Processing and Marketing of Guar (*Cyamopsis tetragonoloba*) in Bikaner District of Rajasthan

राजस्थान के बीकानेर जिले में ग्वार (*साइमोप्सिस टेट्रागोनोलोबा*) का प्रसंस्करण और विपणन

Narayan Lal

Thesis

Master of Science in Agriculture

(Agricultural Economics)

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DEPARTMENT OF AGRICULTURAL ECONOMICS

S.K.N. COLLEGE OF AGRICULTURE, JOBNE

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the degree of

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In the

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(Agricultural Economics)

by

Narayan Lal

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Sri Karan Narendra Agriculture University, Jobner

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This is to certify that this thesis entitled **"Processing and Marketing of Guar (Cyamopsis tetragonoloba) in Bikaner district of Rajasthan"** submitted for the degree of **Master of Science** in the subject of **Agricultural Economics** embodies bonafide research work carried out by **Mr. Narayan Lal** under my guidance and supervision and that no part of this thesis has been submitted for any other degree. The assistance and help received during the course of investigation have been fully acknowledged. The draft of the thesis was also approved by the advisory committee on 10.07.2016.

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Place : Jobner

Dated: / /2016 ***(NARAYAN LAL)***

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Chapter-1
INTRODUCTION

Guar or cluster bean (*Cyamopsis tetragonoloba*) is believed to have originated from Africa but it' has been grown throughout southern Asia. India and Pakistan have distinct advantage of agro-climatic conditions for the cultivation of guar though it is also successfully grown in U.S.A., South Africa, Australia, Brazil, Zaire and Sudan. Guar is a drought-tolerant, multi-purpose annual arid legume crop cultivated mainly during *kharif* season and used for extracting gum from seeds, animal fodder from vegetative part, and also used as green manure. In India the major guar producing areas are Rajasthan, Gujarat and Haryana. The major producing areas are also important processing areas of guar and its derivatives. Guar gum is exported from Kandla and Mumbai port. Guar is being grown in India since ancient time and the tender green Guar is an important source of nutrition to both human being and animals, which is consumed as a vegetable and cattle feed, respectively. In old times, Guar was only used as rich protein to feed cattle. The cluster bean contains vitamin-C, vitamin-K, vitamin-A, dietary fiber, foliate iron and K. the vitamin-K is important for maintaining strong bones and proper development of foetus. It is also used as green vegetable in India. After Second World War there was major shortage of locust bean gum which adversely affected the textile and paper industries. At that time Guar gum was found as the most suitable substitute for scarce locust bean gum. In 1953 the extraction technology of guar gum was commercialized in USA and after about a decade in India 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. Guar Gum is an important ingredient in producing food emulsifier, food additive, food thickener and other guar gum products. India is the largest producer of guar gum products. Its guar gum exporters, guar gum manufacturers, guar gum products suppliers, food emulsifier exporter have reached too many countries. As of now there is a lot of demand for Indian guar gum products, food additives, food thickener and other allied guar gum products. Guar gum is purely an export oriented commodity with about 75-80% of total output exported from the country. Industrially it is used in mining, petroleum drilling and textile industry. In food it is used as a thickener and as a mean of preventing ice crystal formation in frozen desserts. Guar is used in different industries worldwide. Major portion of Guar is recovered as Guar meal/Korma/ Churi during the process of seeds into Guar gum split. Guar Korma /Churi /meal is used as cattle feed or animal feed. It is high in demand. There is around 50-52 % Protein content in Guar meal / Guar Korma / Guar Churi. Generally, there is 70 % recovery of guar Meal from Guar Korma. Rest 30 % is recovered as Guar Gum split. Guar gum split is major industrial product. It is further processed into Guar Gum powder. Guar gum powder is used in many industries. Major demand of guar Gum powder comes from Oil and natural Gas industry. Rate of crude oil has fallen drastically due to miss match in demand and supply. Guar gum is produced from the seed

and this is turned into powder. The powder is used in a host of industries, ranging from bakery, dairy, meat, dressing and sausages, beverages, pharmaceuticals and cosmetics, textile printing, mining, water treatment and paper industry. Guar Gum is one of the most cost effective and functional ingredients available for formulating food products. Soluble in cold water, Guar imparts a high viscosity and exhibits superior water-binding capacity at low usage levels. These characteristics make it suitable for use in applications as diverse as cottage cheese, sauces, soups, and frozen desserts. The nonionic nature of Guar makes it tolerant to extreme salt and electrolyte levels, important criteria when selecting a thickener for nutraceutical beverages. Like other legumes, guar is an excellent soil-building crop with respect to availability of nitrogen. Root nodules containing nitrogen-fixing bacteria can fix 37-196 kg N/ha per year. and crop residues, when ploughed under, improves yields of succeeding crops In India guar crop is cultivated during Kharif season, with an annual production of 25 to 28 M tones. India is the largest producer of guar and contributes 80% of total guar production in the world. In India, cluster bean is mostly grown in Rajasthan, Haryana, Punjab, Uttar Pradesh and Madhya Pradesh. Rajasthan occupies first position in India both in area and production. It accounts for almost 82.1 per cent area and 70% production in India. Haryana and Gujarat has second and third position respectively. Rajasthan has an area of 46.25 lakh hectare, production of 27.43 M tones with a productivity of 593 kg/ha. (Anonymous 2014-15). In Rajasthan, guar is mainly grown in Barmer, Churu, Sriganganagar, Nagaur, Jalore, Sikar, Jaisalmer, Bikaner, Jaipur, Jhunjhunu and Alwar districts. Average yield of crop in Rajasthan is below potential yield. The low yield of crop is mainly due to cultivation of traditional low yielding varieties without or with little fertilization and lack of other improved

agronomic practices. 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 derivatives very much depend on the monsoon condition and its likely production or stockist store guar for as long as 6-7 years. India has been a major player in guar and guar gum trade in the global market. Guar gum has a wide range of industrial applications and the major demand is from various industries. India is the leading net exporter of guar seeds and guar gum. In the year 2012-13 India exported guar to the tune of 21287 crores of which the share of treated and pulverized guar gum comprises of 83% followed by 15% of refined guar split. The trade value for guar meal is to the tune of 0.66% only in export market. Demand for guar gum is linked to oil prices. Higher the oil price, higher is the demand for guar gum, which is used for exploration of shale gas, a substitute for high cost imported oil in the US."Till the time oil prices go up to $70-75/ barrel, and stabilize at $80-90/ barrel, it is difficult for demand for guar to pick up. Guar meal is basically used for domestic consumption Thus, it offer a great scope for increasing its productivity through sound crop husbandry. 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. 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 price 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.

