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An Analysis of Guar Crop in India

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Report Highlights:

Guar gum has emerged as India's largest agricultural export to the United States on strong demand from the oil/gas extraction industry for hydraulic fracturing of subsurface shale. India is the world's largest producer of guar bean (cluster bean), largely cultivated in semi-arid tracts of Rajasthan under rainfed conditions. A study by CCS National Institute of Agriculture Marketing (NIAM) reveals that the guar bean area and productivity shows sharp fluctuation based on the rainfall during sowing (June/July). Guar prices during the previous season also influence guar planting. Guar beans can be stored for long periods (3-6 years), and thus, stocks maintained by traders/processors play a vital role in price discovery. The bulk consumption of guar bean/gum has shifted from food use to industrial use in recent years.

General Information:

Background

India is the world's largest producer of guar bean (cluster bean) with an estimated 80% of guar bean production, and thus of guar gum. As a result of expansion of the shale oil and gas industry, demand soared and the value of guar gum exports to the United States rose to nearly a billion dollars in 2011, further to $3.4 billion in 2012 and then came down to $1.6 billion in 2013. However, guar bean production, area planted, and yield data are incomplete, and in any current (ongoing) year, production estimates are nonexistent. The absence of reliable and accurate information is reflected in price swings that have taken guar prices to a high of INR 320,000 per metric ton (approximately $6,000 per metric ton) and a low of under INR 50,000 per metric ton in one season.

Recognizing the need for improved market information for this commodity, currently India's largest agricultural export to the United States, the Office of Agricultural Affairs, New Delhi, commissioned a study by the CCS National Institute of Agriculture Marketing, Jaipur, to estimate India's historical guar (cluster bean) and guar gum production, supply, and distribution; and to determine factors that can be used to estimate more accurately current crop area and yield during the course of the vegetative season.

The CCS National Institute of Agriculture Marketing, Jaipur submitted the report "An Analysis of Performance of Guar Crop in India" in April 2014. The study is reproduced below.

AN ANALYSIS OF PERFORMANCE OF GUAR CROP IN INDIA (2013-14)

Prepared by

CCS National Institute of Agricultural Marketing
www.ccsniam.gov.in

Prepared for

United States Department of Agriculture
www.usda.gov

AN ANALYSIS OF PERFORMANCE OF GUAR CROP IN INDIA

April, 2014

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We would like to express our thanks to officials of Department of Agriculture, Government of Rajasthan, Rajasthan State Agricultural Marketing Board, Indian Meteorological Department, Regional Centre, Rajasthan Agricultural Research Institute for providing relevant information on the subject.

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(Dr Hema Yadav and Dr Shalendra)

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Summary

India is the largest producer of Guar and contributes 80 percent of total Guar production in the world. Guar crop is cultivated mainly during Kharif season. Total production of Guar bean in India is estimated to have crossed 2.7 million metric tons during the agricultural year 2013-14.

Guar crop has experienced a remarkable journey from a traditional crop grown on marginal lands mainly for food, animal feed and fodder to a crop with various industrial usages ranging from food, cosmetics, printing, pharma textile, etc. The unique binding, thickening and emulsifying property of guar gum powder obtained from guar seed has made it a much sought after product in international market. The United State of America is the largest importer of Guar and its derivatives from India. What had been a minor crop with limited business interest and virtually no need for analysis became in two years India's largest agricultural export to the United States.

The area, production and yield of the crop are inconsistent due to its overdependence on weather and production confined to limited geographical area largely arid regions Guar bean yields vary by as much as 300 percent year on rainfall and weather conditions, making production forecasting extremely difficult compared to other field crops. The Guar crop does not respond to fertilization or to irrigation, and excess rainfall can adversely affect yields. Hence there is a need for analysis of factors influencing yields to enable more accurate estimation of production during the season and just after harvest.

Guar has also witnessed price volatility and uncertainty owing to limited area of production, increasing demand, speculation, lack of reliable market information system etc. In order to understand better the Indian Guar industry this study has been undertaken for the U S Department of Agriculture with the objective to establish a production, supply and distribution (PS&D) baseline for Guar bean and gum in India, to determine input factors that can be used to estimate production in a given crop year before the crop is harvested, and to enumerate the major market actors in the Guar bean and gum market in India.

The analysis of historical data and of relative share of different states in total production and area shows that Rajasthan is the leading producer but suffers from high fluctuation in production. On the other hand Haryana has significant contribution in terms of production based on high productivity. This has been achieved by using high yielding short duration varieties by farmers and assured irrigation.

The significantly higher prices of Guar in recent time have helped expand the crop to non-traditional regions and seasons. The crop is now being cultivated in dry tracts of Madhya Pradesh, Chhattisgarh, Andhra Pradesh, Karnataka, Tamil Nadu and other parts in *kharif* as well as in summer season. The crop has also been able to compete with other *kharif* crops like groundnuts, pearl millet, sorghum, cotton, etc. The crop is now grown on black, deep, clay type of soils along with sandy and red soils. The requirement of region and season based Guar technology is emerging to enhance production with limited inputs so as to widen the economic returns. The need is also emerging for bridging the gaps between yields obtained on the experimental farm yields and at farmer's field. In view of this the study delves on the cultivation practices, sowing requirements, fertilization, seed treatment, disease management, row spacing ,impact of weather parameters, impact of input technology and

selection of varieties. They study also highlights the experiments in progress in introducing summer crop of guar.

The demand of processed Guar in world market is expected to increase with the expansion of shale oil gas fracking to new countries like China and Russia and scaling up in prominent existing countries like USA along with other uses in food and textile industries owing to increased food safety and health concerns. This makes it relevant to study the supply response of Guar crop particularly when the cultivation of crop is confined to a limited geographical area. The supply response of a crop may be estimated in terms of area, yield and output response. The study focuses on area and yield response. In economic analysis of the dynamics of farm supply response, price is usually considered the most critical factors which influence farmer's production decisions. However, acreage under a crop is also influenced by various factors other than prices.

An attempt has been made to work out the response of prices and other factors on farmer's decisions in allocating area under Guar crop. The simple Nerlovian lagged adjustment model has been considered appropriate to study the supply response of Guar. The estimated coefficient for independent variables included in the model have the signs as predicted theoretically except for relative productivity. The results show that prices and production lagged by one time period and rainfall during the sowing time have a positive influence on acreage under Guar crop while risk associated with the prices and relative productivity of Guar in comparison to other competing crops has shown negative impact on the area under crop.

The coefficient of prices of Guar in the previous season is positive and significant at 1 percent level, showing that the prices prevailing in one period will lead to an increase in the area under Guar crop in the succeeding season. This shows that the farmers are responsive to the market signal which sometime may not be the case in developing economies characterized by large number of small and marginal farmers. In addition to lagged prices, the area under Guar crop cultivated mainly under rain-fed conditions in the states is affected by the rainfall received during sowing time.

The estimate of supply response of a crop depends on acreage and productivity. The acreage under a crop is allocated based on expected prices while productivity is determined by availability of inputs and climatic conditions. The farmers may make substantial revisions in the decision in terms of inputs to enhance yield after allocating land. Hence, it is reasonable to assume that both area and yield are influenced by the expected output price.

Farmers may respond by adopting better technology of production with no change in area or by using more or better quality of inputs. Such responses will change the output without changing the area, something that is hidden in the acreage function. The intensive nature of cultivation will not be revealed by the input application alone, but will also be reflected in the quality of inputs and the timing and the method of application. The yield response of Guar is assumed to be affected by prices and other factors like rain and the production risk association with the crop.

The regression analysis has revealed rainfall as an important factor influencing the productivity of the crop cultivated under rain-fed conditions. The relationship of productivity with various factors other than rainfall like temperature, humidity, intensity of rainfall, etc could not be worked out due to paucity of information and relevant literature required to establish the relationship. However, an

attempt has been made on the basis of review of literature and interaction with the experts to find out the association of different factors on productivity.

Marketing and distribution of Guar: Agriculture Produce Marketing Committee (APMC) markets have an important role to play in the supply chain. The APMC market (also called *mandis*) provides a platform for aggregation and operation for various players operating at the wholesale level like traders, stockists, etc. These markets have peak arrivals of Guar seed in the month of November and December. Majority of the processed product is being exported and only a small quantity is being consumed in the local markets.

Stocks maintained mainly by traders and processors play a vital role in marketing and price discovery of Guar as it can be stored for long period without any significant loss to quality and quantity even under normal conditions. Farmers mainly large and medium have shown some instances of retaining the commodity at farm level in expectation of price hike as farmers are having information on the development of market.

Consumption and demand of Guar seed: Considering the importance of Guar as an export crop, an attempt has been made to work out the quantity of Guar bean (in terms of equivalent of quantity exported) exported and consumed domestically. An estimate has also been made of the Guar bean equivalent being exported to USA to assess the size of US Market, and its importance for Guar and Guar processing industry. The analysis is based on the assumption that the Indian Guar processing industry is realizing 29.25 percent of Guar gum from the Guar bean. The quantity left unaccounted after export to US and rest of the world is considered to be consumed in domestic market.

The insights into the industry reveal that there has been a migration of demand from food grade to industry grade. The emergence of demand of Guar from the US petroleum industry and also the oil fields of Middle East has changed the scenario. Prior to 2005 the major demand from the industry was for food grade Guar gum. The consumption of Guar gum by food industry was around 50% of the total Guar gum consumed. The consumption of Guar gum by oil drilling industry was limited to around 30 percent. But at present the scenario has change and the major consumer of Guar gum is from oil drilling industry while the demand from food industry has reduced to around 20 percent.

The Guar crop is mainly cultivated in Rajasthan under rain-fed condition and is thus influenced to a great extent by the monsoon received in the Guar growing areas during sowing time. Given that guar beans can be stored for 3-6 years, the stocks maintained at different level in the supply chain play a vital role in total availably of the crop for processing and export. An attempt has been made to develop data on carry over stock maintained over year to ensure regular supply of the crop by compiling information from different sources. The marketing of guar at different level is constraint by lack of transparency and market information. In spite of the fact that Guar has assumed importance of stratospheric level, there is no systematic collection and dissemination of market information to the stakeholders.

Presently there is no dedicated organization performing task of collection and dissemination of market information to the stakeholders in public domain. There are discrepancies in data collected. However, the Guar industry is largely driven by private players who have their own mechanism of

survey and collection of information. Such discrete efforts need to be consolidated to from a reliable mechanism of market information and advisor services.

Value addition and processing of Guar seed are the most important components of the market. There is lack of technology, proper research and development efforts, skilled manpower, etc. Processing industry is fragmented and most of the units are operating on small scale. There is a need for consolidation to achieve economies of scale and a stable market for Guar. Guar gum has emerged as India's top farm export overtaking traditional heavyweights rice and cotton and looks set to power into the league of top 10 shipments from the country, due to increasing demand from the US oil and gas industry. A systematic approach to Guar industry by providing training, market information, maintaining stock positions, research and development in processing, adopting better technology in processing and value addition will make India retain its share in international market and remain profitable for farmers.

1. INTRODUCTION

Clusterbean, (Cyamposis tetragomoloba (L.) Taub) commonly known as Guar, is a drought and high temperature tolerant deep rooted summer annual legume of high social and economic significance. The qualities of the crop like high adaptation towards erratic rainfall, multiple industrial uses and its Importance in cropping system for factors such as soil enrichment properties, low input requirement, etc have made the guar one of the most significant crops for farmers in arid areas in India.

Guar is a native to the Indian subcontinent. The crop is mainly grown in the dry habitats of Rajasthan, Haryana, Gujarat and Punjab and to limited extent in Uttar Pradesh and Madhya Pradesh. The crop is also grown in other parts of the world, like, Australia, Brazil and South Africa.

India is the largest producer of Guar and contributes 80 percent of total Guar production in the world. In India, Guar crop is cultivated mainly during Kharif season, with an annual production of around 2 million metric tons. Guar crop has experienced a remarkable journey from a traditional crop grown on marginal lands mainly for food, animal feed and fodder to a crop with various industrial usages. Guar gum is an important ingredient in producing food emulsifier, food additive, food thickener and other Guar gum products. The unique binding, thickening and emulsifying quality of guar gum powder obtained from guar seed has made it a much sought after product in international market.

Guar is the source of a natural hydrocolloid, which is cold water soluble and form thick solution at low concentrations. The guar seed consists of three parts: the seed coat (14-17%), the endosperm (35-42%), and the germ (43-47%). It is from the endosperm that guar gum is derived, which is the prime marketable product of the plant. This spherical-shaped endosperm contains significant amounts of galactomannan gum (19 to 43% of the whole seed), which forms a viscous gel in cold water. Like other legumes, guar is an excellent soil-building crop with respect to availability of nitrogen. Root nodules contain nitrogen-fixing bacteria and crop residues, when ploughed under, improves yields of succeeding crops.

The expansion of uses of guar to new areas like extraction of natural and shale gas has transformed guar in recent years into an important export crop. India is the largest producer of Guar gum and its derivatives. Guar gum is largely an export oriented commodity with about 75-80 percent of total output being exported from the country India was the leading exporter of mucilages and thickeners in the world with a share of more than 73 percent in value terms during 2011. Guar now accounts for around 18 percent of India's total agricultural exports (DGCIS & APEDA, 2012-13).

United States has played a significant role in transforming guar crop and guar processing industry in the country. States has been the largest importing country of guar gum and mucilages and thickeners in recent years. Share of USA in total export of Guar gum from India during 2012-13 was reported to be nearly 60 percent. The same quantity in value terms was more than 81 percent. USA was

observed to be the leading importer of mucilages and thickeners with a share of more than 73 percent in value terms during 2011 (APEDA).

In recent years the crop has acquired great significance due to its use in the oil drilling industry for hydraulic fracturing of oil shale, mainly by United States for its concern for the environment and water contamination. United State is the largest producer of shale gas with a huge reservoir of around 665 trillion cubic feet (Energy Information Administration estimates). In recent years, the production of shale gas has increased many folds in the United States. It increased to 10296572 cubic feet from around 3958313 cubic feet in 2009, an increase of around 2.6 times over a period of 3 years. The growth of shale gas industry in US at such a high pace, presence of other major players like Canada and expansion of shale gas extraction to new territories like China and Russia will push the demand of Guar to new heights which is used as a thickening agent in the fracking process. The use of fast hydrated gum as a key ingredient in the process of fracking has helped consolidate the demand of crop in the international market. Increasing demand of Guar on account of growth in shale gas industry along with other factors has made guar a golden crop

The increased demand has resulted in a strong escalation of the prices of guar beans and products. Nevertheless, the prices of guar has shown uncertainty and volatility as the crop is mainly cultivated under rainfed conditions and its production is confined largely to limited geographical area. In addition to increased prices, the multi utility nature of the crop has generated a lot of interest for the crop among different stakeholder. The trajectory of growth of guar industry has been upward as can be seen from Figure-1. There has been a rapid growth in area, production and value over a decade from 2002 to 2012. The guar industry is poised to continue to grow and develop in future owing to higher focus on research in universities and technical institutes of the world.

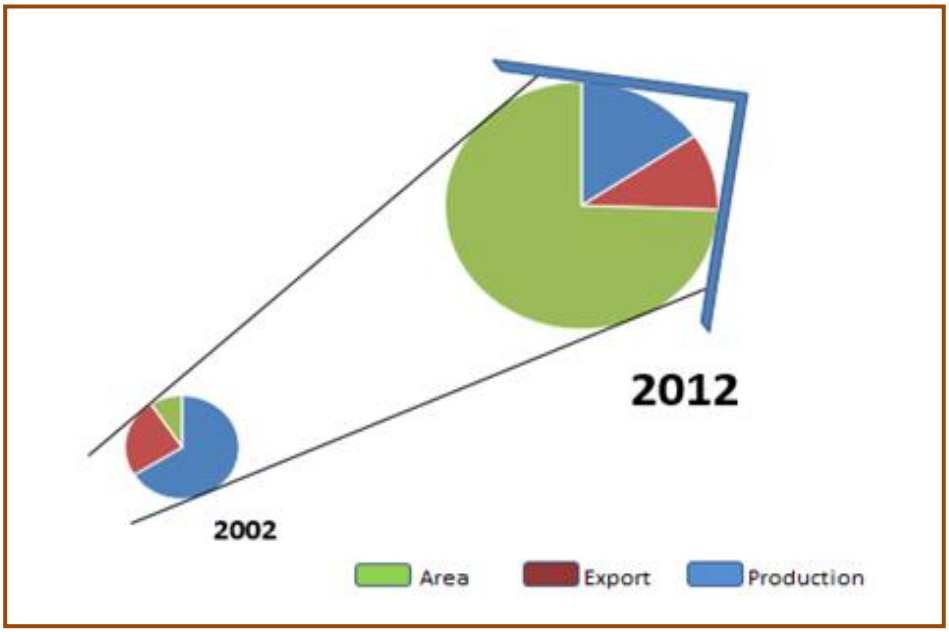

Figure 1. Growth of Guar during last decade

The size of shale gas industry is a major factor in defining demand and prices of Guar in India. The same has been revealed by the increase in prices of the crop in recent years. In the year 2011, imports by various US companies to create stocks anticipating poor supply sparked the speculation and thus price reached to a record high in Indian market. The speculative environment created by the inventories maintained by shale gas industry caused escalation in prices of guar. The prices of guar during the 2013-14 were relatively low probably due to weak demand based on high carryover stock maintained by the US based firms.

1.2 Background of the study

Guar gum is used as a thickening agent and emulsifier in the oil and gas extraction industry for hydraulic fracturing ("fracking") of subsurface shale. Until three years ago it was used almost exclusively in the food processing industry as a thickener and emulsifier, but the research and development by oil and gas industry discovered that Guar gum is the best emulsifier for hydraulic fracturing. As a result of expansion of the shale oil and gas industry, demand soared and the value of Guar gum export rose to nearly INR 212.87 billion in Indian fiscal year (IFY) 2012-13 (April/March) compared to INR 29.39 billion in IFY 2010-11.What had been a minor crop with limited business interest and virtually no need for analysis became in two years India's largest agricultural export to the United States.

The area, production and yield of the crop are inconsistent due to its overdependence on weather and production confined to limited geographical area largely arid regions. Official government production data from the four major producing states (Rajasthan, Punjab, Haryana and Gujarat) are available only with a lag of one year. In addition, Guar bean yields vary by as much as 300 percent year on rainfall and weather conditions, making production forecasting extremely difficult compared to other field crops. The Guar crop does not respond to fertilization or to irrigation, and excess rainfall can adversely affect yields. Hence there is a need for analysis of factors influencing yields to enable more accurate estimation of production during the season and just after harvest.

With Guar products emerging as India's single largest agricultural export in CY 2012, there is a greater need for improved market information for this commodity and an improved ability to estimate production in the current year. The absence of reliable and accurate production and market information is reflected in price swings.

Higher prices for Guar have resulted in production expanding in the traditional states of Rajasthan, Punjab, Haryana and Gujarat as well as into new areas such as Uttar Pradesh and Andhra Pradesh. While the United States is the major buyer, demand for Guar gum from other gas and oil producing countries, notably Russia, Venezuela, and Mexico, is growing, adding to price volatility.

The overall objective is to establish a production, supply and distribution (PS&D) baseline for Guar bean and gum in India, to determine input factors that can be used to estimate production in a given crop year before the crop is harvested, and to enumerate the major market actors in the Guar bean and gum market in India.

In order to understand better the Indian Guar industry this study has been undertaken for the U S Department of Agriculture to:

- To estimate India's historical Guar (cluster bean) and Guar gum production, supply, and distribution
- To identify factors important factors during different stage of cultivation of guar crop to facilitate more accurate estimation of current year yield
- To assess consumption of guar bean and products in various usage/sectors
- To identify major buyers and processors of Guar beans in India

1.3 Approach and Methodology

To meet the objective of establishing a production, supply and distribution baseline for Guar and Guar gum the approach of the study is as follows:

1.3.1 Collection of information on production, supply and distribution balances for Guar in India from 2000 to 2012.

- Collection of state-level area and production data for the period 2000 to 2012, covering all states in which Guar is produced commercially.
- Utilization of data from the Government of India's Directorate General of Foreign Trade (DGFT) and APEDA on foreign trade to establish exports of Guar gum, and apply a conversion factor to these exports to establish a Guar bean equivalent export figure.
- Estimation of annual carryover stocks for the period 2000 to 2012.

1.3.2 Determination of factors for estimating current crop yield potential of Guar beans during the growing season.

- Interview the Guar research institute in Rajasthan and members of the Indian Guar Gum Manufacturers Association to obtain information about the agronomy of Guar production.
- Identification of list of factors (e.g., precipitation, ambient temperature, soil type) that influence Guar yields, and associate with that list parameters that can be used to estimate current crop year yield potential.

1.3.3 Identify major buyers/processors of Guar beans in India

- Interview the processors, buyers and sellers
- Collect information from major Spot and commodity markets

1.4 Data Source

In order to produce a report on India's Guar bean production and end-of-year carryout stocks, including state-level area and production data. The data from the following sources have been used:

- Interviews with Guar producers, traders and guar processors including Indian guar gum manufacturers association.
- Interviews and data collection from Rajasthan State Departments of Agriculture on Guar production.
- Data from Agmarknet, Krishi Rajasthan
- DGFT data on annual (calendar year) exports of Guar gum has been compiled and to Guar bean equivalent using an appropriate conversion factor has been determined. This is based on following data source:

- DGFT and APEDA data on Guar gum exports 2000-2012.
- Interviews with processors of Guar gum to determine an appropriate conversion factor from Guar beans to Guar gum that represents an industry average.

The study with the focus on determining factors for estimating yield potential of Guar beans during the growing season has used regression analysis to identify the key factors. In addition, opinion of experts was also obtained to identify the factors which could not be assessed through regression analysis. These factors will provide a basis for estimating Guar bean production in the growing season based on changes in the parameters (eg. fluctuations in weather conditions). The data source and methodology is as follows:

- Interview with Scientists working at All India Coordinated Research Project on Guar, Durgapura and CAZRI, Jodhpur
- Interview with the members of the Indian Guar Gum Manufacturers Association
- Review of literature of Scientific papers on agronomy of Guar
- Data from Indian Meteorological Department (IMD) on key weather factors (e.g., precipitation, ambient temperature,) that may potentially affect Guar yields
- Use of econometric tools to understand the key factors to be used to estimate current crop year yield prospects.

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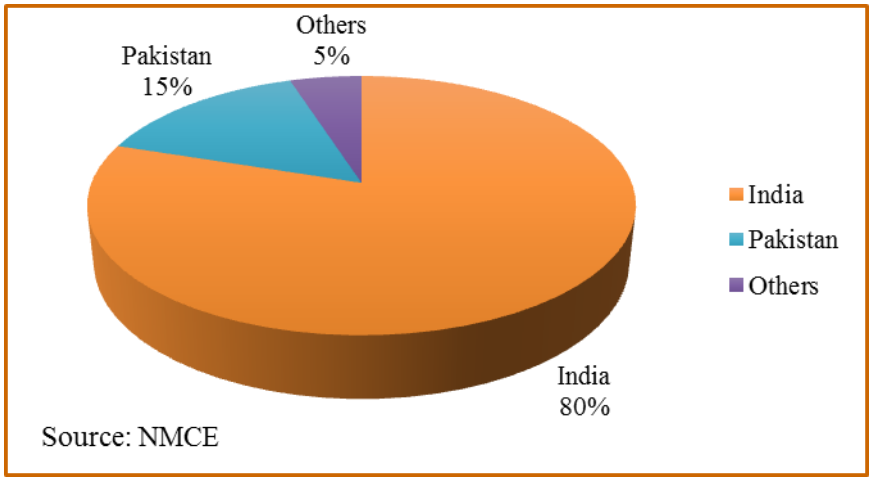
2. PROFILE OF GUAR

Guar is a crop of arid and semi-arid areas cultivated in north and northwest parts of India and east and south-eastern part of Pakistan. In Pakistan, Guar seed is mainly produced in Punjab and Sindh province with about 80 percent of total Guar acreage under irrigation. On the other hand production of Guar in India is mainly confined to arid zones of Rajasthan and parts of Gujarat, Haryana and Punjab. Guar in Rajasthan is mainly cultivated under rain-fed conditions.

Total production of Guar bean in India is estimated to have crossed 2.7 million metric tons during the agricultural year 2013-14 due to good weather conditions in the major Guar producing areas in India. With a moderate production of 250,000 metric tons in Pakistan which is another important guar producing area, the total global production of Guar bean is estimated to have crossed 3 million metric tons during 2013-14. Presently, India accounts for more than three-fourth (or nearly 80 percent) of the total world Guar bean production (Figure-2). The other major producers of Guar are Pakistan, USA, South Africa, Malawi, Zaire and Sudan.

Figure 2. India's share in world Guar production in 2013-14



2.1 Guar bean Production in India

Rajasthan is a major guar producing state in India followed by Haryana and Gujarat and small contributions from the states of Uttar Pradesh, Punjab and Madhya Pradesh. The share of different states in total production of Guar bean in India worked out on the basis of triennium average 2011-12 is presented in Figure-3. The figure suggests that 95 percent of the Guar bean production in India is coming from two states only namely Rajasthan and Haryana. Three-fourth is being contributed by Rajasthan alone.

