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Research Paper

Trends and Economic Dynamics of Guar in India

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ABSTRACT

Guar was once a low-value crop, but recent changes in global markets have made guar crops that fetch large profits. The value of exports of Indian guar products increased at a galloping pace from 602.95 to 21287.01 crores during 2000–2013, making guar products the largest agricultural export in those years. However, the value of exports later declined to 1949.07 crores in 2020–21. The proportion of guar gum powder in total guar products exported from India has remained high, ranging between 61-66 % (in terms of quantity) and 75 % (in terms of value) for the last five years. The study focused on the global production and trade of guar products, the composition of guar products exported from India, trends and variations in guar production, trends in prices, major aspects of demand and supply, uses of guar products, and their derivatives. The guar area, production, and productivity in India showed a positive trend in the last 20 years (2000-2020). Monthly and seasonal fluctuations in guar prices have been observed over time. As for the long-term trend, guar prices in Rajasthan, Gujarat, and Haryana increased gradually from January 2003 to June 2010 and, after that, continued to drop sharply. The supply of guar is greatly dependent on the amount and pattern of precipitation as its cultivation is restricted to dry regions of the country. Globally, oil drilling and mining is the primary consumer industry of guar gum. Farmers and industrialists confront significant obstacles, i.e., price instability, low productivity, unpredictable guar output, low investment in R&D, etc.

HIGHLIGHTS

- The proportion of guar gum powder in total guar products exported from India has remained high, ranging between 61-66 % (in terms of quantity) and 75 % (in terms of value) for the last five years.
- The guar area, production and productivity in India showed a positive trend in last 20 years (2000-2020).
- Monthly and seasonal fluctuations in guar prices have been observed over time.

Keywords: Area, Demand, Exports, Price, Production, Supply

Guar, also known as the cluster bean (*Cyamopsis tetragonoloba*), is a native of India and has long been grown in the country. It has traditionally been used in agriculture as a green manure crop, a vegetable, and food source for cattle. Guar gum is the most significant guar seed product commercially and is used in many different industries, including food processing, oil and gas, paper, textile, cosmetics, mining, and explosives (Bhupender and Amalendu Kumar. 2020). India contributes around 80% of the world's guar production, making it the top producer in the world (Dhaka *et al*. 2019). Guar seed production is estimated to range between 1.0 to 1.6 million tonnes annually. Major export destinations of guar in the world are United States, China, Germany, Japan, Russia, Denmark, France, Italy, Netherlands etc. (Rai, 2015).

The word "guar" originated from the word "gowahaar," which is used most frequently in India as cattle feed (*Gow means cow,* and *Ahaar means*

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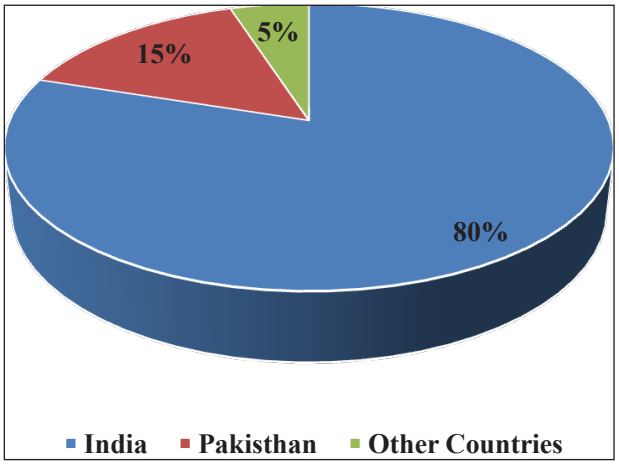
feed). It thrives in semi-arid areas where less hardy crops fail because it is a drought-tolerant legume crop. The crop is suitable for arid and semi-arid climates and can withstand high temperatures and dry conditions. It needs moderately mild conditions with moderate intermittent rainfall and plenty of sunshine to grow, which takes around 14 to 16 weeks for maturity. Light-textured, sandy-to-sandy loam soils that receive 300-500 mm of annual precipitation are ideal for the growth of guar crops (Singh and Santhosh. 2014). It may, however, also be grown well in regions with 500–700 mm of average rainfall (NIAM. 2013). The guar crop is a *Kharif* (summer) crop that is sown in June and July with the onset of monsoon and harvested in late September or early October. Guar is an outstanding crop for soil-building; its root nodules contain bacteria that fix nitrogen and crop residues, which, when plowed into the soil, upturn the yields of succeeding crops (Under sander *et al*. 1991).

The present study examines the global production and trade of guar products, the composition of guar products exported from India, trends and variations in guar production, trends in prices, significant aspects of demand and supply, and traditional and emerging end uses of guar products and its derivatives.

GLOBAL PRODUCTION AND TRADE OF GUAR PRODUCTS

Global production

Guar seed production ranges between 1.0 to 1.6 million tonnes annually. The production of guar, however, varied greatly, primarily due to the monsoon season in India, particularly in Rajasthan (Sharma and Gummagolmath, 2012). India is the world's largest producer of guar seed and the products manufactured from it, accounting for over 80% of global guar seed production, as shown in Fig. 1. With a 15% share, Pakistan is the second-largest producer, and USA, Brazil, South Africa, Malawi, Zaire, Sudan, Australia, and China are other guar producers. Due to the recent increase in the price of guar products, many countries, such as Australia and China, are encouraging guar cultivation and production, challenging India's monopoly.



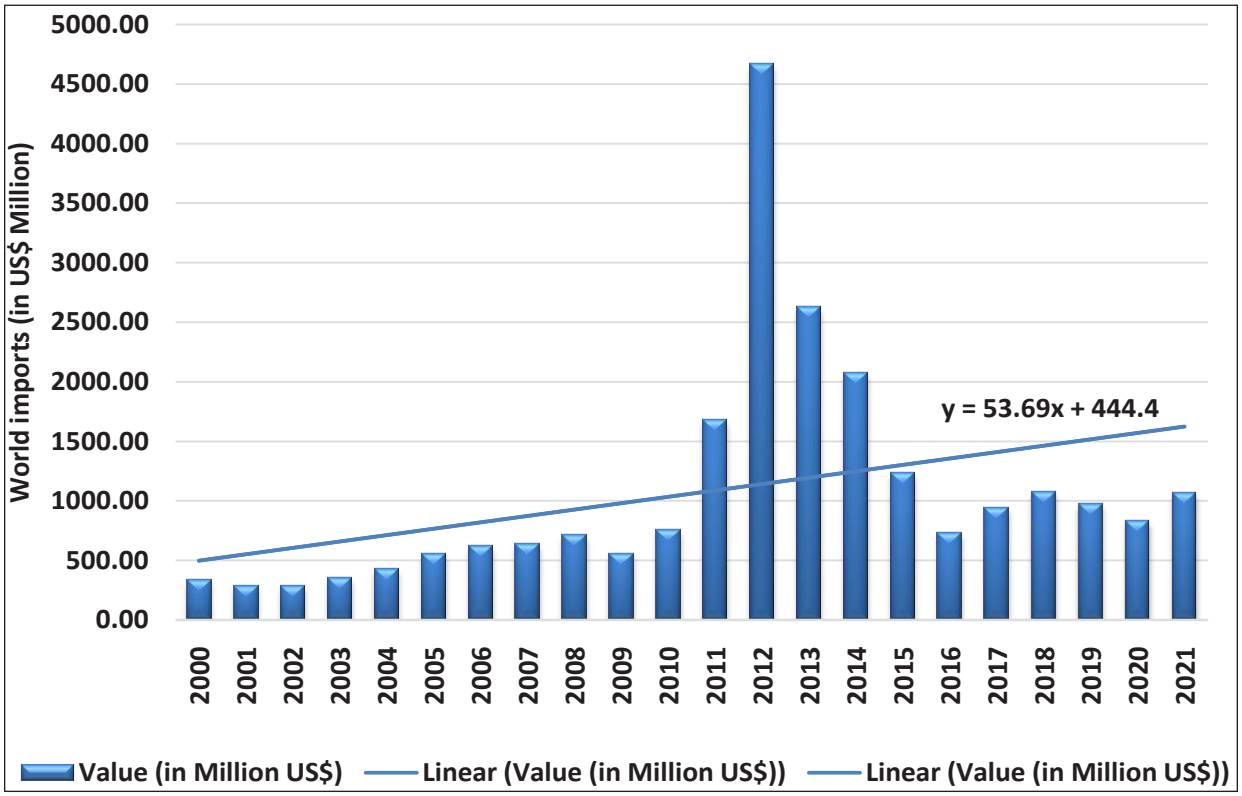
Source: *National Rainfed Area Authority (NRAA) 2014.*