The market of guar has witnessed a shift which was quite unexpected for the participants in the industry. The mean price of guar from 2007 to 2011 was moving around Rs. 2000/qt. to Rs. 2100. But the high price fluctuations in the year 2012 the mean price of entire period (2007-2013) shifted to a new high at around Rs. 3600/qt. at Jaipur market. Mean price of last two year was around Rs. 7600/qt. In 2013 the price is moving towards stability with minor fluctuations.

In the year 2012-13, the export of guar split and gum from India to the world was around 3.3 lakh tonnes. It is estimated that the 20% of output of guar is being consumed within the country. The estimated total output of guar split and gum in the year 2012-13 was around 4 lakh tonnes. The compound Annual Growth Rate of guar gum industry is estimated at 17.6%.

The production of guar at commercial level has been started in many of the African countries which is expected to overcome the trouble caused to the industry due to fluctuations in the production in India. After the emergence of usage of guar in oil drilling industry, there no new application has been emerged so far.

Though India accounts for 75-80% of the total guar produced in the world (60-70% is cultivated in Rajasthan) lack of technology on value

addition diminishes the profits that can be earned from the crop. Lack of awareness among the stakeholders regarding the commercial value of the crop is resulting in under-exploitation of the crop for export. Meager efforts are made for stabilization of guar seed productivity in the country, since guar is not considered widely as a commercial crop. Countries like USA and Australia are making concerted efforts to grow guar seed extensively and thus production is showing increasing trend in those countries. This may lead to loss of international market for Indian guar gum products.

The future of guar industry is for specialized applications and derivatives. It is envisaged that the industry will move towards product differentiation to meet the specific and niche demand. For example in food industry there is growing preference for bio-degradable, non-polluting and organic, products. This gives ample scope for leveraging investment, knowledge management, technology and partnerships for technology sharing and transfer.

Guar Gum is relatively cost effective as compared to other thickeners and stabilizers along with it being an effective binder, plasticizer and emulsifier. One of the important properties of guar gum, a polysaccharide, is that it is high on galactose and mannose. Guar gum is also known as guarkernmehl, guaran, goma guar, gomme guar, gummi guar and galactomannan. Endosperm of guar seeds are used in many sectors of industries like mining, petroleum, textile, food products, feed Products, Pet Food, pharmaceuticals, cosmetics, water treatment, oil & gas well drilling and fracturing, explosives, confectioneries and many more. Since a long time Guar Gum can also be named as a hydrocolloid, is treated as the key product for humans and animals as it has a very high nourishing property. The year 2013 was a strong for

guar sowing and production in India. The total sown area rose by 21 percent in 2013 to reach 10.6 million acres. Rajasthan, Haryana, and Gujarat – the three key guar-producing states –exceeded the sowing area target set by their respective agriculture departments. Non-traditional guar cultivators other Indian states also showed keen interest in the crop in 2013.

The complex nature of the guar gum industry in India warrants close monitoring of the market at all times. The industry starting with a strong stock of guar seeds, ample processing capacity to produce guar gum, and steady global demand. Despite these positive market fundamentals, the guar industry in India remains exposed to price volatility because of potential impact from additional market factors. These factors, which are mainly specific to India, have the potential to disrupt the guar market.

The opaque nature of guar gum supply chain in India demands continuous, close monitoring of developments on the ground to better predict pricing.

According to industry estimates, global guar gum demand grew 33% that is 681k metric tons in the 2011-12 selling season from 510k in 2010-2011. These same sources estimate a more modest 4% increase in demand in 2012-2013 to 711 k metric tons. India is the world's leading supplier of guar gum, producing roughly 80% of global supplies. The US purchased 75% of India's guar gum output in 2011-2012, with China a distant second at 6%. Of this US demand, 62% of it was for industrial grade guar gum, with the majority of that demand being fueled by the oil and gas industry. Guar Global will focus on producing hydroxypropyl guar gum for the US oil and gas industry, where it is valued for its unique gelling properties, making it ideal for resource extraction in drilling and

hydraulic fracturing projects. Guar gum is the main natural (EPA safe) viscosifier for fracking fluids. It mixes with water, leaves behind minimal residue and is easy to crosslink and clean out. It is estimated that each frack utilizes roughly 10,000 lbs of guar gum. Demand for natural gas shows no sign of slowing down, and the International Energy Outlook 2013 predicts global natural gas demand to rise 1.5% annually through 2040.

keeping in mind all the above points, the study entitled "An Economic Analysis of guar cultivation in Bikaner district of Rajasthan" with the following objective was carried out: - to estimate the growth rate in area, production and productivity of guar in the study area to work out the price behavior in study area, to study the economics of processing of guar seed to guar gum, and to identify the problem faced by the guar processors.

1.1 The specific objectives of the study:

1 To estimate the growth rate in area, production and productivity of Guar in the study area.

2 To study the price behaviour of guar in the study area.

3 To study the economics of processing of guar seed into guar gum.

4 To identify the problems faced by the guar gum processors.

1.2 Plan of the thesis

The text of this study runs through five chapters. The present chapter deals with the introduction, importance, objective as well as plan of the study. The review of literature is presented in chapter two. The third chapter deals with the methodology adopted in the selection of crop, region, and the markets, collection of data and analysis, etc.

Chapter 4 deals with the results and discussions and is composed of four sections namely, section A, B, C and D. Section A pertains to the growth rate in area, production and productivity of guar in study area. Section B deals with price behavior in the study area. Section C deals with economics of processing of guar seed into guar gum. Section D deals with problems of guar gum processors. Chapter five deals with the summary, conclusion and policy implication of the study. Literature cited and appendices are given at the end of the thesis.

Chapter-2

REVIEW OF LITERATURE

In this chapter, an attempt has been made to review some of the important studies related to the present investigation. The chapter has been divided in four sections for presenting the available studies in a scientific manner.

