few years declining by almost 23%. Only 4 states occupy the 89% of the total area grown under sorghum. Of these Maharashtra occupies around 53% of annual acreage and Karnataka occupies 18% of the total acreage. Rajasthan and Madhya Pradesh occupy around 8% and 7% respectively (Rao and et al, 2010).

1.2 Regional Importance of the crop

In India, sorghum is principally grown in the central and western parts of Maharashtra and the northern regions of Karnataka, Andhra Pradesh and Tamil Nadu. During the year 2008-09 the acreage, production and yields are 7.88m.ha, 6.5 million tonnes and 0.82quintals per hectare respectively have declined as compared to those of 2006-07 where they were at 8.47m.ha, 7.15 million tonnes and 0.84quintals per hectare. Rabi Sorghum produced in the post rainy period is of superior quality and hence preferred for human consumption. It is sweeter in taste

and is white in colour. However the Sorghum produced in the rainy season (Kharif) is not so much used as human consumption as it is grown mainly from hybrid and poor quality seeds. About 50% of this produce is used as poultry feed, alcohol and animal feed. It is also used in the preparation of porridge, khichdi, rava, papad, roti also known as bhakdi etc.

1.3 Farmers' preferences and adoption pattern:

Many studies have indicated that in the case of the kharif sorghum, farmers preferring hybrids and improved varieties, while in case of rabi sorghum farmers preferring varieties. **It is a paradox to note that why kharif sorghum is dominated by hybrids and rabi sorghum is dominated by local varieties? Thus it is interesting to analyse the farmers preferences and reasons for differential adoption pattern in rabi sorghum at micro level**. In India, adoption rate of improved sorghum cultivars gradually increased from 1% in 1966 to 71% by 1998 (MCS Bantilan 2005). The adoption of improved varieties by farmers has differed markedly by regions/state-wise. The rapid rate of adoption in Tamil Nadu and Maharashtra states is evident from the impact of genetic improvement in sorghum, while a very slow rate of adoption was observed in Rajasthan and Gujarat states due to abiotic factors. The rate of adoption is higher (more than 80%) in central Maharashtra and in some districts of Andhra Pradesh. All these districts have gained significant improvement in terms of yield. With the spread of modern varieties and hybrids of sorghum that began in the mid-1960s there was an important impact on small farmer welfare in India. But it is seen that hybrid breeding in sorghum is targeted more towards the improvement the kharif sorghum and rabi sorghum has been neglected in this aspect.

1.4 Production and Consumption pattern:

Asia alone contributes 30% of world sorghum production. The sorghum area among the total cereals area is a meagre 3.69%; however, it is the fifth important cereal in Asia. Sorghum production in Asia is concentrated mainly in India and China, which together contribute 86% of Asia's total sorghum production. In India sorghum is produced principally in five states i.e. the central and western parts of Maharashtra and the northern regions of Karnataka, Andhra Pradesh, Tamil Nadu and Rajasthan. However **over the past few decades there has been a constant decline in the production of sorghum inspite of it being one of the principal crops. Hence it was interesting to study the production trends of sorghum over the past**

few years and analyse the reasons for the decline in area and develop policies that would help increase the production of sorghum.

Total consumption of sorghum closely follows the global pattern of output as it is mostly consumed in the countries that it is produced in. In most parts of America sorghum is used as animal feed (Rao et al, 2010). Sorghum is major staple food in some regions of India, but is also used for other uses like poultry and animal feed, alcohol production etc. In addition, sorghum is valued greatly as fodder for the livestock in dry areas. Major share of post rainy season sorghum output is used for food, while bulk of the rainy season sorghum output goes for non food uses like feed for the cattle and also for other uses like production of alcohol and ethanol. In India annual per capita consumption has declined sharply. In urban areas it has declined by 74% (8.5kg to 2kg) while the rural areas have experienced a decline of 81%(19.2kg to 3kg) between 1972-73 to 2009-10.(Parthasarathy et al. 2010). **Though at all India level, there has been steep fall in the per capita consumption of sorghum, yet, studies shows that still consumption levels are very high in the rural areas of sorghum production states. Thus it is imperative to analyse the consumption pattern, the reasons for fall in the per capita consumption and exploring strategies to stimulate the demand for the sorghum output.**

1.5 EXPORT COMPETITIVENESS

Since the nineties, globalisation has brought about remarkable changes in the international trade in the world. In the process, the agriculture sector has also benefitted in exports and imports of agricultural commodities that have been produced elsewhere more efficiently. In most developing countries, agriculture continued to play an important role in terms of direct contribution to GDP, foreign exchange, employment, food and income security to the bulk of the population as an occupation and India is no exception. India being an agro-based economy, the economic condition depends on the foreign exchange earnings of the country and it gets compromised when there are increased imports and decreased exports. Hence, it is imperative that the foreign exchange earnings need to be improved through exports. Of late, the terms of trade in agriculture is deteriorating hence farmers' incomes have been dwindling and facing economic crisis especially in dry land agriculture. Thus, one of the options is to increase farmers' income through value addition and exports. **In this endeavour, the export**

potential of sorghum will be studied and the other potential markets within and outside the country will be explored.

OBJECTIVES OF THE STUDY

- To study the production and consumption pattern and trends of Sorghum
- To analyse farmers preference and adoption pattern for different varieties of sorghum
- Analyse the alternate uses
- To study export potential and competitiveness of Sorghum

HYPOTHESIS

- Production trend is accelerating while consumption trend is decelerating.
- Most farmers prefer hybrids and improved varieties in Kharif sorghum and local verities in rabi sorghum
- The alternative uses of sorghum are expanding over time.
- Sorghum is less export competitive

2. Review of literature

PRODUCTION

- **AREA**: Although grown in both the kharif and rabi seasons, the rabi sorghum occupies a larger acreage. Sorghum trend has seen a declining trend of about 23% in the past years. The declining trend is shown in the excel sheet attached. Factors like weather and comparatively higher prices of other commodities also lead to decline in acreage of Sorghum in India over the years. Kharif sorghum accounts for about 45% of the total acreage while the rest 55% goes under rabi. Thus acreage trends in a given year depend on rainfall during the kharif season. In the year 2010 too, Indian kharif Sorghum acreage dropped by around 11% due to dry spells hindering the sowing in all the growing states.\

- **PRODUCTION:** On an average sorghum production in India stood at around 7.5 million tonnes. In India only 4 states occupy 89% of total area under sorghum. Of these Maharashtra occupies around 53% with annual acreage of about 4.14 million hectares during 2007-08. Karnataka cultivated around 1.38 million hectares occupying around 18%. Other major cultivating states are Rajasthan (8%), Madhya Pradesh(7%), and remaining (10%) from other states. However, Indian sorghum production averages 820kg per hectare lower than the global average of around 1.47 tonnes per hectare. (Rao et al, 2010)

- **PRODUCTIVITY:** Indian sorghum yield averages around 820kg per hectare, lower than the global average of around 1.47 tonnes per hectare. But with the recent usage of improved varieties there has been a rise in the productivity of the crop.

CONSUMPTION

Sorghum is the staple of central and western regions of Maharashtra and the northern regions of Karnataka and Andhra 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. 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– a change driven by income growth and urbanization. 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. In urban areas too, a similar inverse relationship holds except for Andhra Pradesh where consumption levels are low. 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 need further investigation (Basavaraj *et al).*

ADOPTION

Adoption is, "the mental process an individual passes from first hearing about an innovation to final adoption" (Rogers, 1962). It is always an individual decision process. The adoption of an innovation is influenced by information about the receivers' socio-economic characteristics, social systems, and the characteristics of the innovation. Moreover, the innovation-decision process can lead to either adoption (a decision to make full use of an innovation), or rejection (a decision to maintain the original). Information and learning are argued to be central to the adoption process. Risk is a major factor limiting the adoption of new innovations (Lindner, 1987). Low adoption rates for improved sorghum cultivars are variously attributed to both inadequacies in the formal seed system and demand-side factors. The harsh, rain-fed environment favours the use of local and narrowly adapted seed rather than externally developed seeds. Local sorghum grain- where the seed output quality is evident and variety identity is recognizable - are an attractive source of seed.
The information from an adoption study can be used to

- provide feedback from farmers that is helpful in refining the˘ technology generation effort
- assess the effectiveness of a technology transfer strategy

- improve the flow of information between research and extension, on the one hand, and policymakers, on the other

- document the impact of a technology generation or extension effort.

Factors that Affect the Adoption of Improved Varieties

Even if improved cultivars are successfully developed and distributed, farmers may not adopt those new technologies for a number of reasons. Major demand-side constraints include risk attitudes, uncertainty, the learning curve, gender, and institutional limitations. Marra et al. (2002) concluded that "[…] recent research about the roles of risk, uncertainty and learning in the adoption of agricultural technologies has finally provided compelling support for the long-held and often-stated view that adoption processes are strongly affected by risk-related issues". Extension, promotion and marketing programmes by government workers and/or the private sector can be positively related to adoption (e.g. Marsh *et al.*, 2000; Llewellyn *et al).*Farmers are often reluctant to adopt a new technology without knowing the new risks associated with those technologies. It has been found that relatively well-educated people tend to adopt innovations more readily than less educated ones (Lapar & Ehui, 2004). Sometimes the decision on adoption is influenced by farmers' knowledge and perceptions about how to use scientific knowledge (Schultz, 1964). A recent IFPRI study by Takeshima and Salau (2009) determined that the other demand-side determinants of seed adoption might include timing of seed release, the channels by which farmers can obtain seeds, awareness of improved varieties, and the effects of natural and man-made disasters. Institutional limitations such as access to credit or land tenure may determine whether or not an innovation is adopted or the speed at which adoption takes place.

Also, Women farmers are often forgotten in official agricultural statistics. Because women play a key role in most agricultural systems, it is important that adoption studies consider the degree to which a new technology reaches women farmers. This requires careful planning of the survey. In the first place, researchers should have a good idea of the crops, cropping systems, or farm operations that are important for women farmers and should make sure that the survey is designed to obtain the relevant information. Perhaps more important, the survey sampling and interviewing strategies should be planned so that women are interviewed where they are the decision makers or have considerable knowledge about a particular subject.

(Derek Byerlee, CIMMYT Economics Program)

Often farmers have limited access to credit due to asymmetric information between farmers and financial institutions. Excess demand puts upward pressure on credit prices thereby limiting access to credit that many farmers need for improved seeds, inorganic fertilizers, or other agricultural technologies. A small farmer or a landless farmer who rents a parcel of land on a short-term contract, are less likely to adopt new technologies that require investments in physical infrastructure and improvements in the land. However, if the technologies do not require modification of the land or if they rely on human capital from the farmer, land tenure will not be a major deterrent to adoption.