Fig. 1: Major producers of guar seed in world

Global trade

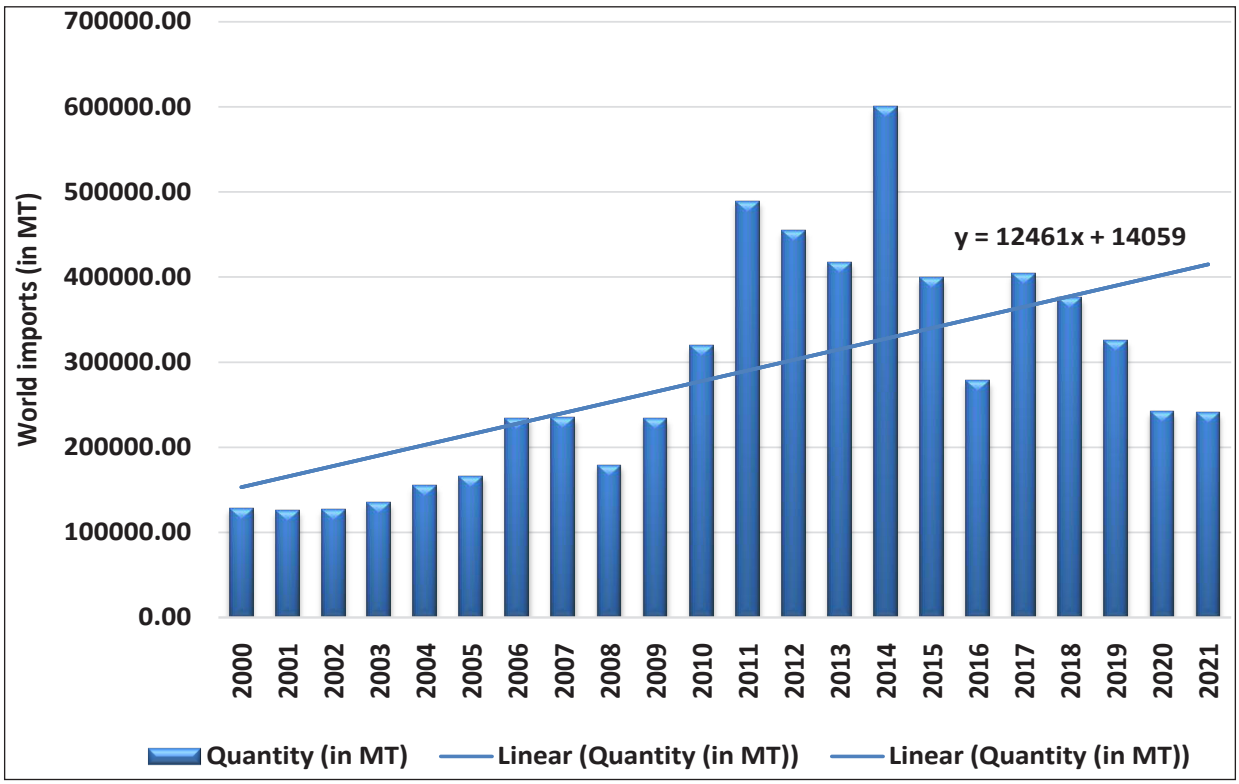
In the Harmonized System Nomenclature, guar products are categorized under the subheading "Mucilages and thickeners derived from locust bean seeds or guar seeds" group (HS code 130232). Guar meal, guar gum refined split, and guar gum treated and pulverized are all included under this sub-heading. It also includes products derived from locust beans, even though the significance of their trading internationally is not included.

The value of world imports of guar from 2000 to 2021 is depicted in Fig. 2, and the trend in quantitative terms is shown in Fig. 3. From US$ 337.59 million in 2000 to US$ 1672.85 million in 2011, global imports increased gradually. However, after that phenomenal rise, witnessed reaching US$ 4666.72 million in 2012 before decreasing to US$ 1061.24 million in 2021. The trend in guar product imports increased from 2000 to 2020 in quantity. Global imports gradually increased from 127676.51 MT in 2000 to 598888.77 MT in 2014 before declining to 239766.50 MT in 2021. Guar has witnessed high import value due to limited production area, increasing demand, speculation, and lack of a reliable market information system (Bannor and Melkamu. 2015). However, the trend in global imports decreased continuously due to the suspension of future trading by FMC and the large inventory buildup by US buyers in 2012 (Rai, 2015).



Source: *United Nations International Trade Statistics Database (UN COMTRADE)*

Fig. 2: Value (in US$ million) of global imports of guar products (HS 130232)



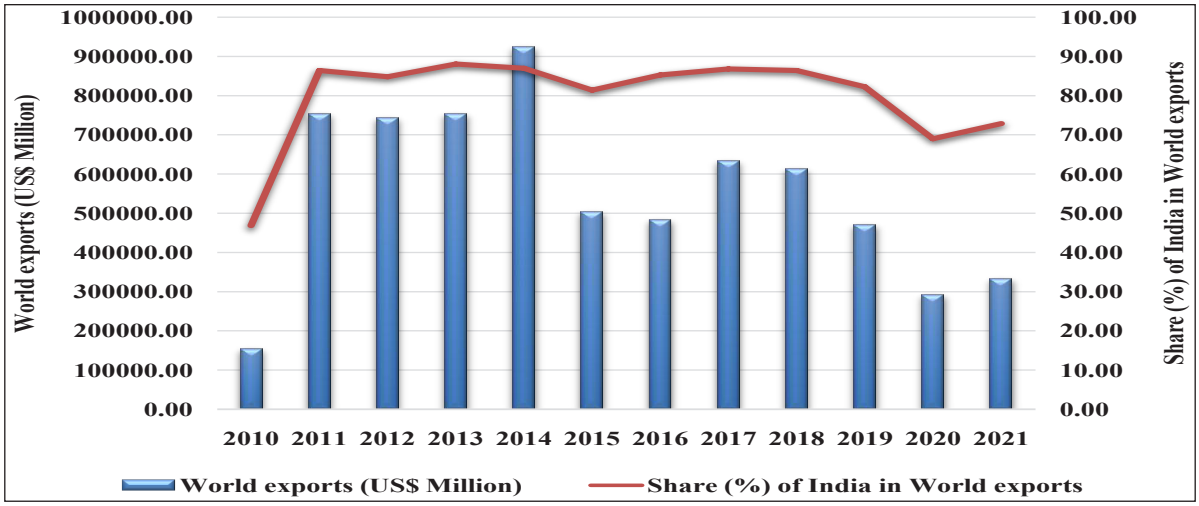
Source: *United Nations International Trade Statistics Database (UN COMTRADE)*

Fig. 3: Quantity (in MT) of global imports of guar products (HS 130232)

LEADING SUPPLIER OF GUAR PRODUCTS – INDIA

India has consistently been a leading supplier of guar products to the global market. Spain, the United States, Pakistan, and Italy are other major exporters of guar products. During 2010-2021, India's share of global export of guar products ranged between 46-69 percent. India had an 88 percent share value of the world's guar product exported in 2013, but that share marginally decreased to 82 percent in 2020 and 69 percent in 2021, as shown in Fig. 4. This decrease in exports is due to weak demand from global markets because of the COVID-19 pandemic, which resulted in trade tensions between the USA and China in 2019 and 2020, pushing down oil drilling activities in the USA. This discouraged the guar seed trade situation for the Indians in terms of exports (IAC. 2021).

India began exporting guar goods to other countries, especially the US and Europe, in the early 1960s (Mathur, 2012). Guar products have evolved to be one of India's top agricultural commodities exported. In fact, in 2012–13, guar exports accounted for about 18% of Indian agricultural exports. There has been a remarkable increase in both the export value and volume of guar products. Figure 5 shows that the export value of Indian guar products increased at a galloping pace from just 602.95 crores in 2000–01 to about 21287.01 crores in 2012–13, making guar products the most significant agricultural export item in those years. The value of exports, however, later decreased to 1949.07 crores in 2020–21. The rise/fall in the value of exports is due more to a surge/decline in unit values of exports in global markets rather than to an increase/decrease in quantity, as can be seen in Table 1.



Source: *United Nations International Trade Statistics Database (UN COMTRADE).*

Fig. 4: Value (US$ million) of global exports of guar products (HS 130232) and share (%) of India

Table 1: Quantity (MT) and value (₹ Crores) of guar products exports from India: 2000-21