2.1 Growth rates in area, production and productivity

2.2 Price behavior

2.3 Processing of guar gum

2.4 Problem faced by the processors

2.1 Growth rates in area, production and productivity

Datarkar *at el.* (2015) reported that groundnut (*Arachis hypogaea* L.) is an annual legume crop grown in semi-arid regions of the world. It is the world's fourth most important source of edible oil and third most important source of vegetable protein. In India, groundnut is the principal oilseed crop, occupying an area of 6.4 million hectares with a production level of nearly 6.7 million tonnes of nuts-in-shell. It accounts for 33.5 per cent of the total area under oilseeds and 36.3 per cent of total oilseeds production. The main objectives of the study was to examine the regionwise compound growth rates in area, production and productivity of *kharif* groundnut in Maharashtra state over different time periods viz; Period-I (1990-91 to 2001-02), Period-II (2002-03 to 2012-13) and overall period (1990-91 to 2012-13). The growth in the area, production and productivity of *kharif* groundnut was estimated by using the compound growth function of the non linear form. The study analyzed that area, production and productivity of *kharif* groundnut had decreased

during the study Period. The decrease in production of *kharif* groundnut in Vidarbha, Marathwada and Western Maharashtra region during the period-I, II and overall Period was due to the increase in acreages under other oilseed specially soybean and other valuable cash crops, lack of irrigation facilities, no use of plant nutrients, prevailing climatic conditions. In case of Konkan region, the increase in production of *kharif* groundnut in Maharashtra during overall Period was relatively more as compared to Period-I and II. This was due to the increase acreages under *kharif* groundnut. The study suggests that, the groundnut crop can be another pillar of agricultural development in the Konkan region and the efforts should be made to improve the productivity of *kharif* groundnut in order to increase *kharif* groundnut production in Vidarbha, Marathwada and Western Maharashtra region of Maharashtra state.

Goudra *et al*. (2011) worked out the compound growth rate of area, production, and productivity of chilli for all the districts of North Karnataka. Area-wise, Belgaum (4.85), Gulbarga (0.81), Raichur (0.40) districts were significant at 10 percent of level of significance. Production-wise, Belgaum (5.49), Bijapur (1.11), Haveri (0.79) districts were significant at 10 percent level of significance. Productivity wise, Bidar (1.74) and Raichur (0.21) districts were significant at 10 percent level of significance. Northern Karnataka as a whole registered positive compound growth rate for area (13.76), production (13.88), productivity (12.20). The area, production and productivity under chilli decreased in North Karnataka with highest instability across all the districts.

Basavaraja *et al*. (2005) in his study on “Kharif sorghum in Karnataka :An economic Analysis” observed that the sorghum, which once occupied more than 18 M h of area in the country, has been on a continuous decline during the past two decade and has fallen down to

10.39 M ha. The growth rates in area, production and productivity of Kharif sorghum have been computed. The deceleration in the Kharif sorghum area in the overall period 1970-71 to 1997 98 and different sub-periods has been found due to the division of Kharif sorghum area to more remunerative crops like oil seeds (groundnut and sunflower) and pulses. The net return and benefit-cost ratio have been found low in the cultivation of Kharif sorghum compared to those of its competing crops, viz. cotton, green gram and groundnut.

Kumar and Mor (2001) analysed the data on area, production and productivity of all the major crops of Haryana, India, namely wheat, rice, gram, bajra [*Pennisetum glaucum*], rape, Indian mustard, sugarcane and cotton (American and desi), for the period 1966-67 to 1995-96. In the production of rice, the area effect was more than the yield effect and their interaction effect was more than the area effect and yield effect. In case of wheat, the area and yield effects were almost the same but their interaction effect was more. For the increase in the production of rapeseed and mustard, the area effect was more than the yield effect but their interaction effect was more than the area and yield effect jointly. In case of cotton (American), the production has increased mainly due to increase in area, very less due to decrease in yield. In case of gram, negative area effect exceeded the yield effect, but in case of sugarcane the positive yield effect exceeded the negative area effect. However, in case of cotton (desi), the negative area effect exceeded the positive yield effect. There was an urgent need to check the decreasing trend in the area under gram and desi cotton. The production of cotton (American), rapeseed and mustard can be further increased by increasing their yield.

Prasad *et al.* (2012**)** computed the growth rates in area, production and productivity of maize crop in the Telangana region of Andhra Pradesh, India, using the data from 1969 to 2009. Besides growth rates, future projections were also estimated up to 2014 AD. The growth models taken under consideration were: linear, quadratic, cubic, exponential, compound, logarithmic, inverse and power functions. The model with the least residual mean square (RMS) and significant adj R^2 was considered to be the best fitted model. The most important assumption of randomness of residuals was verified. In the case of maize area, the compound function was found to be the best trend equation for future projection purpose as it exhibited the least RMS and significant adj R^2 and also satisfied the assumption of randomness of residuals. In the case of maize production, also the compound function was found to be the best trend equation. In the case of maize productivity, the S-curve function was found to be the best trend equation for future projection purpose. In 2014 AD, the maize production in the Telangana region of Andhra Pradesh may reach 1749.71 thousand tonnes.

Devraj (2002) analyzed the trends in area, production and productivity of pulses and food grains in Uttar Pradesh state for the period 1980-81 to 1999-2000. The result of the study revealed the growth rates of area, production and productivity of *Kharif* pulses recorded 2.011, 5.146 and 3,037 per cent per annum, respectively during the study period (1980-81 to 19999-2000), whereas for food grains there were 0.015, 2.330 and 2.345 per cent annum, respectively. He observation that productivity of pulses ranged between 245 kg (*Kharif* mungbean) to 1215 kg per ha (pigeonpea) during the study period.

Mathur and Henry (2005) computed the compound growth rate (CGR) of moth bean, cowpea and mung bean for different parameters for two periods: long-term (1976-2000) and recent years (1991-2000) for different agro climatic regions of western Rajasthan, India. In moth bean, the crop productivity for long-term period indicated a positive trend in zones Ia, IIa and IIb as well as in whole arid Rajasthan (WAR). For recent year's period, it was low positive only in zones IIa and IIb and decreasing in the WAR. The area and production of both periods indicated a negative trend in the WAR. For recent year's period, these parameters were negative in all agro climatic zones. The decrease in area and production were 12.2 and 17.6%, respectively. In cowpea, the major crop area and its production were in zone IIa, where its production and productivity indicated a positive trend for both periods. Except in zone IIb, the area, production and productivity indicated a positive CGR in all the zones of arid Rajasthan in recent year's period. The increase in area, production and productivity was 5.1, 64.0 and 42.5%, respectively, over the long-term period. In mung bean, the area under the crop indicated a positive trend during both periods. Crop production indicated a positive trend in all the zones for long-term period but only in zone Ib in recent year's period. Productivity indicated a decreasing trend in all zones in recent year's period. The increase in area was 44.5% with 41.87% increase in production in recent year's period. The Chow's test indicated significant differences in two periods for zone Ib for mung bean and zones Ib, IIa and WAR for cowpea and there was a positive shift to the technological development during recent year's period.