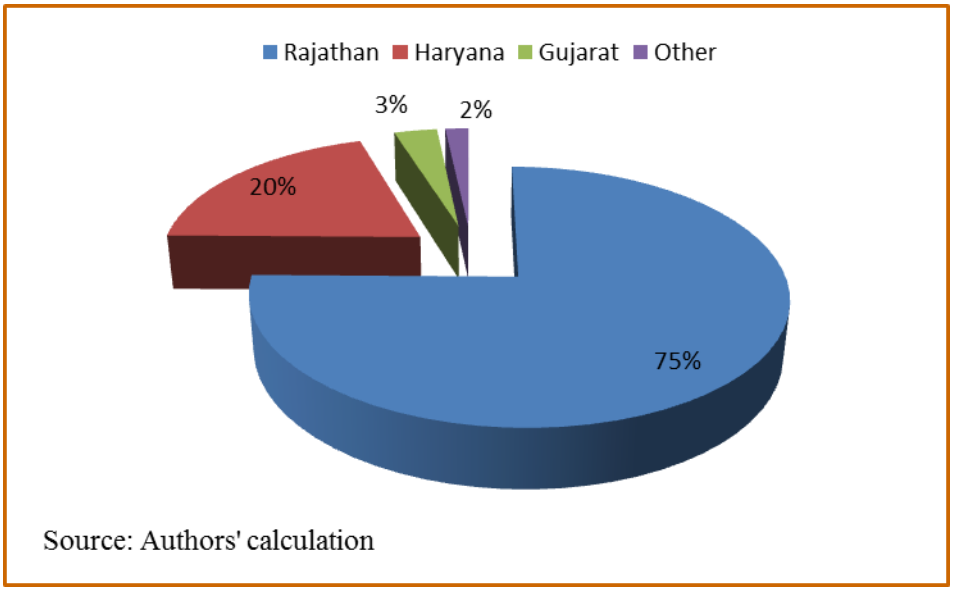


Figure 3. Share of different states in guar bean production in India

The production of Guar in India has seen wide variation during in recent past ranging from 0.2 to 2.7 million metric tons due to the over dependence of the crop on monsoon precipitation (Table-1). Only 0.2 million metric tons of Guar bean was produced from an area of nearly 1 million hectares during 2002-03 due to severe drought. A harvest of 2.7 million metric tons from an area of 5.6 million hectares was achieved in 2013-14 due to good monsoon. In spite of the fluctuation in the area and production of Guar, an increasing trend has been observed during last decade in acreage under the crop and production of Guar bean in India (Figure-4).

Table 1. Area, production and yield of guar in recent past in India

Year	Area (000 ha)	Production (000 tons)	Yield (kg/ha)
2000-01	3497	659	188
2001-02	2903	1090	375
2002-03	975	199	204
2003-04	2854	1513	530
2004-05	2867	903	315
2005-06	2956	1059	358
2006-07	3344	1169	350
2007-08	3472	1789	515
2008-09	3863	1936	501
2009-10	2996	595	199
2010-11	3382	1965	581
2011-12	3444	2218	644
2012-13	5152	2461	478
2013-14#	5603	2715	485
2014-15*	4255	2415	567

Source: Ministry of Agriculture, GOI

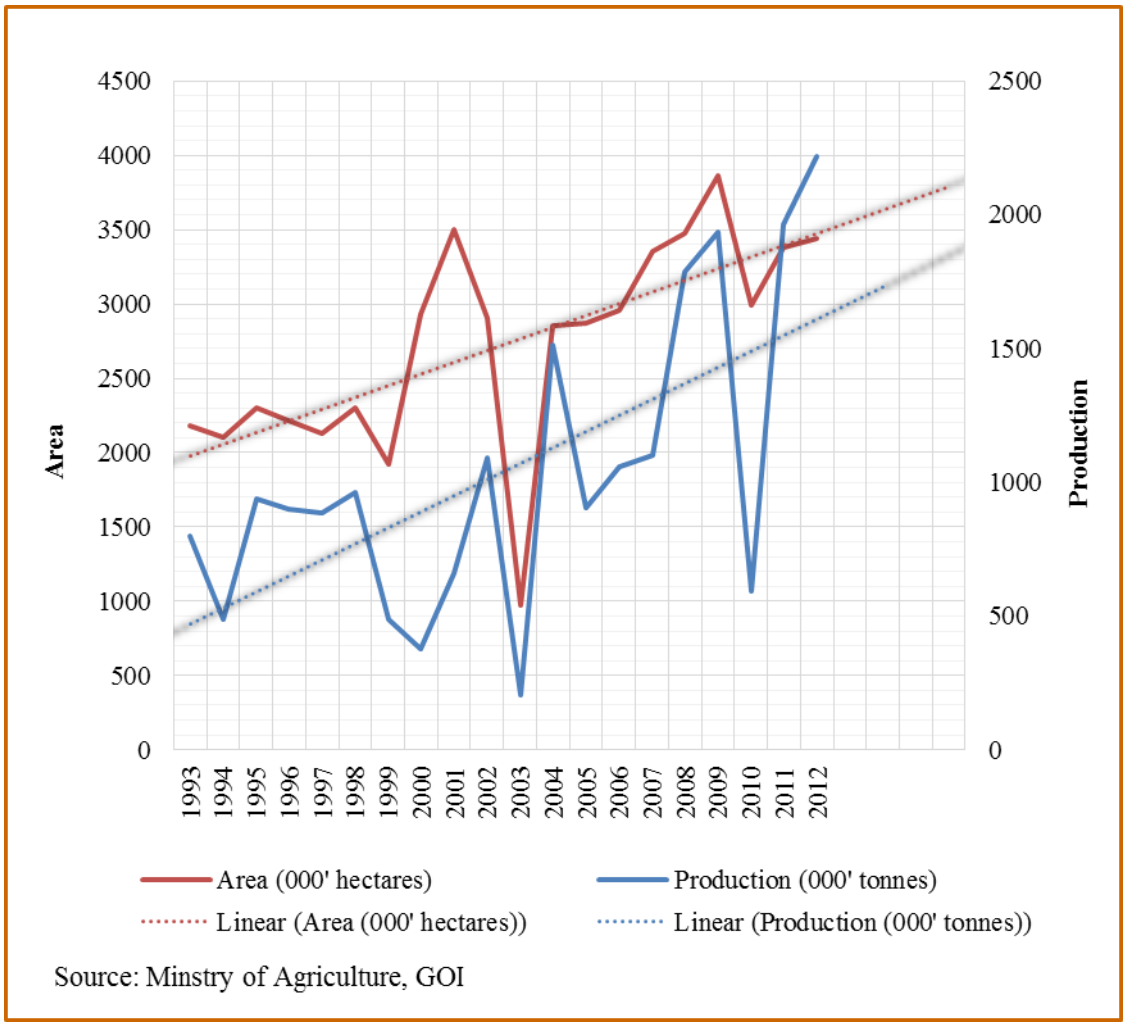
#Figurers for 2013-14 at all India level are not available and hence rough estimates have been worked out on the basis of area and production in Rajasthan and its relative position in guar in India

**Authors estimate based on regression analysis for area and previous three year average for productivity*

Since the prices remained relatively low during 2013-14 at Rs 4500 per quintal, there are predictions that the area under guar may come down to 3.50 million hectares during the current *kharif* season, a decrease of 1.65 million hectares over previous year. Prices being an important factor to influence the farmers decision regarding allocation of area, there is every possibility of some correction in area under guar crop due to low prices but this may not be to the tune of 1.65 million hectares as predicted by some trade observers. As there are factors other than prices to influence the farmers decision like relative profitability, traditional cropping pattern, resource availability, availability of irrigation and markets. An estimate taking these factors in addition to prices into consideration suggests that the area under Guar in the current *kharif* season should be somewhere in the range of 4.25 million hectares. A low-input crop like guar may stand competitive against rest of the leading *kharif* crops even at low prices of Rs 4500. Marginal fluctuations in the relative profitability on account of fall in price coupled with other compulsions like resource unavailability may not encourage farmers to shift to other crops. Availability of resources (like irrigation) and assured markets are also important factors to influence the acreage allocation decision of the farmers. The area under guar crop may be grouped into three categories. The traditional farmers taking guar under rainfed conditions are least likely to shift to other crops due to resource constraints. This category broadly covers an area of 3 million hectares. Traditional farmers taking guar under irrigated condition (e.g. Sri Ganganagar and Hanumangarh are moderately likely to shift to other crops) Non-traditional irrigated resource rich farmers from state like Haryana and Gujarat are most likely to shift to other crop. But this factor may also have limited impact as the increase in the area under guar during last season was primarily due to increase in area under guar in Rajasthan state. Traditional cropping pattern based on the technical knowledge acquired by the farmers may compel them to continue with same crops. The acreage response analysis based on last year prices suggests that the area under guar in the current *kharif* season should be somewhere in the range of 4.25 million hectares.

The progress of Guar bean in India has been presented in Figure-4. It is apparent from the figure that production is increasing at a faster rate than the area under cultivation of Guar due to increase in the productivity. It is expected that the area under cultivation of Guar in India will come down during current year i.e. 2014-15 to around 4.25 million hectares but it is expected to improve in coming years on account of better prices based on increasing demand for factors like use of guar gum in shale gas industry, low-input requirement and relative profitability of crop even at lower prices.

Figure 4. Area and production of Guar in India



Source: Minstry of Agriculture, GOI

2.2 Guar Seed Production in Rajasthan

Rajasthan is largest Guar bean producing state in India. The crop is cultivated in *Kharif* season and sowing starts with the onset of monsoon in the month of June/July. Guar is being grown mainly in arid districts of western part of Rajasthan. A production of 2.0 million metric tons was achieved from an area of 4.5 million hectares in Rajasthan during 2012-13. However, the advance estimates of Department of Agriculture, State Government of Rajasthan suggest that a further increase in area to 4.9 million hectares will help state in achieving a production of more than 2.2 million metric tons during 2013-14. Nearly 90 percent of the area under Guar crop in the country is being contributed almost consistently by Rajasthan state though the same is not true for production which has shown lots of variation owing to over dependence of the crop (in terms of area and productivity) on monsoon (Table-2).

Table 2. Area, production and yield of Guar in Rajasthan

Year	Area		Production		Yield (kg/ha)
	(000 ha)	Percent of Total Area in India	(000 tons)	Percent of Total Area in India	
2000-01	3056	87.38	481	73.01	157
2001-02	2413	83.12	763	70.01	316
2002-03	557	57.03	28	14.07	50
2003-04	2278	79.82	1163	76.85	511
2004-05	1944	67.80	368	40.74	189
2005-06	2445	82.73	566	53.45	231
2006-07	2808	83.98	658	56.27	234
2007-08	2842	81.86	1244	69.56	438
2008-09	3316	85.85	1261	65.14	380
2009-10	2581	86.16	201	33.80	78
2010-11	3001	88.73	1546	78.66	515
2011-12	3000	87.10	1847	83.29	616
2012-13	4526	NA	2023	NA	447
2013-14*	4924	NA	2201	NA	512

Source: Department of Agriculture (DoA), Government of Rajasthan
**Second Advanced Estimate*

The details of the leading Guar producing districts in Rajasthan state is given in Table-3. The table reveals that Bikaner is the leading district both in terms of area (29.1 percent) and production (28.5). The districts of Hanumangarh (16.1 percent), Sriganganagar (10.6 percent) and Churu (9.1 percent) are the other three major producers. These four districts together contribute nearly three-fourth of the total Guar production in the state.

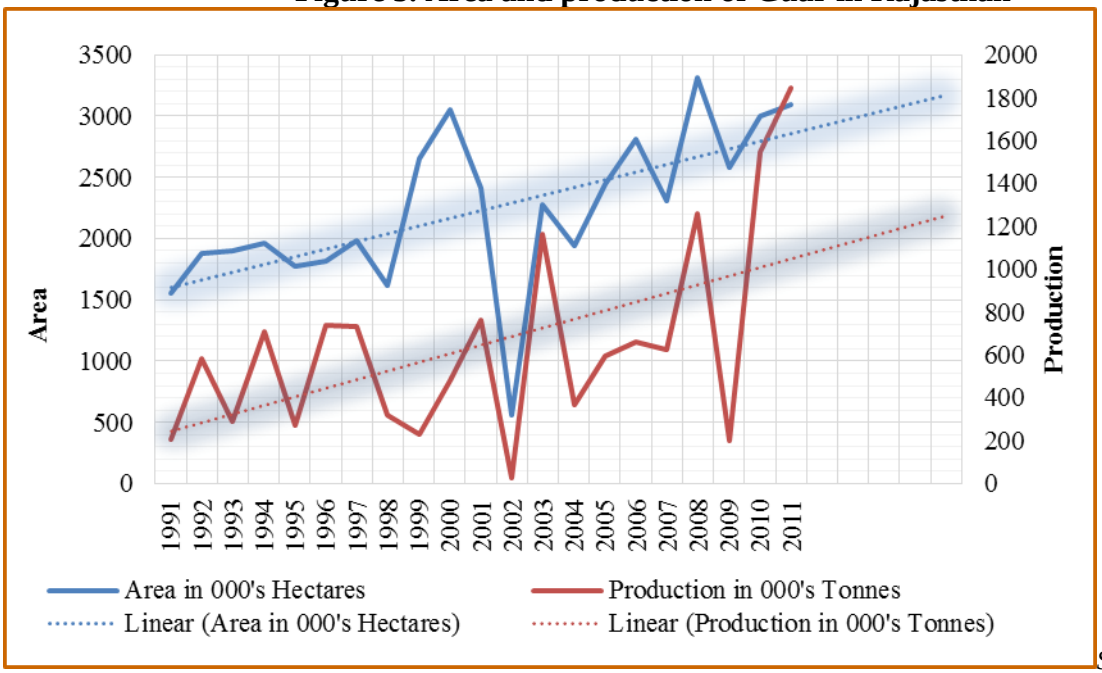
Table 3. Leading Guar producing districts in Rajasthan (TE 2011-12)

Districts	Area (%)	Production (%)
Bikaner	29.1	28.5
Hanumangarh	9.6	16.1
Sri Ganganagar	5.2	10.6
Churu	10.6	9.1
Jaisalmer	13.9	7.5
Barmer	13.8	6.0
Jodhpur	4.6	5.0
Sikar	2.5	4.0
Jhunjhunu	2.0	2.9
Nagaur	2.8	2.5
Jaipur	1.2	2.0
Jalore	1.4	1.5
Alwar	0.6	1.2
Pali	1.0	1.1
Bhilwara	0.2	0.2

Source: Agricultural Statistics (2011-12), Rajasthan

Area and production of Guarbean in Rajasthan for the period 1991-2011 is shown in Figure-5. The lowest production of Guarbean in Rajasthan was recorded at 28,000 tons during 2002-03 (which was a drought year) while the production has increased in recent years. The figure reveals the high degree of fluctuation over year is observed in the production of Guarbean in Rajasthan. This may be due to overdependence of crop on rainfall.

Figure 5. Area and production of Guar in Rajasthan



Source: Department of Agriculture, Rajasthan

2.3 Guarbean Production in other States

In addition to Rajasthan, Guar is also cultivated in Haryana, Gujarat, Uttar Pradesh and Punjab. In terms of area, Haryana and Gujarat are comparable but Haryana has made significant growth in production in recent years due to higher productivity. The latest available official statistics reveal that the production of Guarbean in Haryana has ranged from 91,000 tons in the year 2002-03 to 602,000 tons in 2008-09 (Table-4). The productivity has ranged from 435 kg/ha during 20003-04 to 1627 kg/ha in 2008-09. Productivity in 2011-12 was estimated at 1350 kg/ha against the national average productivity of Guarbean of 644 kg/ha only. The high yielding and short duration varieties developed by Haryana Agricultural University, Hissar viz.; HG 365, and HG 563 and its extensive use by farmers has supported higher productivity in the state. Increasing area under cultivation of Guar in Haryana will help in augmenting the overall production of Guar from India. In Gujarat, a production of 33,000 metric tons was achieved from an area of 37,000 hectares during 2011-12.

Table 4. Leading Guar producing states in India

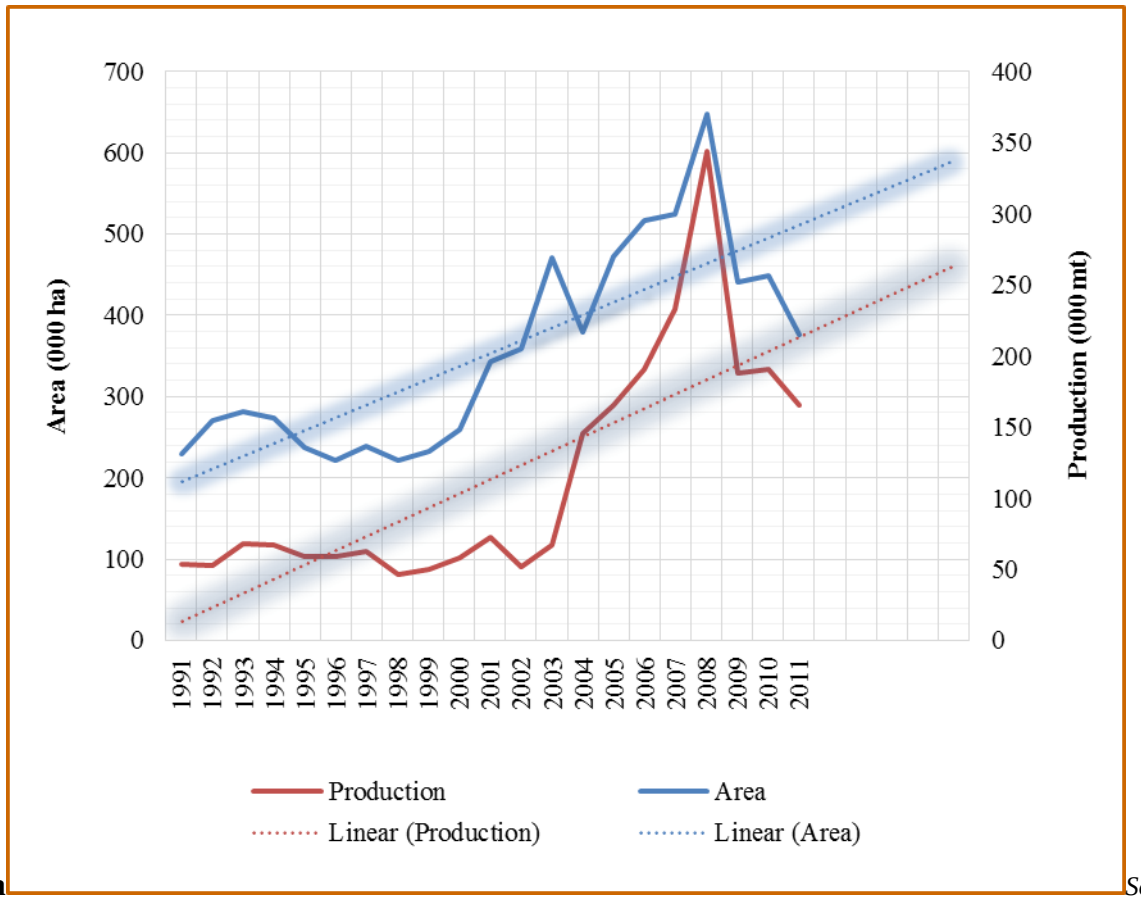
Year	Haryana			Gujarat		
	Area (000 ha)	Production (000 MT	Yield (kg/ha)	Area (000 ha)	Production (000 MT	Yield (kg/ha)
2000-01	148	102	689	273	60.9	223
2001-02	196	127	648	263	112	424
2002-03	205	91	444	213	65	306
2003-04	269	117	435	266	204	766
2004-05	217	254	1171	214	157	733
2005-06	270	289	1070	188	108	575
2006-07	295	334	1132	205	83	404
2007-08	341	395	1200	196	130	662
2008-09	370	602	1627	150	53	353
2009-10	252	329	1305	133	45	337
2010-11	256	333	1300	125	73	586
2011-12	215	290	1350	37	33	892

Source: Department of Agriculture, Haryana & Department of Agriculture, Gujarat

The growth in area, production and yield of Guar seed in Haryana during 1991-2011 is presented in Figure-6. The figure reveals an increasing trend in area and production over years though declining trends are observed during recent years. This may be due to the fact that guar may not find itself competitive at lower prices in area like Haryana and Gujarat with availability of resources mainly irrigation and availability of more remunerative options like cotton in these areas. High fluctuation in prices with no minimum price guarantee as the crop is not covered under MSP system may go

against the crop mainly in area where crops covered under MSP system are available like groundnut and cotton in Haryana and Gujarat.

Figure 6. Area and production of Guar in Haryana



Source: Department of Agriculture, Haryana

The share of different states in total Guar production and area is depicted in Figures-7 and 8, respectively.

Figure 7. Share of different states in production of Guar

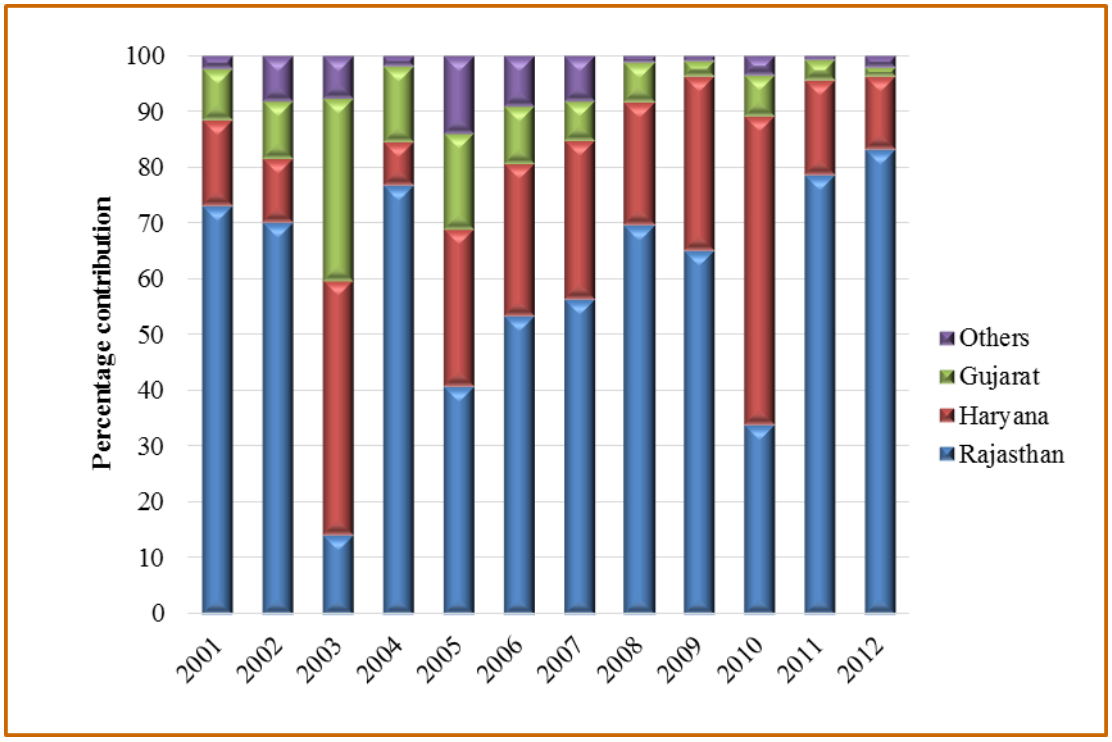
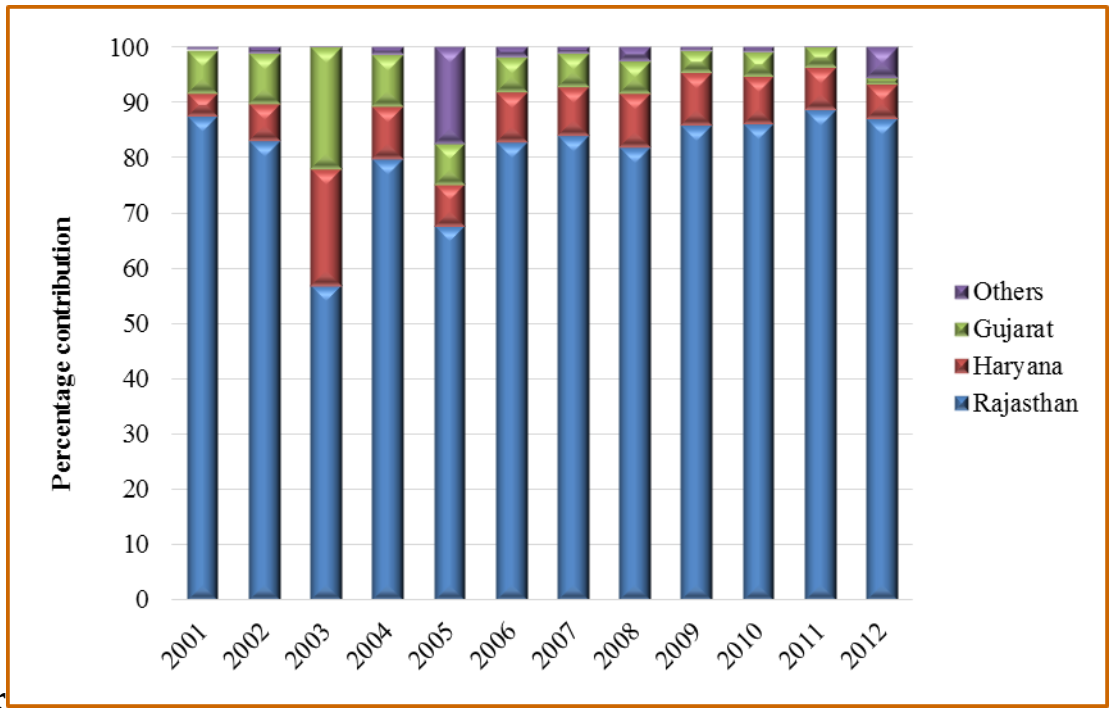


Figure 8. Share of different states in area under



Guar

The crop considered generally for marginalised land has developed a lot of curiosity among farmers mainly from the non-conventional states after sudden rise in the prices owing to its demand in international market mainly USA. The analysis of the relative share of different states in total production and area shows that Rajasthan is the leading producer but suffers from high fluctuation in production. On the other hand Haryana has significant contribution in terms of production based on high productivity. This has been achieved by using high yielding short duration varieties by farmers and assured irrigation. The Rajasthan has shown the lead in production but with high fluctuation in its share. On the other hand the share of different states has been observed to be almost uniform over years. It is also revealed from the chapter that production of Guar in Rajasthan is relying heavily on monsoon while in other state the production is not that much affected by rainfall due to assured irrigation.