For a technology to be successful, extension efforts and testing the technology with on farm trials need to be done. Shortages of family labour explained the non-adoption of technologies in India (Harris, 1972). Labour intensive technologies are more readily adopted by households with a higher labour supply (Hicks and Johnson, 1974). Therefore factors that affect adoption of improved varieties can be summarised as

- Education
- Age
- Gender
- Wealth
- Farm Resources
- Labour
- Credit
- Equipment and machinery
- Land tenure
- Compatibility of technologies with the present farming systems

Adoption is the outcome from the five-stage process (Ravi Shankar *et al)*

- awareness
- interest
- evaluation
- trial
- adoption.

Wilfred Mwangi(et al) examined factors influencing the adoption of improved maize seeds and the use of inorganic fertilizer for maize production by farmers in the intermediate and

lowland zones of Tanzania. The results indicate that availability of extension services, on-farm field trials, variety characteristics and rainfall were the most important factors that influenced the extent of adopting improved maize seeds and the use of inorganic fertilizer for maize production. Farmers preferred those varieties which minimize field loss rather than maximizing yields. Future research and extension policies should emphasize farmer participation in the research process and on-farm field trials for varietal evaluation and demonstration purposes.

Bishal K. Sitaula (*et al)* examined the problems encountered by Nepalese farmers in the adoption of agricultural intensification (AI), and the constraints and complexities of sustainable AI are not thoroughly understood. This study analyzed factors influencing the adoption and extent of AI at household level in the Ansikhola watershed in the central mid-hills of Nepal. Data were collected from a survey of 310 households, four key informant interviews, and two focus group discussions. The results reveal that 63% of the sampled households practice AI, with differences in the area under cropping intensification. The binary logistic regression model results show that irrigation facility, higher crop yield, landholding size, access to credit, and distance to chemical fertilizer store have significant influences on adoption. Likewise, the linear regression model results show that total amount of fertilizer application, net income from cereals and vegetables, and distance to the chemical fertilizer store have significant influences on the extent of AI. The results of this study could contribute to formulating policies based on farmers' need, interest, and capacity in promoting sustainable agricultural intensification.

Remedies

Evolving technologies that can be implemented by farm households with technical, labour and land constraints should be implemented. Overall, these three reports found that the following factors are likely to promote the adoption of improved sorghum and millet cultivars among farmers in SSA:

- **Participatory processes** – In many cases, the adaptive research is in danger of straying far from farmers' needs unless researchers have a way of monitoring farmers' experience with the new technologies being generated. But unless some sort of monitoring is carried out, researchers will not know the degree to which the variety is

actually being used. ICRISAT seed development programs that included farmers in the breeding process had higher adoption rates than programs that created cultivars without farmer input. Program analysis indicates that farmers are more likely to develop varieties that possess traits they desire, such as drought resistance, high yield, and taste.lvi Successful methods of incorporating farmers in the process include

- Structured group interviews
- Direct observations of farmers‟ plots
- Use of a diverse nursery for trait selection by farmers

- **Improved cooperation between government, NGO, and private sector for seed development -** Government, NGO, and private sector programs have tried to increase farmer access to improved cultivars for several decades; however each sector has its own unique constraints. As Tripp explains in a 2006 report, a way to overcome those constraints is to develop a comprehensive seed system in which all three sectors coordinate their activities.lviii As the case study from Tanzania illustrates, programs that adopted a collaborative approach to seed development seemed to have had higher adoption rates among farmers in program areas and better results. Rather than the government agencies managing and controlling all aspects of the seed development process, a large body of research suggests that input from all stakeholders, including smallholder farmers, leads to better results.lix

- **A diversified seed breeding and distribution system** – Governments and research institutions may improve seed availability by selling first generation seeds to the private sector and NGOs who can then multiply and disseminate them to farmers. In locations where farmers cannot afford top-quality, commercial seeds, communities can produce seeds themselves following quality control standards such as the Quality Declared Seed approach (QDS). Furthermore, long-tested varieties from one country may be considered for expedited release in neighbouring areas.

ALTERNATIVE USES

In India, sorghum is traditionally consumed in the form of unleavened flat bread (roti). In southern India, it is consumed in the form of sankati, annam and ganji (thin porridge). Popped

sorghum and sorghum noodles are eaten as breakfast or snack foods. A survey conducted in 2003 by the National Research Centre for Sorghum (NRCS), Hyderabad, Andhra Pradesh has indicated that nearly 20 tonnes of grain per month are being consumed in the form of roti in small hotels in Hyderabad. The other traditional sorghum preparations like annum (cooked, same as rice), sankati and ganji are popular with farmers as a preferred diet (Murty and Subramanian 1981). Noodles made from sorghum are not very common. Although the acceptability of sorghum noodles was not a problem, it was not given adequate attention. The technology for noodle preparation from sorghum makes the product cheaper and healthier as sorghum products are known to have higher levels of vitamin B and dietary fibre. The rainy season grain sorghum consumption has declined during the last decade mainly due to grain deterioration by molds. Therefore, rainy season sorghum grain is priced lower than maize; hence it can replace maize as a raw material in many of the alternative uses. The possible promising alternative food products from sorghum are bakery products, maltodextrins as fat replacers in cookies, liquid or powder glucose, high fructose syrup and sorbitol. Malted sorghum can be a good alternative for baby weaning foods. The industrial products made from sorghum grain include alcohol (potable grade) and lager beer. Commercialization of alcohol production from grain is already in practice. Other technologies such as production of glucose, maltodextrins, high fructose syrup and cakes from sorghum are yet to be scaled up. The sweet sorghum with its juicy sweet stalk has potential as a bio-energy crop. Ethanol can also be produced from sweet sorghum stalk juice. Sweet sorghum products like syrup and jaggery have received good attention from dryland farmers. Shelf life and nutritive value of syrup and jaggery made from sweet sorghum and sugarcane are similar. Attempts for scaling up the technology for alcohol production from sweet sorghum were successful, but more work is needed to integrate the current production with potential market.(CV Ratnavathi et al).

Sorghum is the main crop grown in Botswana, but despite this, its consumption seems to be declining. Consumer preferences were assessed for common cereal products available in the market. For sorghum, the crop is consumed mainly as sorghum meal, prepared as fermented or non-fermented soft (motogo) and semi-stiff porridge (bogobe).

Preparation of the porridge requires that the grain be dehulled first and then milled into a semi coarse meal, before it is cooked with boiling water. Soft porridge is popularly consumed, eaten as breakfast and/or supper. This porridge typically contains solids at a ratio of 1 : 8-10 parts water (Kebakile *et al)*.

To produce the sorghum flour, traditional milling is still practised, but mechanised milling has now become popular throughout the country at a commercial level. However traditionally pound sorghum flour is preferred over the commercial sorghum flour as it is said to provide superior tasting porridge. Flours with lighter colour and moderate texture were considered good. Several commercial sorghum flour brands are available throughout the country, but their quality is very variable. Consumers defined quality in terms of colour, texture and taste, and these parameters were linked to sorghum varieties and the type of milling process.
Studies revealed consumers' desires for "modern" products formulated from sorghum.
Typical products named include bread, biscuits, pasta, "rice", breakfast flakes and fermented beverages (mageu). Also preference for these products is dependent on the age, place of origin, household size, educational level, residential area and gender of the consumer. In Botswana, Sorghum was found to be the most frequently consumed cereal in both the urban and peri-urban areas, followed by maize, wheat, rice and millet respectively (Kebakile *et al).* Other common sorghum products consumed were traditional and commercial sorghum beer (Chibuku and Power), Morvite, and extruded sorghum-soy meals (Tsabana and Tsabotlhe).

Studies in Botswana show that the consumption of sorghum has a direct relationship with age. Consumers over an age of 50 consume sorghum on a regular basis however the younger sections of the society were less inclined towards the consumption of the same. With variation in area this ratio changes further. In urban areas a greater proportion of the younger section preferred not to have sorghum on a daily basis. But their preference changes with the processed goods of sorghum. Cornflakes, biscuits and pasta made from sorghum were more popular among them. Hence it can be concluded that the consumption of sorghum could be increased **by introducing a variety of convenient processed sorghum-based products that could be targeted for the youth**.
Size of family also proved to be a major determinant in the consumption of the sorghum. Families with more than ten members consumed sorghum more frequently than smaller families in both urban and peri-urban centres. Sorghum is by and large a traditional crop and is still highly regarded as such (Kebakile *et al).* Households with large families are typically very traditional and still maintain strong cultural norms and practices, and perhaps the reason for their choice of sorghum as the frequently consumed cereal.
Studies also show that higher the educational level of the consumer, the lower the consumption of sorghum on daily basis. The reason can be attributed to the fact that in rural areas, individuals with non-formal education were not introduced to the outer world and

hence the wide varieties of food of the urban areas were unknown to them, hence their taste for sorghum remained untarnished. Students with higher level of education often move out and develop tastes for more convenient cereal foods such as corn-flakes, and begin marginalising less convenient foods like sorghum porridge. Also Sorghum is recognised as the "poor-man's crop" mainly consumed by the uneducated inspite of its high nutritional values which may also lead to the educated youth discarding the consumption of this crop. The more prevalent mode of consumption of sorghum in India are Roti(Bhakri), Popped sorghum, Popped sorghum flour, Rava, Papad, Khichdi, Roasted soghum, Salted sorghum. A brief description of the above mentioned products are given below.

Roti (Bhakri):

A popular meal of rural India, the crispy or soft Bhakri are extensively consumed and account for around 95% of grain consumption annually. Its preparation is quite difficult and time-consuming. Also sorghum flour has a very less shelf-life upto around 10 days. Hence these are some factors for which the popularity of sorghum food is hampered.

Popped Sorghum:

Kagi moti sorghum is cultivated using OPV seeds and used mainly during festive seasons like *Nag Panchami.* The popular belief is that without Popped Sorghum the celebration of *Nag Panchami* is incomplete. This is grown along with white sorghum in small areas and the same in the sorghum value chain accounts for 1.5 percent.

Popped sorghum Flour (Allihittu)

Popped sorghum flour is prepared from popped sorghum. It is preferred for consumption by old age people and small children. It is also good for people with physical disorders like sugar, obesity etc due to its low level of stickiness and high mineral and fiber content and with low or slow starch digestibility. It finds it usage mainly in the Brahmin community in different combinations because of its easy palatability. In value chain it accounts for 0.15 percent.

Rava (Broken Sorghum)

Broken sorghum is used by aged people and diabetic patients. It is also used during festive season as a special food. It accounts for 1.5 percent in the value chain.