Arora *et al.* (1988) reported that Clusterbean or *guar* is grown as a vegetable, feed and green manure crop in arid and semiarid tracts of the north-western plains of India and is the source of industrial gum.

The paper analyses trends and variability in area, production and yields of *guar* grown for seed in India over the period 1965/66-1985/86. Compound growth rates of area, production and yield are estimated and coefficients of variation calculated for Rajasthan and Haryana states (which account for 81% and 12% of the total area in India, respectively) and for India as a whole. The data indicate that area and production has been increasing over time with moderate annual fluctuations. Variation in production was mainly due to variation in area. Appropriate regulation of prices, management practices and risk factors could be conducive to stabilizing the area under the crop.

2.2 Price behavior

Mali *et al.* (2002) conducted a study entitled “Trends in Arrivals and Prices of Important Oilseeds in Selected Regulated Markets of Western Maharashtra” for the period 1986-87 to 2000-2001. The results of the study revealed that the monthly arrivals of soybean were higher immediately after post harvest period when the prices showed a decline and vice-versa. They found negative and non-significant relationship between arrivals and prices of soybean in Dhule market. However, the significantly negative relationship was noticed for soybean in Kohlapur market. The growth rate of prices of soybean in the selected market showed a significant increase of 6 to 7 per cent per annum during the period under study.

Verma and Kumawat (2015) examined the impact of futures trading on spot prices of mustard seed in the state of Rajasthan. For this purpose secondary data on futures prices collected from the annual reports of the commodity exchange for the financial years 2003 to 2008 and on spot prices collected from Krishi Upaj Mandi, Bikaner for the financial years 2000 to 2008 were used. The period prior to futures

trading was designated as pre futures period (PI) and that of futures trading as futures period (PII). Growth in monthly prices was estimated with the help of exponential function and trend by fitting of quadratic function. Impact of futures trading on spot prices was captured by employing dummy variable technique. Integration among futures and spot markets was studied by computing simple correlation between prices. All the prices - futures, spot market and mandi spot prices for mustard seed recorded significant growth of the order of 0.57 per cent, 0.42 per cent and 0.43 per cent, respectively, during the study period. The trend in all these prices of mustard seed was noted to be curvi linear in shape during the study period, *i.e.*, concave downwards. The significantly high value of 'F' statistic for mustard seed suggested that T and T^2 jointly had significant effect on prices (P). The study also revealed that the futures trading affected the slope of spot prices of mustard seed,*i.e.*, rate of change in the spot prices, without affecting the mean price level. This meant that the regressions were concurrent in nature. Thus it may be inferred that futures prices of mustard reduced the rate of change in the spot prices of the crop in the futures period. The futures market and the spot market were noted to be highly integrated (0.9140) in respect of the mustard seed.

Roopa and Murthy (2015) conducted a study in Haveri district of Karnataka state. Where mulberry area of 947 hectares and cocoon production of 680.511 M tonnes, respectively during 2013-14 was observed. The study was conducted to Trends in arrivals and prices of cocoons in Shirahatti market at Haveri District. In Haveri district Shirahatti taluka market were selected. The trend was computed in order to ascertain the long run movements of market arrivals of cocoon in the Shirahatti market. The trend in arrivals and prices of multivariate cocoon

in Shirahatti market over the year were found to be significant at one per cent probability level with R^2 value of 0.42 and 0.58, respectively. In order to ascertain the long term movement of cocoon price in the Shirahatti market the data relating to prices of cocoon were subjected to non linear (exponential) trend equation analysis.

Abbasi *et al*. (2015) found that wheat and rice are the basic requirement of every household. This paper analyses the price trends for these crops over the last 30 years and based on statistical models, forecast their prices from 2013 to 2017. Different models have been applied to get the best fit model. These were linear trend model, quadratic trend model, exponential growth model and S-curve model. The minimum values of Mean Absolute Percentage Error (MAPE), Mean Absolute Deviation (MAD) and Mean Squared Deviation (MSD) have been acquired and then the forecasting was made for the best fitted model with minimum error. Five year average prices for the individual crop(s) were also calculated to observe the past trend. The study demonstrates that for wheat and rice (Basmati and IRRI); S-Curve model is recommended for forecasting price. The study presents an insight to national policy makers regarding the essential crops and provides them with a reference range of price in future so that they may be able to effectively deal with the increasing concern of food inflation in Pakistan.

Karim *et al*. (2014) made an attempt to analyze the price fluctuation and price trends of rice in Bangladesh by using time series data for the period of 1974-75 to 2010-11. It was observed that Annual price fluctuation of rice was higher than area, yield and production fluctuations. Price fluctuation was highest in periods IV and II. The downward trend of real price was found for rice but in case of

production, area and yield trend line was found upward. For every trend line it was found that for the period III and IV deviation from the trend line was high. Intra-seasonal price variation and coefficient of variation of rice price were quite high in the year 1977-78 and lowest in the year 2004-05. But these figures were decreasing gradually.