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3. GUAR CULTIVATION PRACTICES

Guar (*Cyamopsis tetragonoloba*) is a drought tolerant, multi-purpose legume crop cultivated mainly in the *kharif* season in arid environment. A crop that can be raised in poor soil and require lower agronomic inputs is currently cultivated predominantly in arid regions of northern-western parts of India. It thrives well on light texture, sandy to sandy loam soils receiving 300-500 mm annual rainfall. The significantly higher prices of Guar in recent time have helped expand the crop to non-traditional regions and seasons. The crop is now being cultivated in dry tracts of Madhya Pradesh, Chhattisgarh, Andhra Pradesh, Karnataka, Tamil Nadu and other parts in kharif as well as in summer season. The crop has also been able to compete with other kharif crops like groundnuts, pearl millet, sorghum, cotton, etc. The crop is now grown on black, deep, clay type of soils along with sandy and red soils. There is a need for developing region and season based Guar crop production techniques with optimum use of inputs to increase economic returns. The need is also emerging for bridging the gaps between yields obtained on the experimental farm yields and at farmer's field. In view of this, an attempt has been made in the following sections to better understand the various issues related to the crop and its cultivation.

3.1 Morphology

Guar is an important leguminous annual crop also called as "clusterbean" for its pattern of pod arrangements in clusters. It grows upright, reaching a height of 2 to 3 meters. It has a main single stem with either basal branching or fine branching along the stem. It is a robust, bushy, semi-upright type of plant. Guar has well developed tap root system. Stems and branches are angular, grooved, forked hairs, sometimes glaucous. Guar has branched and un-branched growth habit. It has pointed saw-toothed, alternate, trifoliate leaves with small purple and white flowers borne along the axis of spikelet. It bears hairy pods in clusters of 4 – 12 cm length each pod with 7 to 8 seeds. Seed is hard, flinty, flattened, ovoid and about 5 mm long. Seeds are white, grey or black in colour. Germination is epigeal type. There are both short and tall statured cultivars.

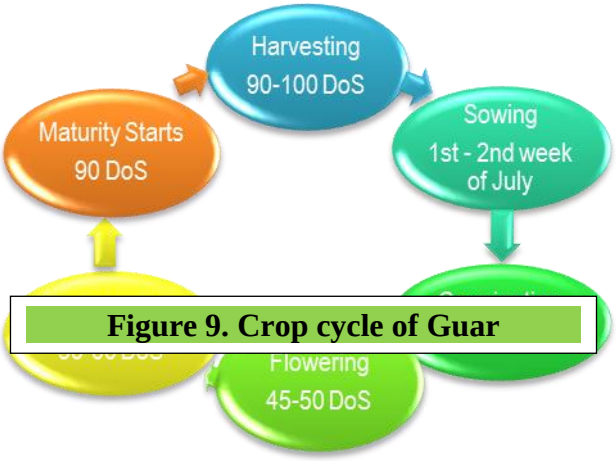

Figure 9. Crop cycle of Guar

This legume develops root nodules with nitrogen-fixing soil bacteria rhizobia in the surface part of its root system. Its leaves and stems are mostly hairy. Its fine leaves have an elongated oval shape (5 to 10 cm length) and of alternate pattern. Clusters of flowers are of white to purple colour. The developing pods are rather flat and slim. Usually, mature seeds are white or gray, but in case of excess moisture they can turn black and lose germination capacity.

3.2 Crop Cycle

Guar is a three-four months crop. From sowing to harvesting it takes about 90 to 110 days. Figure-9 exhibits the major stages of Guar crop cycle. Cycle starts with sowing by first to second week of July. Germination takes place in 4 to 6 days of sowing. Guar is an indeterminate plant showing continuous flowering and poding even upto 80 to 85 days of sowing, if soil moisture is available. However, in general flowering stage starts after 40 to 60 days of sowing (DoS). The pod formation takes place after 50 to 70 days from the date of sowing. Pod matures in 80 to 90 DoS. The harvesting of the crop begins when 90 percent pods are matured roughly 90 to 110 DoS (depending on the variety, soil and climatic conditions).

3.3 Climate

Guar is a photosensitive crop and requires specific climatic condition to grow. For proper germination soil temperature ideally should be around 20 to 25^0C, long day period for vegetative growth and short day period for flowering and pod formation. Being a drought tolerant crop it performs well under arid and semi-arid condition.

In arid condition Guar grows as rain fed crop which requires 300 to 400 mm rainfall in 3 to 4 spells. It grows under wide range of rainfall from 300 to 550 mm, but heavy rainfall invites many diseases. Guar crop performs better in warm climate and grows well in sub-tropics during summer. It can tolerate high temperature even upto 40^0C.

The seed is normally sown in second week of July after rainfall starts. Sowing may get extended upto to August depending on rainfall and is harvested during October and November. It is usually a 90 to 110 days crop. For getting better yield, germination is very important that makes the basic phase of Guar life cycle. Germination is dependent on different factors like seed viability, seed size, seed vigour, soil type, soil moisture, soil temperature and relative humidity. Bolder seeds give higher germination compared to small or medium sized seeds. Bolder seeds may give better shoot length and higher dry matter production. Maximum germination occurs at 25 to 30^0C and it takes about 6 days for complete germination. Guar seeds are known to germinate only after sufficient imbibition, approximately twice their original weight. Guar is not able to germinate well under high saline and submergence conditions. Pre-soaking of Guar seed in good quality water for 2 hours followed by half an hour shade drying may enormously increase germination percentage.

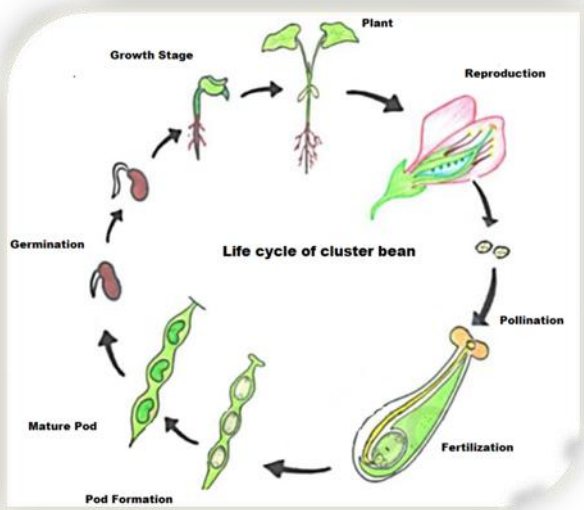

Figure 10. Life cycle of Guar

3.4 Soil

Guar can grow in different type of soils but light textured sandy soils are more suitable for the crop. It performs well on medium-fertile, medium textured; un-logged conditions with neutral pH and well-drained subsoil. Soils with pH 7.0 are considered best for Guar production than acid soils. Guar is a moderately salt tolerant crop. Increase in soil salinity affects the nodulation and reduces pod formation and also yield. Being a legume crop it has ability to fix extra nitrogen in the soil so that it can perform well even in poor fertile soil and nutrient depleted soil. Guar has the ability to fix nitrogen to the tune of 30-40 kg/ha.

3.5 Land Preparation

As such no seedbed preparation is required but for good seed germination two or three ploughings of the field is sufficient for fine tilth which is helpful to the plant in early growth for ample soil aeration and root development. Each plough is followed by planking. At the time of sowing field should be well drained and free from weed to ensure good germination.

3.6 Sowing Requirements

3.6.1. Sowing Method

In India, farmers sow Guar mainly by traditional method of broadcasting. Broadcasting is done manually spreading seed over the soil surface. After broadcasting the seeds, one ploughing is required for proper seed incorporation in the soil. In this method inter and intra row spacing is not followed which creates problem in intercultural operations like hoeing, weeding and removing excessive water in the field. Strategy for proper line and row spacing may help in enhancing the productivity of the crop. Line method normally is done by seed drill which ensures sowing with proper spacing and depth. This method results in good germination and proper weed management and drainage of excess water in the field.

3.6.2 Time of sowing

Sowing time basically depends on availability of rains (30-40 mm at a single stance) and closely follows monsoon rains in the *Kharif* season. Studies indicate that yield is reduced considerably when sowing is delayed to last week of July or first week of August. First to second week of July is the ideal time of sowing for normal crop in arid Rajasthan (Table-5). However, for Haryana, it is end of June to first week of July and first fortnight of August for Gujarat.

Table 5. Optimum sowing time for Guar in different seasons in Rajasthan

Season of Crop	Sowing Time
Summer Crop	25 February to 15 March
Kharif Crop	First to Second week of July after effective monsoon shower

3.6.3. Spacing

Spacing is required to ensure proper utilisation of inputs like nutrients, moisture and light resulting in better production performance of the plant. The sowing strategy involves inter and intra row spacing. The spacing depend on the optimum plant stand/ population required for different regions having varied rainfall intensities.

Trials on sowing methodologies conducted under the aegis of National Network Research Projects on Arid Legumes reveal that the recommended spacing should be 10-15 cm plant to plant distance in a row and 35-60 cm row to row distance on the basis of rainfall, soil type and inputs availability. For instance, for low rainfall (200-350 mm) zones like Jaisalmer, Barmer, Bhuj, Jodhpur, etc., optimum plant population is 110,000 plant/ha, the same can be obtained with sowing strategy of 60 x 10 cm (inter and intra row spacing). Similarly, for the regions particularly semi-arid, having moderate rains (450-500 mm), the optimum sowing strategy has been found to be 45 x 10 cm, which may give required plant population of 150,000 plant/ha. For those regions having still higher rainfalls (550-600 mm) planting pattern of 30x 10 cm has been observed optimum and maximum grain yield can be harvested with 200,000 plants/ ha. All these strategies are for branching type behaviour of varieties. However, for the varieties having un-branched growth pattern with main shoot only (RGC-1066, RGC-1031), the optimum plant spacing having been observed to be 25 x 10 cm. Under late sown conditions, close planting from more seeds and closer interspacing have proved optimum. The plant population with respect to location and rainfall is shown in Table-6.

Table 6. Plant population with respect to location and rainfall

Inter and Intra Row Distances (cm)	Locations	Rainfall (mm)	Plant Population (000/ha)
60 x 10	Jodhpur, Bikaner (Arid)	200-350	110 plants
45 x 10	Durgapura (Semi-arid)	450-500	150 plants
30 x 10	Agra (Semi-arid)	550-600	200 plants

Source: D Kumar, Guar International Conference 2013, Jaipur
Note: under normal sown conditions, invariably a plant population of 125000-150000 plants per hectare is optimum at 45 cm spacing for branched type varieties. In late sown condition, inter row spacing of 30 cm was observed better than 45 cm.

3.6.4. Seed Rate

Seed rate also depends on variety, purpose and time of sowing. Generally 10-12 kg seed per hectares is recommended for spreading type varieties whereas 15-16 kg /ha for un-branched varieties. In late sown conditions more seed is applied and lines are sown closer. Yadav et al (2002) at Bawal and Yadav et al (2003) at Hissar, while working on early maturing Guar variety HG 365 recommended 12-15 seed per hectares depending on the soil types (Table-7).

Table 7. Effect of seed rate on yield and quality of Guar seed cv HG 365

Seed Rate (kg/ha)	Seed Yield (tons/ha)	Gum Yield (tons/ha)	Gum (%)	Protein (%)
10	1.430	0.446	31.24	39.13
15	1.641	0.509	31.02	28.86
20	1.567	0.470	29.99	27.89
25	1.528	0.456	29.85	27.35
CD at 5%	0.015	--	0.71	0.36

Source: Yadav et al (2003)

3.6.5. Seed Treatment

Seed treatment is essential for checking early seedlings mortality and development of diseases at later stages.

a) For killing the spores of dry root rot fungus, seed is treated with Ceresan or Thiram at the rate of 3 gm/kg seed.

b) Seeds can be treated with Imidachlorpid at the rate of 6 ml/kg seed to control sucking pest like Jassids and Aphids.

c) Immersion of seeds in hot water at 50^0C for 10 minutes followed by drying at room temperature before sowing helps in killing fungus mycelium and inactivating their spores.

3.7 Inoculation of seeds

Guar is a legume crop and its roots bear nodules with special kind of bacteria that converts atmospheric free nitrogen to fertilizer available form. This symbiotic relation between bacteria and root nodules helps to reduce the cost of nitrogen fertilizer for crop. Therefore, to maintain the population of bacteria in the soil with respect to growth of plant seeds of Guar are to be inoculated with these bacteria before sowing. This is done by preparing a 10 percent sugar or *gur* solution in boiling water. This sugar solution is allowed to cool. After cooling, 3-4 packets of Guar bacterial culture (Bradyrhizobium sp.) are mixed to make a thin paste. This paste is coated over to the seed. Seed is dried under shade for 30-40 minutes before sowing.

3.8 Moisture and water requirement

Guar is a drought-tolerant summer legume that requires only 300-400 mm annual rainfall. Adequate moisture ensures maximum production of forage and grain. Areas with low humidity are best for growing Guar as grain crop. Guar is highly sensitive to water logging throughout development period. Drainage is very important during *kharif*. The crop responds well to supplementary irrigation. The seed protein content improve when irrigation is given at 50-60 days of sowing but the irrigation at later stages deteriorate the seed quality.

3.9 Fertilization

3.9.1 Effect of nitrogen

Being a leguminous crop, it does not respond much to nitrogen, yet a small starter dose (20 kg N/ha) stimulates growth of the plants in early stages. Application of small dose of nitrogen improves the nodulation and nitrogen fixation in Guar whereas application of excessive amounts of nitrogen results in slow nitrogen fixation process. Application of 20 kg N/ha results in higher grain and straw yield. On sandy loam soil it leads to significant increase in physiological parameters like crop growth rate, leaf area index, yield attributes, grain yield and stalk yield of Guar.

3.9.2 Effect of phosphorus

The application of phospharic fertilizer is important for effective nodulation, bolder seed size and consequently improved yield. Application of phosphorus helps in better plant growth lead by better root system (elongate) and increased number of seeds per pod and per 1000-seed weight. Application of 40kg P_2O_5/ha increase the seed and stalk yield, dry matter accumulation, crop growth rate, leaf area index and yield contributing characters *viz,* number of pods per clusters, number of pods per plant and seed yield per plant. In sandy loam soil a dose of 30 kg/ha P_2O_5 is found as optimum and economical. Higher application of phosphorus results in lowering of gum content. Application of 20 kg P2O5 per hectare to Guar increased both the gum and protein content in seeds. Inoculation or 40-60 kg P_2O_5 per hectare increases the protein content but reduced the gum contents.

3.9.3 Effect of Zinc

In general, arid zoned/ rain-fed soils are deficient in micro nutrients particularly Zinc and Iron, hence same must be ensured through soil application. Results of coordinated trails over locations and years

indicate that Guar responds very well to ZnSO4 upto 25-30 kg/ha. Hence it is recommended to supply basal dose of 25 kg ZnSO4/ha. Zn has been found to increase earliness and gum content. It also provides resistance towards BLB disease to some extent.

Studies on the effect of micro-nutrients conducted at Hissar, Bawal, Durgapura and Gwalior revealed that at all the locations one spray of 0.5 percent $ZnSO_4$ either at 25 or 45 DoS gave significantly higher seed yield than control, but statistically equivalent to soil application of $ZnSO_4$@ 25 kg/ha except at Hissar where 0.5 percent $ZnSO_4$ spray proved better than soil application (Table-8). $FeSO_4$ had no effect on the seed yield of Guar at Hissar and Bawal but significant response was observed at Durgapura and Gwalior, where one spray of 0.5 percent of $FeSO_4$ at 45 DoS gave significantly higher seed yield than control (Kumar, 2009).

Table 8. Effect of Iron and Zinc spray on seed yield of Guar

Treatment	Seed Yield (tons/ha)				
	Durgapura	**Gwalior**	**Bawal**	**Hisar**	**Mean**
Control	0.497	0.532	0.52	1.221	0.692
0.5 % $FeSO_4$ spray 25 DoS	0.573	0.612	0.547	1.283	0.753
0.5 % $FeSO_4$ spray 45 DoS	0.604	0.61	0.563	1.21	0.746
0.5 % $FeSO_4$ spray 25 & 45 DoS	0.656	0.609	0.55	1.27	0.771
0.5 % $ZnSO_4$ spray 25 DoS	0.604	0.734	0.677	1.576	0.898
0.5 % $ZnSO_4$ spray 45 DoS	0.653	0.702	0.66	1.483	0.87
0.5 % $ZnSO_4$ spray 25 & 45 DoS	0.67	0.688	0.68	1.631	0.917
Soil applied 25 kg $ZnSO_4$/ha	0.679	0.683	0.72	1.301	0.845
CD at 5 percent	0.092	0.054	0.072	0.196	--

Source: Anonymous (2002-03)

3.10 Nitrogen Fixation

Inoculation of seeds of leguminous plants with rhizobia is important to increase nodulation and thus nitrogen fixation. Strains of legume bacteria are selective in terms of which crop species they will nodulate. Cross-inoculation groups have been developed to account for these differences. Any plants within a cross-inoculation group can be inoculated with a culture of the right kind of bacterial strains. Richmond (1926) stated that Guar belong to the cowpea cross-inoculation group. He also found that rhizobia strain that formed nodules on cowpea also formed nodules on Guar roots. Plants grown from inoculated seeds were slightly taller with more nodes on the main stem and weighed more than plants grown from non-inoculated seeds. Nodulation was significantly correlated with shoot growth. However, nitrogenase activity level per plant declined significantly with plant maturity. Oke (1969) stated that the younger Guar plants seemed to be more efficient fixers of nitrogen than older ones.

3.11 Input Technologies in Guar

The adoption of technology differs on the basis of farmers' perception, environmental conditions and the existing area and productivity of the region. In other words for environmentally poor regions and poor farmers for livelihood security only, LITs are applicable. On the other hand, for better

environments, prosperous farmers and export oriented and business oriented big houses HITs are recommended. The practices adopted in HIT and LIT for production of Guar is exhibited in Table-9.

LITs

LIT is a way to optimize the management and use of internal production inputs (i.e., on-farm resources) and to minimize the use of production inputs (i.e., off-farm resources), such as purchased fertilizers and pesticides, wherever and whenever feasible and practicable, to lower production costs. For the districts of Churu, Jaisalmer, Bikaner, Badmer, Bhuj, etc where soils are poor, rainfall is too meagre (200-300 mm), farmers are not ready to afford more money due to fear of crop failures, for such areas and farmers, inputs use have to be specific with priority for pure seed, seed treatment against Root Rot and sowing methods. It will ensure that crop will not fail. In LIT regions where area is large but productivity is low for instance in Bikaner, Jodhpur and Sikar, Guar is grown in 1.188, 0.662 and 0.144 million hectare with poor productivity of 180, 159 and 351 kg/ ha respectively. Productivity needs to be increased to the level of 500, 400 and 600 kg/ha in Bikaners, Jodhpur and Sikar, respectively (Table-10). It can be achieved in LIT regions with intensive efforts.

Table 9. Region wise high input (HITs) and low input technologies (LITs) for Guar

Sr No	Regions/ Districts	Technology LITs/HITs	Varietal Priority	Planting Priority	Fertility Priority	Cropping sequences/rotations	Inter/mixed cropping
Rajasthan							
1.	Churu Jaisalmer Bikaner Badmer	LITs	RGC-936 RGM-112 HG-365 HG-563	Line sowing 60×10cm, hand weeding, Interculture upto30-40 dos	Nil	Monocropping, Guar-Guar,Guar-Guar-Bajra,Guar-Bajra	Guar+Bajra (3:1),if delayed rains upto 1st week of August Guar + Moth Bean+Bajra+Til+Cowpea (25% seed of each crop)
2	Ganganagar Hanumangarh	HITs	RGC-1066 RGC-1031	Line sowing 40×10cm,Deep interculture upto 30-40 days, full prod. package	Full fertility package	Sole Cropping, Guar-Mustard, Guar-Wheat crop, substitutions Groundnut,, Cotton,, Bajra	Limited mix or Intercropping
3	Nagpur, Jodhpur Sikar Jhaunjnu	HITs/LITs	RGC-1002, RGC-1003, RGC-1017, RGC-936	Line sowing 45×10cm, Deep interculture upto 40 days	Urea spray@1-2% at 50-60 DAS	Guar-Mustard, Guar-Guar, Guar-Bajra, Guar-Guar-Bajra/Sorghum Guar-B.tournifortii	Guar:Bajra (3:1)
4	Pali, Jalore Jaipur, Bheelwara Alwar	HITs	RGC-1038, HG-884, HG-1031 RGC-986	Line sowing 40×10cm, Deep interculture upto 40 days, production package	Fertility package	Guar-Wheat Guar-Mustard	Guar+Bajra/Sorghum (3:10)
Haryana							
	Sirsa Hisar Bhiwani Rewari	HITs	HG-365 HG-563 HG-884	Line Sowing,35×40cm Deep interculture upto 40 days, production package	Full Fertility package	Substitution,Cotton,bajra,til, Groundnuts. Crop sequence: Guar (HG-884,HG-2-20)- Wheat, Guar(HG-365, HG-563)-mustard for saline water Guar-Wheat	Guar+Bajra (3:1) Guar+Sorghum(3:1)
Gujarat							
6	Kutch Banasknath	LITs	HG-365 RGC-936 GG-2	Line Sowing,60×10cm, deep interculture upto	Spray of urea@1-2% at 50-	Guar-Bajra, Guar(GG-1)-Mustard(irrigated) North Gujarat:Guar-potato,	Guar+Bajra (3:1) Guar+Sorghum(2:1) Mixed cropping for North

	GG-1	40 days	60 DAS	Agri-silviculture system Guar with *P.cineraria*	Gujarat: Bajra+Moth Bean Cowpea+Guar (0.40,3.0,5.0&3.75kg/ha respectively)

Source: D. Kumar and K. S. Solanki (2012)

HITs

HIT is an intensive agriculture which uses fertilize, pesticides and modern machinery to guarantee a large crop output. HITs are applicable for resource rich prosperous farmers mainly from districts like Jaipur, Jalore, Alwar, Pali, etc having semi-arid region with high rainfall (400-500 mm) and Ganganagar, Hanumangarh with low rainfall (300-350 mm) but availability of irrigation facilities.

Table 10. Region-wise area, productivity and proposed enhanced productivity of Guar in Rajasthan through LITs

Regions	Districts	Area (million ha)	Productivity (kg/ha)	Proposed Productivity (kg/ha)
Sikar	Sikar and Jhunjhuni	0.144	351	600
Bikaner	Bikaner, Churu and Jaisalmer	1.188	180	500
Jodhpur	Jodhpur, Barmer and Nagaur	0.662	159	400

Source: Kumar and Solanki (2012)

3.12 Pest and Diseases of Guar

Guar is susceptible to a number of diseases but bacterial blight and Alternaria leaf spot are the major ones. The productivity sometimes reduces greatly due to cultivation of traditional strains which are late maturing and highly susceptible to a number of diseases. To enhance the yield and to improve the seed quality there is need to increase awareness about the many diseases which deteriorate the quality and yield of the Guar.

1. Alternaria leaf spot (*Alternaria Cucumerma var. cyamopsidis)*

It is seed borne disease affecting the Guar crop across the country. The disease is visible primarily on leaf blade as dark brown, round to irregular spots varying from 2 to 10 mm in diameter. In the early stage of infection, water soaked spots appear on the leaf blade which later on turn on greyish to dark brown with concentric zonation, demarked with light brown lines. On the under surface the spots are light to greyish brown. In severe infection, several spots merge together involving a major part of the leaf blade. If the plants are infected in the early stage of growth, they may not flower, thereby causing severe losses. High losses (43-87%) occur when it attacks at seedling and reproduction stage. Excessive rainfall and humidity favours the incidence of this disease. The maximum severity take place between bloom and pod set. Biochemical studies indicate that polyphemol oxidase and peroxidise enzyme increase the intensity of ALS, while catalase enzyme activities may reduce its intensity.