Papad

Though not a regular food prepared on a regular basis, it is prepared in urban areas during festive seasons. In rural areas, though, it is consumed more frequently. Papad of sorghum accounts for 1.5 percent of total food consumption.

Khichdi

Khichdi is prepared and consumed during summer to beat scorching heat as sorghum is believed to have cooling effect against the same, thus consumed with butter milk. Mostly it is consumed in rural areas while its consumption in the urban areas is minimal. In value chain it accounts for 0.5 percent (B. Dayakar Rao *et al).*

Roasted sorghum

It is generally prepared by roasting on medium heat. It is roasted on dried cow dung; cakes of dried cow dung make for excellent roasting medium - slow and long lasting. Bunches of Hurda (*Hurda is the name given to tender sorghum. In early January, sorghum grain is juicy and very tender. Just the right time to be eaten roasted. It is generally picked from fields and cooked there and then, the young sorghum tastes very good when roasted*) with stems that work as a grip are pushed in the hot pit. In about five minutes the tender grains are nicely roasted. The pit keepers, i.e Hurda makers, have mastered the art of holding the roasted Hurda, burning hot, in their bare palms. Vigorous rubbing, using both the palms, separates the roasted Hurda from the chaff. Generally farm party called Hurda Party is organized where the freshly plucked young tender jowar is roasted. It can be directly eaten after roasting when it is still hot and tender. To accompany they have jaggery (gud), shengdana-lassun chutney (groundnut-garlic chutney), dry khobra chutney (dry coconut), garlic and chilly chutney etc (Shilpa Mittal). It is available for mainly three months (November to January). Its benefit cost ratio is almost 1:3. Thus it is quite profitable for the farmers as well. It is sold for almost Rs.200-300 per kilogram.

Salted Sorghum

It is prepared by first boiling the sorghum seeds and then after adding masala it is served.

Sorghum consumption has been facing a downward trend for quite a long time now. However there has been a favourable turn of events. As reported by Economic Times "Food companies' rush to capitalise on the multigrain 'fever' is giving a new air of respectability to coarse cereals, once known as the poor man's staple. The market for jowar, bajra and ragi is witnessing a turnaround never seen before as urban Indians begin to take a more active interest in what comes off their plate. Jowar, or sorghum, is the biggest beneficiary. Price of this cereal — seen lower down the scale from wheat until a few years ago — has tripled in the past three fiscals, beating even its superior cousin in the game. Jowar is currently ruling at 34-36 per kg as against 21 a kg for Saurashtra Lokwan and 26 per kg for MP Sihor — the two costliest wheat varieties in the Pune wholesale market.

Export Competitiveness

The concept of international competitiveness is often used in analyzing countries' macroeconomic performance. It compares, for a country and its trading partners, a number of salient economic features that can help explain international trade trends. This concept encompasses, first of all, qualitative factors or factors that do not lend themselves readily to quantification. Thus, capacity for technological innovation, degree of product specialization, the quality of the products involved, or the value of after-sales service are all factors that may influence a country's trade performance favourably (**Durand *et al***).

During the past 10 to 15 years, many developing countries have made good progress in liberalizing their trade policies by removing quantitative import restrictions (QRs) and reducing tariffs. But in practice all developing countries' tariffs are still high enough to create significant levels of anti-export bias (disincentives to export). In addition, tariff structures are typically escalated, with higher tariffs on final goods than on intermediate materials and components. Developing countries are also increasingly resorting to anti-dumping actions and imposing anti-dumping duties on top of normal tariffs, and QRs of various kinds are still imposed. Import duties on final goods increase their prices, thereby increasing the profitability of producing import substitutes. By contrast, exports must be sold at going prices in world markets, and so resources are diverted from the production of exports to production for the domestic market. The best way to reduce anti-export bias and to improve the environment for export growth is to reduce protection of the domestic market. This means reducing tariffs, reducing or eliminating tariff escalation, and eschewing the use of anti-dumping and QRs. But reforms of this kind are often long and difficult. Economists say there is a need for India to raise export competitiveness if it wants to achieve a higher level of sustainable growth.

In most developing countries, agriculture continued to play an important role in terms of direct contribution to GDP, foreign exchange, employment, food and income security to the bulk of the population as an occupation and India is no exception. India being an agro-based economy, the economic condition depends on the foreign exchange earnings of the country and it gets compromised when there are increased imports and decreased exports. Hence, it is imperative that the foreign exchange earnings need to be improved through exports. Economists say there is a need for India to raise export competitiveness if it wants to achieve

a higher level of sustainable growth. It is evident that there is high potential in the export of certain agricultural products in India due to its relative comparative advantage. Of late, the terms of trade in agriculture is deteriorating hence farmers' incomes have been dwindling and facing economic crisis especially in dry land agriculture. Thus, one of the options to increase farmers' income is through value addition and exports. In this endeavour, we focus to analyse the trends in supply, alternative uses and the export competitiveness of dryland cereal viz. Sorghum.

Maize has been a traditional feed grain in Thailand and Indonesia for many decades. Recently, there was a big shortage of maize supplies due to increasing demands from the rapidly growing poultry industry. Consequently, large quantities of maize grain have to be imported annually to balance the deficits in both countries. The chance to increase maize production seems limited due to continuous environmental stresses resulting in unfavourable conditions for profitable maize cultivation at subsistence levels. It is anticipated that sorghum with its unique ability to better withstand environmental stresses such as drought should be seriously studied to be an addition alternative feed grain for this wet tropical region. As sorghum is drought tolerant; it may be a good alternative feed grain in these areas. The essential need is to develop a sound breeding program to breed more adaptable varieties and hybrids with better yield and quality. (**B Boonsue**).

Globally USA is the highest producer of sorghum followed by Nigeria and India. 10.13% of the world produce, approximating at around 7 million tonnes, comes from India. In India, rabi sorghum occupies a slightly higher acreage than Kharif Sorghum. Kharif sorghum However the total acreage under sorghum is facing a declining trend for the past few years declining by almost 23%. Only 4 states occupy the 89% of the total area grown under sorghum. Of these Maharashtra occupies around 53% of annual acreage and Karnataka occupies 18% of the total acreage. Rajasthan and Madhya Pradesh occupy around 8% and 7% respectively.(**Rao et al, 2010**)

Only small quantities of sorghum are imported or exported from India. The export demand mainly stems from the feed industry in developing countries. During 1972–73 India imported 396,000 tons of sorghum, mainly due to drought prevailing during the period. After the 1990s, India has more or less stopped importing sorghum. However, India's export surged during 1993–94 due to good sorghum production. The demand for sorghum in the importing

countries is primarily for feed use, and hence only sorghum produced during rainy season is exported as the sorghum produced during postrainy season is used for domestic food consumption as this is of good quality (**Kleih et al. 2000**)

How is Competitiveness Measured?

Ideally, measures of competitiveness should satisfy three basic criteria: First, they should cover all the sectors exposed to competition, i.e. represent all goods traded or tradable that are subject to competition and only those goods; Second, they should encompass all the markets open to competition; and, Third, they should be constructed from data that are fully comparable internationally. In practice, none of the indicators that are available fulfil these three criteria. Data and other limitations mean that compromises have to be made at every stage, so that any measure of competitiveness is in fact only a rough approximation of the ideal. The competitiveness term in the equation for a given country's manufactured export volumes is the differential between the country's export price and that of its competitors on their common markets. On the assumption that a country's export prices do not depend on the country of destination, competitors' export prices are determined by a double weighted pattern **(Durand *et al)***.

There are different ways to calculate the export competitiveness. One of them is policy analysis matrix (PAM) approach **(Mohanty *et al)***. The PAM is a computational framework, developed by **Monke and Pearson (1987)** and augmented by **Masters and Winter-Nelson (1995),** for measuring input use efficiency in production, comparative advantage, and the degree of government interventions. The basis of the PAM is a set of profit and loss identities that are familiar to any businessman (**Nelson and Panggabean, 1991**). The basic format of the PAM is a matrix of two-way accounting identities. The PAM framework can also be used to calculate important indicators for policy analysis. The nominal protection coefficient (NPC), a simple indicator of the incentives or disincentives in place, is defined as the ratio of domestic price to a comparable world (social) price. NPC can be calculated for both output (NPCO) and input (NPCI). The most difficult tasks are estimating social prices for outputs and inputs and decomposing inputs into their tradable and non-tradable components (**Yao, 1997**). The domestic price used in this computation could be either the procurement price or the farm gate price while the world reference price is the international price adjusted for

transportation, marketing and processing costs. Nominal Protection Coefficient basically helps in measuring the divergence of domestic price from the international price thus determines the degree of export competitiveness of the commodity in question (**Gulati *et al*. 1999**). The competitiveness of the commodities under consideration is treated under export hypothesis that implies that these commodities are treated as exportable and competes with the domestically produced commodities at a foreign port.

Nominal Protection Coefficient

$NPC_i = P_{di} / P_{wi}$

Where NPC_i : Nominal Protection coefficient of commodity i

P_{di} : domestic (India) price of commodity i.

P_{wi} : World reference price (border price equivalent) of commodity i, adjusted for transportation, handling and marketing expenses.

For exported commodities, social prices at the farm gate are calculated by adding marketing cost from the respective world reference price in the domestic currency, converted to domestic currency.

Under exportable hypothesis if,

NPC is more than 1 then the produce is supposed to be competitive, thus implies that domestic prices are less than the international prices and thus India's produce is internationally competitive.

If NPC is very close to one it suggests that the domestic price is slightly below the international price.

NPC is less than 1 then the produce is not competitive, implying that domestic prices are more than the international prices and thus India's produce is not internationally competitive

3. Methodology

The research findings of the paper have been arrived at using methodological selection of area and collection of data and meticulous analysis of data. This chapter aims at providing with a brief albeit appropriate details of the methodology used in the study to arrive at the results.

3.1 **Data Requirement**

The study contemplates an assessment of some varied topics such as farmers' adoption the production and consumption of sorghum trends. The study also includes as part of its objective, studying the alternative uses of sorghum and alongside study the export potential of sorghum. Therefore the data needed for the completion of all the objectives are as follows**:**

i. Determining farmers' preference regarding adoption of improved varieties of seeds of sorghum

For detailed analysis of this objective, data was required from farmers of both HOPE and Controlled clusters in Western Maharashtra regarding their preferences in new improved varieties of sorghum

ii. Analysis of production and consumption of sorghum over a span of time

Time series data over the last forty years was required to analyse the trends over time in production and consumption of sorghum.

iii. Exploring the alternative uses of sorghum

The consumption of sorghum is falling over time but there is a silver lining. Sorghum foods are gradually becoming popular among the new generation. With the increasing awareness of sorghum's benefits to control lifestyle-related disorders and availability of such foods in outlets has led to an increase in its consumption

iv. Studying the export competitiveness of sorghum

Since international trade has generally grown at a faster rate compared to the growth of GDP over the past two decades in India hence for that it was interesting to study the export potential of sorghum. For this data was needed on the f.o.b prices and transport cost and other charges such as handling and marketing etc so as to be able to calculate the NPC coefficient.