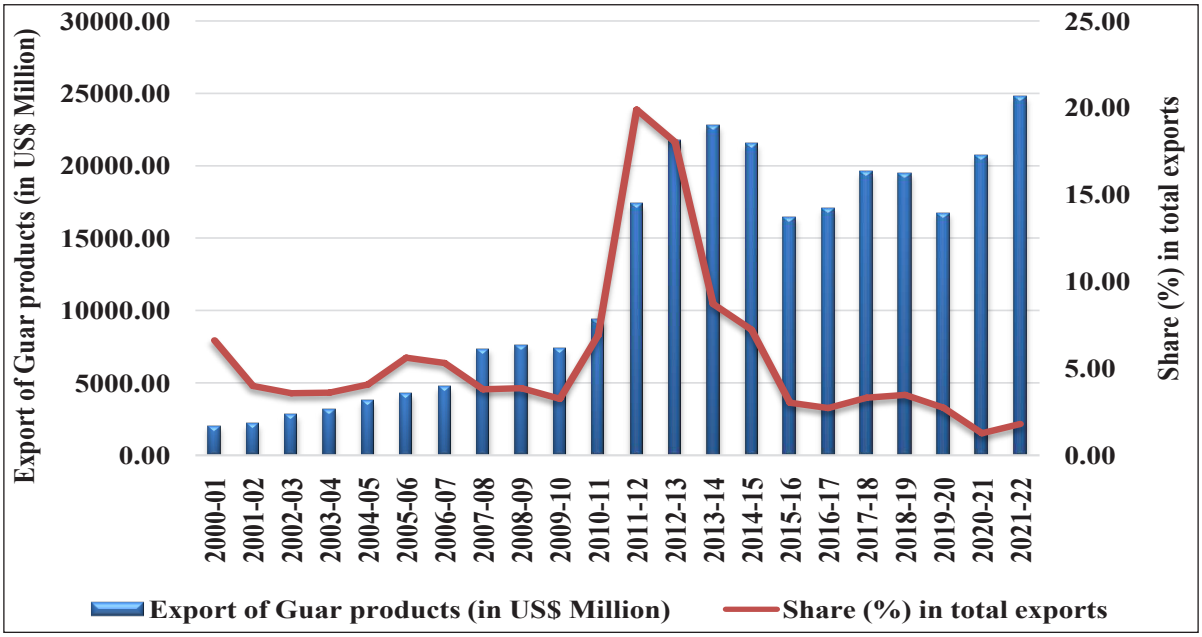
Year	Quantity	Value	Year	Quantity	Value
2000-01	129530.84	602.95	**2011-12**	707326.43	16523.87
2001-02	117883.03	403.09	**2012-13**	406311.81	21287.01
2002-03	111826.36	486.15	**2013-14**	601945.42	11734.52
2003-04	120561.27	507.9	**2014-15**	665177.71	9479.94
2004-05	131299.98	689.48	**2015-16**	325250.71	3233.87
2005-06	186718.4	1049.23	**2016-17**	419948.19	3106.62
2006-07	189304.36	1125.79	**2017-18**	494101.27	4169.56
2007-08	211166.56	1125.75	**2018-19**	513211.87	4707.05
2008-09	258567.56	1338.99	**2019-20**	381880.14	3261.6
2009-10	218479.74	1133.31	**2020-21**	234871.29	1949.07
2010-11	441607.7	2938.7			

Source: *Agricultural and Processed food products Export Development Authority (APEDA).*

COMPOSITION OF GUAR PRODUCTS EXPORT FROM INDIA

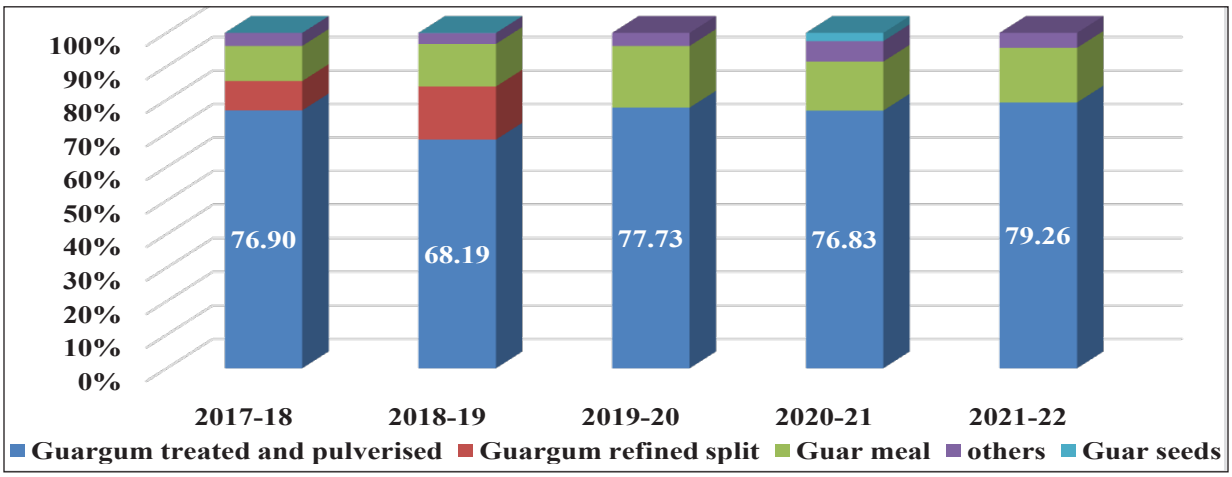
Guar seed exports from India are banned, and only processed and semi-processed guar seed products are allowed to be exported. Guar gum treated and pulverized, guar gum refined split, and guar meal are all processed guar seed products. Guar gum treated and pulverized (finished product) and refined splits (semi-processed product) are the two primary types of processed guar exported from India (NRAA. 2014). Fig. 6 illustrates how the Indian guar export basket has been dominated by guar gum treated and pulverized which is also known as guar gum powder. Guar gum powder constituted more than 75% of all guar product exports from India during each of the last five years.

In terms of export quantity, guar gum powder is the most dominant item. As indicated in Fig. 7, the proportion of guar gum powder in total guar products exported from India has remained high, ranging between 61 and 66% over the last five years up to 2021–2022. In the recent three years, the share of guar splits, a semi-finished product has decreased in value and volume terms.



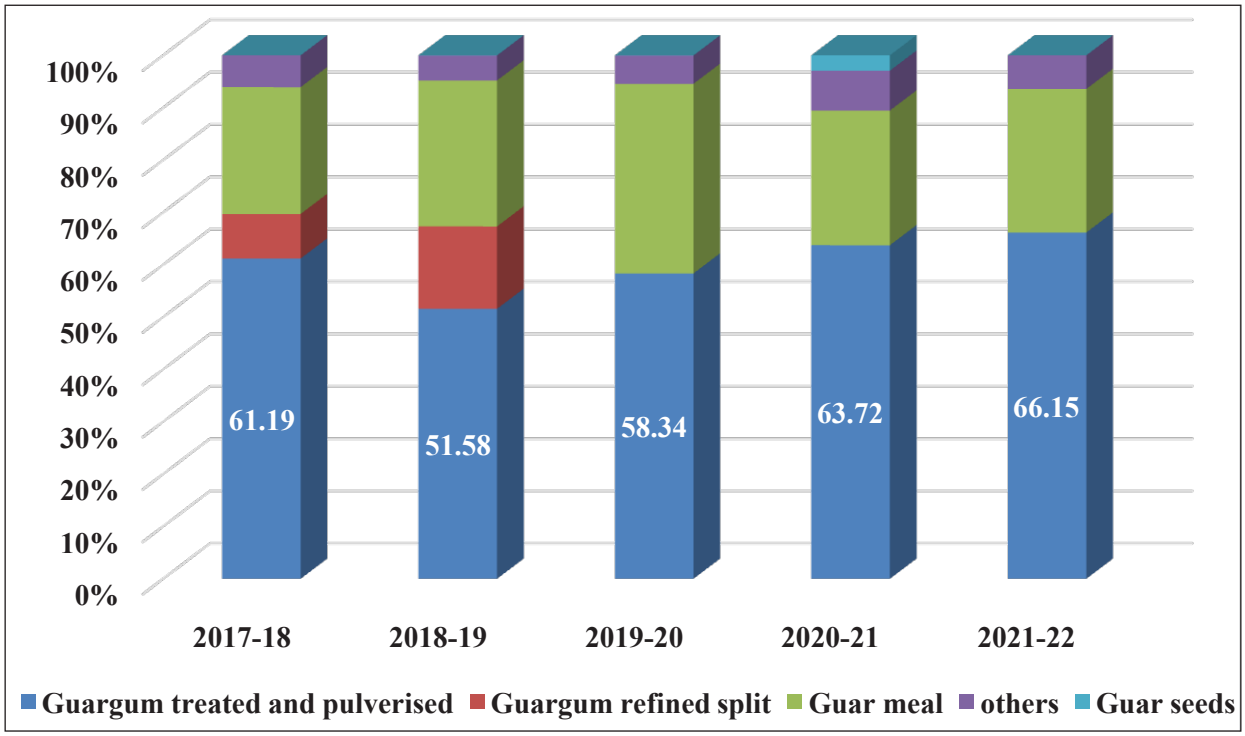
Source: Department of Commerce, Ministry of Commerce and Industry, Government of India.

Fig. 5: Export of guar products from India and its share in total Indian exports



Source: Department of Commerce, Ministry of Commerce and Industry, Government of India.

Fig. 6: Composition of guar products export (value in US$ million) from India, 2017-2022



Source: *Department of Commerce, Ministry of Commerce and Industry, Government of India.*

Fig. 7: Composition of guar products export (quantity) from India in 2017-18 to 2021-22

MATERIALS AND METHODS

The study pertains to the country- India as a whole. The time series data for a period of 20 years from 2000-01 to 2019-20 pertaining to the area, production, and productivity of guar crops in India was collected from the Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India. Data n monthly wholesale prices of guar was collected from Directorate of Marketing and Inspection (DMI) website (agmarknet.gov.in) for 20 years, i.e., from 2003 to 2021.

Analytical techniques

1. Absolute change and relative change

One of the methods of studying comparison into change over time/state/crop is by estimation of absolute change. This can be carried out by the base and current year of the concerned period. Absolute change fails to depict a comparative change among the variables and therefore, in addition to absolute change, relative change also has been included in the present study.