Control: Sowing of pathogen free seeds or cultivars resistant to pathogen**.** There are no resistant varieties available. Zineb (0.2%) and copper oxychloride are two fungicides proved most effective as two sprays at an interval of 15 days in controlling diseases. A combination of Zineb with

streptocycline is recommend for simultaneously controlling bacterial leaf blight and alternaria leaf spot, diseases.

2. Powdery Mildew (*Odio Taurica, Erysphe Taurica*)

The disease manifests only on leaves. The affected leaves are covered with mycelial patches dotted with the fruiting bodies. Severely affected plants are defoliated and weakened by premature drying and death of infected leaves. The incidence of powdery mildew is more observed in the regions where crop season is prolonged. Warm temperature (33% or above), highhumidity (more than 80 percent) and bright sunshine are congenial conditions for disease development. The perithecal stage of the fungus first appears on the dried leaves. Under favourable condition the mildew causes considerable defoliation.

Control: Application of benlate, sulphur compounds etc. inhibit the germination of conidia of Erysiphe. Seed treatment with streptocycline (0.025%) and spraying a combination of streptocycline and dinocap (both 0.01%) is very effective for controlling powdery mildew.

3. Dry root rot (*Acrophomina phaseolina, R. solani, Fusarium cacrulenum roslsfii, Cecosmo spora vasinfecta*)

The disease is most severe under dry and warm growing conditions. It is caused by *Macrophomina phaseolina. T*he disease may occur at any stage of the crop from pre-emergence to maturity and can appear as seedling blight or dry root rot. Seedling blight occurs primarily on the cotyledons in the form of damping off or as elongated black cankers on growing seedlings. Infected seedlings can be easily uprooted. In grown up plants, the disease appears as bronzing of leaves on one or more branching followed by drooping of the upper tender parts of the shoots. Affected plants continue to grow without having clusters or pods, but may break easily in strong winds. Nodule formation in these plants also reduces drastically. Highly affected plants rarely produce any grain or produce infected seeds.

Control: Rotation with less susceptible crops like moth bean or pearl millet or keeping the land fallow reduce the population of pathogen. Mulching of the soil with pearl millet stover, low plant density and farm yard manure singly or in combination of effectively conserved the soil moisture and reduce the population densities of the pathogen. Incorporation of Zinc or Copper (5kg/ha) or Sulphur (10kg/ha) coupled with FYM also bring down the dry root rot incidence. Bavistin seed treatment @ 2 g per kg seed and spray with the same @ 0.1 percent is suggestive measures to control the disease.

4. Bacterial Leaf Blight *[Xathomonas axonopodis pv (Cyamopsidis)]*

It may cause yield losses from 32 – 68 percent. The congenial situations causing spread of this disease are scattered rains, high temperature (20-30 ^{0}C) and humidity. High nitrogen doses (20-40 kg/ha) may also result in higher disease index. Plants at early growth (20-30 days) may be more susceptible, leading to their drying due to stem rotting. Presence of high specific activities of oxidative enzymes, viz polyphenol oxidase and per-oxidase enzyme have their possible role in disease resistance mechanism.

3.13 Integrated Disease Management

Integrated disease management approaches for Guar are as follows:

(i) Growing short duration varieties like HG-365, HG 563, RGC-936 to escape the disease incidence

(ii) Using hot water treatment of seed (56^{0}C) for 10 minutes before sowing

(iii) Soil solarization in the month of May is found most effective in checking soil borne pathogens

(iv) Spraying Streptocycline @ 150 ppm twice at 15 days interval at the appearance of BLB

(v) Spraying Di. M-45 @ 0.2 percent thrice at an interval of 15 days at the appearance of AB, also spray imidacloprid once to check insect pests

(vi) Use kitazin @ 2 ml/kg seed along with Chloropyriphos @ 4 ml/kg and streptocyline @ 1g/kg seed to check the presence of insect pests, fungi and bacterial during storage

(vii) Using mustard residue (2.5 t/ha) = Bacillus thuringiensis (ST) 4g/kg = One summer irrigation to check pre and post emergence seedling mortality

(viii) Spraying the crop with wettable cresan and cupravid @ 1 kg/ha at an interval of 15 days at the appearance of PM disease.

3.14. Climate and Variety

Guar is very drought-tolerant and sun-loving, but susceptible to frost. It requires sufficient soil moisture before planting and during maturation of seeds. Frequent drought periods can lead to delayed maturation. On the contrary, too much moisture during early phase of growth and after maturation leads to lower seed quality. The pattern of rainfall plays an important role in the selection of seed varieties of Guar (Table-11).

Table 11. Improved varieties of Guar suitable for different cropping regions of Rajasthan

Sr. No.	Average Rainfall (mm)	Region/District	Cropped Area (000 ha)	Productivity (kg/ha)	Varieties	Maturity (days)	Remarks
Rajasthan							
1	170-200	Churu	315.00	235	RGC-936	85-90	Suitable for arid Rajasthan
		Jaisalmer	190.00	10	HG-365	80-85	High viscosity (3500 cP) and ruling variety of Haryana
2	200-250	Bikaner	411.00	215	RGC-936	85-90	Suitable for Haryana, high gum and viscosity profile
		Barmer	325.00	135	RGC-365	80-85	
					RGC-563	85-90	(4050 cP)
3	250-300	Ganganagar	180.00	807	HG-365	80-85	
		Hanumangarh	319.00	870	RGM-112	85-90	
					RGC-1066	100-105	Suitable for mechanical harvesting
4	300-350	Nagur	155.00	420	RGC-1038	95-100	Suitable for summer season and wide spacing (40-50 cm)
		Jodhpur	183.00	180	HG-884	95-100	High gum content (30-31%) and viscosity (3000-3500 cP)
5	375-400	Sikar	78.00	311	RGC-1002	100-105	
		Jhunjnu	62.00	280	RGC-1017	95-100	
6	400-450	Pali	67.45	708	RGC-1038	95-100	
		Jalore	69.50	675	RGC-1031	105-108	Suitable for irrigated conditions
7	600-650	Jaipur	55.14	780	RGC-1002	105-108	
		Bhilwara	37.00	600	HG-20-2	110-112	Gum content 31.41% suited for wider spacing and irrigated conditions
8	700-800	Alwar	34.66	1000	RGC-986	115-120	Dual purpose and suitable for canal command areas
Haryana							
9	200-250	Bhiwani	90.00	900	HG-365	80-85	

10	200-225	Mohindergarh, Bawal	30.00	985	HG-563	80-85
11	300-350	Sirsa	101.00	1400	HG-884	95-100
12	250-300	Hisar	70.00	1200	HG-2-20	110-115
Gujarat						
13		Banaskantha	61.60	604	GG-2	80-85
		Kutch	58.10	610	HG-563	80-85
					HG-365	80-85
					RGC-936	85-90

Source: D. Kumar, Guar International Conference (2013), Jaipur

There are many varieties developed at national level from various research institutes but the most favoured varieties are RGC 936 (Short duration early maturity), RGC 1002, RGC 1004 (Long duration late maturity) and RGC 1031. When there is late onset of monsoon, farmers are giving preference to RGC-936, a short duration variety which matures early. With early onset of monsoon, farmers are giving preference to RGC 1002 and RGC 1004, long duration variety which matures late.

As seen in Table-11, climate of Rajasthan is having a mix of arid, semi-arid, humid and sub-humid tropics. In arid (Western and North-west districts) and semi-arid (Central and Eastern districts) tropics of Rajasthan, almost all varieties of Guar are being cultivated. As specified earlier, the selection of varieties depends mainly upon onset of monsoon and that is why there is no specificity in seed variety selection in these regions. In case of humid and semi-humid (Southern and South-Eastern districts) tropics of Rajasthan, mainly RGC 936 is cultivated. Seed variety RGC-936 is well suited to all the regions of state as well as country. The maturity period for RGC -936 is 70-90 days only.

3.15 Summer Guar: An emerging Concept

Guar is a deep rooted, drought hardy, summer annual legume of great economic significance. Historically, it has remained confined to very specific habitats of arid districts of Rajasthan, Haryana and Gujarat. Sudden spurt in prices of guar gum from December, 2011 have attracted the attention of corporate world, new and non-traditional farmers, traders and seed companies throughout the country. The researchers have also explored the possibility of cultivating the crop in non-traditional regions and in non-traditional season (s). The crop has shown potential to be grown during summer season.

Certain promising genotypes and varieties of guar, consisting 6 (RGC-986, RGC-936, RGC-1066, RGC-936-1-5-1, HG-884 and HG-563) during rainfed conditions of kharif 2011; and 10 (RGC-986, RGC-936, RGC-1066, RGC-936-1-5-1, RGC-1031, RGC-1003, RGM-112, HG-884, HG-365, HG-563) were evaluated during irrigated conditions of summer 2012. The outcome of the experiment reveals favourable results for guar cultivated during summer season over kharif season in terms of maturity period, plant height, number of pods per plant and number of seeds per pod (Table-12). The cultivation of guar in summer season may help in increasing guar yield by 2.5 – 3.0 times, percent gum content almost by 1.7, guar gum yield by 320 kg/ha and viscosity of guar gum by 339 cP over rainy season. It has been due to climatic conditions (high temperature, low humidity, and sunny sky) and controlled availability of soil moisture proved useful in reducing diseases and insect pests' infection in summer season leading to better source-sink relationship. Enhanced grain yield potential in summer season could also be due to better podding potential, and more number of grains, besides, reduction in extra biomass. The new system provides avenues for

> By shifting guar cultivation in summer season, where 4-5 irrigations are available, grain yield can be increased by 2.5 – 3.0 times over traditional cultivation in rainy season. Summer crop will enhance gum yield and improve its quality. Hence, it is new concept of farming system encouraging taking two crops every year in arid and semi-arid regions.

guar cultivations in non-traditional season, economic use of available irrigation water, and increasing cropping intensity in arid and semi-arid regions.

Table 12. Characteristics of different varieties of Guar in terms of maturity, plant height, pods per plant and seeds per pod

Genotypes	Days to Maturity		Plant Height (cm)		No. of pods/ plant		No. of seeds/ pod	
	Kharif 2011	**Summer 2012**	**Kharif 2011**	**Summer 2012**	**Kharif 2011**	**Summer 2012**	**Kharif 2011**	**Summer 2012**
RGC-986	76.88	94.33	70.19	49.60	52.09	60.17	6.94	8.00
RGC-1066	81.4	83.67	92.71	72.17	50.96	57.92	6.00	7.99
HGS-563	72.88	83.67	67.69	45.77	60.94	68.00	6.71	7.88
RGC-936-1-5-1	72.13	88.00	71.73	48.04	51.60	60.00	7.13	8.50
HG-884	77.06	84.33	76.65	43.67	60.27	68.00	7.08	8.93
RGC-936	75.81	85.33	74.90	46.08	52.25	58.01	7.35	8.25
Mean	76.11	87.05	75.6	45.88	54.69	62.01	6.87	8.26
SEM(±)	2.24	1.07	3.90	2.05	1.66	4.13	0.08	0.23
LSD(p= 0.05)	8.16	3.38	14.19	6.45	6.05	13.00	0.29	0.73
LSD(p= 0.01)	12.80	4.81	22.26	9.18	9.49	18.49	0.46	1.04

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4. DETERMINANTS INFLUENCING GUAR SUPPLY AN ANALYSIS OF RAJASTHAN

Guar has emerged as an important export crop in recent year for its multiple uses in various industries. Guar gum is one of the important items of export, and accounts for 18 per cent of India's total agricultural exports in 2012-13 (DGCIS).

The demand of processed Guar in world market is expected to increase with the expansion of shale oil gas fracking to new countries like China and Russia and scaling up in prominent existing countries like USA along with other uses in food and textile industries owing to increased food safety and health concerns. According to energy consultants Wood Mackenzie, thousands of shale wells are expected to be drilled in the USA, additionally around 400 shale gas wells are expected to come from outside USA mainly confined to China and Russia during 2014. The fracking may also commence in UK in 2014 after a suspension of 18 months ban imposed by the Government (Bakhsh and Swint, 2013).

The food safety and health issues in cosmetics, food and textiles industries and use of appropriate material in fracking to safeguard contamination of ground water is going to further consolidate demand of processed Guar in world market. The increased demand is going to have an escalating effect on prices as has been seen in recent years. The responsiveness of farmers to economic incentives determines agriculture's contribution to the economy specially where the sector is largest employer of labour. Supply response is fundamental to an understanding of this price mechanism (Nerlove and Bachman, 1960).

This makes it relevant to study the supply response of Guar crop particularly when the cultivation of crop is confined to a limited geographical area. The supply response of a crop may be estimated in terms of area, yield and output response. The study focuses on area and yield response. In economic analysis of the dynamics of farm supply response, price is usually considered the most critical factors which influence farmer's production decisions (Khan et. al., 1988). However, acreage under a crop is also influenced by various factors other than prices.

Other factors influencing supply response include weather, risk, and relative productivity. The crop being rain-fed may be affected by the variability in intensity and pattern of monsoon during the sowing season. Since the crop is not covered under prices support policy and experienced high price fluctuations in recent years, the risk associated with the prices of crops may also play an important factor in defining acreage under the crop. Relative productivity of Guar is important as a profit oriented farmer will opt for most profitable crop.

Considering this, an attempt under the chapter has been made to work out the response of prices and other factors on farmer's decisions in allocating area under Guar crop. The simple Nerlovian lagged adjustment model (Nerlove, 1956) has been considered appropriate to study the supply response of Guar. Of all the econometric models used to estimate agriculture supply response, the Nerlovian Model is considered to be one of the most influential and successful (Braulke, 1982).

4.1 Nerlovian Lagged Adjustment Model

In its simplest form, with one determinant, the model expressing linear relationship between the planned acreage and the previous year's price can be presented as the follows:

$$A_t^* = a + bP_{t-1} + u_t \quad \ldots\ldots\ldots (1)$$

$$A_t - A_{t-1} = \beta (A_t^* - A_{t-1}); 0 \leq \beta < 1 \quad \ldots\ldots\ldots (2)$$

A_t^* is the acreage farmers would plant in period t if there are no difficulties of adjustment. As A_t^* is unobservable, equation (1) cannot be estimated. Therefore, assuming that acreage actually planted in period t equals acreage actually planted in period t-1 plus a term that is proportional to the difference between the acreage farmers would like to plant now and the acreage actually planted in the proceeding period, hypothesis (2) is made. Technological/ institutional factors prevent the interned acreage from being realized during the period and the parameter β is called the acreage adjustment coefficient. Expressing A_t^* in terms of directly observation variables, the equation for estimation become

$$A_t = a_o + b_o P_{t-1} + c_o A_{t-1} + v_t \quad \ldots\ldots\ldots (3)$$

Where,

$a_o = a\beta$

$b_o = b\beta$

$c_o = 1-\beta$ and

$v_t = \beta u_t$

The reduced form of the equation would remain basically the same even if additional independent variables are incorporated into the estimating equation. The response relationship in this study was estimated with the help of following equation.

$$ACREAGE_t = b_o + b_1 PRICE_{t-1} + b_2 ACREAGE_{t-1} + RPTY_{t-1} + RAIN_t + RISK + U_t$$

Where,

$ACREAGE_t$	=	Current year acreage or planned acreage of Guar
$PRICE_{t-1}$	=	Last year price
$ACREAGE_{t-1}$	=	last year acreage
$RPTY_{t-1}$	=	Relative per hectare productivity (INR/ha) of Guar to weighted average productivity of other competing crops like Bajra, Maize, Groundnut and Moong
RISK	=	Risk associated with the price assurance of the crop at harvesting time measured in terms of standard deviation in previous years
$RAIN_t$	=	Rain received in the month of June and July during current year i.e. sowing

		time
U_t	=	error term

4.2 Information Source

The analysis is confined to Rajasthan the leading Guar producing state. The information to estimate the supply response using Nerlovian adjustment model has been obtained from various secondary sources like publication of Department of Agriculture, CAZRI, Water Resource Department, Rajasthan Agricultural Statistics at A Glance 2011-12, India Meteorological Department, agmarknet.nic.in, www.india stat.com, etc. for the period 1981 to 2012. The estimates could not be made for other emerging Guar producing states like Haryana, Punjab and Gujarat due to unavailability of sufficient information.

The analysis for Rajasthan state also focuses on estimating the aggregate response function which may slightly vary from the actual picture prevailing in the Guar producing area. District level analysis generating more accurate estimates could not be worked out due to lack of consistent time series information on all the relevant variables considered in the model. Nevertheless, it is assumed that the results of the model would represent near real picture for following reasons:

(i) The Guar production in the state is confined to three divisions only namely Bikaner, Ganganagar and Jodhpur consisting of seven districts. These three divisions accounted for nearly 90 percent of total area under Guar during 2011-12.

(ii) The prices for a commodity of international importance traded on forward and futures market are assumed to be integrated in different markets of the states. Even in case of absence of true integration, it is believed that the inter-relationship of prices in different markets will follow the same proportion over years.

The model considered for supply response also suffers from some limitations, as discussed below:

(i) The state level rainfall during the sowing season has been considered as a proxy variable not only for actual rainfall received by the Guar producing area during sowing time but also for various other weather factors like rainfall distribution through time and space, temperature, humidity, sunshine, wind, quality of soil, etc. (Soontaranurak, 2011).

(ii) Standard deviation in prices prevailing in previous seasons is taken as a proxy variable to represent the risk associated with the prices of the crop.

4.3 Results of the Supply Response Equation

The results of the Nerlovian relationship between area under Guar cultivation and prices, rainfall during sowing period, risk associated with prices and relative productivity of Guar for the period from 1982-2012 is presented in Table-13. The estimated coefficient for independent variables included in the model have the signs as predicted theoretically except for relative productivity. The results show that prices and production lagged by one time period and rainfall during the sowing time have a positive influence on acreage under Guar crop while risk associated with the prices and relative productivity of Guar in comparison to other competing crops has shown negative impact on the area under crop.

The coefficient of prices of Guar in the previous season is positive and significant at 1 percent level, showing that the increase in prices prevailing in one period will lead to an increase in the area under Guar crop in the succeeding season. This shows that the farmers are responsive to the market signal which sometime may not be the case in developing economies characterized by large number of small and marginal farmers. In addition to lagged prices, the area under Guar crop cultivated mainly under rain-fed conditions in the states is affected by the rainfall received during sowing time. The same has been reflected by the positive coefficient of rainfall during the sowing time which is significant at 1 percent.

Table 13.Regression results for the Guar supply response

Dependent Variable: Acreage under Guar Crop

Independent Variables	Coefficients	t Stat	Significance
Constant	10.9349	3.03	1%
PRICEt-1	0.0084	6.29	1%
RAINt	0.2335	2.80	1%
ACREAGEt-1	0.0890	0.74	NS
RPTYt-1	-2.6326	-1.63	NS
RISK	-0.0142	-3.02	1%
Adjusted R2 = 0.6876	Observations = 30	--	--

The coefficient of lagged acreage of Guar is also observed to be positive though statistically non-significant indicating increase in acreage in one period will be followed by increase in area in the following period. This may be true for various reasons like the tendency of farmers to re-use the seed for four to five seasons generated from their own field after use of certified seed procured from some specialized agency.

Acreage under a crop also depends on the productivity (value per hectare) of competing crops like bajra, maize, moong and groundnut. The coefficient of relative productivity per hectare of Guar is found to be negatively associated with the acreage under the crop. Though, the results are statistically non-significant but reveals direction opposite to the theoretical believe. This may be an indication of the fact that marginal price-differential may not be sufficient to induce the farmers to change their traditional dictated and time tested crop rotation practice (Bhagat, 1989). There may be other strong factors influencing the farmers' decision to substitute crop like crop rotation systems followed by the farmers, relative risk involved in growing crops and compatibility of their skills to take a particular crop. There may be other constraints like irrigation and infrastructure, lack of complementary agricultural policies, etc. (Bingxin, et al, 2010).

Agricultural production processes are generally a complex combination of decisions made under conditions of risk and uncertainty. Agricultural production in developing countries particularly is characterized by various kind of uncertainty (Colman and Young, 1989) including the difference between the price prevailing at sowing time and at harvesting time. This uncertainty may influence farmer in dedicating acreage for a particular crop. This factor has been incorporated in the model

though a proxy variable defined by the standard deviation of prices prevailing in previous seasons. The coefficient of the variable is negative and highly significant suggesting that the acreage under the crop will come down as the uncertainty increases even if the lagged prices are ruling high.

These variables together explain around 70 percent variation in the area brought under cultivation of Guar crop in Rajasthan. This seems to be a reasonable fit considering the nature of Guar crop and limitation of the model in terms of assumption and proxy variables considered.

4.4 Factors Determining Yield of Guar

The estimate of supply response of a crop depends on acreage and productivity. The acreage under a crop is allocated based on expected prices while productivity is determined by availability of inputs and climatic conditions. The farmers may make substantial revisions in the decision in terms of inputs to enhance yield after allocating land. Hence, it is reasonable to assume that both area and yield are influenced by the expected output price. The idea of yield response to price is further supported by the literature that area function alone might under-estimate the actual level of supply response. Farmers may display response by adopting better technology of production with no change in area or by using more or better quality of inputs. Such responses will change the output without changing the area, something that is hidden in the acreage function. The intensive nature of cultivation will not be revealed by the input application alone, but will also be reflected in the quality of inputs and the timing and the method of application (Mythili, 2008).

The yield response of Guar is assumed to be affected by prices and other factors like rain and the production risk association with the crop. The response relationship of productivity of Guar with other factors is estimated with the help of following equation.

$PTY_t = b_o + b_1 PRICE_{t-1} + RAIN_t + RISK + U_t$

Where,

$ACREAGE_t$	=	Current year productivity of Guar
$PRICE_{t-1}$	=	Last year price
RISK	=	Risk associated with the productivity of the crop at measured in terms of standard deviation in previous years
$RAIN_t$	=	Rain received in the month of June and July during current year i.e. sowing time
U_t	=	error term

The results of the relationship of productivity of Guar with last year prices, rainfall and production risk for the period from 1982-2012 is presented in Table-14. The estimated coefficient for independent variables namely lagged prices of Guar, rainfall during sowing time and the production risk have the direction as predicted theoretically except for production risk.

The table shows that lagged prices are having a positive influence on the productivity but the results are not statistically significant. The over dependence of the crop on nature in terms of rainfall and other factors may have reduced the impact of prices only to define acreage and not productivity. The

coefficient of rainfall of Guar during sowing period is positive and significant at one percent level, showing that productivity of Guar being cultivated in the state under rain-fed conditions is affected by the rainfall mainly during the sowing period. The coefficient of independent variable production risk measured in terms of variation in the yield during previous years has been found positive and statistically significant at one percent level. The variation in yield in previous seasons is found to be encouraging farmers to take better care of the crop to ensure better productivity.

Table 14. Regression results for the Guar yield supply response

Dependent Variable: Yield of Guar Crop

Independent Variables	Coefficients	t Stat	Significance
Intercept	-111.61	-1.25	1%
Lagged Price	0.05	1.28	NS
Rainfall	0.74	2.56	1%
Production Risk	1.07	2.80	1%
Adjusted R2 = 0.3769	Observations = 30	--	--

The equation has explained only 38 percent variation in the yield, which is attributed to following reasons:

(i) Input related aspects could not be covered in the model

(ii) Policy aspects and infrastructure could not be included due to unavailability of information

(iii) Guar has over dependence on nature. Taking rain a proxy for all the weather related aspects make it a weak link of the model.

The analysis reveals that the acreage allocation under the Guar crop in Rajasthan is responsive to economic incentives expected as reflected by the positive coefficients of the last year prices. Economic orientation of the farmers is also reflected by consideration of risk factor associated with the crop in terms of fluctuation in prices. Though the prices of Guar have ruled high in recent years but the farmers have reduced the acreage under the crop as a reaction to high fluctuation in prices. It has also been observed that farmers are only willing to divert area from their traditional crop to Guar only if significant relative monitory gains are expected. Marginal price-differential may not be sufficient to induce the farmers to change their time tested traditional dictated crop rotations. Another vital factor defining acreage under Guar crop is rainfall. Since the Guar crop is practiced under rain-fed conditions in Rajasthan state, adequate and timely rainfall is required for farmers to allocate area under Guar crop.

The rainfall has also emerged as expected a vital factor influencing the productivity of the crop cultivated under rain-fed conditions. A detailed model capturing all the weather related parameter could not be worked out due to paucity of information and relevant literature to establish relationship of productivity with various other factors. Nevertheless, the model attempted including prices, rainfall and risk associated with crop production has revealed that the most significant factor defining productivity of Guar crop in Rajasthan is rainfall. Expected prices have shown an influence on acreage but not on productivity. Under rain-fed conditions farmers rely on bringing more area under the crop then enhancing productivity to increase supply in response to the prices.