3.2 Source of Data:

The study of the first objective was carried out in Western Maharashtra since there is a large concentration of rabi sorghum in that area. In the first stage a reconnaissance survey and focussed group meetings were conducted in order to select the rabi sorghum infested areas and zeroed down on the farmers who engaged in the production of the same. In the second stage, using a structured questionnaire, primary data on the preferences of farmers about the traits that they would prefer in improved varieties were collected. Out of those interviewed, a section of farmers were from the HOPE cluster and a section from Controlled cluster i.e the section that has not been adopted by the HOPE project.

Followed by this, interview was conducted with a company that produces Sorghum foods to get the information on the status and acceptability of sorghum food among the consumers.

Secondary data on production and consumption of sorghum over the last four decades were collected from different sources like NSSO, Agricultural Statistics at a glance-2012 (Government of India, Ministry of Agriculture) and United States Department of Agriculture (USDA).

For the calculation of Nominal Protection Coefficient data on FOB prices of sorghum adjusted for transportation and insurance costs from the manufacturer to the port of departure, as well as the costs of loading the vessel were needed.

3.3 Sampling

Three villages were selected, two of them were under HOPE cluster and the third belonged to Controlled area. Nimblak and Islak were HOPE adopted villages while Burudgaon was a control area village. 3 farmers from Nimblak and Islak and 2 farmers from Burudgaon village were interviewed. Data thus collected in the form of a structured questionnaire was then tabulated. The general information about each are presented below:

3.4 Design of Questionnaire

A structured questionnaire was prepared keeping in view the objectives of the study. The schedule covered the important aspects of the study of the first objective i.e. analysing farmers' preference regarding improved varieties of seeds. The questions hovered on subjects like their preference of traits in improved varieties, rate of adoption and reasons for non-adoption, what are the major constraints that are faced by the farmers in the cultivation of the improved varieties. General information about the farmer regarding his family size, total cultivable land, area allotted under rabi sorghum, total production of the crop etc were also collected.

In a second questionnaire meant for collecting data on the second objective i.e. alternative uses of sorghum, questions regarding consumers' response towards sorghum products, what are the products that are fast gaining popularity in the market, the process of making them, cost of production etc were asked and the data was collected from companies that engage in the production of sorghum products.

3.5 Method of Data Analysis

Discussed below is a description of the method involved in the analysis of the collected data.

The data collected from the villages of Maharashtra are tabulated to arrive at proper conclusions. Simple descriptive statistics have been used for the tabulation of the data. For the preparation of the table for the ***Preferred Traits*** the mean of the farmers preference for each trait, of each cluster was calculated and then expresses in terms of percentage.

For the preparation of the next table pertaining to ***Major Constraints faced by the farmers in the cultivation of improved varieties of sorghum,*** the Garret-Ranking Method was used and then the percentage of farmers facing the constraint was calculated for both HOPE and Controlled clusters separately.

Garret Ranking Technique

This technique was used to evaluate the constraints and the preferred traits of the farmers. In this method the order of merit given by the respondents were converted into ranks by using the following formula:

$$\text{Percent Position} = \frac{100(\text{Rij} - 0.5)}{\text{N}j}$$

Where,

R_{ij} = Rank given for the i^{th} items by the j^{th} individual,

N_j = Number of items ranked by the j^{th} individual.

The percentage position of each rank thus obtained was then converted into scores by referring to the table given by Henry Garrett. Then for each factor the scores of individual respondents were added together and divided by the total number of respondents for whom the scores were added. These mean scores for all the factors were arranged in the order of their ranks and inferences were drawn.

The third table of ***Rate of Adoption,*** the mean was taken for calculating the grain yield and fodder yield and area covered under each variety in both the HOPE and Controlled cluster over a span of three years.

Then the area under the traditional and improved variety was calculated and expressed in the form of pie-charts.

Nominal Protection Coefficient

NPC is a simple indicator of the incentives or disincentives currently in place. It is defined as the ratio of domestic price to international price. The domestic price used in these computations could be either the procurement/support price or wholesale price while the world reference price (border price equivalent) is the international price adjusted for transport costs (both international as well as domestic), marketing costs and processing costs necessary to make the commodity comparable. An appropriate exchange rate is used to convert international reference prices into comparable domestic currency equivalents.

$NPC_i = P_{di} / P_{wi}$

Where NPC_i : Nominal Protection coefficient of commodity i

P_{di} : Domestic (India) price of commodity i.

P_{wi} : World reference price (border price equivalent) of commodity i, adjusted for transportation, handling and marketing expenses.

Freight on Board (F.O.B) Price

The pricing term indicates that the cost of the goods, including all transportation and insurance costs from the manufacturer to the port of departure, as well as the costs of loading the vessel are included in the quoted price. This means that the buyer has to bear all the costs and risks of loss of damage to the goods from that point. The FOB term requires the seller to clear the goods for export. However F.O.B does not include shipping freight and insurance charges.

Hence the FOB price of sorghum is calculated to be $340/MT which when multiplied by the current exchange rate of Rs.60.23 becomes Rs.20478.2. therefore the price of per kilogram of sorghum is Rs.20.47 which is the international reference price.

The prevailing domestic price is Rs.15 per kilogram. The NPC is 15/20.47 which turns out to be 0.73. To get a sensitive analysis this process is repeated for exchange rate when it is

$1 = Rs.50, $1 = Rs55, $1 = Rs65, $1 = Rs70 and the NPC turns out to be 0.88, 0.8, 0.77, 0.71 respectively.

4. RESULTS AND DISCUSSION

Production

In the 1950's the area under sorghum was 16 million hectare which increased to 18 million hectares during the same decade but remained constant throughout the 60's. Since then there was a continuous drop in the area. Almost 1 million hectare area was lost between 1970 and 1973 and another 1 million ha between 1988 and 1989. During the last 10 years, the reduction in area continued and current area is 6.32 million ha. Therefore, during the last 5 decades, a total area of 9.6 million ha has been diverted to other crops.

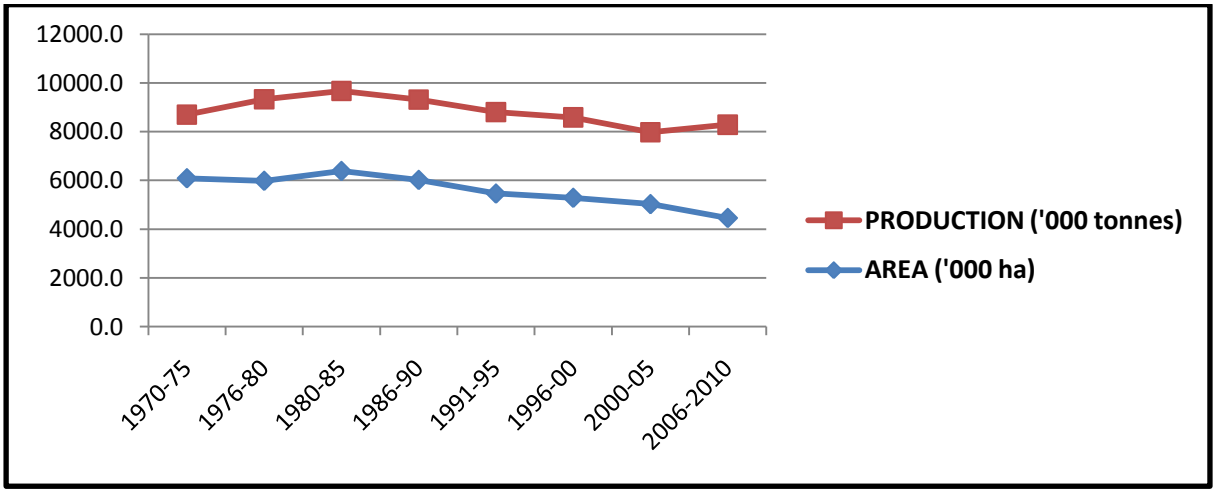
In the 60's Kharif had a greater share of 62% while rabi had a mere 38%. But with the passage of years, due to low grain quality of Kharif crops which fetched lower prices, area under Kharif shifted to rabi. Current share of rabi stands at 55% which is approximately 4.4 million hectares, while Kharif is 45% of the total area under sorghum in India.

Table 4.1 **Chart reflecting Area, Production and Productivity for four decades**

YEAR	**AREA ('000 ha)**	**PRODUCTION ('000 tonnes)**	**PRODUCTIVITY (Kg/ha)**
1970-75	**6090.6**	**2605.0**	**426.2**
1976-80	**5986.2**	**3340.0**	**556.6**
1980-85	**6389.6**	**3280.8**	**513.9**
1986-90	**6022.2**	**3296.4**	**548.0**
1991-95	**5462.4**	**3340.2**	**607.4**
1996-00	**5288.5**	**3296.7**	**624.2**
2000-05	**5029.0**	**2942.7**	**584.2**
2006-2010	**4461.6**	**3823.8**	**857.4**

1970-1990 (CAGR)	**-0.02**	**1.81**	**1.83**
1990-2010 (CAGR)	**-1.26**	**0.63**	**1.91**

Declining trends in Sorghum Production



Hence we see after analysing data for the last four decades starting from 1971-72 that there is a declining trend in area. There are hardly five states in the country which are engaged in the production of sorghum hence the area under the crop is not increasing rather it is declining by the years.

It has fallen from 16.78 million hectares to 6.32 million hectares in 2011-12. Pre-liberalisation the area under sorghum was declining at a negative growth rate of 0.02, but with the passage of time the rate of decline has increased and post liberalisation the the area decreased at a rate of 1.26. This also has serious implications on the livestock industry as the quantity of sorghum fodder has also been decreasing along with the decrease in area.

The reasons for this sharp decline in area could be attributed to the following:

1. Despite being the fourth important staple cereal of the country, sorghum is traditionally being identified and seen as a crop belonging to marginal farming conditions, source of succour to the poor in the hinterland of arid and semi-arid

regions and with low potential to promote economic growth. It is tagged for years as the “poor-man’s crop” which is a major reason why it is not gaining popularity among the upper classes of the society.