For estimation of absolute and relative changes following equations have been used:

$$\text{Absolute change} = Y_n - Y_o$$

$$\text{Relative change} = \frac{Y_n - Y_o}{Y_o} \times 100$$

Where,

Y_o = The base year (Triennium Average for area, production, and productivity 2000-01 to 2002-03)

Y_n = The current year (Triennium Average for area, production, and productivity 2017-18 to 2019-20).

2. Coefficient of variation

For estimation of fluctuation in area, production, and productivity of guar for the study period, the coefficient of variation has been used:

$$\text{Coefficient of variation (CV \%)} = \frac{S.D}{Mean} \times 100$$

Where,

$$\text{Mean} = \frac{\sum x}{n},$$

$S.D = \sqrt{v}$ (Variance)

3. Trend analysis

The linear trend shows a constant amount of change or constant arithmetic rate of growth (b) or an estimate of the absolute increase per unit. To study the trend of guar, the trend analysis has been carried out using the linear trend method. For the estimation of the trend (linear) the following equation has been used:

$$\text{Linear trend } (Y) = a + bx + \mu,$$

Where,

Y = Dependent variable (Area/Production/Yield),

a = Constant/ Intercept value,

b = Regression coefficient,

x = Independent variable (Time period),

μ = Error term with mean zero and constant variance.

4. Compound growth rate

Compound growth rates of area, production, and productivity of guar crop were calculated for India as a whole for the study period mentioned earlier by fitting an exponential function of the form.

$$Y = Ab^t$$

$$Log\ Y = Log\ A + t\ log\ b$$

Where

Y = Area/Production/Productivity

A = Constant

$b = (1 + r)$

r = compound growth rate

t = time variable in years (1,2,3,…,n)

In log form 'b' will be calculated by using formula;

$$Log\ b = \frac{\sum t.\log Y - \left(\sum t.\log \sum Y / N\right)}{\sum t^2 - \left[\left(\sum t\right)^2 / N\right]}$$

Where,

N = Number of years

The percent of compound growth rate is;

$$[(\text{Antilog of } 'b') - 1) \times 100$$

5. Seasonal indices by the method of simple averages

It is the simple method of measuring seasonal variations in a time series and involves the following steps:

(i) Arrange the data by years and months

(ii) Compute the average $\bar{x}_1$, (i = 1, 2, …, 12) for the i^{th} month for all the years. (i^{th} month, i = 1, 2, …, 12 represents January, February, …, December respectively).

(iii) Compute the average $\bar{x}$ of the monthly averages, i.e., $\bar{x} = \frac{1}{12}\sum_{i=1}^{12} \bar{x}_t$.

(iv) Seasonal indices for different months are obtained by expressing monthly averages as a percentage of $\bar{x}$. Thus,

Seasonal index for i^{th} month = $\left(\frac{\bar{x}_t}{\bar{x}}\right) \times 100$; i = 1, 2, …, 12.

RESULTS AND DISCUSSION

Trends in guar production

Guar is produced mainly in the northwestern part of the country, especially in Rajasthan, Haryana, Gujarat, Uttar Pradesh, and Punjab. About 98 percent of guar cultivation is concentrated in just these states. Table 2 shows the change and variation in area, production, and productivity of guar in India. The area under guar cultivation augmented by 42.99 percent (1056.73 000'ha) from 2458.53 000' ha (base year) to 3515.27 000'ha (current year) with a coefficient of variation of 31.33 percent from 2000-01 to 2019-20. The guar production improved by 128.74 percent (835.93 000 tonnes) from 649.3 000' tonnes (base year) to 1485.23 000' tonnes (current year), reflecting 52.57% of the variation in production. The guar productivity increased by 65.95 percent (0.17 tonnes/ha). From 0.26 tonnes/ha (base year) to 0.42 tonnes/ha (current year) with a coefficient of variation of 31.63 percent. The variation in the area, production, and productivity of guar might be attributed to its cultivationprimarily in rainfed conditions.

Trends and growth in the area, production, and productivity of guar are depicted in Table 3. The area under guar cultivation in India increased

Table 2: Variation in area, production and productivity of guar in different states of India

States	Average	Base year	Current year	Absolute change	Relative change (%)	SD	CV (%)
Area (000′ ha)							
Rajasthan	3115.41	2007.55	3120.54	1112.99	55.44	1059.29	34.00
Gujarat	206.08	239.67	111.21	-128.46	-53.60	90.24	43.79
Other States	341.52	211.32	283.52	72.20	34.17	121.59	35.60
India	3663.01	2458.53	3515.27	1056.73	42.98	1147.69	31.33
Production (000′ tonnes)							
Rajasthan	1238.62	444.15	1193.83	749.68	168.79	794.72	64.16
Gujarat	120.03	75.67	69.34	-6.32	-8.36	78.75	65.61
Other States	318.50	129.49	222.06	92.57	71.49	121.59	38.18
India	1677.16	649.30	1485.23	835.93	128.74	881.72	52.57
Productivity (tonnes/ha)							
Rajasthan	0.36	0.18	0.38	0.20	110.29	0.16	44.64
Gujarat	0.53	0.32	0.41	0.09	29.22	0.21	39.39
Other States	0.95	0.62	0.79	0.16	26.10	0.31	32.18
India	0.43	0.26	0.42	0.17	65.96	0.14	31.63

Table 3: Trend and growth in area, production and productivity of guar in India

States	Trend value (b)	Compound growth rate (% per year)
Area (000′ ha)		
Rajasthan	106.40	4.44
Gujarat	-0.03	-0.44
Other States	2.69	1.32
India	105.96	3.45
Production (000′ tonnes)		
Rajasthan	79.98	10.75
Gujarat	3.89	3.01
Other States	0.77	1.36
India	82.28	6.75
Productivity (tonnes/ha)		
Rajasthan	0.02	6.04
Gujarat	0.01	3.46
Other States	0.00	0.04
India	0.01	3.19

with a positive trend of 105.96 000′ ha/year with a compound growth rate of 3.45% per year. Production of guar increased with a positive trend of 82.28 000′ tonnes/ year, with a growth rate of 6.75% per year in India during the study period. Productivity of guar in India amplified with a positive trend of 0.01 tonnes/ha and a compound growth rate of 3.19 percent/year in India. The positive trend in the area under guar exhibited due to its profitability over competing for crops and productivity enhancement due to the adoption of good agricultural practices and the use of newer promising varieties.

The trend in guar area, production, and productivity is harmful in some states as guar area is captured by other remunerative crops with improved irrigation facilities. But the overall trend in guar area, production, and productivity in the country increased from 2000-01 to 2019-20, as shown in Fig. 8.

The large fluctuation in both the production and area of guar in India was observed mainly due to variability in the amount and distribution of rainfall, especially in Rajasthan (Sharma *et al*. 2012). The key reason for low productivity is that most of the crop is grown in semi-arid zones of the state, depending upon only rainfed conditions and hence very little