Sharma and Singh (2014) in this present study analysed the behaviour of market arrivals and prices of pearl millet in Rajasthan. In Nagaur market, the arrivals in the peak period were maximum during last 10 years (2000-01 to 2009-10). These were in the range of about 55.91 (2003-04) to 79.92 per cent (2008-09) of the total arrivals. In Jodhpur market, the arrivals of pearl millet followed more or less the same pattern as in Nagaur. In Jaipur market, the arrivals in peak period were maximum. The maximum arrivals were in the peak period followed by mid-period and lean period. The seasonal indices analysis of arrivals and prices revealed that when major portion of the produce was received in the market, the prices were at the lowest. The correlation between arrivals and price in Jodhpur market was positive and statistically significant. This positive and significant correlation coefficient could be attributed to the off-season supplies of pearl millet which fetch higher prices. Trend analysis of arrivals of pearl millet in the selected markets of the State shows that the trend values of arrivals in Jaipur, Jodhpur and Nagaur showed an increasing trend over the years

Mahalle, *et al.* (2014) in this study concluded that an increasing trend in arrivals was mainly found in Washim, Yeotmal, Nandura and Shegaon markets. Whereas, decreasing trend in arrivals observed in Akola, Latur and Nanded markets. All study markets showed increasing positive trend in wholesale price of pigeonpea during study period. The price behaviour in off-season was on higher side and reverse was the

case in on-season. Washim market had higher intra year price variation followed by Latur, Akola, Yeotmal, Shegaon and Nanded market. The lagged price is an important factor in determining the current price than the market arrivals. The market integration showed that out of seven markets five markets were integrate

Daundkar, *et al*. (2015) found that, with the increase in arrivals of agricultural commodity in the market, their prices come down and vice versa. For this study, the data on arrivals and prices was under taken up. For the study, the data available in monthly reports of Agricultural Produce Committee Pune market, for the period of 10 years was used, the annual compound growth rate of arrivals in case of onion (4.42) were found positive and annual compound growth rates of prices in the onion (13.03) were positive growth rate indicating thereby positive relationship in Arrivals and prices per annually. Arrivals were noticed highest during the month of February (15.01) followed by March. It means that the market was flooded with onion from January to March. The lowest indices of arrivals were noticed in the month of September (5.43). The indices of lower arrivals were from August to November. In case of price indices was noticed highest in the month of November (11.81). The higher prices indices were noticed during August to December. While lowest in April (4.37) followed by May. The monthly arrivals and prices of onion in Pune market shows great fluctuations and no any specific trend was observed.

Sharma and Burark (2015) investigated the price behaviour of maize and market concentration in Nimbahera market of Rajasthan. In view of this the present study was undertaken by collecting monthly wholesale prices of maize in major maize markets of Rajasthan for a period of 12 years (2002 to 2013). The seasonal price index pro ides a

measure of the month to month variation in maize prices. Price of maize was found to be highest during off season and lowest during harvest season. Since maize is a *Kharif* crop, the arrivals were high during October to January. The higher seasonal indices of prices were observed during April to August during which the arrivals were found to be low. The Lorenz ratio was less than 0.5 in Nimbahera market. It can be concluded that the moderate market competitiveness in markets as the arrivals were concentrated among few large traders. The Lorenz ratio 0.49 for maize in Nimbaheda market showing moderate market concentration.

Jambhale et al. (2012) A study was carried out during 2010-2011 to determine seasonality in arrivals and price of selected farm commodities. Seasonality in arrivals and prices indicated that at an overall level of arrival of wheat was highest in summer season (14744 qt.) As compared to rainy and winter seasons, price of wheat was highest in winter season. As compared to summer and rainy seasons in groundnut, it was seen that at an overall level of arrival of groundnut was highest in rainy season (1705.66 qt.) as compared to summer and winter price of groundnut, it was highest in rainy season followed by summer and winter. In case of gram the highest price was in winter season (Rs. 2182/qt) and in case of soybean the highest arrival was in winters (3090 qt.) and the highest price in rainy season (1705 qt). In case of onion the highest arrival was in summer (2585 qt.) and the highest price in winter season (831 qt). It was observed that there was no any specific relation between the per quintal price of wheat, gram, soybean, onion and season but there was specific relation between the per qt. price of groundnut with season.

2.3 Processing of guar gum

Meena *et al.* (2006) conducted a study to examine the economic viability of different sizes of chilli processing units in Jodhpur District, Rajasthan, India. The data were gathered from 12 processing units in the district, during 2000-01. Results showed that the cost of processing per quintal of chilli was Rs. 180.06, Rs. 167.30, Rs. 234.42 for small, medium and large processing units, respectively. Margin of processors increased with an increase in the size of processing unit. However, the difference in the size of processing units had no influence on the recovery of chilli powder. Value addition by investment rupee as processing cost and returns to per rupee investment, also increased with an increase in size of processing unit. All the processing units were operating above the break-even quantity, but failed to utilize their installed capacity.

Al-Quadi and Al-Karaki (2000) paper identifies the factors that affect the processing and marketing of olives in Jordan. In addition to the transportation model that is developed, cost of processing and marketing are analysed and assessed. The results indicate a surplus in the production capacity of processing in some areas such as Irbid and a shortage in others such as Karak. The cost of transportation, processing and containers per kg was estimated at about 440 fils, 430 fils, and 440 fils for lacquered tin, uncoated tin and plastic containers, respectively. The marketing margins analysis indicates that the share of the farmer from the price paid by the consumer is about 77%, 83% and 68% in the case of olives packed in plastic containers, tin containers or glass containers, respectively. In return, the share of the farmer from the consumer price of olive pickling amounted to 21%, 18%, and 34% in the case of containers made of plastic, glass or tin, respectively.

Tewodros. (2014) studied Chickpea value chain study was conducted in selected districts of the south region where CIFSRF project was operating. In total 227 respondents comprising 162 chickpea producers; 11 local assemblers; 8 rural wholesalers; 8 urban wholesalers and 38 retailers were interviewed. The study finding shows that the chickpea value chain actors are broadly classified into three viz., inputs suppliers, direct market actors and enablers. Chickpea producers sold their chickpea products to different market intermediaries and final consumers. About nine chickpea marketing channels were identified. The total amount of chickpea that was transacted through these marketing channels in 2012/13 was 9,181 qts. Out of which the project site farmers supply 77% while 27% were imported from other chickpea producing areas. The study result shows that the total gross marketing margin was 45.8% with producer participation margin of 54.2%. Approximately 10.2% out of a total gross marketing margin of 45.8% constitutes the total marketing charges, giving a net marketing margin of 35.5%. Although this suggests an appreciable level of profits reaped by traders, volumes traded are relatively low as compared to other cereals. The market intermediaries incurred different marketing costs such as packing, processing, transportation and loading unloading. Determinants of chickpea producer participation in alternative market options were analyzed. A multinomial logit analysis results show that family size, landholding, access to market information and Income from crops was positively influences wholesale market participation as compared to farm gate. Similarly landholding, access to market information and extension services positively influence consumer market participation than farm gate while access to information and income from crops positively influences retails market participation than farm gate. On the other hand membership to cooperatives was negatively influences wholesale, retail

and consumer market participation than farm gate market option. Households distance from nearest market negatively influences wholesale market participation than farm gate market option while off farm activities negatively influences retail market participation than farm gate. The study suggested that availing credit for agricultural marketing, promoting collective marketing, strengthening of extension service, provision of market information and road development improves farmers marketing margin and chickpea value chain performance.