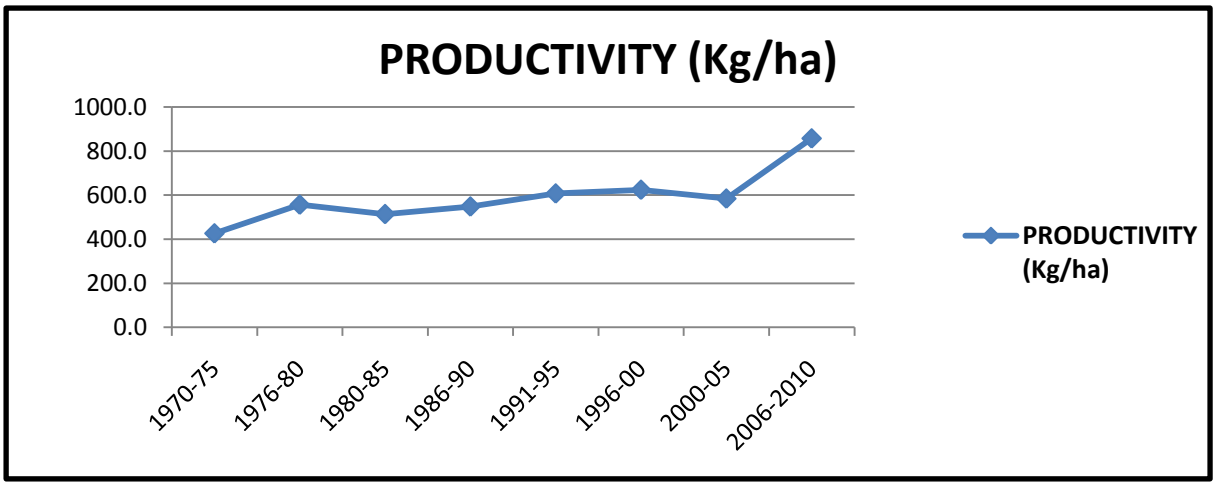
2. The traditional sorghum farming in most regions was a hapless gamble with nature to ease out a mere survival of man and animal. Sorghum is the natural crop of choice in situations of low and uncertain rainfall because of its drought hardiness.

3. With the low market price farmers are shifting to more profitable crops. Thus sorghum is constantly being substituted by its competing crops like chickpea, sunflower etc.

4. Lopsided government policies which only aid the ascent of “fine” cereals like rice, wheat has worked against sorghum. The introduction of rice and wheat in the Public Distribution System has made easy, the availability of these in remote places at subsidised rates. Thus the procurement of sorghum is very low.

5. Also the Government does not come to the rescue of sorghum farmers when the crop is either badly damaged by weather conditions or when there is a glut in production while regular protection against such losses is extended to crops such as rice, wheat, cotton, tobacco, chillies, etc.

6. The rationale of fixing MSP shifted against sorghum and coarse cereals over years. the MSP of rice and sorghum were equal during 1980-81 but by 1995-96, MSP of sorghum has become 9.0% lower than that of rice.



However the production and the productivity of the crop provide a more hopeful picture. During the 70's, the total production rose from 8.74 million tonnes to 11.2 million tonnes due to continuous rise in the productivity from 537 kg to 694 kg/ha. However the rise in productivity could not nullify the effect of the sharp decline in area. With the recent surge in the cultivation of improved varieties the productivity of sorghum is increasing at a rate of 1.91, post-liberalisation as against 1.83 which was the pre-liberalisation growth rate. Even with the productivity experiencing a positive growth rate due to the higher productivity of the improved varieties of crops.

Consumption

In India Sorghum was used as a human consumption in the early 1960's but it has sharply declined down the years although on a total volume basis the decline is quite marginal. According to the National Sample Survey Organisation (1988), consumption of sorghum as food is 44.3, 31.7, 17.02 and 16.41% in Maharashtra, Karnataka, Gujarat and Madhya Pradesh, respectively. It has often been seen that the consumption of sorghum is indirectly proportional to rise in income levels as it is wrongly tagged as a poor-man's crop inspite of the fact that sorghum has high nutritional values.

Table 4.2 : **Consumption Trend over the last four decades**

Market Year	Domestic Consumption ('000 MT)	Growth Rate
1970-75	**9563.80**	**0.0260**
1975-80	**11300.00**	**0.0114**
1980-85	**11306.60**	**-0.0003**
1985-90	**10605.80**	**0.0322**
1990-95	**10266.20**	**-0.0078**
1995-2000	**8865.20**	**-0.0303**
2000-05	**7370.00**	**-0.0019**
2005-12	**6814.29**	**-0.0288**

1970-90 (CAGR)	**0.85**
1991-12 (CAGR)	**-2.56**

After analysing the data for the last four decades it has been seen that there has been an alarming decline in consumption with a negative growth rate of 2.56 post liberalisation as against the positive growth rate of 0.85 in the pre liberalisation period. The 70's till the middle of 80's saw a rise in sorghum consumption with consumption rising from 9563 MT to 11306 MT. However 80's onwards the consumption starts falling. In the years 2005 to 2012 consumption has plummeted down to 6814 metric tonnes as against 11306 metric tonnes in mid 80's. The reasons in the fall in consumption can be attributed to:

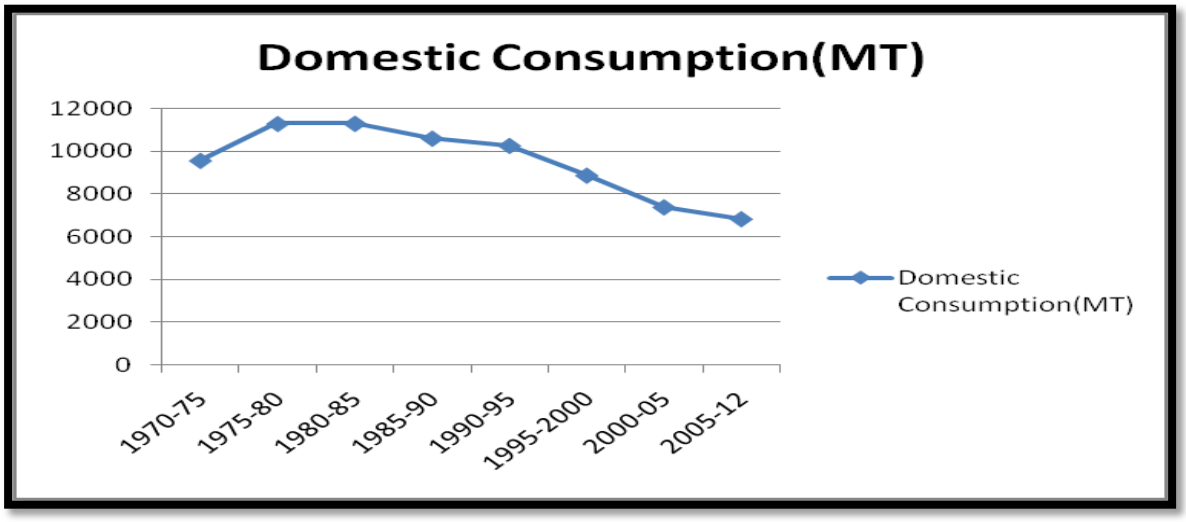
1. *Availability of "Fine" Cereals*: Due to the extensive reach of PDS and the inclusion of only fine cereals like rice and wheat in the PDS, the consumption of sorghum has been affected. The easy availability of rice and wheat in remote places at subsidised rates has led to consumers opting for these cereals instead of sorghum which is also considered a coarse cereal.

2. *Rise in per capita income:* With the rise in the per capita income the demand for sorghum which is considered an inferior good goes down as the Engel's Law comes into play. Thus the consumption of sorghum is affected in this manner as the consumers tend to spend more on superior goods.

3. *Change in tastes and preferences:* The change in tastes and preferences of the consumers due to rise in disposable income. Also due to formal education people tend to migrate to urban areas from rural areas, where they develop tastes for easy and quick foods.

4. *Difficulties involved:* The difficulties involved in the making of sorghum "roti" deter most people from consuming it. Also the shelf life of sorghum flour is ten to fifteen days.

Decline in Sorghum Consumption over four decades



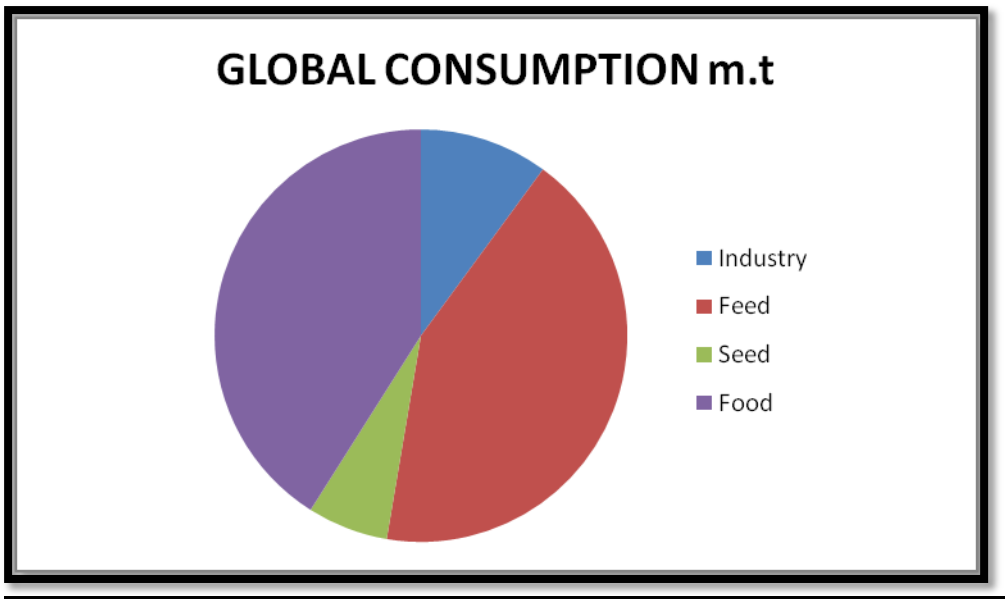
SEGMENT WISE GLOBAL SORGHUM CONSUMPTION

At a global level it has been seen that sorghum finds its usage as feed, food, seed, and industrial consumption. The details have been shown below with the pie chart

Table: 4.3 **Global Sorghum Consumption**

Segment	Global consumption (MT)	Percentage
Industry	6.38	10.06
Feed	27	42.59
Seed	4.01	6.33
Food	26	41.02
Total	63.39	100