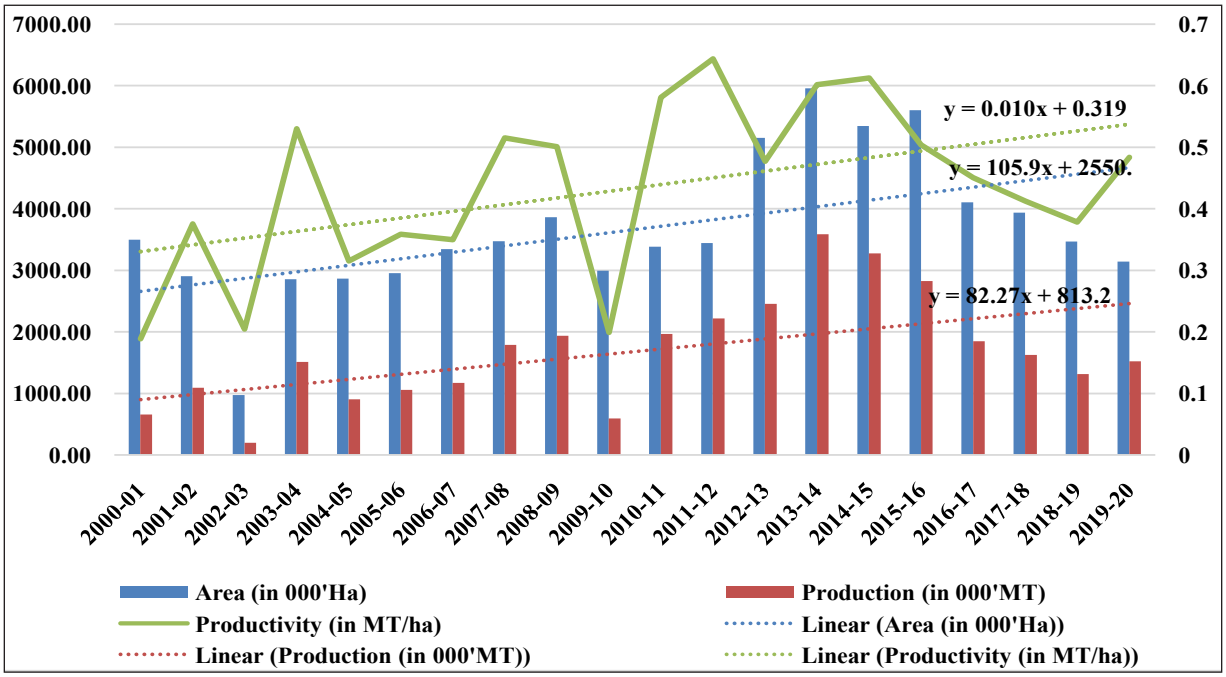
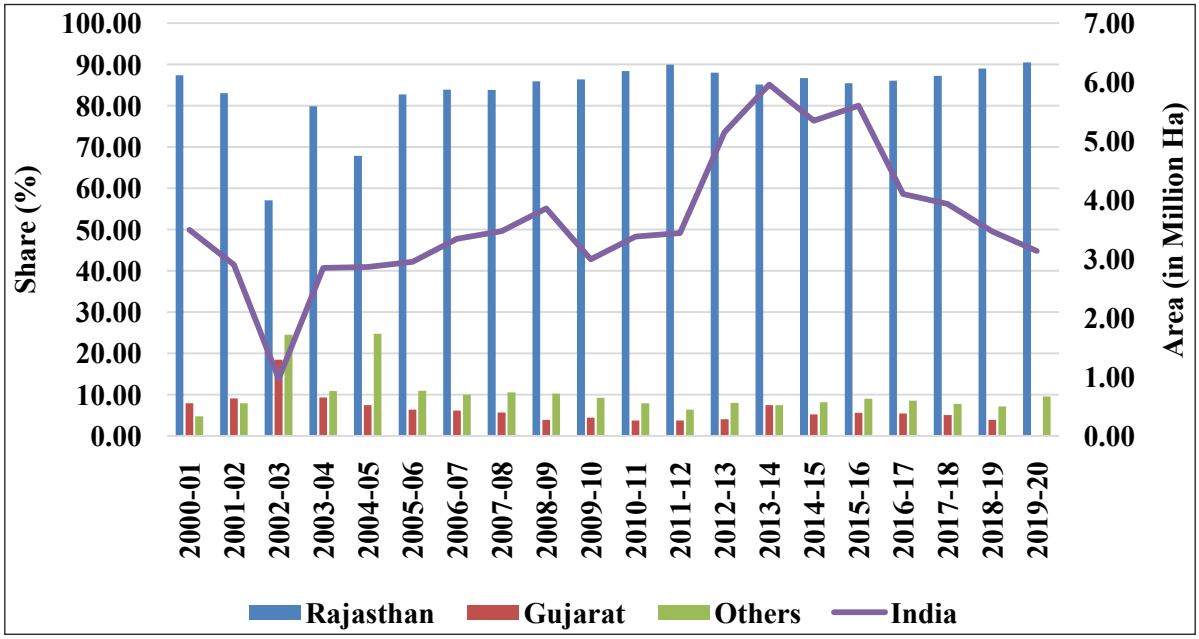


Fig. 8: Trend in area, production and productivity of guar in India from 2000-01 to 2019-20



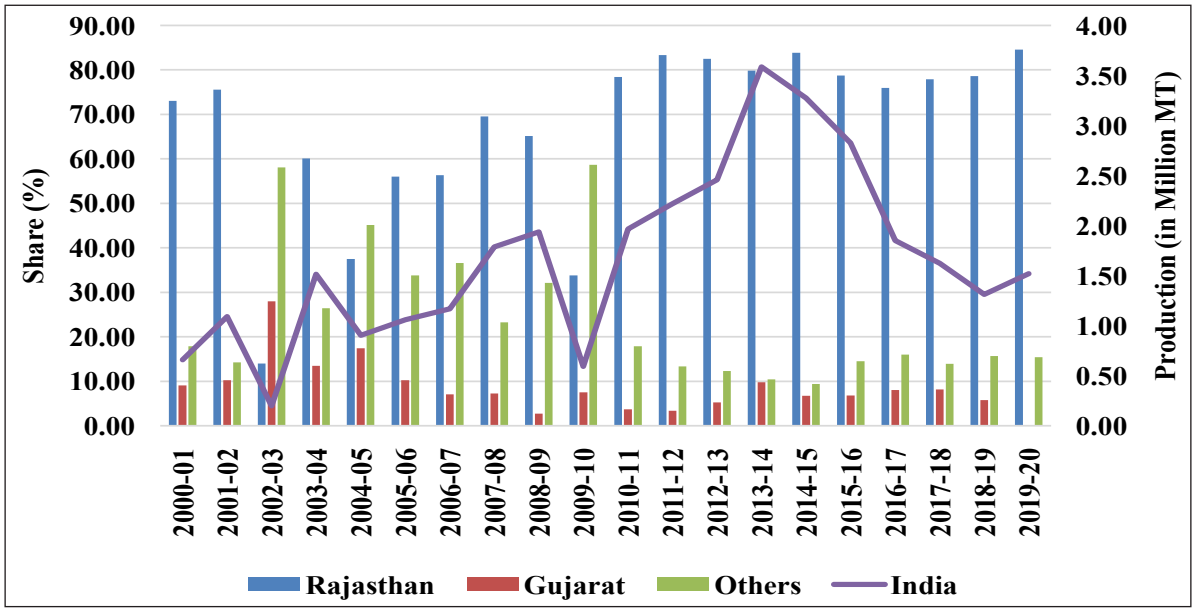
Source: *Directorate of Economics and Statistics, Ministry of Agriculture & Farmers Welfare, Government of India & Agriculture Statistics at a glance*

Fig. 9: Share (%) of significant states in total area (Million ha) of guar

investment in good agricultural practices (Kumar 2015). The area under Guar cultivation is decreasing over the years as the price realization from pulses, oilseed, and cotton is higher for farmers compared with Guar seed (The Economic Times. 2022).

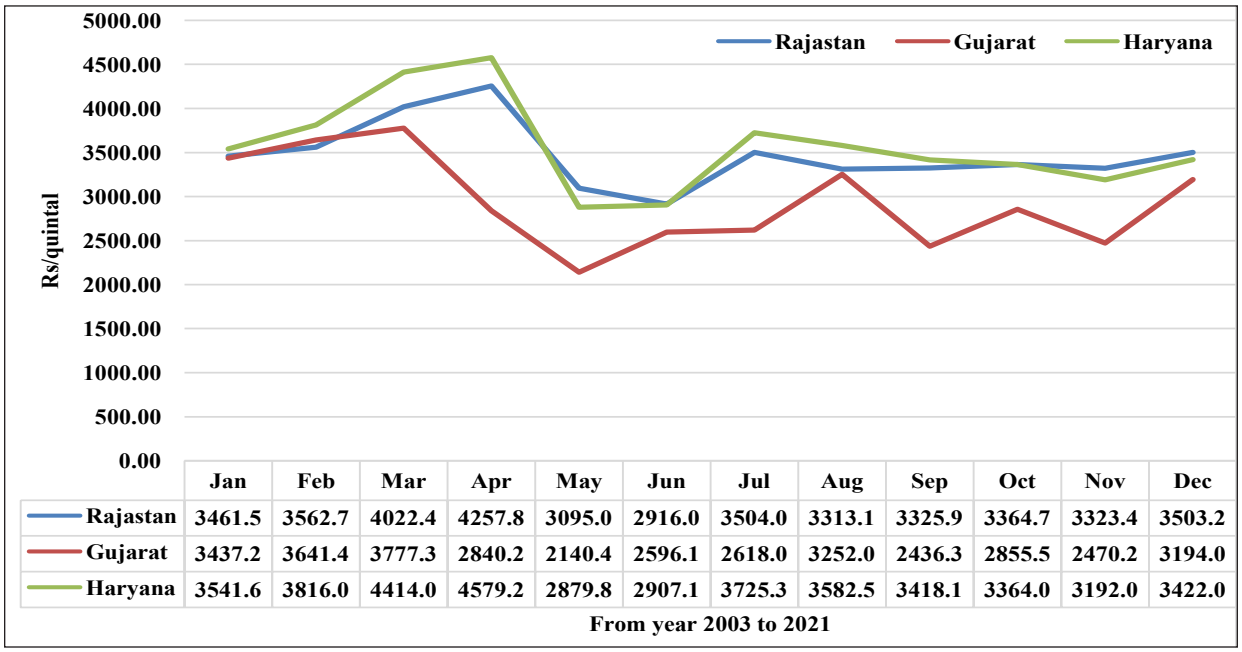
Fig. 9 shows that Rajasthan is the most critical guar-growing state and accounts for nearly 90% of the area under guar cultivation in the country. It is also grown in some areas of Gujarat, Haryana, Punjab, and Uttar Pradesh, but these states account for a small part of the area and production.