Rezaei *et al.* (2011) in thier study investigated the effect of guar gum and arabic gum on physicochemical, sensory and flow behaviour properties of frozen yoghurt. The results indicated that gums significantly affected the viscosity, overrun and melting rate of frozen yoghurt. The highest overrun value was observed in sample containing 0.5% arabic gum. Frozen yoghurt containing 0.3% guar gum had the highest viscosity. The longest first dripping time was observed in sample containing 0.5% arabic gum. Flow behaviour of samples showed that all frozen yoghurts exhibited shear thinning behaviour. Guar gum at a concentration of 0.2% and arabic gum at a concentration of 0.5% presented the best total acceptability. The results of this study revealed that the frozen yoghurt produced with arabic gum had the better overall sensory and physicochemical characteristics.

Deepak *et al.* (2014) reported that guar gum is a novel agrochemical processed from endosperm of cluster bean. It is largely used in the form of guar gum powder as an additive in food, pharmaceuticals, paper, textile, explosive, oil well drilling and cosmetics industry. Industrial applications of guar gum are possible because of its ability to form hydrogen bonding with water molecule. Thus, it is chiefly used as thickener and stabilizer. It is also beneficial in the control of

many health problems like diabetes, bowel movements, heart disease and colon cancer. This article focuses on production, processing, composition, properties, food applications and health benefits of guar gum.

Huang *et al.* (2014) carried out a response surface analysis to optimize the extraction techniques of guar gum from the seed of *Cyamopsis tetragonoloba* (Linn.) Taub. based on the results of single factor test with temperature, pH value and ratio of material to water as the factors. The results showed that the optimal conditions of guar gum extraction were: pH 4.0, 52°C and the ratio of solid to liquid 1:30 g/mL, the actual extraction rate of guar gum reached up to 30.3%, which was close to the predicted value of 30.6%.

Vishwakarma *et al.* (2009) found that the guar (*Cyamopsis tetragonoloba*) is one of the most important commercial crops grown in arid and semi-arid regions of India and contributes to 80% of total world production of guar. The guar processing industries in India are mainly located in Rajasthan, Haryana and Gujarat states. Out of 150 guar split manufacturing industries, approximately 125 are located in Jodhpur (Rajasthan). The capacity of plants varies between 3000-5000 tonnes per year. The seed contains 30-35% galactomannan located in the endosperm (also called guar gum split). Guar is processed using dry milling method in which the seed is split in to two halves using a burr mill. The germ is separated from cotyledons with a pin mill. The splits are heated for 10-15 minutes followed by dehulling using a dehuller. The hull and germ free cotyledons are known as guar gum splits. Grinding of these splits gives refined guar gum powder that has various food and industrial applications. The powder is soluble in cold as well as hot water and produces viscous gel. Approximately 80% of the guar gum produced

in India is exported to various countries. The status of guar industries in India, its export potential, properties of guar gum powder, various uses and problems associated with this industry are discussed in this paper.

Mudgil *et al.* (2014) reported that guar gum is a polysaccharide obtained from guar seed endosperm portion. Enzymatically hydrolyzed guar gum is low in viscosity and has several health benefits as dietary fiber. In this study, response surface methodology was used to determine the optimum conditions for hydrolysis that give minimum viscosity of guar gum. Central composite was employed to investigate the effects of pH (3-7), temperature (20-60°C), reaction time (1-5 h) and cellulase concentration (0.25-1.25 mg/g) on viscosity during enzymatic hydrolysis of guar (Cyamopsis tetragonolobus) gum. A second order polynomial model was developed for viscosity using regression analysis. Results revealed statistical significance of model as evidenced from high value of coefficient of determination ($R2=0.9472$) and $P<0.05$. Viscosity was primarily affected by cellulase concentration, pH and hydrolysis time. Maximum viscosity reduction was obtained when pH, temperature, hydrolysis time and cellulase concentration were 6, 50°C, 4 h and 1.00 mg/g, respectively. The study is important in optimizing the enzymatic process for hydrolysis of guar gum as potential source of soluble dietary fiber for human health benefits.

2.5 Problems faced by the processors

Sharma and gummagolmath (2012) observed that there is a high year-to-year variation in production of guar, and consequently, in exports of guar and its derivatives. Guar gum is mainly used in the food and bakery industry, the food safety concerns are becoming important for the guar processing industry. The preparedness of guar split and guar gum manufacturing industries for these food safety concerns, high

fluctuations in area, production and productivity of guar seed, high volatile prices of guar seed and gum splits, are crucial limitations to the growth of guar industry. The paper has discussed these issues and strategies in guar value chain and guar gum processing industry. Lack of technical knowledge and processing technology for industry-specific value-added products, poor market linkages with farmers and unstable trade policies are the main issues confronting the guar industry. The paper has given some suggestions for reforming guar industry in India.

Malik and Saraf, (2013) conducted a study to analyse the economics of guava processing with the objectives of estimating benefit cost ratio, capacity utilization, cost of processing, price spread, marketing efficiency and constraints faced by guava processors in processing of guava in Allahabad district of Uttar Pradesh (U.P.) India. The processing of fresh guava was undertaken only by 10 units (processing firms) in the study area, so all the 10 units were evaluated for the present study. The processing units included cottage scale (03), small scale (05) and large scale (02). The study revealed that returns per rupee invested in cottage scale units, was calculated as 2.74 in making jelly and 2.99 in jam; for small scale units, it was 2.28 in jelly, 2.43 in jam and 1.89 in toffee; and for large scale units, the returns per rupee invested were 2.52 in the manufacture of jelly, 2.82 in jam and 2.01 in toffee. As far as capacity utilization is concerned, the large scale units utilized 92.16% of installed capacity followed by cottage scale units with 86.73% and small scale with 79.89% capacity utilization, respectively. The cost of processing per quintal of guava was found to be Rs.176.60 (cottage scale), Rs.195.58 (small scale) and Rs.222.90 (large scale). Major problems faced by processors were non-availability of skilled labours, lack of capital, setting of guava products and degree

of competition, etc. It could be concluded from the study that guava processing was an economically viable entrepreneurial activity and provided ample opportunities for employment generation particularly for the local youth, and also earning much required foreign exchange. This could be possible provided the government functionaries and concerned agencies take steps towards strengthening infrastructural support for a better marketing mechanism to be in place, and introduce export promotion schemes to boost the processing industry, given its competitive advantage. Efforts need to be made to encourage local unemployed youth to opt for guava processing as their livelihood source, by providing training and financial support to them.