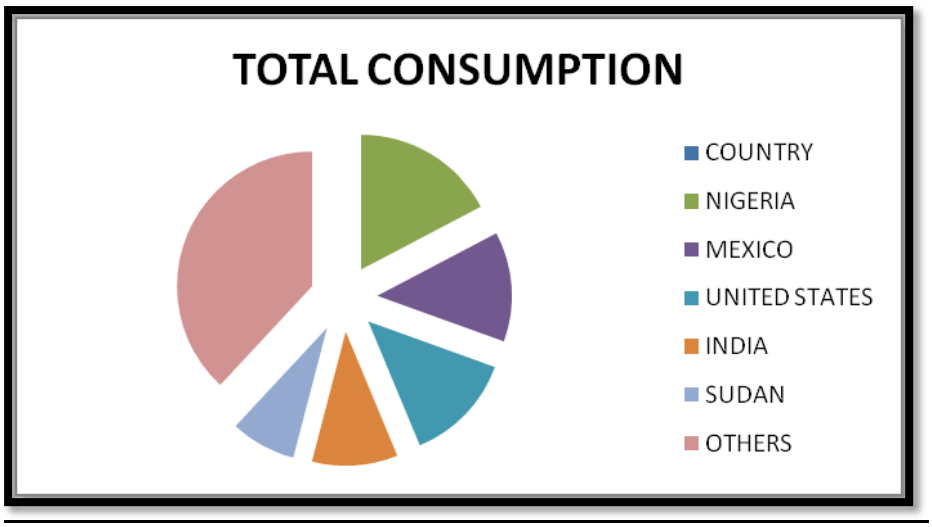
During the year 2008-09 total production was around 64.19 million tonnes out of which industries account for nearly 10% i.e. around 6.38 million tonnes. However livestock and feed consumption account for the lion's share of the consumption, accounting for almost 42.5% (27 million tonnes). It is seen from the table that Seed demand accounts for 6.33% (4.01 million tonnes). Food consumption accounts for 41.02% (26 million tonnes). There has been a decline in the feed consumption in the less developed countries like Nigeria due to spiralling prices and larger import dependence. Poultry industry in Mexico is a major consumer of sorghum, consumption being mainly in the form of mixtures and feed concentrates. Total consumption of sorghum closely follows the global pattern of output as it is mostly consumed in the countries that it is produced in. In most parts of America sorghum is used as animal feed.



SOURCE : DIRECTORATE OF SORGHUM RESEARCH

Table 4.4 MAJOR SORGHUM CONSUMING COUNTRIES IN THE WORLD

Country	Total Consumption	
	Volume	Percentage
NIGERIA	10.95	17.27
MEXICO	8.4	13.25
UNITED STATES	8.38	13.22
INDIA	6.53	10.3
SUDAN	4.98	7.86
OTHERS	24.15	38.1
WORLD	63.39	100



Nigeria is the country who has the highest consumption of sorghum. Sorghum enjoys a large and growing domestic demand because of its extensive use as food in virtually all parts of the country. Nigeria is closely followed by Mexico who is also world's largest importer of sorghum. USA and India follow suit and thus are among the major consuming sorghum countries in the world.

ADOPTION

The views of the 5 farmers regarding the adoption pattern of improved varieties, their preferred traits, the major constraints faced by the farmers in the cultivation of the improved varieties and the rate of adoption are tabulated below. However some of the salient features and their socio-economic facts are presented below to get a clearer picture about the adoption pattern of sorghum.

Table 4.5 : Salient Features

Particulars	HOPE		Control
	Nimblak	Islak	Burudgaon
Total Geographical area (ha)	2372	1055	1158
Total Operational Holdings (ha)	1671	555	925

Total Population	**7240**	**2670**	**4627**
Total Household	**835**	**308**	**617**
Per Capita Holding	**2.01**	**1.8**	**1.5**
Area Classification (2010-11)			
(i) Rabi Jowar (ha) (%)	**965 (57.8)**	**485 (87.3)**	**365 (39.5)**
(ii) Wheat (ha) (%)	**45 (2.7)**	**25 (4.5)**	**200 (21.6)**
(iii)Sugarcane (ha) (%)	**35 (2.1)**	**5 (0.9)**	**85 (9.2)**
Popular cultivars in case of rabi sorghum	**Phule Reveti, Vasudha,Suvarna**	**Phule vasudha, Suvarna**	**Maldandi**

4.6 Socio-economic features of the Farmers

Characteristics	**HOPE area**		**Control area**	
Family size (No.)	**8.67**		**7.5**	
Male (%)	**4.33**	**50 (%)**	**2.50**	**46(%)**
Female (%)	**3.67**	**42.31(%)**	**3.1**	**40(%)**
Children (%)	**2.67**	**30.77(%)**	**2**	**27(%)**
Size Class of holdings				
Small and Marginal : <2 ha (%)	**35**		**37**	
Medium & large: >2.01 ha (%)	**75**		**60**	

The per capita holding in Nimblak and Islak is greater than in Burudgaon. Also the percentage of medium and large farmers is more in HOPE clusters than in Control areas. The area under Rabi sorghum in HOPE areas is greater than that of Control areas. However it can be seen that area under wheat is much higher in control cluster is higher than that of HOPE area as sorghum due to its less remunerative value is slowly getting substituted by other crops. Thus there is a serious need for some improvements so that the yield and profitability of the crop can be increased.

On interviewing the farmers of both the HOPE clusters and the Controlled clusters on their preference of traits in improved varieties the following table has been prepared

4.7 Preferred traits:

Sl. No.	Preferred Traits	HOPE area	Non-HOPE area
I	**Production**		
	a. Higher Grain yield	30	60
	b. Short duration	78	40
	c. Drought tolerant	70	95
II.	**Consumption**		
	a. Better taste	98	99
	b. High keeping quality	63	70
	c. Grain size	96	94
	d.Grain colour	97	85
III.	**Fodder**		
	a.Higher Fodder yield	50	100
	b.Palatability/taste	87	98
	c.Juicy	43	65
	d.Brittle	56	67
IV.	**Marketing**		
	a.Lustre	38	45
	b.Thickness	67	57
	c.Bold grain size	86	91
	d.Colour of grain	93	90

V.	**Any other**		
	Resistance to lodging	85	84

In HOPE clusters since the farmers already have the privilege of cultivating improved varieties of seeds they are not so much concerned about High Grain Yield as much they are about it being Drought Tolerant and of Short Duration. Severe droughts hit Maharashtra last year as a result of which most of the farmers lost much of their crops. The grain yield was negligible and the fodder was not half as leafy and juicy as other years. Hence drought tolerance is a trait they look forward to, in improved varieties. In years of good rainfall they prefer to grow crops which have a higher market price and demand like wheat and thus short duration is a trait they want.

When it comes to consumption though, both the HOPE cluster and the Controlled cluster farmers want good taste as an important trait of the improved variety followed by an appreciable grain size and grain colour. The grain size should be bold and the colour should be good. High keeping quality is however a trait which ranks fourth in their order of preference.

In controlled clusters maximum farmers are still cultivating Maldandi since it is better in taste and they face the problem of non availability of quality seeds. Hence for them higher fodder yield is an important trait. However for farmers in the HOPE clusters it is not so important as they are already availing of that facility. Better taste is also another important trait. The fodder also needs to be leafy and juicy. Brittle is a trait, not particularly favoured by the farmers. According to the farmers engaged in the cultivation Maldandi, fodder taste is quite good from Maldandi hence for them to shift to improved varieties the fodder yield and taste should be better than the present cultivating variety.

For better marketing the two important traits that farmers want in the improved varieties are bold grain size and bright colour of the grain as consumers prefer these qualities. Thickness of the grain is also important followed by good luster. Among other traits resistance to lodging is a trait preferred by both HOPE and Controlled cluster farmers.

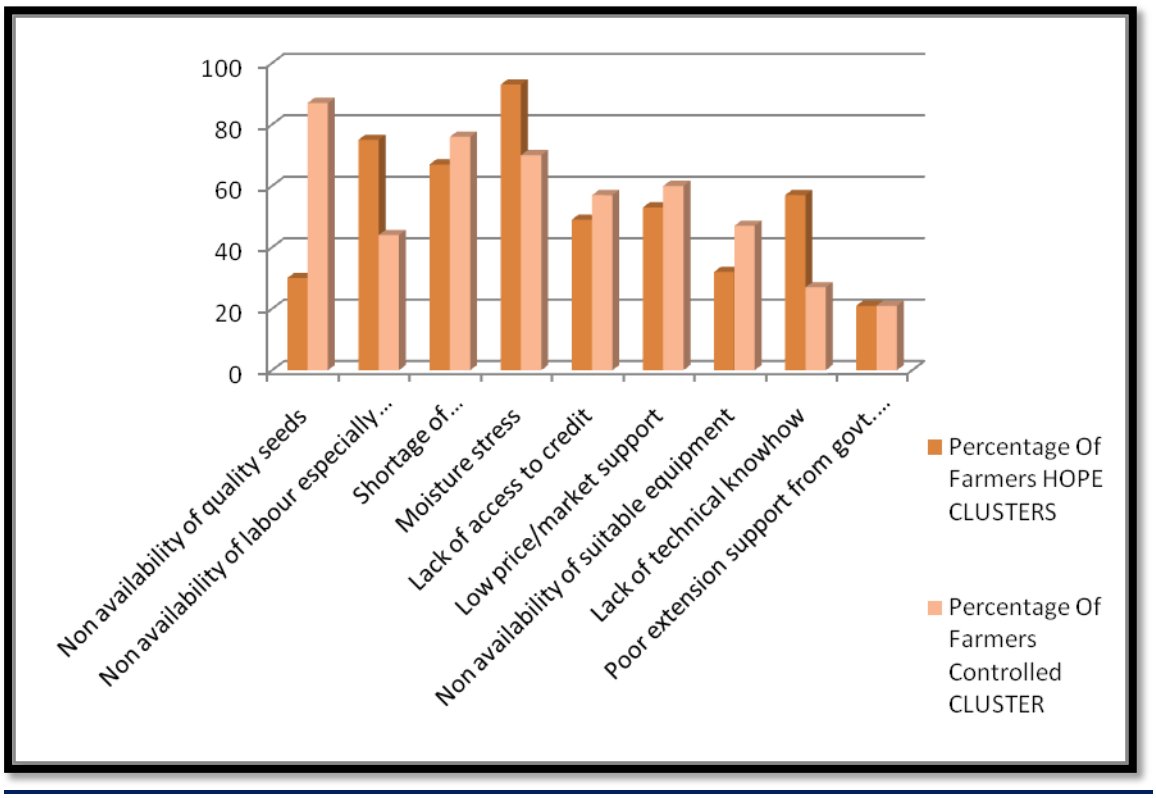
Table: 4.8 Major constraints faced in cultivation of improved technologies/ varieties of Rabi Sorghum (Rank)

Sl. No.	Constraints	Rank		Percentage Of Farmers	
		HOPE Clusters	Controlled Clusters	HOPE cluster	Controlled cluster
1	Non availability of quality seeds	VI	I	30	87
2	Non availability of labour especially during sowing and harvesting time	II	V	75	44
3	Shortage of fertilizer/manures/chemicals	III	II	67	76
4	Moisture stress	I	III	93	70
5	Lack of access to credit	VII	IV	49	57
6	Low price/market support	V	VI	53	60
7	Non availability of suitable equipment	VIII	VII	32	47
8	Lack of technical knowhow	IV	VIII	57	27
9	Poor extension support from govt. officials or NGO	IX	IX	21	21

The collected data has been tabulated for easier analysis of what are the problems faced by the farmers that come in the way of their adoption of improved varieties of sorghum seeds. It has been found that whereas the HOPE cluster villages have been blessed with easy availability of quality seeds, this is one of the main drawbacks faced by the farmers of the Controlled clusters. They do not have access to quality seeds and thus they still prefer producing the traditional varieties which are more easily available from the market yard or the seed dealers. Non-availability of labour during sowing and harvesting poses a serious problem for the Hope cluster villages while it is not one of the major issues with the Controlled villages. Non-availability of manure and fertilisers is a however a problem faced by both.