Rajasthan is the most critical guar producer state, followed by Gujarat and Haryana. During 2000-20, Rajasthan's average stake in total guar seed



Source: *Directorate of Economics and Statistics, Ministry of Agriculture & Farmers Welfare, Government of India & Agriculture Statistics at a glance*

Fig. 10: Share (%) of major states in total production (million MT) of guar in India



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rajastan	3461.5	3562.7	4022.4	4257.8	3095.0	2916.0	3504.0	3313.1	3325.9	3364.7	3323.4	3503.2
Gujarat	3437.2	3641.4	3777.3	2840.2	2140.4	2596.1	2618.0	3252.0	2436.3	2855.5	2470.2	3194.0
Haryana	3541.6	3816.0	4414.0	4579.2	2879.8	2907.1	3725.3	3582.5	3418.1	3364.0	3192.0	3422.0

Source: *Agricultural Marketing Information Network (AGMARKNET).*

Fig. 11: Monthly average wholesale prices (₹/quintal) of guar in major producing states (January 2003 – June 2021)

production in the country was recorded at more than 80% as shown in Fig. 10. However, the share of various states in the total national production has fluctuated over the period.

Trends and dynamics in prices of guar in India

The average monthly wholesale prices of guar in India's three central producing states are shown in Fig. 11. In March and April, the average wholesale price was found to be higher, whereas it was lower in other months. Monthly and seasonal fluctuations in guar prices have been perceived over time. As for the long-term trend, guar prices in Rajasthan, Gujarat, and Haryana amplified gradually but

remained within the range of ₹ 1000 and ₹ 2000 per quintal from January 2003 to June 2010. However, in 2012 and 2013, prices substantially shot up. Prices surged in Rajasthan from about ₹ 3,775 per quintal in July 2011 to ₹ 13,584 per quintal in July 2012. During the same period, prices increased from ₹ 4,074 per quintal to ₹ 14,651 per quintal in Haryana, and in Gujarat, prices increased from ₹ 2024 per quintal to ₹ 7533 per quintal. The escalation in the price of guar was recorded to increase demand for guar gum in gulf countries, Europe and USA. After July 2012, prices started to tumble dramatically. After January 2013, prices continued to fall sharply but remained within the range of ₹ 3000/quintal to ₹ 5000/quintal.

The year 2011-12 was a watershed year for the development of the guar industry in India. The demand for fast-hydrated gum for fracking purposes in the shale gas industry touched new heights. This resulted in a rise in the prices of guar products (Rai, D.K. 2015). World demand for guar gum skyrocketed, and the price of guar increased mainly because of increased oilfield shale gas demand (Gresta *et al.* 2013).

Monthly seasonal indices of guar prices in central producing states are provided in Table 4. In Rajasthan, seasonal indices were more than the average seasonal price in the remaining months. Monthly seasonal indices were more than average seasonal price in January, February, March, August, and December in Gujarat and less than the average seasonal price in the remaining months. In Haryana, monthly seasonal indices are more than average seasonal average seasonal price in February, April, July, and August and less than seasonal average prices in the remaining months.

FACTORS INFLUENCING PRICE MOVEMENTS

Demand and supply factors interact to determine the price of any good, and guar prices behave similarly. Certain underlying factors, in turn, affect supply and demand. Additionally, future trading impacts price changes, at least in the short term.

Supply-side factors

Since rainfall during the monsoon season is the primary factor influencing guar production in India, any delay or inadequacy in the monsoon season hampers planting and ultimately impacts total production. The long shelf life of guar seeds makes it easier to hold back stocks from the market in anticipation of higher prices in the future period. Fig. 12 depicts the changes in wholesale guar prices between 2003 and 2019 in India's three central guar-producing states and the nation as a whole.

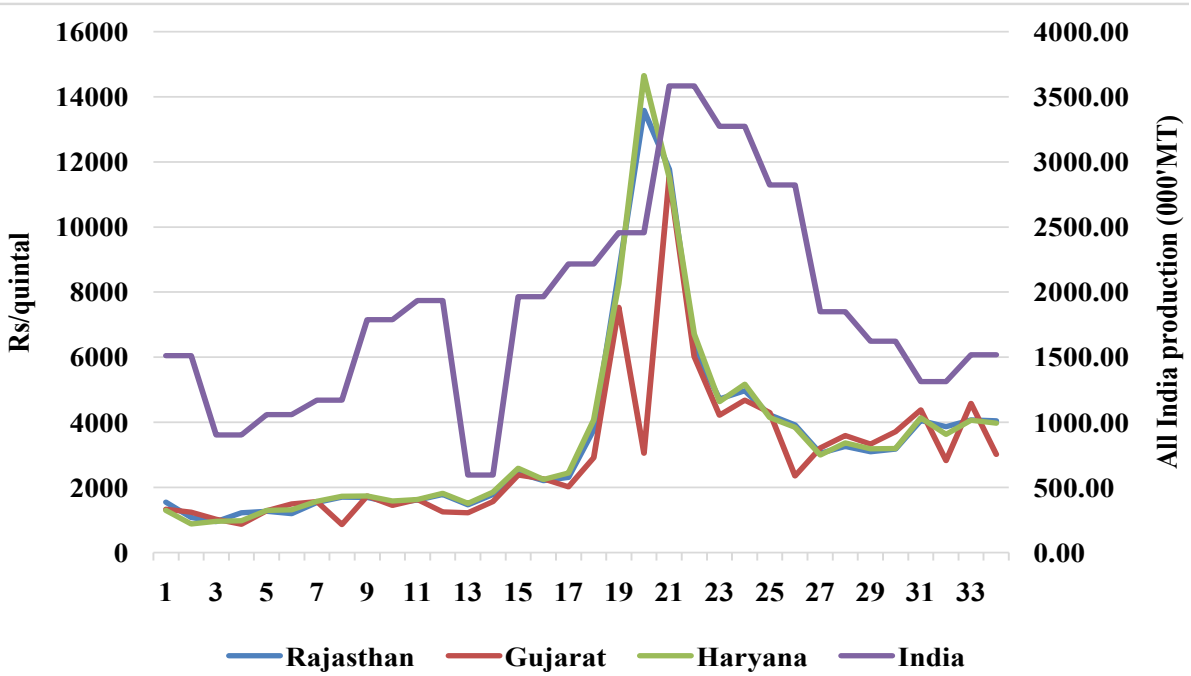
Table 5 shows the mean rainfall (mm) of Rajasthan, Gujarat, and Haryana for the monsoon months, southwest monsoon season, and annually from 1989-2018. The sharp drop in production in 2002 and 2009 was observed due to the severe drought that affected the producing regions in that year.

Demand side factors

More than 75–80% of the guar produced in India is

Table 4: Monthly seasonal indices (%) of prices of guar in major producing states (January 2003 – June 2021)

States	Monthly seasonal indices	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Seasonal average
Rajasthan	Monthly Average	3461.58	3562.71	4022.45	4257.84	3095.04	2916.07	3504.04	3313.18	3325.99	3364.70	3323.47	3503.26	3470.86
	Seasonal indices	99.73	102.65	115.89	122.67	89.17	84.02	100.96	95.46	95.83	96.94	95.75	100.93	
Gujarat	Monthly Average	3437.21	3641.46	3777.36	2840.21	2140.41	2596.12	2618.03	3252.00	2436.38	2855.58	2470.27	3194.07	2938.25
	Seasonal indices	116.98	123.93	128.56	96.66	72.85	88.36	89.10	110.68	82.92	97.19	84.07	108.71	
Haryana	Monthly Average	3541.69	3816.07	4414.09	4579.24	2879.81	2907.13	3725.31	3582.50	3418.10	3364.02	3192.07	3422.06	3570.17
	Seasonal indices	99.20	106.89	123.64	128.26	80.66	81.43	104.34	100.34	95.74	94.22	89.41	95.85	



Source: *Agricultural Marketing Information Network (AGMARKNET) & Directorate of Economics and Statistics, Ministry of Agriculture & Farmers Welfare, Government of India*

Fig. 12: Annual wholesale prices and production of Guar seed

Table 5: Mean rainfall (mm) for the monsoon months, southwest monsoon season and annual

Mean rainfall (mm)	June	July	August	September	South West Monsoon	Annual
Rajasthan	51.5	156.1	144.7	61.9	414.2	454.9
Gujarat	103.5	275.3	193.0	122.9	694.7	722.4
Haryana	57.7	130.9	137.5	84.5	410.6	499.7