4.5 Factors Influencing Productivity of Guar

The regression analysis has revealed rainfall as an important factor influencing the productivity of the crop cultivated under rain-fed conditions. The relationship of productivity with various factors other than rainfall like temperature, humidity, intensity of rainfall, etc. could not be worked out due to paucity of information and relevant literature required to establish the relationship. However, an

attempt has been made on the basis of review of literature and interaction with the experts to find out the association of different factors on productivity. The factors considered have been categories into technical, climatic and social factors.

Technical Factors

(i) **Certified seed** – The availability of good quality certified seed can play a vital role in enhancing the productivity of a crop mainly in case of guar which is a low input crop. In the absence of availability of good quality seed the farmers are forced to rely on their own seed which may severely affect the productivity due to mixture lines leading to different maturity and different plant height.

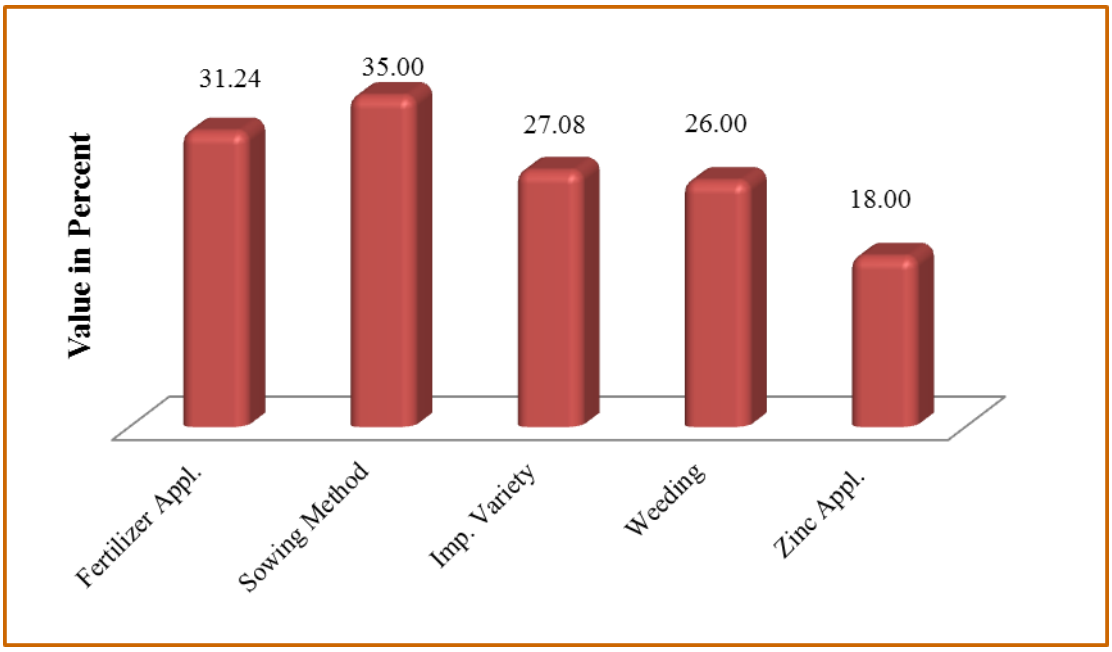
(ii) **Sowing Method** – Method of sowing affects the seed germination, plant population per unit area and crop yield. The most common practice i.e. broadcasting should always be avoided because it gives higher weed population and results in poor resource management. Optimum plant population with respect to the rainfall received in the area can help improving the yield of the crop. The same may be maintained through Inter and Intra Row Distances strategies.

(iii) **Weed management** – Weed management is very important in cultivation of guar as the initial growth of the crop is very slow posing serious exposure to weeds. It is therefore very important to clear the field from weed mainly within 20 days; another weeding is required at 35-40 days. Weeds in guar may causes reduction in yield in the range of 30-50 percent and loses may go upto 70-90 percent depending on the intensity of weed infestation. Weed control alone may help in increasing the seed yield in guar by more than 60 percent (Kumar, 2009).

(iv) **Supplementary Irrigation** – Though the crop being cultivated mainly under rainfed conditions due to its drought tolerant nature but the moisture is required by the crop at some critical stages like germination and flowering. In the absence of rainfall, a supplementary irrigation during the flowering state may help in enhancing the yield of the crop.

(v) The production inputs like sowing methods, improved variety; weeding along with fertilizer application were studied at multi-location farmer's field to evaluate the influence of these factors on productivity under rainfed conditions. Results have been presented in Figure-11. Sowing method has emerged as the most critical component. The showing method resulting in optimum plant population obtained from line sowing at adequate spacing of 60, 45 or 35 cm may increase grain yield up to 35 percent. Fertilizer application (20 kg N + 30-40 kg P_2O_5/ha) in the form of basal dose only drilled before sowing may help in increasing the grain yield by about 31.24 percent. The role of pure seed of suitable variety for the region depending on rainfall and soil type has been found to be 27 percent in increasing grain yield. Weeding at critical stages (upto 30-35 days of sowing) may increase grain yield by 26 percent

Figure 11. Effect of different components on grain yield of Guar FLDs during 2002-07 (Total Field Level Demonstration, FLDs conducted 463)



Climatic Factors

(i) **Rainfall –** Guar is being mainly cultivated under rainfed conditions. The crop tolerant to drought condition requires adequate moisture at some critical stages. The relationship between distribution of rainfall and critical stages of the growth of crop is presented in Table-15. The crop needs dry weather during the maturity time and rains during the last fortnight of maturity can be detrimental to the production. The spread of rainfall through the crop cycle in a more or less consistent manner is an important determinant influencing the guar production.

Table 15. The rainfall requirement with respect to growth state of guar crop

Stage of growth	Days	Rainfall (mm)
Sowing/ germination	0-6 days	30-40 mm
Branching	20 days	75-95 mm
Flowering	50-60 days	75-95 mm
Pod formation	70-75 days	75-95 mm
Seed Maturity	75-90	No rainfall

(ii) **Temperature** – The crop flourishes better under hot conditions and is sensitive to cold. The range of maximum and minimum temperature during day and night is presented in Table-16. The optimum temperature for obtaining maximum yield is 15 to 35 ^{o}C. The crop starts deteriorating at temperature above 40 ^{o}C

Table 16. The optimum temperature requirement for achieving maximum productivity of guar

Temperature	Minimum	Maximum
Night temperature	Above 15 ^{o}C	--
Day temperature	Above 15 ^{o}C	Less than 35 ^{o}C

(iii) **Humidity** – Humidity has a major role to play in the overall growth of the crop. The crop prefers longer days with humidity in the range of 60-70 percent. During germination slightly more humid conditions are required (70-80%). During maturity crop requires warmer days with less humidity and no rainfall is required.

Social Factors

The crop is being cultivated under rainfed conditions as low-input crop. The farmers use minimal off-farm inputs and provide limited interculture care. The crops need to be approached with a commercial perspective and the farmers need to be trained to adopt irrigation, better inputs and better cultivation practices, Guar producers intend to reap benefit in the short run by taking advantage of the price rise. The long run benefits can be accrued by focusing on yield enhancement. Use of High Input technology (HIT) needs to be fostered in the area of good rainfall and Low Input Technology (LIT) in rainfed cropping areas. A judicious balance between HIT and LIT will be helpful in getting better returns from cultivation.

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5. MARKETING AND DISTRIBUTION OF GUAR

5.1 Guar Supply Chain

Guar seed is used for animal feed, extracting Guar split, powder and Guar gum. There are number of Guar processing units in Jodhpur, Bikaner, Ganganagar, Alwar and Jaipur districts of Rajasthan state, Bhiwani and Sirsa districts of Haryana state and Deesa and Ahmadabad districts of Gujarat state. These units can be grouped into Guar split manufacturers and Guar gum processors. Though the involvement of processing and high demand in international market have made the marketing and distribution of guar crop very complex, Agriculture Produce Marketing Committee (APMC) markets have an important role to play in the supply chain. The APMC market (also called *Mandis*) provides a platform for aggregation and operation for various players operating at the wholesale level like traders, stockists, etc. The trade in these markets are facilitated by commission agents and the traders have to pay prescribed market fee on the value of transaction. Mandi fee for Guar in Rajasthan is charged at the rate of 1.60 percent of value, while in Haryana it is 1.0 percent, in Gujarat it is 0.50 percent and in Punjab there is no market fee charged on Guar trade. These markets have peak arrivals of Guar seed in the month of November and December. The major markets for guar in different states are given in Table-17.

Table 17. Major APMC trading centres for Guar seed in India

State	Mandi
Rajasthan	Jodhpur, Bikaner, Sriganganagar, Hanumangarh, Churu, Sikar, Jaipur, Jaisalmer, Barmer, Nagaur, Nokha, Renwal
Haryana	Adampur, Fatehabad, Hisar, Sirsa, Bhiwani, Ellanabad
Gujarat	Kachch, Banaskanta, Sabarkanta, Mehsana, Patan, Ahemdabad
Punjab	Bhatinda

Source: agmarknet.nic.in

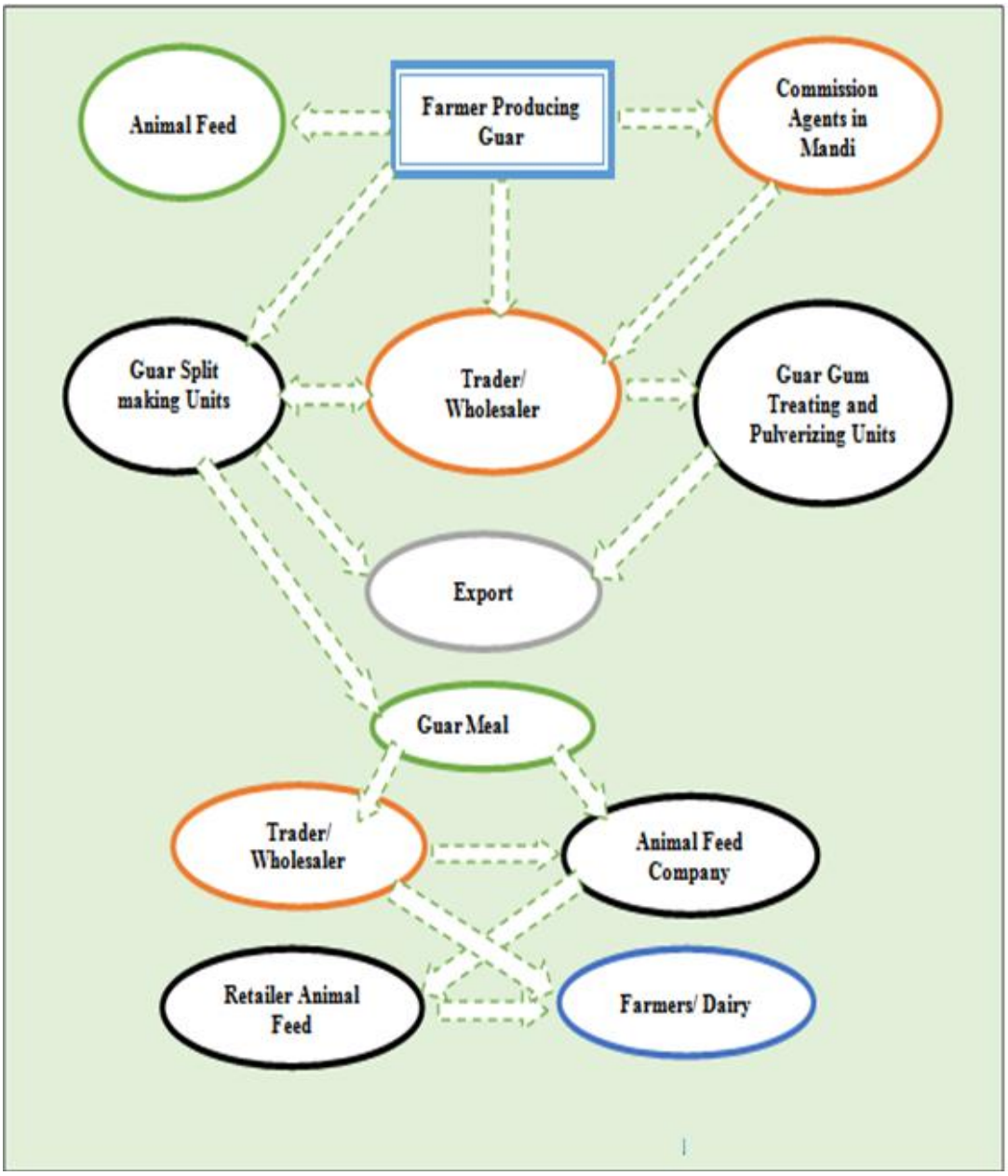
The commission agents charge a prescribed brokerage of two percent from the buyers to facilitate the trade in APMC markets. The trade in these markets takes place on the basis of physical examination based on the traders defined industry grades, although AGMARK grades are available. The long storage life of the commodity facilitates the traders in releasing the commodity purchased from the market in staggered way as per the demand. The price in the market (trader to miller) is influenced by the stock positions. Most of the traders store Guar bean in their own storage warehouses instead of accredited warehouses. Warehousing facilities for storage of Guar bean is inadequate. The quality of the commodity is not maintained properly at the warehouses and strict regulations for the warehouses should be introduced under new initiatives like Warehousing Development and

Regulatory Act 2007. Such arrangements will also facilitate farmers in availing the benefits of pledge financing, which at present is not reaching farmers and other stakeholders.

The supply chain of guar and its various derivatives is presented in Figure-12. As can be seen, split manufacturers procure Guarbean either from village traders or from farmers in the market (*Mandi)* through commission agents. Another chain which exists in the market is direct sale by farmers to traders/ stockist through commission agent. Subsequently, the traders sell it to split manufacturers or Guar gum processors. Processors after processing Guar seed into split either export directly or through exporters. Processors also sell Guar split to the local gum processors. Similarly, gum processors source Guarbean either from village traders, farmers through commission agents, stockist/ traders or procure split from split manufacturers. After processing of Guarbean/ split into different industry specific Guar gum products, the final product is exported and/or made available to the domestic market.

Majority of the processed product is being exported and only a small quantity is being consumed in the local market. At processors level, the splits are packed in plastic bags of 50 kg size while Guar powder is packed in paper bags of size 25 kg of powder. These packets are arranged in containers consisting of 800 packets for smooth bulk movement. These processed products are being stored at the trader/ processor level by their own arrangements. The assessment of current stocks and carryover stock in this situation is quite difficult and hence leads to speculation. Although market forces determine the price in long run but the Guar industry has witnessed high price fluctuations in the recent years.

Figure 12. Supply chain of guar



5.2 Distribution of Guar bean

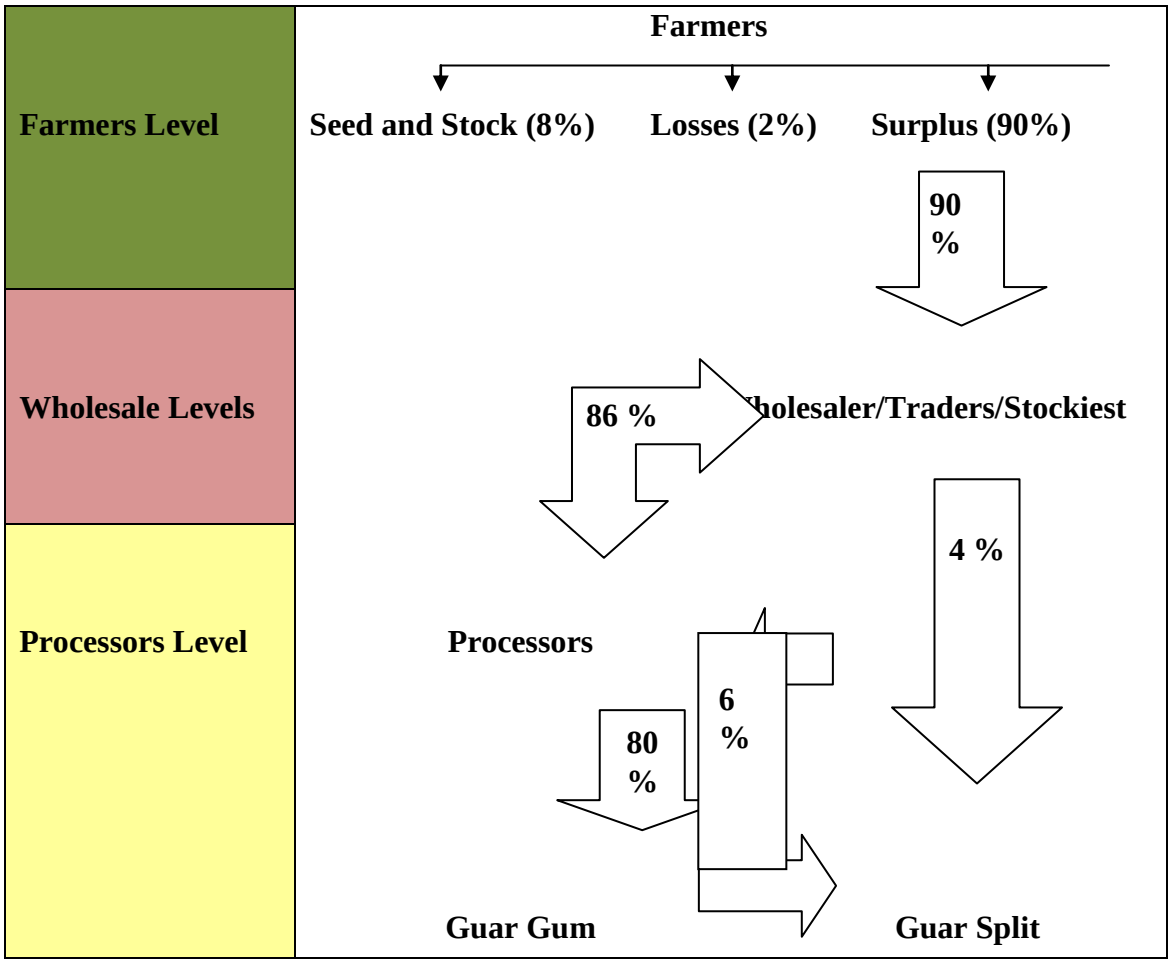
The surge in demand in international market and consequent strong surge in prices has created interest for the Guar crop amongst all the stakeholders involved in the marketing and distribution. Broadly, there are three important players involved in the distribution of guar i.e., producer-farmers, wholesalers and processors.

Producer-farmers are important not only for the production but also for their behaviour defining the quantity of marketable surplus. The crop which traditionally has been popular among resource poor small holders has been retaining a portion of their produce mainly for seeds. However, in recent years the high prices of the crop have made it competitive and popular among large farmers also, and they have a tendency to stock in anticipation of good prices. Farmers are generally retaining around 8

percent of their production for seeds and price advantage. There are around two percent post-harvest losses also due to poor handling of the crop. The estimates presented in Figure-13 are based on information collected through interaction with a small sample of producers and other stakeholders and thus are indicative only.

At the wholesale level, majority of the produce i.e. 86 percent of the bean is procured by the processors for preparation of guar gum and splits. Of this, about 80 percent is utilized for guar gum preparation and 6 percent for split preparation. A small portion of beans (4 percent) is processed into split directly at wholesale level by some traders to take advantage of price in international market for guar split.

Figure 13. Distribution of Guar seed produced



5.3 Consumption and demand of Guar Seed

Considering the importance of Guar as an export crop, an attempt has been made to work out the quantity of Guar bean (in terms of equivalent of quantity exported) exported and consumed domestically. An estimate has also been made of the Guar bean equivalent being exported to USA to assess the size of US Market, and its importance for Guar and Guar processing industry. The analysis is based on the assumption that the Indian Guar processing industry is realizing 29.25 percent of Guar gum from the Guar bean. The quantity left unaccounted after export to US and rest of the world is considered to be consumed in domestic market (Table-18).

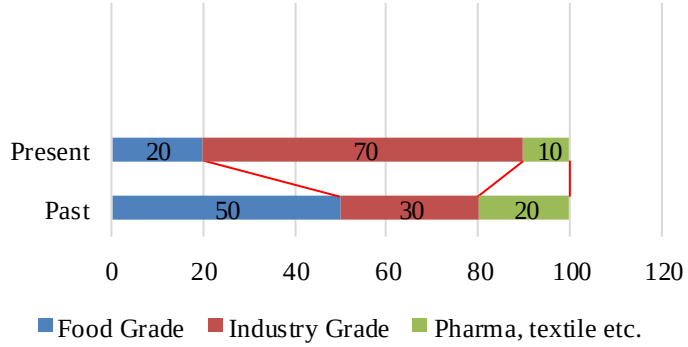
Table 18. Consumption of Guar Bean in Equivalent-term

Year/ Unit	Production (000 tn)	Carryover (000 tn)	Total (000 tn)	US (000 tn)	World (000 tn)	DOM (000 tn)	US (%)	World (%)	DOM (%)
2010	1965	350	1775	735	776	264	41	44	15
2011	2218	540	2633	1484	933	216	56	35	8
2012	2000	125	1675	838	561	277	50	33	17
							50	37	12

Source: Author's Calculation, DGFT and APEDA

The insights into the industry revealed that there has been a migration of demand from food grade to industry grade. The emergence of demand of Guar from the US petroleum industry and also the oil fields of Middle East has changed the scenario. Prior to 2005 the major demand from the industry was for food grade Guar gum. In Europe, Guar gum has EU food additive code E412. Xanthan gum and Guar gum are the most frequently used gums in gluten-free recipes and food grade products demand for the percent of Guar gum was around 50 consumed. The total Guar gum The consumption of Guar gum by oil drilling industry was limited to around 30 percent. But at present the scenario has changed and the major consumption of Guar gum is from oil drilling industry while the demand from food industry has reduced to around 20 percent (Figure-14).

Fig 14. Past and Present Guar Usage Pattern of Industries



5.4 Need for market information by industry

The marketing of guar at different level is constraint by lack of transparency and market information. In spite of the fact that Guar has assumed importance of stratospheric level, there is no systematic collection and dissemination of market information to the stakeholders. The information requirement of industry to make a better decision are-

1) Area under cultivation and estimated production for a season
2) Climate data for industry to estimate the supply from major production centers
3) Estimated requirement of major importing countries and expected price in different markets
4) Quality specifications for different countries
5) Changes in international trade policies
6) Different application and specific grades accordingly

Farmers are aware of the prices prevailing in the market and refer to exchange prices while making a marketing decision. Nevertheless, the consistent and reliable market information will help participants to make better decision. The systematic collection of market information is required to

be followed by assured, reliable and consistent dissemination of market information to farmers and industry. The extension and advisory service also needs to be geared up to enable farmers, traders and processors to be able to make analysed decision for present and future.

Presently there is no dedicated organization performing task of collection and dissemination of market information to the stakeholders in public domain. There are discrepancies in data collected. However, the Guar industry is largely driven by private players who have their own mechanism of survey and collection of information. Such discrete efforts need to be consolidated to from a reliable mechanism of market information and advisor services.

Value addition and processing of Guar seed are the most important components of the market. There is lack of technology, proper research and development efforts, skilled manpower, etc. Processing industry is fragmented and most of the units are operating on small scale. There is a need for consolidation to achieve economies of scale and a stable market for Guar.

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6. PROCESSING AND USAGE OF GUAR

The Guar seed consists of three parts namely the seed coat (14-17 percent), the endosperm (35-42 percent), and the germ (43-47 percent). The different constituents of the Guar seed are presented in Table-19. Guar gum the prime marketable processed product of the plant comes from the endosperm. The other by-product of the processing like Churi and Korma are used for Cattle feed. Various steps involved in the processing of guar seed is presented in Figure-15.

Table 19. Constituents of Guar grain

Part of Seed	Protein %	Ether Extract %	Ash %	Moisture %	Fibres %	Types of Sugar
Hull (14-17%)	5	0.3	4	10	36	D-glucose
Endosperm (35-42%)	5	0.6	0.6	10	1.5	Galactomannon
Germ (43-47%)	55.3	5.2	4.6	10	18	Glucose

6.1 Guar Splits

When the polished endosperm are removed and separated from the fine layer of fibrous material a husk and refined Guar splits are obtained.

6.2 Guar Powder

These refined splits are then pulverized and treated and processed for specialty grade products for usage in industries. After pulverization, sieving is done to get the required mesh size i.e. fine, coarse, etc. and is converted into powder by a variety of means and processing techniques depending upon the desired end product. The Guar gum is mechanically extracted by roasting, differential attrition, sieving and polishing of Guar seeds. The sieved gum is then passed through the blenders to make it homogenous and later it is packed for marketing. The gum is refined to make yellowish white powder as per the quality specifications required by user industries and grades specified.

The processors dominated marketing of Guar seed operates on the trade defined standards. However; specifications for Guar seed have also been defined by Directorate of Marketing and Inspection through AGMARK standard.