Inability to adopt the newer technologies of dry farming has led to moisture stress being a problem with both the groups of villages as these villages are characterised by scanty rainfall leading to drought conditions. Low access to credit, poor price and lack of technical knowhow are among the other barriers to better adoption of improved varieties of sorghum seed

Graphical Representation of the Percentage Of Farmers facing the major Constraints



Thus it is quite apparent from the diagram that Moisture stress is a major issue with the farmers of HOPE clusters while non-availability of quality seeds is a problem faced by the Controlled cluster farmers. Labour problem is faced by both the type of farmers. Hence these problems should be looked into and given some serious thought.

Table 4.9 Rate of Adoption

Particulars		Improved variety (acres)	Improved variety (%)	Maldandi(acres)	Maldandi (%)
2010-11	Area covered	22	35.83	26	54.17
	ADOPTION RATE	LOW		MODERATE	
	Reason for Non-adaption	Lack of Knowledge, Poor taste		Low Yielding Variety	
	Grain yield (quintal/acre)	3.85		3	
	Fodder yield	230		430	
2011-12	Area covered	24	50	22	45.83
	ADOPTION RATE	MODERATE		MODERATE	
	Reason for Non-adaption	Lack of Knowledge, Poor taste		Low Yielding Variety	
	Grain yield	4		3.25	
	Fodder yield	200		150	
2012-13*	Area covered	32	66.67	17	35.42
	ADOPTION RATE	HIGH		LOW	
	Reason for Non-adaption	Lack of Knowledge, Poor taste		Low Yielding Variety	
	Grain yield	6		3.5	
	Fodder yield	375		200	

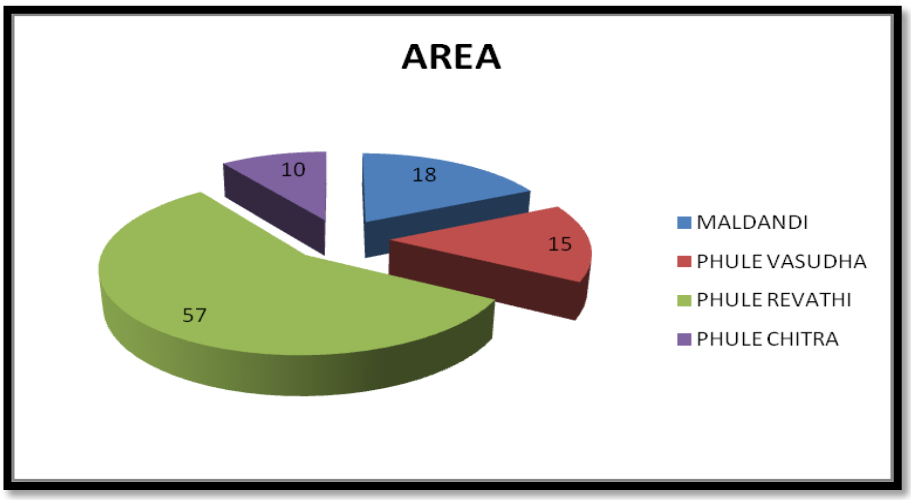
Reasons mentioned in the table are the most prevalent reasons. Other prevailing reasons are as follows:

a. Cannot get the seed at all	b. Lack of cash to buy the seed	c. Lack Of Knowledge
d. Poor taste	e. Low yielding variety	f. Expensive seed cost
g. No market	h. Poor price	i. Others specify

In the year 2010-11 improved varieties had not caught up as much as Maldandi. Due to its lack of popularity among the farmers the rate of adoption was low. Maldandi on the other hand was being cultivated on a larger area. While the improved varieties were cultivated on 45.83% land, Maldandi was cultivated in 54.17% land. The reasons for non adoption of the improved varieties were attributed to lack of knowledge and poor taste. Farmers not cultivating Maldandi said since it is a low yielding variety hence it is not used by them. Over the years the adoption rate of improved varieties started increasing and thus increased the grain yield and fodder yield as the area under these improved varieties started increasing. By 2011-12 the improved varieties were being used in more or less the same proportion as Maldandi. With the passing of years the area under improved varieties are expected to surpass that of Maldandi as can be seen from the table. But for that more villages need to be adopted under different projects that would facilitate the easy availability of quality seeds and manures and fertilizers.

Classification of Area under Traditional and Improved Varieties of Seeds in Hope Cluster

VARIETIES	AREA
MALDANDI	15
PHULE VASUDHA	20
PHULE REVATHI	70
PHULE CHITRA	10

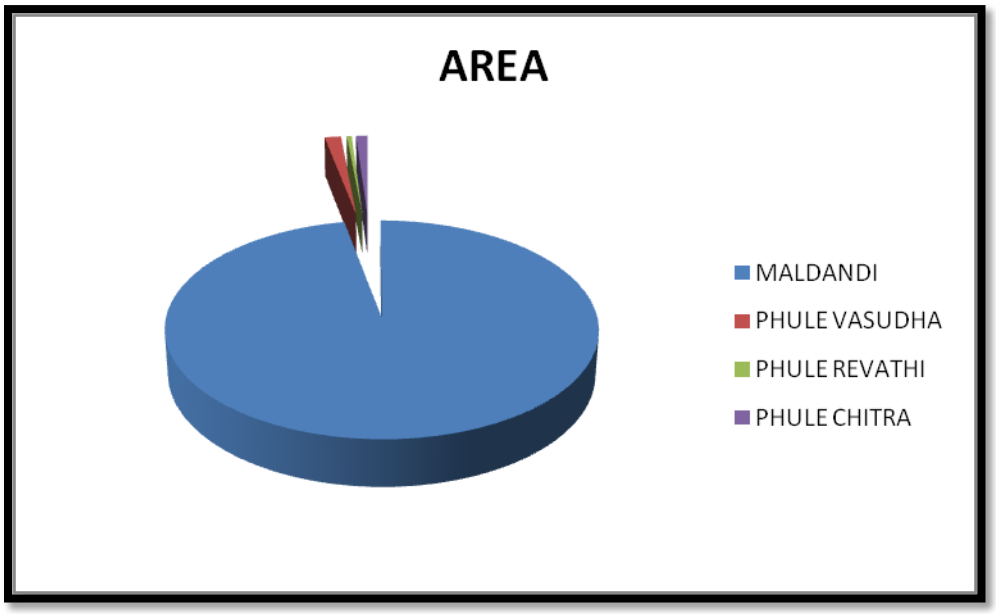


The data collected from the villages Islak and Nimblak, both villages adopted by HOPE, goes on to show that Maldandi is fast being replaced by other more improved varieties. Phule Revathi is the more popular improved sorghum seed being used by the farmers in these villages. However there are still farmers who are cultivating varieties of Phule Vasudha which according to them is more appropriate when there is a drought condition as this variety does not fail to produce crops even in extreme harsh conditions of very little rainfall. Phule Revathi on the other hand is the variety which gives higher yield and is being adopted by most of the farmers as it gives them a chance to bring to the market higher quantity of produce and in the process, earn more money. Phule Chitra is being adopted by lesser number of farmers with the advent of improved varieties of seeds.

In the Controlled Cluster i.e. the villages that have not been adopted by the HOPE project, there is however a different scenario Now we analyse the scenario in the Controlled clusters. Data collected from the village of Bururgaon shows us that Maldandi is the dominating variety. Phule Vasudha has been adopted by some 1.5% farmers and Phule Revathi and Phule Chitra together constitute a minor 0.5%.

Classification of Area under Traditional and Improved Varieties of Seeds in Controlled Cluster

VARIETIES	AREA
MALDANDI	97
PHULE VASUDHA	1.5
PHULE REVATHI	0.45
PHULE CHITRA	1.05



The farmers in the village of Bururgaon do not produce Sorghum for commercial purposes. They rather produce the crop for household consumption. Thus they prefer the traditional variety i.e. Maldandi as it is more tasty and nutritious. Also the fodder quality is better than that of the improved varieties. Fodder from Maldandi is juicer, has more leaves and is less brittle thus it is more favoured by the animals. Hence 98% of the farmers prefer Maldandi variety. There is however another problem prevalent among these farmers as to why they are not open to improved varieties of sorghum seeds. They procure the seeds from the nearby market yard and thus find it a major problem to go all the way to the Mahatma Phule Krishi Vidyapith to procure improved variety seeds. They however said that they are open to experimenting if they are supplied a bag of seeds as sample by the University. Hence we see that there is scope for introducing improved varieties of seeds in these villages and some amount of serious thought should be given to this issue.

ALTERNATIVE USES

There are certain major processors who supply processed sorghum foods into the market viz, SAKAS Foods in Pune, Shree Malad Dal Mills, ITC, Britannia etc. Companies are launching new products every day to cash in on rising consumer concerns about health and well-being. There are now multigrain breads, biscuits, even dosas in the market. Leading bakery and dairy products maker Britannia Industries is procuring multigrains for its NutriChoice biscuit as well as porridge and oats under its Healthy Start breakfast mix brand. Another food maker, ITC Foods, launched its multigrain flour Aashirvaad four years ago which is now growing at nearly 3-4 times the overall atta market. The product is a mix of wheat, soya, black gram, oat, maize and psyllium husk (Bhosale, Jacob). Even Directorate of Sorghum Research (DSR) are in talks with ITC to launch 18 new sorghum based products such as Pasta, Idly, Dosa etc. With the rising awareness among people about the high nutritional values of sorghum which help in fighting diabetes, arthritis and celiac disease and also helps in development of bones and teeth the consumption is at last witnessing an increasing trend. But the decrease in area and production is putting an upward pressure on price of the same.