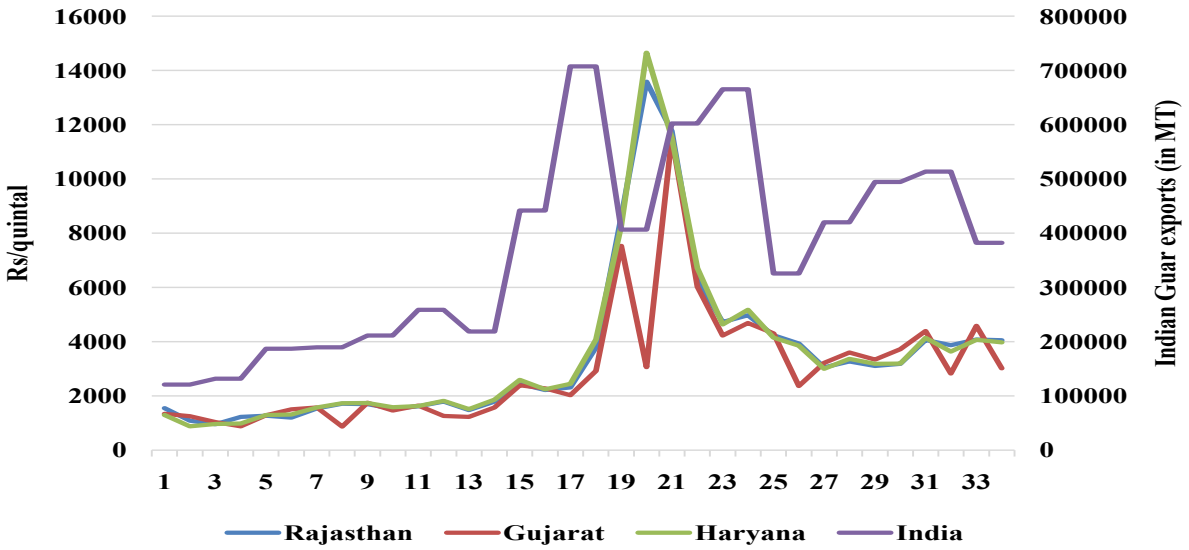
Source: *India Meteorological Department (IMD).*

exported in different forms. Until 2011, the oil and gas industry received roughly 60% of total guar gum exported from India, while the remaining was destined for the food and allied industries to make ice cream and toothpaste. The use of guar gum in the food industry was adversely crushed by a sudden high increase in guar prices in 2011–2012, and the food industry's proportion of global guar gum exports significantly lessened in 2012. The textile printing industry accounted for the majority of domestic consumption. As seen in Fig. 13, there appears to be a fairly significant correlation between local wholesale prices for guar and trends in Indian exports.

APPLICATIONS/ USES OF GUAR PRODUCTS

As previously said, guar has been used since ancient times in agriculture as a green manure crop, a vegetable, and food source for cattle. However, due to advancements in R&D and the discovery of its properties, guar products are now exploited in a wide range of sectors. Guar gum has more than 1,200 applications across a wide variety of industries, according to some industry sources. Guar meal, a by-product after extraction of guar gum from guar seeds, is a rich source of protein and is used as animal feed. Animal feed manufacturers buy guar meal, which is then sold to dairy and cattle farms.

The following discussion covers guar's main traditional and non-traditional uses and its derivative products.



Source: *Agricultural Marketing Information Network (AGMARKNET) & Agricultural and Processed food products Export Development Authority (APEDA).*

Fig. 13: Guar exports (in MT) from India and wholesale prices (₹/Quintal) in major states (2003-2019)

Table 6: Application-wise consumption of guar products in the world

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 (Thickner)	25-30%
Pharmacy grade	Cosmetics & medicines (as binder and thickner), Slimming (Reducing weight & laxative)	5-10%
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 (increasing strength and decrease porosity), Tobacco (binding and strengthening) & Photography (Gelling and Hardening)	5-10%

Source: *National Institute of Agricultural Marketing (NIAM).*

Uses in oil and gas industry

The largest guar gum consumer and high demand is the oil and gas industry, particularly the shale gas industry. Guar gum derivatives and industrial grade powder are used as thickeners, stabilisersstabilizers, suspending agents in industrial preparations, mud drilling, and oil well stimulation. However, its usage of guar gum is also extended to the food, textile, and pharma industries. Globally, oil drilling and mining is the primary consumer industry of guar gum followed by the food industry, and significant applications are presented in Table 6.

Uses in Other Industries

Food Industry: In baked foods; Guar gum increases the shelf life by increasing water absorption in cakes. It adds softness and increases the shelf life of bread (Keskin *et al*. 2007 and Ribotta *et al*. 2001). In salad dressing, guar gum is employed as a thickener due to its cold water dispersibility, compatibility with extremely acidic emulsions, and affordability in comparison to other viscosity ingredients (Goldstein and Alter, 1959a, b). In dairy products, guar gum is used to stabilise and bind water. It is used to make cheese, ice cream, sherbet, liquid milk products, etc., Guar gum also lessens crystal formation in frozen food products (Sutton and Wilcox, 1998). In particular, for usage in high temperature and short time (HTST) operations, its hydration and water binding properties serve as an ice cream stabilizer. In meat and pet food product

preparations, guar gum is used as a binder and lubricant. It can reduce the time needed to fill a can and enables storage with less weight loss. Guar gum enhances viscosity while food is being cooked in a kettle so that canning may be done quickly and with minimal spilling on the floor (Ercelebi and Ibanoglu, 2010). In the beverage industry, guar gum is used to thicken or regulate viscosity at a level of 0.25 to 0.75 percent of the product's total weight. Dietetic beverages without sugar must also have gum to enhance the mouth and body feel. Guar gum's ability to withstand decomposition at low pH levels makes it beneficial. In addition, guar gum is simple to use in most beverage processing facilities because it is soluble in cold water.

Paper Industry: Just before producing the paper sheet, guar gum is added to the suspension of pulp. Lignin is intended to be removed during the pulping process, creating a fibrous pulp. A significant portion of the hemicelluloses that are typically found in wood is also removed during this process. It considerably improves the pulp's ability to retain moisture and the tensile strength of the paper made from the pulp. The natural hemicelluloses in the paper binding are replaced or supplemented with galactomannans and cationic guar gum. Guar gum provides writing and printing paper's surface a denser surface. It improves the writing properties, bonding strength, and hardness of the paper (Whistler, 1948).

Textile Industry: In textile printing, guar derivatives like depolymerized and carboxymethyl are often utilized. High color yield, reduced bleeding effect, increased sharpness, and efficient dye penetration is all features of these improved derivatives (Sharma and Ramprakash, 2005). In addition to this, guar is also utilized as a sizing agent.

Mining and Mineral Industry: Guar gum is used as a chemical flotation agent in the mining industry by adhering to the surfaces of hydrated minerals. Guar gum acts as a depressant during the flotation process, preventing other reagents from adhering to the talc surfaces and other gangues, which are extracted alongside the valuable minerals. Guar gum is used as a and depressant in the mining of potash, gold, copper, and platinum group metals (PGM) (Jain *et al*. 2013).

Explosives industry: Guar gum's water-proofing, thickening, and foam-stabilizing properties make guar to prepare explosive materials. The most commonly used polysaccharide for thickening slurry explosives is oxidized guar gum. Water-resisting ammonium nitrate stick explosive is made using guar gum as a binding agent. The oxidized gum in the outer wall of the explosive stick quickly swells when submerged in water, and the resulting gel slows the leaching of the salts. For slurry explosives, it is also used as a thickening and gelling agent. Guar has recently replaced other gelling agents as the main ingredient in water-based slurry explosives (Salgaonkar and Purohit, 2021).

Pharmaceutical industry: Pharmaceutical companies frequently employ guar gum and products derived from it. They are used as a thickening, stabilizing, clouding, binding, process aid, pour control for suspensions, anti-acid formulations, preservation, emulsification, water retention/water phase control, tablet binding and disintegration, nutritional foods, controlled drug delivery systems, slimming aids, etc. A significant non-caloric source of soluble dietary fiber is guar gum. As a dietary fiber, guar gum powder is widely exploited in capsules (Tripathy and Das, 2013).

Cosmetic industry: A guar gum derivative called cationic guar gum is utilized as a thickening in several cosmetic products. This derivative is used in cosmetics and toiletries like hair and skin care products, cleaning, and bathing goods to impart various performance functions like thickening, conditioning, foam stability, softening, and lubricity (Nemade and Sawarkar, 2015).

Traditional uses: Guar immature pods are preserved for human consumption by being dried, salted, and preserved. The dried pods are fried like potato chips, and the green pods are cooked like French beans. In times of drought, mature seeds are often used as a pulse. Cattle are fed green feed prepared from the chopped guar plant. Cattle are fed guar seeds, a rich source of protein after they have been boiled in a large kettle. Guar is also employed for several medical applications. Night blindness is treated by eating leaves. Guar seeds are used as a smallpox chemotherapeutic treatment. Seeds are also used as a laxative agent. Guar seeds that have been boiled are applied in poultries for enlarged livers head swellings, and on swellings due to broken bones. The guar crop has also been utilized

as a cover crop, green manure, and to improve the soil quality (Rai, D.K. 2015).

KEY ISSUES AND CHALLENGES TO GUAR INDUSTRY

Some of the significant challenges faced by Guar industry (Rai, D.K. 2015), like erratic production and supply uncertainty in production, are mainly due to the large proportion of guar cultivation being confined to the dry and un-irrigated regions of the country. Thus, the entire supply is determined by the amount and spatial distribution of rainfall, especially in Rajasthan. Further, low productivity is also one of the key reasons due to the non-availability of high-yielding guar seeds at affordable prices in some guar-producing areas. Moreover, the guar crop is less focused on research priorities on a farm. Lack of market intelligence, lack of regulation on quality maintenance in warehouses, inadequate quality certification for guar seeds, and private sector processing of guar are some bottlenecks in the efficient marketing of guar (Sharma and Gummagolmath, 2012). The trade barriers like imposing import duties on guar products by some countries like China and getting quality certificates from govt. Authorities also hindered the export. The guar industry is likely to face challenges from cheaper substitutes in various sectors, especially in the oil and gas sector. For instance, tamarind kernel is reported to have replaced guar gum to a significant level in the textile sector for use in different types of dyes, fabrics, and textile printing applications. Similarly, *Cassia tora* is being extensively used in the food industry and is expected to replace guar gum in pet food, etc.