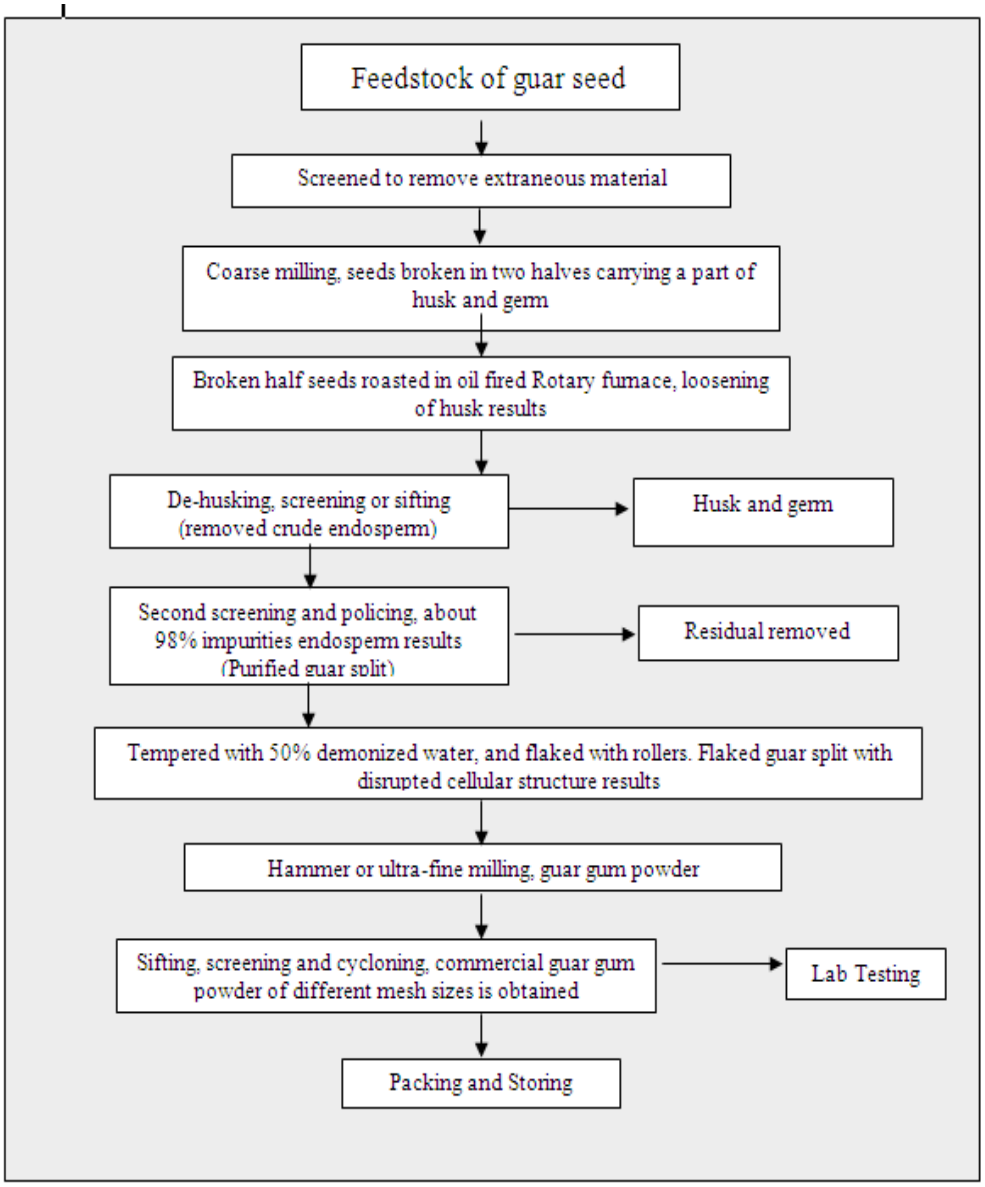

Fig 15. Steps in Processing of Guar Seed

6.3 Guar Gum

Refine Guar Splits are the sole raw material for manufacturing Guar gum powder for pharmaceutical and food grade material. The properties of Guar powder, which make it useful in various applications, are -

- Easy solubility in cold and hot water
- Film forming property
- Resistance to oils, greases and solvent
- Better thickening agent
- Water binding capacity
- High viscosity
- Functioning at low temperatures

6.4 Efficiency of Processing Industry

The Guar seed is consumed primarily by the processing industry for the extraction of Guar gum which fetches high prices in export market. Only a small proportion of raw Guar seed processed for Guar gum is consumed in the domestic market mainly the by-products like churi and korma for animal feed. Since the efficiency of any processing industry is defined by the realization of main product from processing, an attempt has been made to analyse the rate of realization of Guar gum and other derivatives from the Guar seed through processing. Compilation of information collected through interaction with processors of different size using varied degree of technology has revealed that only 29.25 percent is realized as Guar gum from the total quantity of seed processed. A large proportion of the raw material to the tune of 66.5 percent is received as by-product in the form of Churi (34.5 percent) and Korma (32.0 percent). A waste of 4.25 of the raw seed has also been observed with the use of existing Guar seed processing technology (Table-20). The realization of Guar gum from seed may be enhanced by adopting better technology, minimization of waste and promoting high gum content seed varieties. Cultural practices may also help in improving the gum content of seed as has been suggested by various research studies.

Table 20. Realization of different product from processing of Guar bean

Processed outcome	Share (%)
Gum	29.25
Korma	32
Churi	34.5
Waste	4.25

Source: Primary Survey

6.5 Uses of Guar and its derivatives

Guar was traditionally used for feeding animals in Rajasthan and green pods were used for vegetable purpose. With the development in processing technology in the country, Guar seed is being used for extracting gum powder, which has many applications including food preparations, beverages, textiles, paper industry, petroleum industry, mining, explosives, pharmaceuticals and cosmetics

6.6 Traditional Uses of Guar

The traditional uses of Guar are as following:-

Human Consumption

- Immature pods are dried, salted and preserved for future use
- Immature pods are dried and fried like potato chips
- Green pods are cooked like French beans
- Mature seeds are used as an emergency pulse in time of drought

Cattle Feed

- Plants are cut and used as green forage.
- Beans are used as high protein feed.

Medicinal Purposes

- Plants are mashed, then mixed with oil and used as a poultice on cattle boils.
- Leaves are eaten to cure night blindness.
- Seeds are used as a chemotherapeutic agent against smallpox.
- Boiled Guar seeds are used as poultices for the plague, enlarged livers, and head swellings and on swellings due to broken bones.
- Seeds are used as laxative.

Crop and Soil Improvement:

- Plants are used as shade for ginger
- Guar commonly is used as a cover crop and green manure.

Industrial Use

The guar gum is being consumed in a variety of industries ranging from oil drilling to textile, paper, explosive, food processing, pharmaceuticals, cosmetics, etc. The Industry-wise applications of Guar gum are presented in Table-21.

Table 21. Industry-wise applications of Guar gum derivatives

Sr. No.	Industry	Uses	Derivatives	Functions
Industrial/ Technical				
1.	Oil well drilling	Driling Fluids hydraulic fracturing	Borate cross-linked guar gum, hydroxy alkyl ether derivatives	Control of water loss, viscosity, suspension, turbulence, mobility, friction reduction
2.	Textile Printing	Cotton, Rayon silk, wool sizing, carpet printing	Carboxy-methyl guar, hydroxy propyl guar, modified guar gum	Reduces wrap breakage, reduces dusting film forming thickening for dye
3.	Paper	Wrapping paper, kraft, photographic paper, filter	Oxidized guar gum, cross-linked guar gum, amino ethyl gum, modified guar gum, guar gum formate,	Replaces hemi cellulose, increase strength, fold, pick, pulp hydration, retention of fines, decreases porosity
4.	Mining	Concentration of ore, filteration	Aminoethyl guar gum, sulphate of guar gum	Flocculating and settling agent, filter aid
5.	Explosive	Stick explosive, blasting slurries	Reticulated guar gum, cyanoethyl ether of guar gum	Water proofing, gelling agent
6.	Water Treatment	Industrial water, drinking water	Food grade guar gum	Coagulant aid (food approved)
7.	Tobacco	Reconstitution of fragmental tobacco	Reaction product of carboxymethyl cellulose and guar gum	Binding agent, strengthening agent

Sr. No.	Industry	Uses	Derivatives	Functions
8.	Coal Mining	Coal suspension, shock impregnation	Borate cross-linked guar gum	Friction reducing suspending agent
9.	Fire fighting	Water for fighting fires	Guar gum with ethylene glycol and glycerol	Friction reducing, dispersion and direction control
10.	Ceramic	Enamels, electroceramics	Chlorinated guar gum	Fixing, binding thickening agent
11.	Photography	Emulsions, gelatine solutions	Borate cross linked guar gum, hydrolysed guar gum	Gelling, hardening agent
12.	Synthetic Resins	Polymerization, suspension, collagen dispersion	Suspension of guar gum with CMC	Thickening, Binding agent
Food Applications				
13.	Frozen foods	Ice creams, Soft serves, frozen cakes	Food grade guar gum with CMC	Water retention, ice crystel inhibitor, stabilizer
14.	Bakery	Bread, Cakes, Pastry, Icing	Non-metabolised guar gum	Dough improvement, greater moisture retention, prolonged self life
15.	Processed Cheese	Cottage cheese, cream cheese	In combination with other water soluble gums	Increase the yield of curd solids, improves tenderness
16.	Dairy Products	Yoghurts, desserts, molasses	In combination with other water soluble gums	Inhibits when separate keeps texture after sterilization
17.	Dressing and Sauses	Salad cream, pickles, barbecue relish	In combination with other water soluble gums	Fast, cold dispersible thickening and texturising agent
18.	Instant mixes	Pudding sauses, desserts, beverages	In combination with other water soluble gums	Fast, cold dispersible thickening and texturising agent
19.	Canned Foods	Pet foods, corned meat, baby foods	In combination with other water soluble gums	Acid resistant thickening and suspending agent
20.	Beverages	Cocoa drink, fruit nector, sugarless beverages	In combination with other water soluble gums	Acid resistant thickening and suspending agent
21.	Animal Feed	Veterinary preparations, calf milk replacer	In combination with other water soluble gums	Suspending agent, granulating agent
Pharmaceuticals				
22.	Pharmaceuticals	Laxative, slimming aids Gastric hyper acidity Diabetic treatment Cholesterol Vitamin formation preparation	Food grade guar gum Food grade guar gum Food grade guar gum Food grade guar gum Food grade guar gum	Bulking agent, bulk forming appetite depressant Synergistic activity with bismuth salt Reduction of urinary glucose loss Reducing aid Stable water soluble suspension
Cosmetic				
23.	Cosmetics	Ointment Lotions	Hydroxypropyl guar (HPG) Hydroxypropyl guar (HPG) Food grade guar gum	Thickening agent gives unctuousness Lubricating, suspending agent Disintegrating and

Sr. No.	Industry	Uses	Derivatives	Functions
		Tablets Hair Shampoos Hair Conditioners	Cationic guar Hydroxypropyl guar (HPG)	granulating agent Detergent compatible thickener Protective colloid film forming agent

Source: NIAM, 2010

The major consumer of Guar gum is oil drilling and mining with the global consumption of 60-65 percent followed by food processing industry accounting for 25-30 percent consumption. (Table-22)

Table 22. Application-wise Global consumption of Guar Derivatives

Type of Application	Target industries	Global Consumption
Food grade	Bakeries (Bread), Dairy (Ice cream, Sherbets, Cheese etc.), Dressing (Sauces, Ketchup's), Beverages (Chocolate drinks) & Pet Food (Thickener)	25-30%
Pharmacy grade	Cosmetics & medicines (as binder and thickener) Slimming, (Reducing weight & laxative)	05-10%
Industrial grade	Oil drilling (as a well stimulant and fraction reducer), Mining (increased yield, filter aid), Explosives (Gelling agent), Coal Mining (fraction reducer, binding)	60-65%
Other	Textile printing (Thickening agent for dyes), Paper (increase strength and decrease porosity), Tobacco (binding and Strengthening) & Photography (Gelling and Hardening)	5-10%

Source: NIAM, 2010

A by-product of the Guar processing is Guar meal (mixture of husks and germ) which is a potential source of protein. It is used for cattle as well as poultry feeding. Toasting of Guar meal improves its nutritive value. It can be used up to 10 percent in poultry diet and can replace up to 100 percent protein supplements such as ground nut oil cakes in ruminants. Various derivatives of Guar gum are available that will stiffen gels even up to a water content of 99 percent. Commercially important derivatives of Guar gum are:

- Hydroxy and Carboxy Alkylated Guar gum
- Oxidized Guar gum
- Acetates of Guar gum
- Cationic derivatives of Guar gum
- Sulphated Guar gum
- Guar gum formate
- Guar gum acryl amide
- Borate cross linked Guar gum
- Reticulated Guar gum
- Carboxy methyl hydroxy propyl Guar gum
- Depolymerized Guar gum

Guar gum has emerged as India's top farm export overtaking traditional heavyweights rice and cotton and looks set to power into the league of top 10 shipments from the country, due to increasing demand from the US oil and gas industry. The Guar gum exports have shot up nearly 139 percent on a year-on-year basis between April and January 2013, with shipments of about $4.9 billion. In the previous year, it rose 374 percent in January alone compared to the same month of 2011.

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7. PRICE AND TRADE OF GUAR

7.1 Price Movement of Guar

Guar bean has shelf life of more than 3 years without losing out on any of its properties or qualities. It requires the minimum maintenance and handling environment. Therefore, traders or stockist store guar for as long as 6-7 years. However, prices of Guar bean as well as its derivatives very much depend on the monsoon condition and its likely production.

Factors Influencing Guar Price

1. Rainfall during sowing and critical stages of growth
2. Area sown under the crop in major states like Rajasthan, Haryana, Punjab, Gujarat, etc.
3. Pattern of arrivals on a regular basis in markets like Jodhpur, Bikaner, Sriganganagar, Adampur, Bhiwani, Siwani, etc.
4. Demand from millers or processors and export demand
5. Carrvover stock.

The prices are observed to be highly volatile during monsoon months due to market speculation. There is a good correlation between rainfall and production in Rajasthan as the Guar crop is rain-fed. The effect of rainfall on production is seen less in case of Haryana where Guar is an irrigated crop. The other factors like pattern of arrival, demand from millers and export also cause volatile price movement.

7.2 Fluctuation in Spot prices

The spot price of Guar seed for the last 7 years i.e., from 2007 to 2013 reflects high volatility of prices. The Spot price at Jaipur market and Sri Ganganagar are analyzed. The price fluctuates highly during monsoon period i.e. July to October. Guar seed traded at Kishangarh Renwal market between INR 4000/qt. during Oct, 2012 to INR 15000/qt. in the month of December, 2012. In 2013 the highest price at Jaipur was recorded in the month of January at INR 14400/qt. and lowest recorded was INR 4200/qt. in August. Highest fluctuation in prices of Guar bean has been observed in the year 2012. During the year 2012, prices at Sri Ganganagar market ranged from INR 7752/qt. to INR 28556.2/qt. Annual volatility (measured as Coefficient of Variation) in *Mandi* prices of Guar seed at different markets has been worked out and presented in Table-23.

Table 23. Volatility in Guar bean Prices (C.V. in %)

Year	Rajasthan			Haryana		
	Ganganagar	**Jaipur**	**Hanumangarh**	**Adampur**	**Fatehabad**	**Hissar**
2007	5.5	6.0	5.9	6.0	6.7	6.9
2008	7.2	8.5	7.8	8.0	7.1	9.6
2009	20.9	19.3	22.0	21.1	21.5	20.2
2010	7.8	8.4	8.0	6.7	8.3	14.7
2011	29.4	50.6	36.1	28.1	29.5	25.4
2012	46.1	38.5	33.8	47.7	56.3	56.7
2013	29.2	39.5	28.3	24.5	23.5	56.6

Source: Agmarknet

Results of the analysis reflect that there was high volatility in prices of Guar bean at Hissar (56.7% and 56.6% in 2012 and 2013, respectively), Fatehabad (56.3% in 2012), Jaipur (50.6% in 2011), Adampur (47.7% in 2012), Sri Ganganagar (46.1% in 2012) and Hanumangarh (36.1% in 20011) markets, as indicated by the higher magnitude of CV in the respective markets.

The price of Guar seed ranged from INR 4000/- per quintal to INR 11000/- quintal at Jaipur market in 2013. While for the same period the price range at Sri Ganganagar was from INR 7752/- per quintal to INR 28556/- per quintal. In the year 2013 the ranges of price at Jaipur and Sri Ganganagar market were INR 4361/- per quintal to INR 11482/- per quintal and INR 5004/- per quintal to INR 11743/- per quintal respectively.

The high price fluctuation in Guar is mainly on account of higher fluctuation in area and production of Guar seed depending on the spread and level of monsoon rainfall in the producing centers and the export demand of Guar gum from the importing countries.

7.3 Futures Trade for minimizing Price risk

Futures trade in agri-commodities provides good hedging platform for the farmers, processors, exporters, etc. in the value chain. Futures trade in Guar bean started in the month of April, 2004 on NCDEX platform with the objective of price discovery and price risk management. Futures contracts for Guar gum are traded mainly on NCDEX platform. The total value of output of Guar seed is estimated at INR 1,238 crore during 2005-06 (June – July), which has enjoyed a futures turnover of INR 299,305 crore (242 times of Guar output) during May 2005- March 2006.

Total value of Guarbean and Guar gum traded on NCDEX has continuously increased in the initial years and reached to the peak during 2006-08. In 2006 Guar bean and Guar Gum together contributed to 45 percent of total agricultural commodity traded at NCDEX and 37 percent of overall commodity trade of the exchange. The trend was continuing till 2008 as 39 percent of agricultural commodity trade was from Guar only. From the year 2009 the share of Guar in agricultural commodity trade and overall commodity trade of NCDEX started declining. In the year 2010 the

share of Guar in total agricultural commodity trade of NCDEX was only 13 percent. Up to November 2013, the share of Guar in total commodity trade of NCDEX is only around 9 percent.

Table 24.Volume and Value of trade on Commodity Exchange

Volume in 000's Metric Tons and Value in INR billion

Year		Guarseed (A)	Guargum (B)	Total A+B	% of Agri trade at NCDEX	% of Total Trade at NCDEX
2004	Volume	47154	2189	913.14	13	11
	Value	805	108			
2005	Volume	188721	7631	3550.99	6	5
	Value	3202	349			
2006	Volume	140957	3062	2975.34	45	37
	Value	2823	152			
2007	Volume	65042	1112	1258.14	44	38
	Value	1207	51			
2008	Volume	60372	839	1154.53	39	35
	Value	1117	38			
2009	Volume	90298	4271	2202.52	15	14
	Value	1991	211			
2010	Volume	109862	6690	2906.26	13	11
	Value	2558	348			
2011	Volume	89985	8590	4539.76	20	16
	Value	3520	1019			
2012	Volume	3301	387	492.96	20	19
	Value	353	140			

Source: NCDEX

The total quantity traded on commodity exchanges was 88 times of total quantity of Guar seed produced in the year 2004-05, 179 times in the year 2005-06, 146 times in the year 2006-07 and 53 times in the year 2007-08.

Table 25. High –Low difference in Guar bean prices in India (INR/tons)

Year	High	Low	Average	Difference (H-L)
2004	18817	10028	13999	8789
2005	20404	13583	15671	6821
2006	23364	15606	18242	7758
2007	19637	17441	18486	2196

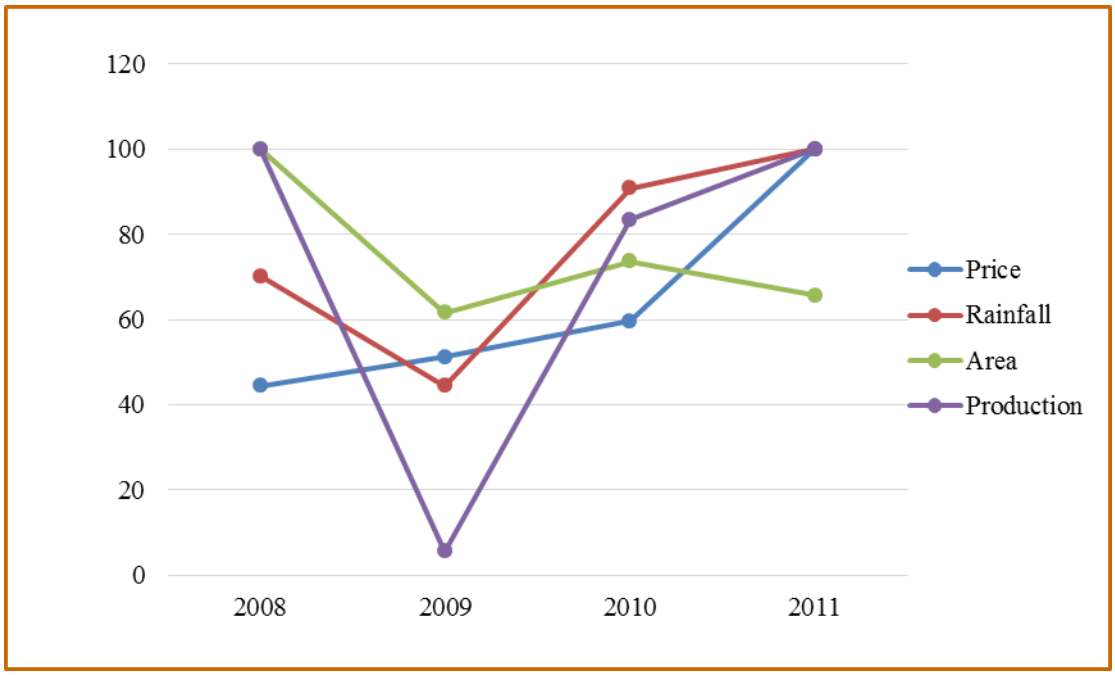
Source: Agmarknet

The high-low price difference after introduction of commodity futures in Guar seed indicates that the spot price volatility of Guar seed has decreased (Table-25).

7.4 Price Fluctuations due to Area, Production and Rainfall

The price of Guar depends upon rainfall and area under cultivation of Guar. The rainfall has more impact on price than production, while with increase in area under cultivation the price decreases to a little extent.

Fig 16. Movement of price determining factors at Sri Ganganagar market



From the Figure-16, it is clear that the rainfall and area under cultivation is moving in same direction while with increase in area under cultivation price is decreasing.

Table 26. Impact on spot price of Guar due to variation in factors (in short run)

r^2 Between	Rainfall	Area	Production
Price	51 (0.72)	25 (-0.50)	14 (0.37)

Source: Author's Calculation

Here in case of correlation between price and rainfall, result obtained shows a positive relation. Here r^2 for relationship between price and rainfall is 51, which shows linear relationship between rainfall and price. The relationship between price and area has a negative correlation coefficient and the value of r^2 is 25. The correlation coefficient for relationship between price and production has a positive but very week association as reflected by a correlation coefficient of 14.

7.5 Trade of Guar

The volume and value of the trade in terms of export of Guar derivatives from India during recent years is presented in Table-27. The table reveals the processed commodity is exported mainly as

Guar gum treated and pulverized constituting more than 83 percent during 2012-13 followed by Guar gum refined splits and a very small quantity as Guar meal. The proportion of refined Guar split, an intermediate product, has dropped to 30 percent of total Guar derivatives export from the country, but still a sizeable quantity of exports is contributed by this raw material used for processing into different industry specific Guar gum products. The major share of the Guar processed in India is exported either in form of semi processed product i.e. refined splits or in form of Guar powder.

Table 27. Export of Guar derivatives from India

Quantity in '000' Tons and value in INR billion

Items with Code		IFY 2010-11		IFY 2011-12		IFY 2012-13		Growth percentage over an year	Percentage share in 2012-13
HS Code	Product	**Qty**	**Value**	**Qty**	**Value**	**Qty**	**Value**		
13023230	Guargum Treated & Pulverised	317.2	23.7	524.8	144.8	263.2	177.6	23	83
13023220	Guargum Refined Split	83.0	5.1	102.4	19.2	70.5	33.9	76	16
13023210	Guar Meal	41.4	0.7	80.2	1.2	74.8	1.4	20	1
	Total	441.6	29.4	707.3	165.2	408.6	212.9	119	100

Source: Directorate General of Commercial Intelligence (DGCIS), Ministry of Commerce, GOI.
Note: Indian Financial Year runs from April to March

There has been 76.29 percent growth in the value of Guar refined split traded in IFY 2012-13 compared to IFY 2011-12. India continues to be a major exporter of refined split. The value of treated Guar gum has also recorded a growth of 22.59 percent. The United States of America has been a major market for India whose status in Indian guar processing industry has further consolidated in recent years mainly in value terms with a share of more than 80 percent during 2012-13. In addition to US, India is also exporting to countries like China, Germany, France, Mexico, Argentina, Japan, Indonesia, etc.

Guar gum is classified under Mucilages and Thickeners group (HS code 13032) in harmonized system of classification in international trade. Mucilages and Thickeners include derivatives of Locust bean, Locust bean seeds and Guar Seeds. India is the largest exporter of Guar gum and mucilages with 73 percent (Table-28) share of world mucilages and thickeners trade, followed by USA (5.5 percent), Spain (4.4 percent), Pakistan (4.3 percent), Italy (2.3 percent) and Germany (1 percent). Countries like USA, Spain, Italy, Germany, etc. imports Guar refined split from India and process it into industry specific Guar gum products and re-export it.