SAKAS: SAKAS mills established in the year 1986 engaged in the manufactur of various products like wheat flour, rice flour, sorghum flour, bajra flour, soybean flour and corn flour. Interaction with Mr. Nikhil Sahasrabudhe revealed that their monthly sale is around 20.4 tonnes, and their annual sale reaches upto almost 245 tonnes.. Sorghum in their company are processed in the following ways. Cleaned Sorghum grains are directly stone ground (in Flour Mill) to make sorghum flour. It is later sieved and then packed for sale. Sorghum is then heated to high temperatures until it puffs / pops. It is then ground into coarse flour and subsequently packed.

Sakas has a lion's share in the market catering to around 35% of the demand. Its market coverage area includes Pune, Baramati and Mumbai. The cost of production of sorghum flour is Rs.30 per kilogram while that of puffed sorghum flour is Rs 80 per kilogram. Also the shelf life of puffed sorghum flour is more than that of sorghum flour, lasting upto 2 months or 60 days when kept in an airtight container while that of sorghum flour is 20 days. Their peak time is during summer and they procure the grains from the APMC Pune, Solapur and Aurangabad.

Table 4.10: **Details of Sakas Foods**

Sorghum output used in milling (tonnes)	**252.7**
Total Output (Flour)	**245**
Ratio of Flour and grain	**0.96**
Monthly Sale of flour	**20.4**
Procurement of Grain	**Pune, Baramati, Mumbai**
Sorghum flour (Cost Of Processing)(Rs./Kg)	**30**
Puffed Sorghum Flour (Cost of Processing)	**80**

Table 4.11: **Analysis of Cost and Returns from Processing**

Cost of Procurement (Rs./Kg)	**20**
Cost of Processing (Rs./Kg)	**5**
Net Cost (Rs./Kg)	**25**
Selling Price (Rs./Kg)	**40**
Net Margin (Rs./Kg)	**15**
Flour to Grain Ratio	**0.96**
Value of the output (0.96*40)	**38.4**
Cost to Return Ratio	**1.536**

Thus it can be concluded from the Cost-to-Return ratio that for every rupee expended on the processing of Sorghum flour a net income of Rs.1.54 has been generated. Thus it can easily be concluded that the processing of sorghum flour is cost effective.

With the passage of time the demand for sorghum products are increasing and there is thus a serious need to explore the alternative uses of sorghum. Also with the constant entry of big firms engaged in the processing of sorghum products, in the market, the scope for popularising sorghum is increasing by the day. Thus the objective that the alternative uses of sorghum are expanding over time is proved true.

Export Competitiveness

The NPC of sorghum is calculated to be 0.73. To get *a sensitive analysis,* the exchange rates are taken to be $1 = Rs.50, $1 = Rs.55, $1 = Rs.65, $1 = Rs. 70.

The NPC are respectively 0.88, 0.80, 0.68, 0.63**.**

In all the cases the NPC < 1 hence we can safely conclude sorghum falls in the non-tradable band of crops. They are sufficient import substitutes but are not export competitive as they are unable to recover the extra costs of transporting it to foreign markets.

5. CONCLUSION and POLICY IMPLICATIONS

The study shows that overall the farmers prefer improved varieties over the local varieties. But for the first time around they need to be provided with the seeds and then only they are ready to take the risk. Hence the Universities and the Government need to address the problem and make sure that the dissemination of knowledge is widespread and wholesome. In improved varieties the farmers prefer drought tolerance as the most important trait followed by short duration and high grain yield. In the respect of higher grain yield though, the view of the farmers of the Control farmers vary considerably from that of HOPE cluster. Since the latter already cultivate improved varieties and are satisfied with the yield, hence higher grain yield is not as important to them as it is to the farmers of the control area.

However, the improved varieties have failed to perform in the fodder front. The farmers' response in this regard is far from overwhelming. Hence this sends a strong message to the breeders that these aspects should be looked into and worked on. However for consumption, production and marketing the improved varieties have done a good job.

Sorghum production on the other hand is facing a downward trend. The growth rates have indicated that there is a sharp decline in area, which is quite disturbing. However the production and productivity have a positive growth rate mostly due to the usage of HYV seeds. But decline in growth rates in area have serious implications from livestock point of view, hence it should be looked into. Some of the policy implications that can be given a thought may be:

- Introduction of Sorghum in PDS like Rice and Wheat thus increasing the quantity that gets procured.
- Raising the bar of the MSP for the crop so that there is higher incentive to the farmers for the production of sorghum.
- Research should be carried on for the evolution of low cost technology, efficient use of available moisture to raise and stabilise the production of Sorghum. Because unless their pay-of-potential depressed by low value, is alternatively improved by high yields or low unit cost of production, farmers will have absolutely no incentive to produce sorghum and it will keep getting substituted by other high-value competing crops.

- Exploration of alternative demand channels in order to widen the markets i.e. using it as a cattle and poultry feed, processing of sorghum products. But it is imperative that to make that viable, there needs to be a sharp reduction in the cost of production so that it becomes cost-effective.

- Improve on the low level of inter-state movement of this crop. It has been seen that some of the sorghum growing areas are among the identified pockets of poverty hence there exists a class specific demand of this product. But sorghum needs to rise above the tag of being a poor-man's crop. For that to happen there needs to be value addition to the product and the mobility of the crop should be increased as the demand gets localised. It mostly is consumed in the states that it is produced in and in our country sorghum is majorly produced in just five states.

The **Consumption** of sorghum is also declining with a negative growth rate 2.56. Hence this dire situation should be dealt with immediate actions.

- The government should introduce policies that will not just help promote fine cereals but also aid the promotion of coarse cereals.

- Value addition should be done to the crops.

- Introduction of sorghum in easy to make, convenient foods like flakes, noodles etc should be done as one of the major deterrents in the consumption of sorghum foods is its inconvenience in preparing the food.

- With new companies entering the market with brand new sorghum products, some amount of aggressive marketing should happen for the promotion of sorghum products.

Case study of SAKAS Foods indicated that processing sorghum foods are cost effective and also that there is an impressive market demand. Thus this has gone on to prove that processing sorghum foods is cost effective. Also with increasing awareness of sorghum's benefits to control lifestyle-related disorders and availability of such foods in outlets has led to an increase in its consumption. There is potential in bakery industries, distilleries etc. With

new companies showing a growing interest in the processing of sorghum products, the market is soon expected to be flooded with sorghum products.
Thus introduction of sorghum in foods that appeal more to the youth like pasta, pizza, dosa, idly etc will on one hand escalate the consumption of sorghum to a great extent and on the other increase the nutritive value of junk foods.

After calculation of NPC, it is found out that Sorghum is not export competitive which is surprising as India is among the major producers of sorghum. Hence with the increased usage of HYV seeds in the production of sorghum and after meeting the domestic demand, the produce can be increased so as to meet the export demand in countries like Mexico, Japan etc. Thus with the continued technological development, subsequent reduction in the cost of production and further dissemination of knowledge sorghum can be tried to be exported in future.

APPENDIX

The area, production and productivity of Rabi Sorghum over the last four decades.

YEAR	AREA	PRODUCTION	PRODUCTION
1970-71	6449.0	2285.0	354
1971-72	6905.0	2361.0	342
1972-73	5310.0	1621.0	305
1973-74	6049.0	3145.0	520
1974-75	6305.0	3388.0	537
1975-76	5884.0	2510.0	427
1976-77	5687.0	3166.0	557
1977-78	5924.0	3174.0	536
1978-79	6133.0	3506.0	572
1979-80	6559.0	3927.0	599
1980-81	5628.0	2927.0	520
1981-82	6122.0	3292.0	538
1982-83	6543.0	3276.0	501
1983-84	6254.0	3260.0	521
1984-85	6482.0	3651.0	563
1985-86	6547.0	2925.0	447
1986-87	6216.0	2715.0	437
1987-88	6401.0	3635.0	568
1988-89	5650.0	3108.0	550
1989-90	6076.0	3670.0	604
1990-91	5768.0	3354.0	581
1991-92	4818.0	2389.0	496
1992-93	5417.0	3425.0	632
1993-94	5872.0	4131.0	704
1994-95	5565.0	3091.0	555
1995-96	5640.0	3665.0	650
1996-97	5674.9	3948.1	696
1997-98	5597.6	2565.6	458
1998-99	4751.6	3135.5	660
1999-00	5424.8	3866.4	713
2000-01	4993.4	2968.1	594
2001-02	5322.4	3328.2	625
2002-03	5056.4	2789.7	552
2003-04	4868.2	1837.7	377
2004-05	4993.8	3199.9	641
2005-06	4904.1	3558.0	726
2006-07	4734.4	3444.0	727

2007-08	4264.4	3811.0	894
2008-09	4600.0	4100.0	904
2009-10	4400.0	4200.0	935
2010-11	4309.0	3564.0	827

Table showing the consumption of sorghum over the last four decades.

Market Year	Domestic Consumption	Growth Rate
1970	9106	-13.24%
1971	8222	-9.71%
1972	8804	7.08%
1973	10169	15.50%
1974	10450	2.76%
1975	10174	-2.64%
1976	10524	3.44%
1977	11561	9.85%
1978	11736	1.51%
1979	12048	2.66%
1980	10631	-11.76%
1981	11962	12.52%
1982	10853	-9.27%
1983	11819	8.90%
1984	11502	-2.68%
1985	10397	-9.61%
1986	9066	-12.80%
1987	9500	4.79%
1988	10070	6.00%
1989	12714	26.26%
1990	11679	-8.14%
1991	8299	-28.94%
1992	12294	48.14%
1993	11825	-3.81%
1994	9399	-20.52%
1995	9514	1.22%
1996	10888	14.44%
1997	8182	-24.85%
1998	8690	6.21%
1999	8850	1.84%
2000	7716	-12.81%
2001	8300	7.57%
2002	7150	-13.86%
2003	6700	-6.29%
2004	7200	7.46%

2005	7500	4.17%
2006	7100	-5.33%
2007	7900	11.27%
2008	7200	-8.86%
2009	6600	-8.33%
2010	6800	3.03%
2011	6100	-10.29%
2012	6000	-1.64%

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