Kharade *et al*. (2009) undertaken a survey in Tasgaon tahsil of Sangli district, Maharashtra, India, to study the constraints faced by the grape growers in the adoption of postharvest technological practices and their suggestions to overcome these constraints. A total of 160 grape growers selected in 10 villages were interviewed. Most of the grape growers faced problems such as high transporation charges (92.5%) due to long distance market (90.0%), unremunerative rates for grapes (96.87%), excessive fluctuation in market rates (89.75%), higher commission charges for marketing of grapes (88.75%) and lack of knowledge about preparation of processed products of grape, except for raisin (93.75%). More than half of the grape growers faced problems such as high cost of processing of grape and high cost of packing materials (64.37%), and delay of payment by the commission agent (76.25%). More than one third of the grape growers had problems such as high cost of raisin making (43.75%), lack of processing industry (48.12%), uncertainty of market rate (48.73%), lack of guidance about grape export and unavailability of proper guidance about preparation of

processed products (36.25%). Most (93.75%) of the grape growers suggested that the transportation charges should be reasonable, and adequate provision for obtaining remunerative price is needed. The majority (92.50%) of the grape growers suggested for compulsion on middlemen for payment in time and majority (83.12%) of them suggested that the government should provide minimum support price. Some of them (78.12%) suggested that the commission rate should be reasonable. More than half (63.12%) of the grape growers have suggested for the arrangement of guidance about postharvest technology of grape through camp, rallies, etc. Some 71.25% of the grape growers suggested for establishment of grape board at state or district level.

Chapter-3

Methodology

This chapter describes the methodology adopted for the selection of study area, crop, region, markets, collection of data as well as the analytical tools and techniques used to arrive at the stated objective. For the sake of convenience, the methodology has been presented under following heads:

A. Selection of sample

B. Collection of data ;and

C. Analysis of data

3A. Selection of sample

3A.1 Selection of the Crop

Rajasthan occupies first place in terms of area and production of guar in India. Therefore, guar crop was selected purposively as study crop.

3A.2 Selection of the Region

Bikaner having maximum area under Guar was purposively selected for the study.

3A.3 Selection of the Markets

Three regulated markets from Bikaner district having the highest arrivals of guar were selected for the study.

3B. Collection of data

Both primary and secondary data were collected for the study. The primary data were collected from the selected guar gum processors, using personal interview method. Selection of processors based on a list of processors made with the help of tehsil Headquarter

and selected two processors one medium size processor and second one large size processor.

Secondary data of guar, for the district of Bikaner were collected on farm harvest prices and monthly and annual wholesale prices. Period for which data collected was year 2000 onwards and data were obtained from published records and reports of Directorate of Economics and Statistics (DES), Directorate of Agriculture (DOA) and Rajasthan State Agricultural Marketing Board (RSAMB), Government of Rajasthan, Jaipur.

3C. Analysis of data

3C.1 Compound growth rate analysis:

To study growth in area, production and productivity of guar in Bikaner district and Rajasthan state, compound growth rates were worked out by using the following formula:

Exponential equation:

$$Y_t = ab^t U_t \text{ ……………………………(i)}$$

Where,

Y_t is area/production/productivity of guar in time period t

t is time element which takes the values 1, 2,3…..n

a and b are parameters to be estimated

Where b= (1 + g); g is the rate at which y grows every year in relation to its value in preceding years.

U_t is the error term

On logarithmic transformation of Equation (i) we get :

$$\text{Log } y_t = \text{Log } a + t \text{ Log } b + \text{Log } U_t \text{ .... (ii)}$$

Equation (ii) can be rewritten as

$$Y^*_t = a^* + b^*_t + U^*_t$$

Where, $Y^*_t = \log Y_t$, $a^* = \log a$; $b^* = \log b$ and $U^*_t = \log U_t$

The compound growth rate will be obtained as

$g = (\text{Antilog } b^* - 1) * 100$

The 'F' value was used for testing the significance of compound growth rates.

3C.2 Price behaviour

The collected data were analysed by using the following tools and techniques to achieve the stated objectives. The analysis of trend, cyclical, seasonal and irregular behaviour of prices involves separating and studying the nature and behaviour of these components from the price series. It is assumed (hypothesized) that the components are joined together in a multiplicative fashion as represented below:

$P_t = T \times C \times S \times I$ (in monthly price series)

$P_t = T \times C \times I$ (in yearly price series)

For examining the trend in prices linear function was estimated by using the OLS method:

Measurement of Growth in Prices Both linear as well as compound growth rates were estimated by OLS method using the following forms of models.

(i) Linear model

Where,

$P_t = \beta_0 + \beta_1 T_t + U_t$ ----------(i)

P_t = Yearly index number of wholesale /farm harvest prices of guar for year't'

T_t = Serial number of year't'

U_t = Disturbance term with usual assumptions for year't'

β_0 and β_1 are regression coefficients to be estimated.

(ii) Compound growth model

$P_t = \beta_0 \beta_1^T U_t$ ……..(ii)

Where,

P_t = Annual farm harvest /annual wholesale prices of guar in year‘t’

T = Time element which takes the value 1, 2, 3, 4…….. n

U_t = Disturbance term such that OLS assumptions are satisfied for linear regression model for logarithmic transformation in case of exponential (compound growth) model; and β_0 and β_1 are constants or parameters to be estimated.

On taking logarithms of both the sides, the equation takes the form

$\text{Log } P_t = \text{Log } \beta_0 + T \text{ Log } \beta_1 + \text{Log } U_t$ ----------(i)

This equation was estimated by the ordinary least squares technique.

The compound growth rate (g) were estimated as :

$$(g) = (\beta_1 - 1) \times 100 \quad \text{……..…. (ii)}$$

Where,

g = Estimated computed growth rate in per cent per year.