Table 28. Major Exporting countries of Mucilages and Thickeners (in value term for year 2011)

Sr No.	Country	Share (%)
1	India	73.07
2	USA	5.52
3	Spain	4.50
4	Pakistan	4.38
5	Italy	2.40
6	Germany	1.68
7	France	1.32
8	China	1.14
9	Denmark	1.02
10	Switzerland	0.96
11	Morocco	0.90
12	Netherlands	0.90
13	United Kingdom	0.60
14	Belgium	0.36
15	Turkey	0.30
16	Philippines	0.18
17	Russian Federation	0.12
18	Sweden	0.12
19	Japan	0.12
20	Portugal	0.12
21	Poland	0.06
22	Australia	0.06
23	Austria	0.06
24	United Arab Emirates	0.06
25	Trinidad and Tobago	0.06

Leading importing country of Guar gum or mucilages and thickeners group is USA with about 62 percent of total world mucilages and thickeners import followed by Germany (6 percent), Canada (4 percent), China(2.8 percent), Italy (2.5 percent), etc (Table - 29).

Table 29. Major importing countries of Mucilages and Thickeners (in value term for year 2011)

S. No.	Country	Share (%)
1	USA	62.88
2	Germany	6.33
3	Canada	4.08
4	China	2.88
5	Italy	2.51
6	Japan	2.45
7	Denmark	1.88
8	France	1.76
9	Russian Federation	1.69
10	United Kingdom	1.38
11	Mexico	1.32
12	Netherlands	1.19
13	Australia	1.13
14	Belgium	1.00
15	Brazil	0.94
16	South Africa	0.88
17	Argentina	0.75
18	Indonesia	0.69
19	Thailand	0.69
20	Spain	0.69
21	Switzerland	0.63
22	Poland	0.63
23	Austria	0.63
24	Rep. of Korea	0.56
25	Malaysia	0.44

7.6 Export of Guar gum to USA

Total quantity of Guar gum exported from India was about 409 thousand metric tons valued at INR 212.9 billion during 2012-13. Export of Guar gum to USA has also increased in both quantity and value term. The compounded annual growth rate (CAGR) of export of Guar and its derivatives form India in quantity terms has been recorded at 7 percent for the world during 2002-2013, while the growth rate for USA during the same period has been recorded at 22 percent. The USA has emerged as an important player for Guar and Guar processing industry in recent year owing to expanding shale gas fracking industry (Table-30). The demand for Guar and its various derivatives in USA has increased at much faster rate than for rest of the world as depicted by Figure-17.

In addition to USA, China is also emerging as an important importer of refined Guar split. These are the countries acquiring strength in the processing of Guar split to the value added Guar gum and other industry specific products. China and USA now started exporting value added products to other countries. During 2006-07, China emerged as largest importer of Guar refined split, according to trade sources China imposes import duty to the tune of 15 percent on import of Guar gum and import of Guar refined split is free. Thus, China is encouraging import of intermediate product, process it into different industry specific Guar gum products and re-export it.

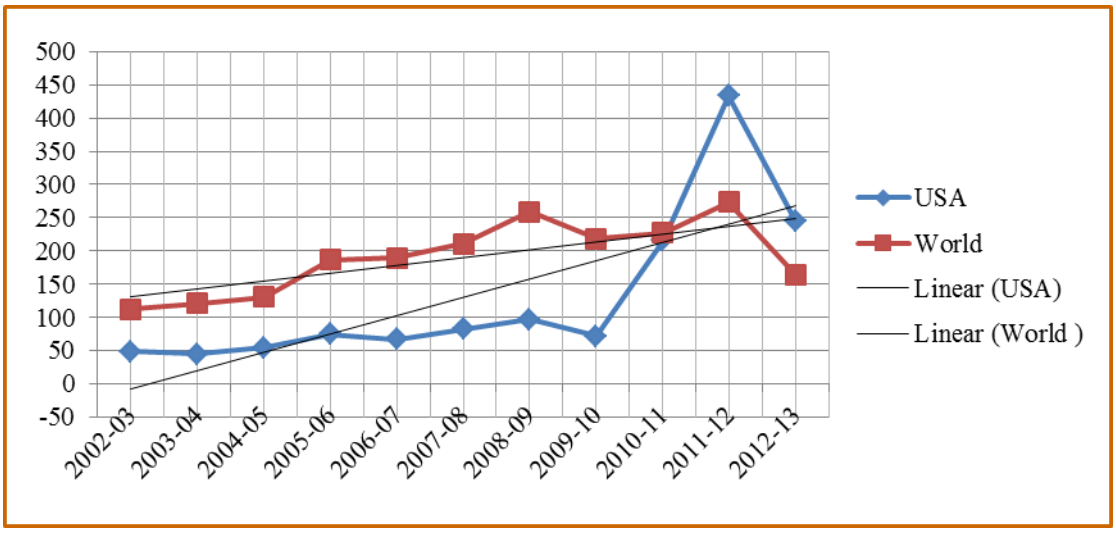
Table 30. Share of USA in Total Export of Guar and its Derivatives from India

(Figures in '000' tons)

Year	Export to USA	Export to World	Total Export	Share of US in total export (%)
2002-03	49	112	161	30.4
2003-04	45	121	166	27.1
2004-05	54	131	185	29.2
2005-06	75	187	262	28.6
2006-07	67	189	256	26.2
2007-08	82	211	293	28.0
2008-09	97	259	356	27.2
2009-10	72	218	290	24.8
2010-11	215	227	442	48.6
2011-12	434	273	707	61.4
2012-13	245	164	409	59.9

Source: APEDA & DGCIS, Ministry of Commerce

Fig 17. Growth of exports to USA vis-a-vis world over years



Source: DGCIS, Ministry of Commerce

7.7 Availability of Guar for Processing and Export

Given that the guar beans can be stored for 3-6 years, the stocks maintained at different level in the supply chain play a vital role in total availably of the crop for processing and export. An attempt has been made to develop data on carry over stock maintained over year to ensure regular supply of the crop by compiling information from different sources. The Table-31 reveals that the processing industry is relying heavily on maintaining stock to safeguard against the high fluctuation of prices and high year to year variation in production owing to over dependence on monsoon.

Table 31. Carry over stock of Guar bean over years (million tones)

Year	Opening Balance	Production	Total Availability	Used	Carryover Stock
2004-05	0.75	0.50	1.25	0.61	0.64
2005-06	0.64	0.60	1.24	0.79	0.45
2006-07	0.45	0.70	1.15	0.74	0.41
2007-08	0.41	0.80	1.21	0.50	0.71
2008-09	0.71	0.80	1.51	0.85	0.66
2009-10	0.66	0.40	1.06	0.70	0.36
2010-11	0.36	1.33	1.68	1.14	0.55
2011-12	0.55	2.22	2.76	2.02	0.74
2012-13	0.13	2.46	2.59	2.12	0.47
2013-14 *	0.55	2.72	3.27	2.37	0.90

Source: Ministry of Agriculture, Government of India, NCDEX and Author estimates based on Industry information; Production: Govt. Estimates and information from market and industry sources; Export: Based on Guar Gum exports and Guar Seed required to produce the same and Local Consumption - Information from industry and market sources

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8. ISSUES IN GUAR INDUSTRY AND TRADE IN INDIA

The various issues related to Guar industry and trade have been summarized as under:

Research and Development: The issues pointed out by the stakeholders related to research and development on guar production included lack of availability of high-yielding varieties with high viscosity gum, poor access of farmers to production technology and quality seeds, low seed replacement ratio, etc. It was suggested that SAUs/ research centres should develop varieties taking care of the requirements of the industry. The easy availability of production technology and HYV seeds were the main requirements of farmers.

Marketing of Guar and its Products: The issues observed during discussions with stakeholders related to marketing of guar seed and products included lack of containers and transportation facilities for processed products from processing point to the port of export, lack of storage facilities, poor linkage of buyers to and development of value-added products of gum for use in different industries. It is suggested that a part of revenue from export taxes need to be diverted to create a national level research and development institute for the purpose.

Promotion of Guar Industry and Export: The issues identified relating to promotion of guar industry were lack of certification laboratories in the processing centres, policies promoting export of intermediate product, competition from countries strong in processing of value-added products of gum, etc. The requirement of the stakeholders included establishment of certification laboratories at the processing locations, framing policies discouraging export of intermediate product, and concerted efforts for developing/importing processing technology for value-added products.

Table 32. Issues and suggestions to strengthen guar industry in India

Theme	Sub-theme	Issues and challenges	Recommendations/ requirements
Research and development	Enhancement in production	Low yield	More area under cultivation of high-yielding short-duration varieties. Improve seed replacement rate.
	Market preferred varietiies	Low gum content and low viscosity varieties	High gum content and high viscosity varieties (like HG 365).
	Value drivers for research and development	Low value addition	Cess on guar export to fund R&D. Hydrolysed guar for dietary fibre use. Cationic guar for personal care use. Hydroxypropyl guar for construction, personal care, oil field uses. Odourless and tasteless guar for use in food. Development of HYVs / high viscosity for fast hydrating guar. Removal of odour of guar meal and its use as a protein supplement for human consumption. Research – industry linkage to be strengthened.
Marketing	Market infrastructure	Long distances to port of exports	Develop hinterland ICDs and link to rail network.
		Lack of storage	Warehousing in rural areas.
		Lack of cleaning and grading units	Cleaning & grading units in market yards.
	Marketing efficiency	Long supply chain	Promote direct marketing and contract farming.
	Market information and intelligence	Non-accessible to the farmers	Ensure daily market info dissemination. Popularize use of commodity futures for price risk management.
Processing	Processing technology	Gap in process / technology for value-added products. Splitting and pulverizing technology.	Import or develop process and technology. Establish techno centre to identify and make available the cost-effective and latest technology for processing. Export promotion council to assign techno-studies.
Industry and export	Certification issues for export	Multiple certificates required for food grade guar Time-consuming process of getting certificate	Regional laboratories, certification agencies at processing centres.
	Policies for export	Substantial export of intermediate products	Policies to encourage export of value- added products & discourage exporting intermediate products. Special assistance for adoption/ import of advanced processing technology.
Industry value chain	Identification of new market opportunities	New applications of guar, action oriented plan	R&D for development of new products and its technology, capacity building industry for food safety aspects.
	Understanding of demand, guar varieties and production requirement	Absence of knowhow with industrialists on various varieties of guarseed	Products are tailor-made as per customer requirement. Dissemination of information on suitable varieties of guar to the processors.
	Demand for specialized labour, professional advice and technical support	Shortage of trained manpower in industry. Lack of knowhow on technology, product biochemistry	Develop trained manpower by imparting technical training. Specific streams of courses relating to hydrocolloids, polymer technology, etc.
Industry-farmer' relationship	Governance and representation of stakeholders	Negligible representation from farmers Farmers groups or cooperatives are missing	Guar growers associations be promoted and strengthened with proper representation.
	Roles, leadership quality, skills, competencies, decision structures	Associations are not very effective	A federation of national guar industry association with regional chapters including farmers groups
	Requirement of whole-of-chain industry body to address fragmentation	Very much required To be aware about the regional disparities and a wholesome approach	R&D institution looking all aspects (right from production to export) of guar. A national approach be devised to rectify the gaps and fragmentation.

Source: Purshottam Sharma and K C Gummagolmath (2012)

Guar Industry Value Chain: The concerns on guar value chain indicated that there was a fragmented supply chain in guar bean and products with lack of skilled manpower and lack of knowhow on technical & emerging market requirements among the small split manufacturers. The measures to strengthen the value chain include development of specialized manpower and capacity building of fragmented industry on the food safety aspects.

Guar Industry Associations/ Representation: Though guar industry associations exist in the country, there is lack of farmers groups/ associations and lack of coordination among different associations. Hence, it is suggested that there should be a national level federation of guar industry and farmers associations with close coordination for a better information flow as a backward linkage and product flow as forward linkage

ANNEXURE

Area, Production and Productivity in leading Guar growing states in India

Area in 000 ha
Production in 000 MT
Productivity in kg/ha

Year	Rajasthan			Haryana			Gujarat			India		
	Area	**Production**	**Yield**	**Area**	**Production**	**Yield**	**Area**	**Production**	**Yield**	**Area**	**Production**	**Yield**
2000-01	3056	481	157	148	102	689	273	61.0	223	3497	659	188
2001-02	2413	763	316	196	127	648	263	112.0	424	2903	1090	375
2002-03	556	28	50	205	91	444	213	65.0	306	975	199	208
2003-04	2278	1163	511	269	117	435	266	204.0	766	2854	1513	530
2004-05	1944	368	189	217	254	1171	214	157.0	733	2867	903	315
2005-06	2445	566	243	270	289	1070	188	108.0	575	2956	1059	358
2006-07	2808	658	234	295	334	1132	205	83.0	404	3344	1169	350
2007-08	2842	1244	269	341	395	1200	196	130.0	662	3472	1789	515
2008-09	3316	1261	380	370	602	1627	150	53.0	350	3863	1936	501
2009-10	2581	201	78	252	329	1305	132.7	44.7	337	2996	595	198
2010-11	3001	1546	515	256	333	1300	124.6	73.0	586	3382	1965	581
2011-12	3000	1847	547	215	290	1350	37	33.0	889	3444	2218	157

Source: 1. Ministry of Agriculture, Government of India 2. Ministry of Agriculture, Government of Rajasthan 3.Ministry of Agriculture, Government of Gujarat 4. Directorate of Agriculture, Government of Rajasthan

District wise Area and Production of Rajasthan (Area in ha and Production in MT)

Region/ District	2000-01		2001-02		2002-03		2003-04		2004-05		2005-06		2006-07		2007-08	
	Area	Production	Area	Production	Area	Production	Area	Production	Area	Production	Area	Production	Area	Production	Area	Production
Ajmer	14313	687	6156	4578	7030	28	2294	2133	5320	358	2099	241	6285	4119	13812	7400
Dausa	21994	4712	10008	7851	2989	307	15990	13685	11144	7893	10664	8003	9985	8050	11215	10356
Jaipur	103941	8314	85005	71998	60617	1306	66966	56027	55006	40762	55421	27414	51389	41104	55143	43060
Alwar	45672	40832	45161	21240	15628	452	23463	22955	15028	51334	21018	12925	27900	28842	34662	39916
Bharatpur	10739	9747	12766	11830	5400	424	5438	5277	4129	3585	3141	2864	3591	3528	6816	5994
Dholpur	4507	3670	3690	3004	1141	201	1597	130	889	1244	727	945	608	790	937	937
Karauli	6499	2460	4696	3710	2903	371	3286	2903	2739	2322	1766	1855	1946	2169	2591	3136
S.Madhopur	15861	3016	8353	3427	719	1	5395	2698	2313	1165	2235	1125	2058	946	3398	1606
Baran	0	0	0	0	0	0	63	96	24	37	13	9	0	0	0	0
Bundi	10741	1027	2085	1397	630	122	1352	1351	110	110	180	265	178	153	932	1192
Jhalawar	0	0	0	0	0	307	0	0	0	0	0	0	0	0	0	0
Kota	2623	1517	528	529	0	0	199	189	0	0	0	0	1	0	0	0
Tonk	3120	105	1505	633	653	0	1212	1213	4255	332	5298	4625	4025	403	6554	6532

	2	5	3	8	3		7	0		4				7		
Barmer	375328	47638	316994	22461	17398	131	312217	146777	295916	16018	352687	24678	421817	56342	354664	73403
Jodhpur	236773	14847	166454	70189	2415	1187	153429	83029	153698	10579	160539	10387	183810	62300	149975	21590
Nagaur	277121	45558	143387	38066	82694	1450	141538	70663	170656	31571	151655	63747	155820	42026	129094	69892
Hanumangarh	247525	88106	233810	82495	78845	3717	244003	278200	166037	24302	203742	147927	287382	76256	319617	277972
SriGanganagar	147181	52421	145694	49998	37984	11328	159514	52363	65234	21414	59294	40605	120301	96959	180141	145425

District wise Area and Production of Rajasthan (Area in ha and Production in MT)

Region/ District	2000-01		2001-02		2002-03		2003-04		2004-05		2005-06		2006-07		2007-08	
	Area	Production	Area	Production	Area	Production	Area	Production	Area	Production	Area	Production	Area	Production	Area	Production
Bhilwara	47299	492	11664	1158	5644	44	10985	5988	6956	3225	16312	2030	21379	12801	36921	18820
Chittorgarh	18734	4550	7833	39213	4902	696	5858	5756	3306	2158	4315	3601	4227	4195	5009	5009
Rajsamand	8068	236	2207	3972	2723	283	3364	2298	2288	936	5833	3407	5482	7171	8498	7309
Banswara	2036	350	1888	1015	1718	473	2000	1316	455	84	1164	444	1268	98	779	548
Dungarpur	2582	251	2671	0	2392	505	2212	3539	3432	1220	2981	845	1799	45	1875	3000
Udaipur	8358	1612	7100	4692	7816	2585	9610	5654	10980	7447	13085	8233	14951	4880	13768	15943

Jhunjhunu	74344	6364	64597	64922	23974	416	53019	53103	54237	35616	65427	18235	61228	11525	68196	15327
Sikar	113530	12988	92352	46619	56277	882	71924	36346	85533	26935	79999	24895	78448	32842	79603	41583
Jalore	84102	700	87786	41285	14344	79	61073	54979	72741	3662	64147	23044	50163	33837	69506	38186
Pali	52884	119	25251	19530	14838	20	25746	18819	29212	9012	49129	16356	50699	35894	67450	45761
Sirohi	18643	876	23508	23508	4824	23	5723	2797	12841	643	11927	9708	1630	879	5713	5713
Bikaner	177006	17770	188284	21105	7273	316	194277	45904	139876	39961	478384	77074	511789	107661	605869	251457
Churu	579067	34205	384057	64902	81731	198	327274	112995	364155	18923	373731	34284	387280	20514	347229	66980
Jaisalmer	317591	75097	313560	32316	5047	0	356411	63070	205838	2511	247735	23452	340474	14532	329752	19686
Total	**3056264**	**481217**	**2412598**	**763348**	**556429**	**27852**	**2278347**	**1163170**	**1944348**	**368351**	**2444648**	**565809**	**2807913**	**658425**	**2842269**	**1243733**

Source: Directorate of Agriculture, Government of Rajasthan

AGMARK Grade Standards

Grade designations and definitions of quality of Dehusked split (Refined) Guar Gum

Definition of quality (Special characteristics)							
Grade Designation	Moisture % by weight (Max.)	Ash % by weight (Max.)	Protein % by weight (on dry basis)	Residue insoluble in acid (Max.)	Gum % by weight (Min.)	Black splits % (Max.)	General Characteristics
Standard	10.0	1.0	Not more than 9%	5.0	80.0	1.0	The dehusked split Guar gum shall :
General	11.0	2.0	Not more than 9%	7.0	75.0	2.0	(a) be obtained by milling Guar seeds after removal of husk from Guar pods of the plant botanically known as Cyamopsis tetragonoloba family Leguminosae.
							(b) be free from dirt, dust added colouring matter visible mould growth insect infestation and ob-noxious smell.
							(c) have characteristics shape, size and colour

* Includes organic extraneous matter such as stems, straw, chaff.

Grade designations and definitions of quality of Guar Gum (Pulverised)

Definition of quality (Special characteristics)									
Grade Designation	Moisture % by weight (Max.)	Ash % by weight (Max.)	Protein % by weight (on dry basis)	Residue insoluble in acid (Max.)	Gum % by weight (Min.)	Viscosity at 25^0C in centipoises (Min.)	pH	Arsenic As2O3 ppm (max)	Lead ppm (Max.)
Grade-I	11.0	0.5	<= 9%	3.0	80.0	3000	5.5-7.5	1.0	5
Grade-II	12.0	1.0	<= 9%	5.0	70.0	2000	6.0-8.0	1.0	5
Grade-III	13.0	1.5	<= 9%	7.0	55.0	1000	6.0-	1.0	5

							8.0		

* Includes organic extraneous matter such as stems, straw, chaff.

Details of stakeholders procured for interaction on sample basis

Sr. No.	Name of the Firm	Name of the Person	Mobile Number/Telephone Number	Telephone Number/ Mobile Number	Address Line 1	Pin Code	City	State	Email ID	Category (Miller/ Trader/ Producer/Exporter)
1	Adarsh Guar Gum Udyog	Mukesh Jain	9928083353		Opp. Krishi Upaj mandi	344001	Barmer	Rajasthan	mukesh@adarshGuargum.com	MILLER
2	Altrafine Gums	Ajit Patel	9825714702	079-25890401	88/2, GIDC Estate, Phase I,	382445	Ahmedabad	Gujarat	info@altrafine.com	MILLER
3	Anil Trading Co.	Rakesh Ji	0291-2570753	9829023753	N-11, Mandor Mandi	342005	Jodhpur	Rajasthan		TRADER
4	Arihant Industries	Mevaram Ji		9414107450	Anaj Mandi, Barmer	344001	Barmer	Rajasthan		TRADER
5	Arvind Goyal Trading Company	Mr.Arvind Goyal	9416924667		Shop No. 40,Mandi, Siwani	127046	Siwani	Haryana		Trader
6	Asharam Mahendra Kumar	Girdhar	0291-2722199	5107199	B18 Basni Krisi Upaj Mandi	342005	Jodhpur	Rajasthan		TRADER
7	Ashok Broker	Akash Deep Gupta	0291-2721432	9414126777	A-4, Basni Krisi Upaj Mandi	342005	Jodhpur	Rajasthan	ashokbroker@gmail.com	BROKER
8	Ashok Industries	Ashok	9314709015	9414100329	F44Medium Ind.Area;Phase I	342005	Jodhpur	Rajasthan		MILLER
9	Balaji Trading co	Sanjay Agarwal	0151-2250139	9414138347	236, New Grain Mandi	334001	Bikaner	Rajasthan		TRADER
10	Balaji Trading Company	Manohar lal Mohan kumar	0151-2250242	9414138347	176, Krishi upaj mandi	334001	Bikaner	Rajasthan		TRADER
11	Balchand Mukesh Kumar	Mr Mukesh Kumar	9416811104		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
12	Banwari lal Beli Ram	Mr Vivek Rao	9467050866		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana	raovivek8@gmail.com	BROKER
13	Bhaktawar Mal Govind Ram	Mohan Lal Mundhra	0291-2721926	9314321926	C4, Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan		TRADER

Sr. No.	Name of the Firm	Name of the Person	Mobile Number/Telephone Number	Telephone Number/ Mobile Number	Address Line 1	Pin Code	City	State	Email ID	Category (Miller/ Trader/ Producer/Exporter)
14	Bhansali Gums	Ghewar Singh Ji	9829022904		E 375Medium Ind.Area;	342005	Jodhpur	Rajasthan		MILLER
15	Bhawani Trading	Mahesh Ojha	0291-5107173	9829027173	E3, Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan		TRADER
16	Bhawarlalji	Bhawarlalji	9829021663		Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan		TRADER
17	Bhimsen Ved Prakash	Mr.Mukesh Goyal	9610284342		Anaj Mandi, Raisinghnagar	335051	Raisinghnagar	Rajasthan		Trader
18	Bihari Lal Chabil das	Mr. Sunil Kumar Jain	9416042145		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana	ajakhiljain31@gmail.com	BROKER
19	Buccha Trading co	Jethram Buccha	0151-2250414	9414263454	85, Krishi upaj mandi	334001	Bikaner	Rajasthan		TRADER
20	Budh Ram Bris Lal	Mr.Mukesh	9672990934		Anaj Mandi, Raisinghnagar	335057	Raisinghnagar	Rajasthan		Trader
21	Chandra Prakash	Sanjay Jain	9314709018		Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan		BROKER
22	Chhagan lal Harishkumar	Harish Agarwal	9414506347	9414137312	44, New Grain Mandi	334001	Bikaner	Rajasthan		TRADER
23	Chiranjiv Lal Company	Mr.Chiranjiv Lal	9414091591		Anaj Mandi, Raisinghnagar	335053	Raisinghnagar	Rajasthan		Trader
24	Chopra Gwar Gum Ind	Prakash Chopra	9314709071		E 20 Medium Ind.Area	342005	Jodhpur	Rajasthan		MILLER
25	Dabri Food Products	Ramesh Jindal	9215144034		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana	dabrijindal67@yahoo.com	MILLER
26	Damodar Sarswat	Manoj/ Damodar Sarswat	0151-2250577/2250387	9829025536	R-4, Krishi upaj mandi	334001	Bikaner	Rajasthan		TRADER
27	Dargar Trading co	Arun Dargar	0151-2250911	9414139039	39, New Grain Mandi	334001	Bikaner	Rajasthan	arundargar@rediffmail.com	TRADER
28	Deepak Guar Mill	Anjani Goyal/Krishna	9416049803		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		MILLER
29	Deepak Trading	Vagaram	0291-5107139	9829025696	E111-13 Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan	vagarambhati@yahoo.com	BROKER
30	Delu Trading Company	Mr Bhim Singh	9416593804		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER

Sr. No.	Name of the Firm	Name of the Person	Mobile Number/Telephone Number	Telephone Number/ Mobile Number	Address Line 1	Pin Code	City	State	Email ID	Category (Miller/ Trader/ Producer/Exporter)
31	Dev Raj	Mr Dev Raj	9416024115		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
32	Dhajaram Jaidev	Jaidev Gupta	9414088183	0154-2472875	131 New Mandi Yard	335001	Srigangana gar	Rajasthan		TRADER
33	Dinesh Chand		9414671795		Basani Krishi Upaj Mandi	342005	Jodhpur	Rajasthan		TRADER
34	DS Mittal & co	DS Mittal	0151-2250872	9414137910	9, New Grain Mandi	334001	Bikaner	Rajasthan	dsmittalbkn@yahoo.com	TRADER
35	Dugar and Company	Shikhar Chand Dugar	9414142666		Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan		TRADER
36	Gandhi Guar Gum Industries	Gandhi Ji	0291-2740308	2740408	E92 M I A ;IInd Phase	342005	Jodhpur	Rajasthan		MILLER
37	Ganeshilal Cotton Industries	Sandeep Mittal	9215729574		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana	sandeep574@rediffmail.com	MILLER
38	Ganga ram Satpal	Satpal Agarwal	0151-2251984	9414211568	70, New Grain Mandi	334001	Bikaner	Rajasthan		TRADER
39	Gangaram / Balbeer Kumar	Mr.Surender/Mr Balbeer Mittal	9254242086		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
40	Ganpati Guar Gum	Ayush Goyal	9215242305		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana	anoopbansal85@gmail.com	MILLER
41	Ganpati Trading & Co	Rajender Agarwal	9982307761		Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan	rjhunjhunuwala@yahoo.co.in	TRADER
42	Ghadsana Trading co	Mangeram Goyal		9414139703	167, New Grain Mandi	334001	Bikaner	Rajasthan		TRADER
43	Ghanshyam Das Rajesh Kumar	Mr Ghanshyam Das	9466239877		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
44	Goyal Brothers	Mr Rajkumar goyal	9416042355		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana	helloji12@gmail.com	BROKER
45	Goyal Trading Company	Mr.Rajesh Goyal	9255181327		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana	gtc2008@ymail.com	BROKER
46	Hanuman Traders	Indra Kr.	0151-2250408	9414139617	201, Krishi upaj mandi	334001	Bikaner	Rajasthan		TRADER
47	Hanuman Trading co	Bhimraj Bajaj		9414137322	237, New Grain Mandi	334001	Bikaner	Rajasthan		TRADER
48	Hanuwantrajji	Hanwantraj	0291-5107184	9829025930	B3 Basani Krisi Upaj	342005	Jodhpur	Rajasthan		BROKER

Sr. No.	Name of the Firm	Name of the Person	Mobile Number/Telephone Number	Telephone Number/ Mobile Number	Address Line 1	Pin Code	City	State	Email ID	Category (Miller/ Trader/ Producer/Exporter)
					Mandi					
49	Hari Kishan Ramesh Kumar	Mr. Shiv Kumar	9255544751		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
50	Harlal Ram Kumar	Mr Shubhash Kumar	9813444270		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
51	Haryana Guar Gum	Kailash/Surendra Singhal	9315432455		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana	surendra_agra@yahoo.co.in	MILLER
52	Hindustan Gum	Mr. Vinod Acharya	0291-2740309	9829023087	E 282 M I A	342005	Jodhpur	Rajasthan	hichem@vsnl.com	MILLER
53	HP Guar Gum	Kartik Goyal	9215400009		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana	mr.kartik555@rediffmail.com	MILLER
54	Inderchand Raj Kumar	Mr Inder Chand	9416080308		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
55	Jai Bharat Gum and Chemicals	Mr.Ravindra Kedia	9813517653		Siwani Mandi ,Bhiwani	127046	Siwani	Haryana	jaibharat@vsnl.com	Miller
56	Jainsons Industries	Prashant Bohra		9828130372	F-547, MIA, II phase	342005	Jodhpur	Rajasthan		MILLER
57	Jairam Das Punnet Kumar	Mr.Puneet Garg	7568824151		Anaj Mandi, Raisinghnagar	335061	Raisinghnagar	Rajasthan		Trader
58	Jayamal Ram Ramswaroop	Mr Purushottam Rana	9416076301		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
59	Jhamboo Kharwa		0291-3105613		Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan		BROKER
60	Jineshwar Kr. Amratlal	Hastimal	0291-2721731	9829026731	C5, Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan		TRADER
61	Kailashchand Manojkumar	Kailash Mittal	9414090347	0154-2485947	85, New Mandi Yard	335001	Sriganganagar	Rajasthan	kailashmittal47@gmail.com	TRADER
62	Kakkad Trading Company	Mr.Atam Prakash	9888330737		Shop No.31-A,Grain Market, Rajpura	140401	Rajpura	Punjab		Trader
63	Kalyan Commodities	Mr.Shyam Kalyani	9414091563		Anaj Mandi, Raisinghnagar	335052	Raisinghnagar	Rajasthan		Trader
64	Kamal Agro	Rambilas	9316196595		Anaj Mandi,	12505	Adampur	Haryana	kamalagro@gmail.com	MILLER

Sr. No.	Name of the Firm	Name of the Person	Mobile Number/Telephone Number	Telephone Number/ Mobile Number	Address Line 1	Pin Code	City	State	Email ID	Category (Miller/ Trader/ Producer/Exporter)
					Admapur,Hissar	2				
65	Kanaram and Company	Mr Jagdish Delu	9416173223		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana	jkdelu2990@gmail.com	BROKER
66	Kanhaiyalal Rajkumar	Indrakumar Khatri	0151-250408	9414139617	189, New grain mandi	334001	Bikaner	Rajasthan		TRADER
67	Kasaniya Trading Company	Mr Kapil Moneywal/ Bhakti singh	9466404761		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana	globalvishnoi@gmail.com	BROKER
68	Kewal chand Kanwarlal	Raja Babu		0151-2250834	40, New Grain Mandi	334001	Bikaner	Rajasthan		TRADER
69	Kheram Pur Brothers	Mr Ashish Goyal	9802720021		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
70	Kisan Agro	Pawan Goyal	9316042577		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana	pawangoyal77@gmail.com	MILLER
71	Kothari brothers	Pramod Khotari	9414140502	0151-2251210	228, New Grain Mandi	334001	Bikaner	Rajasthan		TRADER
72	Krishna Industries	Ratan Kumar Mittal	9255596769		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana	shreekrishnaadr@gmail.com	MILLER
73	Kundanamal Mohanlal	Shivratan Modi		9414137445	55, New Grain Mandi	334001	Bikaner	Rajasthan		TRADER
74	Ladhuram Hastimal	Pawan Ji		9414106432	Anaj Mandi, Barmer	344001	Barmer	Rajasthan		TRADER
75	Lahia Abhishek	Abhishek	9314422155		Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan		TRADER
76	Lalit Kumar Chandak & Co.	Raju Sa	0291-2570066	2570841	C-6 Mandor Mandi	342005	Jodhpur	Rajasthan		TRADER
77	Lamberti Hydrocolloids Pv lt	Mahendra Tripathi	9099611911	02827-254254	Plot No. 1&2, SIDC Road, Veraval	360024	Rajkot	Gujarat	tripathi.mahendra@lamberti.com	MILLER
78	Laxmi Guar Gum	Vishwanath	9896123464		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana	laxmigumadr@gmail.com	MILLER
79	Liladhar Anandkishore	Sri Gopal Agarwal		9414514845	36, New Grain Mandi	334001	Bikaner	Rajasthan		TRADER
80	Liyaqatali Hyder Ali	Md.Rafyq(guddu)\HyderAli	0151-2251409	9982683131	Opposite lalgarh	334001	Bikaner	Rajasthan		TRADER

Sr. No.	Name of the Firm	Name of the Person	Mobile Number/Telephone Number	Telephone Number/ Mobile Number	Address Line 1	Pin Code	City	State	Email ID	Category (Miller/ Trader/ Producer/Exporter)
					railway station					
81	Lotus Gums	Shayam Kamal Sharma	9829027259	0291-2513259	G-657, MIA, 2nd Phase, Basni	342005	Jodhpur	Rajasthan	info@lotusgum.com	MILLER
82	LR Gum and Chemicals	Mr Ashok Goyal	9416383393		Shop No. 67,Mandi, Siwani	127046	Siwani	Haryana	lrgumandchemicals@gmail.com	Miller
83	Lucid Hydrocolloids	Uday Merchant	022-24158059	9324150001	401 A, Navbharat Estates, Zakaria Bunder Road, Sewri (W)	400015	Mumbai	Maharashtra	admin@lucidgroup.com	Miller
84	Lunawat Dal Mill	Vedprakash	0291-2740019	9414100765	E 102 Medium Ind.Area;	342005	Jodhpur	Rajasthan		MILLER
85	Maa Vankal Group	Rakesh Dhariwal	9829028082		196, SS Market Yard	385535	Deesa	Gujarat	maavankal@yahoo.co.in	MILLER
86	MadanLal Jagdish Chand	Mr Sudhir Asija	9729290007		Anaj Mandi, Admapur,Hisar	125052	Adampur	Haryana	sudhirasija79@gmail.com	BROKER
87	Madanlal Sarswat	Madanlal Sarswat	0151-2250351	9414138351	126, Krishi upaj mandi	334001	Bikaner	Rajasthan		TRADER
88	Mahalaxmi store	Satyanarayan Saraswat	0151-2251240	9414142356	88, New Grain Mandi	334001	Bikaner	Rajasthan		TRADER
89	Mahaveer Corp.	Dinesh Jain	0151-2251976	9414138976	90, Krishi upaj mandi	334001	Bikaner	Rajasthan		TRADER
90	Mahender Kumar Rakesh Kumar	Mr.Udhister Agarwal	9416042375		Anaj Mandi, Admapur,Hisar	125052	Adampur	Haryana	atulbansal1983@gmail.com	BROKER
91	Mahendra Kr. Manish Kr.	Jatan Chajjer	0151-2250639	9829217639	185, Krishi upaj mandi	334001	Bikaner	Rajasthan		TRADER
92	Mahesh & Co.	Mahesh Phophalia	0291-2721172	9829021787	C6, Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan	maheshphophalia1@gmail.com	TRADER
93	Maheshwari Trading	Jugal Kishore	9829154161		Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan		TRADER
94	Mahinder Trading Company	Mr Mangal Sen	9992623146 / 9416263171		Anaj Mandi, Admapur,Hisar	125052	Adampur	Haryana		BROKER
95	Malani Bros.	Pankaj Malani	0291-2725647	9414132841	E/11-9,Basni Krishi Upaj	342005	Jodhpur	Rajasthan		TRADER

Sr. No.	Name of the Firm	Name of the Person	Mobile Number/Telephone Number	Telephone Number/ Mobile Number	Address Line 1	Pin Code	City	State	Email ID	Category (Miller/ Trader/ Producer/Exporter)
					Mandi					
96	Maloo Agency	Mukesh Maloo	0291-5106628	9414132369	C1 Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan		BROKER
97	Manoj kumar Pankaj Kumar	Manoj Goyal	9414093379		Anaj Mandi, Sriganganagar	335001	Sriganganagar	Rajasthan	manoj.gupta550@gmail.com	TRADER
98	Manoj Mediator	Manoj Saraswat	0151-2250370	9414143529	R-4, New Grain Mandi	334001	Bikaner	Rajasthan	mk_sarswat@yahoo.in	TRADER
99	Manoj Trading Company	Mr.Piyush Singh	9828437765		Anaj Mandi, Raisinghnagar	335062	Raisinghnagar	Rajasthan		Trader
100	Maxam India Pvt. Ltd.	Dr. Rajendra Kumar Verma	9910330166	011-22444846	209, Ansal's Vikas Deep, Laxmi Nagar	110092	Delhi	Delhi	rverma@maxam.net	User
101	Megha Guar Gum	Rajinder Goyal	9215142401		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana	meghagum@gmail.com	MILLER
102	Meghraj Ganeshlal	Harish Agarwal	0151-2251240	9414141240	94, Krishi upaj mandi	334001	Bikaner	Rajasthan	aggarwal.harish53@gmail.com	TRADER
103	Mehta Traders	Mr Madan Lal Mehta	9896954907		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
104	Mohan Ajencies	Mohan Surana		9414139111	87, New Grain Mandi	334001	Bikaner	Rajasthan		TRADER
105	Mohan Lal Satya Narayan	Mr Mahesh Kumar Goyal	9812342054		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
106	Mohinder Trading Company	Mr. Mohinder Kumar	9417040882		Shop No.208,Grain Market, Rajpura	140401	Rajpura	Punjab		Trader
107	Mohta Trading Company	Mr.Manish Goyal	9509040957		Anaj Mandi, Raisinghnagar	335058	Raisinghnagar	Rajasthan		Trader
108	Munna lal Trading Company	Mr.Tejram Thekedar	9461258448		Anaj Mandi, Raisinghnagar	335056	Raisinghnagar	Rajasthan		Trader
109	N M Foods Pvt. Ltd.	Manoj Gupta	9414089375		New Mandi Yard	335001	Sriganganagar	Rajasthan		TRADER
110	Nahata Trading Co.	Ghewar G	0291-2570820	9829026820	I/I-8, Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan		TRADER
11	Nanuram	Mr.Ashish Jindal	9416056248		Shop No.	12704	Siwani	Haryana	nrjgum@gmail.com	Miller

Sr. No.	Name of the Firm	Name of the Person	Mobile Number/Telephone Number	Telephone Number/ Mobile Number	Address Line 1	Pin Code	City	State	Email ID	Category (Miller/ Trader/ Producer/Exporter)
1	Jindal Gum and Chemicals				12,Mandi, Siwani	6				
112	Navkar Broker	Rinku Guleria	0291-3112107	9314712107	Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan		BROKER
113	Navratan daga & co	Navratan Daga		9414142764	B-61, New Grain Mandi	334001	Bikaner	Rajasthan		TRADER
114	Nikhil Brokers	Somparikh	9829290523		Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan		BROKER
115	Nirmal Kumar Mundhir	Mr.Narender	9928049670		Anaj Mandi, Raisinghnagar	335054	Raisinghnagar	Rajasthan		Trader
116	Om Agro Industries	Suresh Thakkar		9824087483	Anaj Mandi, Deesa	385535	Deesa	Gujarat	omgum.india@hotmail.com; piyush0306@ymail.com	Trader
117	Paliran Tejimal	Mr Neeraj Bansal	9416080051		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
118	Pankaj Gums	Paras Setia		9314714264	F-146-B, II phase MIA	342005	Jodhpur	Rajasthan		MILLER
119	Pawan kumar Vipin kumar	Pawan Agarwal		9414138604	123, New Grain Mandi	334001	Bikaner	Rajasthan		TRADER
120	Phulchand Indrersen	Mr Vikas	9254142117		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana	vikash.gupta2007@gmail.com	TRADER
121	Phursani Trading Company	Mr. Rajender Vishnoi	9215145529/429/329		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
122	Pokar Chand Manak Chand	Devilal Rathi	0291-5107143	9829023127	A22, Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan		TRADER
123	Pokermal Pradeep Kumar	Mr Prdeep Benival	9416042101		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana	pardeep29@hotmail.com	BROKER
124	Poonam Chand Lalit Kumar	Mr Lalit Kumar	9416390954		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
125	Poonam Chand Praveen Kumar	Mr Harish chandar	9416042298		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
126	Pradeep Trading company	Mr. Shyam/Sushil	9416080184/9466206400		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
127	Praveen Trading	Mr Surjeet Singh	9466249367		Anaj Mandi, Admapur,His	125052	Adampur	Haryana		BROKER

Sr. No.	Name of the Firm	Name of the Person	Mobile Number/Telephone Number	Telephone Number/ Mobile Number	Address Line 1	Pin Code	City	State	Email ID	Category (Miller/ Trader/ Producer/Exporter)
	Company				sar					
128	Prayag Chand Shubh Karam Das	Mr. Hanuman das	9416042187		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
129	Prem kumar Pradeep kumar	Pradeep Agrawal	9414093938		New Mandi Yard	335001	Sriganganagar	Rajasthan		TRADER
130	Premcem Gums	Premal Joysher	022-21026196	9820102977	401, Udaybhanu Apartments, M.G Road, Rajawadi Ghatkopar East	400077	Mumbai	Maharashtra	info@premcemgums.com	Miller
131	Premnath Shivpaul	Shivpal Khatri	0151-2252255	9414138355	114, New Grain Mandi	334001	Bikaner	Rajasthan		TRADER
132	Pursuram Chajuram	Mr Ramswaroop singhal	9416132623		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
133	Raghavji	Shravanji	9314715849		Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan		BROKER
134	Raichand Amit Kumar	Mahendra	9314709017		Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan		BROKER
135	Rajasthan Guar Gum Industries	Bheeru Jain	9829225829		F 115Medium Ind.Area;	342005	Jodhpur	Rajasthan	rajgum@datainfosys.net	MILLER
136	Rajesh Trading Company	Mr. Rajesh Kumar	7597828105		Anaj Mandi, Raisinghnagar	335055	Raisinghnagar	Rajasthan		Trader
137	Ram Chand Madan Lal	Mr Chunnilal Goyal	9466576065		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
138	Ram Chandra Rajesh Kumar	Meethu Sa	5107205		B-15,Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan		TRADER
139	Ram Niwas Dhoot	Ram Niwas	3109066	9314709066	C-2, 1st Floor	342005	Jodhpur	Rajasthan		BROKER
140	Ram Pratap Ram Gopal	Mr Pawan Kumar	9812922229		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
141	Rama Industries	Mitul Shah		9825047093	Patan highway road, Near G.I.D.C	385535	Deesa	Gujarat	info@ramagum.com	MILLER

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142	Rambilas/mukesh Kumar	Mr. Suresh Kumar	9215831044		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
143	Ramdev Trading Co.	Satya narayan	9461240013		Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan	No email ID	TRADER
144	Rameshwar Das Ghanshyam Das	Mr Bhimrat Bansal	9812158230		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
145	Ramnarayan Biyani	Ramnarayan Biyani	0151-2250609		176, Krishi upaj mandi	334001	Bikaner	Rajasthan		TRADER
146	Rohit Trading Co	Mahaveer Singh	9001790036		Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan	pawan422@gmail.com	TRADER
147	Rohtas Brothers	Mr Pankaj Singhal	9215540735		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana	sumitsinghal107@gmail.com	BROKER
148	Ruchi Soya Industries Pvt. Ltd	A P Dadoo	9810183855	0124-4613300	3rd Floor Universal Trade Tower, Sector 49	122001	Gurgaon	Haryana	ap_dadoo@ruchigroup.com	MILLER
149	Sajal Kumar Pawan Kumar	Mr Sajal Kumar	9466003324		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
150	Sambhu Trading Co.	Basant Bhai/Babulal	0151-2250399	9414139399	164, Krishi upaj mandi	334001	Bikaner	Rajasthan	brokerstcbkn@yahoo.in	TRADER
151	Sanjay Gupta Sole Prop	Sanjay Gupta	9414089864		129, New Dhaan Mandi	335001	Sriganganagar	Rajasthan	sanjay_kumar_garg2007@yahoo.com	TRADER
152	Sanjay Trading co	Sanjay Bansal	0151-3290336	9414138270	105, New Grain Mandi	334001	Bikaner	Rajasthan	stc_bikaner@sanjaytrading.com	TRADER
153	Sanjharam Radheshyam	Mr Radheshyam Gharwal	9416544735		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
154	Saraswati Gum and Chemicals	Mr.Dipin/Mr Govindram	9729085177		Shop No. 26,Mandi, Siwani	127046	Siwani	Haryana	sarasgum1998@gmail.com	Miller
155	Sathi Trading Company	Mr. Bagrawat Singh	9416990650		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
156	Satish Kr.Manoj Kr.	Satish\ Shekhar	0151-2250486	9414137043	65, Krishi upaj mandi	334001	Bikaner	Rajasthan		TRADER
157	Shakti Trading Co.	Jaiprakash Saraswat	0291-2721309	9829026536	B Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan	jpsarswat@gmail.com	BROKER
158	Shiv Chandra	Devilal Arora	9992000751		Anaj Mandi,	12505	Adampur	Haryana		BROKER

Sr. No.	Name of the Firm	Name of the Person	Mobile Number/Telephone Number	Telephone Number/ Mobile Number	Address Line 1	Pin Code	City	State	Email ID	Category (Miller/ Trader/ Producer/Exporter)
8	Chabil Das				Admapur,Hissar	2				
159	Shiva Traders	Jagdish Pediwal	9351206171		98, Krishi upaj mandi	334001	Bikaner	Rajasthan		TRADER
160	Shivgopal Gopikishan	Amit Goyal		9829146968	21, New Grain Mandi	334001	Bikaner	Rajasthan	shriharimtc@yahoo.co.in	TRADER
161	Shobhachand Sanjaykumar	Sanjay Mahipal	9414089553		20 New Dhan Mandi	335001	Sriganganagar	Rajasthan	mahipal_food@yahoo.co.in	TRADER
162	Shree Raghav Broker.	Hanumanji Sarswat	0291-2720049	5107123	C9Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan		BROKER
163	Shree Trading co	Radhakishan Chandak	0151-2250314	9414142254	132, New Grain Mandi	334001	Bikaner	Rajasthan		TRADER
164	Shri Balaji	Sonu Bansal	9729023731		Near Anaj Mandi,admpur Hissar	125052	Adampur	Haryana	mr.sonubansal@gmail.com	MILLER
165	Shriram Industries	O P Soni		9829027076	C-80, II phase	342005	Jodhpur	Rajasthan		MILLER
166	Shubhash Chand Ajay Kumar	Mr Shubhash Chand	9416043511		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
167	Shuchand Kasur and Sons	Mr Rajesh Kumar	9416216403		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
168	Siddarth Broker	Rajesh Lunawat	0291-5106798	9314438149	A-24, Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan		BROKER
169	Singhal Trading Company	Mr Rajender Prasad	9255487531		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
170	Singla Commodities	Mr. Rajesh Jindal	9414380986		Anaj Mandi, Raisinghnagar	335060	Raisinghnagar	Rajasthan		Trader
171	Sohan Lal Sunil Kumar	Vimal Vadera	0291-3118525	9314715239	Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan		TRADER
172	SS Chem Industries	Ashok Ji	9829021965		F 60 Medium Ind.Area;	342005	Jodhpur	Rajasthan		MILLER
173	Subhash Sharma	Mr.Subhash Sharma	9255411609		Siwani Mandi ,Bhiwani	127046	Siwani	Haryana		Trader
174	Subhlaxmi Traders	Omprakash Mundhara	0291-2721216	9829028110	E 111Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan		TRADER
17	Sumati Gums	Shreyans Mehta	9799506999		Basni	34200	Jodhpur	Rajasthan	shreyansmehta9@gmail.com	MILLER

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5	Pvt. Ltd.				Industrial Area	1				
176	Sunil Kumar Patawari	Mr.Sunil Jain	9414091633		Anaj Mandi, Raisinghnagar	335063	Raisinghnagar	Rajasthan		Trader
177	Sunita Hydrocolloids	P.K Hissaria	0291-2740075		E-394, MIA Phase II, Basni	342005	Jodhpur	Rajasthan	pkhissaria@shplindia.com	MILLER
178	Supreme Gums Pvt. Ltd.	N K Jain	9829097078	0141-2770741	G-999/1000, Sitapura Ind. Area	302022	Jaipur	Rajasthan	info@supremegums.com	Miller
179	Suraj Trading Co.	Rakesh Rathi	0291-2721143	9314707962	A-2,Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan		TRADER
180	Tickuram Gum and Chemicals	Mr.Vipin Agarwal	9991091007		Siwani Mandi ,Bhiwani	127046	Siwani	Haryana	vipin_agg@yahoo.co.in	Miller
181	Ugam Chand Moolchaand	Gopsa	0291-5107128	9314709091	C2, Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan		TRADER
182	Umed Chajjer	Umed Chajjer	9314710596		C16 Basani Krisi Upaj Mandi	342005	Jodhpur	Rajasthan		TRADER
183	Urmiyaram Suryakant	Mr Shyam kumar jain	9215810051		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
184	Vaisabhi Ram Ganga Ram	Mr.Chiranjilal	8432184101		Anaj Mandi, Raisinghnagar	335059	Raisinghnagar	Rajasthan		Trader
185	Vikas WSP	B D Agrawal		9829225644	B-86,87 Udyog Vihar	335002	Sriganganagar	Rajasthan	vikaswspltd@gmail.com	MILLER
186	Vimal Mills	T.C. Baid	0291-2740593	9829022304	Medium Ind.Area	342005	Jodhpur	Rajasthan		MILLER
187	Vinod Kumar Pawan Kumar	Mr. Ramesh	9215144034		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana		BROKER
188	Vishal Guar Gum	Ashok	9896001020		Anaj Mandi, Admapur,Hissar	125052	Adampur	Haryana	vishalGuargum@gmail.com	MILLER
189	Westraj Gum	Champalal Mehta		9414107523	Opp. Krishi Upaj mandi	344001	Barmer	Rajasthan		TRADER
190	Yashita Investment	Bajrang Modi	9828921789		Basni Krishi Upaj Mandi	342005	Jodhpur	Rajasthan	bajmodi1980@gmail.com	BROKER

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