RECOMMENDATIONS

Guar has grown to be one of the most important agricultural exports from India and is now a significant alternative commercial crop for farmers in the dry regions of the nation. Guar processing has grown into a significant sector with thousands of job opportunities and hundreds of industrial facilities. Derivatives of guar gum are utilized in a wide range of industries, and its by-products are frequently used for both human and animal use. Farmers and the industry, however, confront significant obstacles such as price instability, low productivity, unpredictable guar output, insufficient R&D, etc. Stakeholders must take action to improve the industry's prospects for the future while also assisting in resolving the issues that farmers and the industry are currently facing. The various initiatives like investment in R&D for the evolution of High Yielding Varieties (HYV) for better access to improved seeds, promotion of value addition, inclusion in the Merchandise Exports from India Scheme (MEIS), strengthening of future trading exchanges regulatory framework for better price discovery, hedging and price risk management and establishment of regional laboratories and certification agencies near to processing hubs.

The guar processing industry has to strengthen and expand its existing association to serve the whole industry's interests for better access to market intelligence and information. Further, to establish derivative manufacturing facilities in India, the industry should collaborate with multi national companies to acquire recent technologies. Although India is the world's largest producer of guar products, all the patents are held by companies in western countries. Industry alone can invest in R&D and product innovations that may be patentable. Guar industry in India should also endeavor to increase the area covered by contract farming and set up plans to guarantee farmers receive a fair price.

Farmers should be motivated to utilize certified and truthfully leveled (TL) seeds and adopt the improved production strategies as evolved by various national R&D organizations and seed firms. To reap benefit as much as possible from price changes, progressive farmers should also be actively engaged in the future trading of guar products.

CONCLUSION

From the study, it is observed that the value of exports of Indian guar products increased at a galloping pace from 602.95 to 21287.01 crores during 2000–2013, making guar products the largest agricultural export in those years. However, the value of exports later declined to 1949.07 crores in 2020–21. The proportion of guar gum powder in total guar products exported from India has remained high, ranging between 61-66 % (in terms of quantity) and 75 % (in terms of value) for the last five years. The guar area, production, and productivity in India showed a positive trend in the

last 20 years (2000-2020). Rajasthan alone occupies a four-fifth share in total guar seed production in India. Monthly and seasonal fluctuations in guar prices have been observed over time. As for the long-term trend, guar prices in Rajasthan, Gujarat, and Haryana increased gradually from January 2003 to June 2010. After July 2012, prices began to fall intensely, and from January 2013 onwards, prices continued to drop sharply but remained within the range of ₹ 3000/quintal to ₹ 5000/quintal. The supply of guar greatly depends on the amount and pattern of precipitation as its cultivation is restricted to dry regions of the country. There appears to be a fairly significant correlation between local wholesale prices for guar and trends in Indian exports. Globally, oil drilling and mining is the major consumer of guar gum and trailed by the food industry. Guar gum products are utilized in a wide range of industries. Farmers and the industry, however, confront significant obstacles such as price instability, low productivity, unpredictable guar output, low investment in R&D, etc. The initiatives are required to improve the industry's prospects for the future by resolving the various issues faced by guar growers and guar industry.

REFERENCES

AGMARKNET. 2022. Disponible in https://agmarknet.gov.in (Last Accessed on June 22, 2022).

APEDA. 2022. Disponible in https://agriexchange.apeda.gov.in (Last Accessed on June 15, 2022).

Bannor, R.K. and Melkamu, M. 2015. Forecasting wholesale price of cluster bean using the Autoregressive Fractionally Integrated Moving-Average Model: the case of Sri Ganganagar in Rajasthan in India. *J. Bus. Manag. Econ.*, **3**(8): 01-07.

Bhupender and Kumar, A. 2020. An Economic Analysis of Production and Marketing of Cluster bean in Rajasthan. *Int. J. Curr. Microb. Appl. Sci.*, **9**(6): 4044-4055.

Department of Commerce. 2022. Ministry of Commerce and Industry, Government of India. Disponible in http://commerce.nic.in (Last Accessed on June 19, 2022).

Dhaka, A., Singh, H. and Shailaza. 2019. Growth and instability of cluster bean in Bhilwara district of Rajasthan. *Agric. Sci. Digest.*, **39**(3): 190-194.

Directorate of Economics and Statistics. 2022. Ministry of Agriculture and Farmers welfare, Government of India. Disponible in http://eands.dacnet.nic.in. (Last Accessed on June 24, 2022).

Ercelebi, E.A. and Ibanoglu, E. 2010. Stability and rheological properties of egg yolk granule stabilized emulsions with pectin and guar gum. *Int. J. Food Prop.*, **13**: 618–630.

Goldstein, A.M. and Alter, E.N. 1959a. Gum Karaya: Industrial gums, polysaccharides and their derivatives. p. 343-360. In Whistler (ed). Academic Press, New York.

Goldstein, A.M. and Alter, E.N. 1959b. *Guar Gum: Industrial gums, polysaccharides and their derivatives*. p. 321. In Whistler (ed). Academic Press, New York.

Gresta, F., Sortino, O., Santonoceto, C., Issi, L., Formantici, C. and Galante, Y.M. 2013. Effects of sowing times on seed yield, protein and galactomannans content of four varieties of guar (*Cyamopsis tetragonoloba L.*) in a Mediterranean environment. *Ind. Crops Prod.*, **41**: 46–52.

IAC. 2021. Disponible in https://www.indoasiancommodities.com (Last Accessed on August 27, 2022).

Indian Meteorological Department. 2022. Ministry of Earth Sciences, Government of India. Disponible in http://mausam.imd.gov.in (Last Accessed on June 15, 2022).

Jain, N., Garg, K., Karmakar, N.C. and Palei, S.K. 2013. *Guar Gum in Hydraulic Fracturing in Indian Shale Mines.* Paper presented at Present Technology and Safety scenario in Mining and Allied industries (PTSM) Conference.

Keskin, S.O., Sumnu. G. and Sahin, S. 2007. A study on the effects of different gums on dielectric properties and quality of breads baked in infrared-microwave oven. *Eur. Food Res. Technol.*, 224: 329–334.

Kumar, D. 2015. *Guar: Status, potential, prospects, challenges and R&D Road map*. Report prepared by Technology Information, Forecasting and Assessment Council (TIFAC).

Mathur, N.K. 2012. *Industrial Galactomannan Polysaccharides.* CRC Press, Taylor & Francis Group, New York, USA.

Nemade, S.N. and Sawarkar, S.B. 2015. Recovery and synthesis of guar gum and its derivatives. *Int. J. Adv. Res. Chem. Sci.*, **2**(5): 33-40.

NIAM. 2013. Guar industry outlook 2015. Report prepared by NIAM, Jaipur and National Commodity & Derivatives Exchange Limited (NCDX), November.

NIAM. 2014. An analysis of performance of guar crop in India. Disponible in http://ccsniam.gov.in (Last Accessed on July 15, 2022).

NRAA. 2014. Potential of rainfed guar (Cluster beans) cultivation, processing and export in India. Policy paper no. 3, National Rainfed Area Authority, New Delhi, India.

Rai, D.K. 2015. Trends and economic dynamics of guar in India. Working paper, Indian Council for Research on International Economic Relations, New Delhi, India.

Ribotta, P.D., Leon, A.E. and Anon, M.C. 2001. Effect of freezing and frozen storage of doughs on bread quality. *J. Agric. Food Chem.*, **49**: 913–918.

Salgaonkar, K. and Purohit, S.J. 2021. Guar Gum. *Am. J. Eng. Res.*, **10**(1): 301-306.

Sharma and Ramprakash. 2005. Guar gum grafting and its application in textiles. *Asian J. Exp. Sci.*, **19**: 77-81.

Sharma, P. and Gummagolmath, K.C. 2012. Reforming cluster bean industry in India: issues and strategies. *Agric. Econ. Res. Rev.*, **25**(1): 37-48.

Singh. and Santosh, K. 2014. An analysis of guar crop in India. GAIN Report Number: IN4035, USDA Foreign Agricultural Services, Washington, DC, USA.

Sutton, R.L. and Wilcox, J. 1998. Recrystallization in ice cream as affected by stabilizers. *J. Food Sci.,* **63**: 104–107.

The Economic Times. 2022. Disponible in https://economictimes.indiatimes.com (Last Accessed on August 25, 2022).

Tripathy, S. and Das, M.K. 2013. Guar gum: present status and applications. *J. Pharm. Sci. Innov.,* **2**(4): 24-28.

UN COMTRADE. 2022. WITS Datbase. Disponible in https://comtrade.un.org (Last Accessed on June 20, 2022).

Undersander, D.J., Putnam, D.H., Kaminski, A.R., Kelling, K.A., Doll, J.D., Oplinger, E.S. and Gunsolus, J.L. 1991. Guar, alternative field crops manual, Disponible in https://hort.purdue.edu (Last Accessed on June 27, 2022).

Whistler, R.L. 1948. Guar-a new industrial crop. *Chem. Ind.,* **62**: 60–61.