β_1 = Antilog of Log β_1

The standard error (S.E.) of the compound growth rate was calculated using the formula:

$$\text{S.E. (g)} = \frac{100\,\beta_1}{\log_{10}^{e}} \sqrt{\frac{\left(\Sigma (\log P_t^2) - \frac{(\Sigma \log P_t)^2}{N}\right)\left(\Sigma T^2 - \frac{(\Sigma T)^2}{N}\right)(\text{Log } \beta_1)^2}{\left(N - 2\right)\left(\Sigma T^2 - \frac{(\Sigma T)^2}{N}\right)}}$$

Where:

$\log_{10}^{e}$ = 0.4343

S.E. (g) = Standard error of compound growth rate

N = number of observations and other notations have meanings as defined earlier

Student’s ‘t’ test were used to test the significance of the estimated compound growth rate as follows:

$$t_{n-2} = \frac{g}{S.E.\ (g)}$$

Suffix (n-2) denotes the degrees of freedom of 't'

Analysis of Seasonal Component

The seasonal pattern in prices were analysed by constructing seasonal index numbers. Seasonal index numbers are a set of numbers showing relative prices during different months of a year the average for the year being 100 and total 1200. To know if the seasonal indices have undergone a change during the period under study, seasonal indices for the initial two years period were compared with the seasonal indices for the last two years were worked out for both the period, separately following the percentage of centered 12 months moving average method. The seasonal price indices were compared to know the changes in seasonal pattern overtime. The 12 months moving average is a fairly good estimate of the trend and cyclical components combined. The steps involved in the construction of seasonal price index by this method are:

(i) Generating a series of 12 months moving totals
(ii) Generating a series of 12 months moving averages
(iii) Generating a series of centered 12 months moving averages

This was done by working out the correction factor and multiplying the average for the month by the correction factor which were estimated as follows:

$$K = \frac{1200}{S}$$

Where K is correction factor and S is sum of average indices for 12 months.

Multiplication of average for each of the month by the correction factor yields the index of seasonal prices. The percentage of centered 12 months moving average provides an index of seasonal and irregular components combined because:

$$\frac{P_t}{MA_t} \times 100 = \frac{T \times C \times S \times I}{T \times C} \times 100 = (S \times I)\ 100$$

The irregular components were removed in the process of averaging each month's ratio over the years and also through correction factor.

This provides a good estimate of seasonal price index. The differences in the seasonal price indices for these two sub periods were compared with the help of 'F' statistics.

Intra year price variation

(i) Average Seasonal Price Variation

The average seasonal price variation (ASPV) was calculated as :

$$ASPV = \frac{HSPI - LSPI}{\frac{HSPI + LSPI}{2}} \times 100$$

Where:

HSPI and LSPI are the highest and the lowest seasonal price indices, respectively.

(ii) Coefficient of variation

The intra year price variation were measured by working out coefficient of variation (CV) the method followed is as under.

$$CV = \frac{\sigma}{\bar{S}} \times 100$$

Where CV is coefficient of variation, σ is estimated value of standard deviation of seasonal price indices and $\overline{S}$ is the arithmetic mean of seasonal price indices. Since the arithmetic mean of seasonal price indices is always 100, the standard deviation in it is the coefficient of variation. The standard deviation and arithmetic mean were calculated by the following formula:

$$\sigma = \sqrt{\frac{\Sigma (S_i - \overline{S})^2}{n - 1}}$$

$$\text{and } \overline{S} = \frac{\Sigma S_i}{n}$$

Where S_i is the seasonal index for the i^{th} month (i = 1 to 12) and n is the number of months, *i.e.* = 12.

3C.3 Cost and Margins in processing of guar –

S. No.	Particulars	Units (Per annum)
1	Full processing capacity	
2	Actual processing quantity	
3	Processing costs	
(A)	Fixed costs (Rs)	
(B)	Variable costs (Rs)	
(C)	Total costs (excluding the cost of raw material) (Rs)	
4	Total costs (including the cost of raw material)	
5	Total receipts (Rs)	
6	Processing margin (Rs)	
7	Processing margin (Rs)/quintal of guar seed	

4D: Problem faced by the processors:-

The various problems related to Guar industry have been summarized as under:

Research and Development

The issues pointed out by the processors related to research and development on guar production to know- how or skill in the way of adoption of particular recommended production technology.

Marketing of Guar and its Products

The issues observed during discussions with processors related to marketing of guar seed and products in the way of adopting of particular marketing operation.

Promotion of Guar Industry and Export

The issues identified relating to promotion of guar industry in the way of adopting of particular recommended policies permoting export of guar intermediate products.

Sales tax and government polices

The issues identified relating to promotion of guar industry in the way of minimize sales tax and regulating price policy.

Chapter-4

Results and Discussion

In this chapter efforts have been made to discuss the growth rates of area, production and productivity of guar in Bikaner district of Rajasthan, as well as price behavior of guar in study area and economics of guar gum processing, In the present investigation, secondary data were collected and use for achieving the objective oriented results. Bikaner district was selected to achieve the specific objectives of the study. This districts has maximum area under guar. On an average, it accounted for 70 per cent of the total area under guar and 80 per cent of the total production of guar in the state during triennium ending 2014-15. Time series secondary data on annual wholesale prices and monthly arrivals of guar were collected for the period 2000-01 to 2014-15.

These data were then subjected to computer analysis and the results so obtained were discussed and presented under the following four section:

Section A : To estimate the growth rate in area, production and productivity of Guar in the study area.

Section B : To study the price behavior of guar in the study area.

Section C : To study the economics of processing of guar seed into guar gum.

Section D : To identify the problems faced by the Guar gum processors.

Sections – A

Growth rates of area, production and productivity of Guar in Bikaner district and in Rajasthan.

This section deals with the growth rates of area, production and productivity of guar in Bikaner district of Rajasthan.

The aggregate production of a crop is the resultant of area and produtivity of that crop. The growth pattern of area, production and productivity of guar in this context is important. Compound growth rates of area, production and productivity of guar were worked out for Bikaner district and for Rajasthan state as whole to assess the direction of change in these variables over time.

Table: A.1 Compound growth rates of area, production and productivity of Guar in Bikaner and Rajasthan (2001-15)

(Per cent per annum)

Particular	Area	Production	Productivity
Bikaner	15.95	21.45	4.74
Rajasthan	7.76	15.54	7.22

TableA.1 shows that area of guar in Rajasthan during the study period 2001-2015 registered a compound growth rate of 7.76 per cent per annum. Production under the crop in Rajasthan increased at a compound growth rate of 15.54 per cent per annum. Like production, productivity of the crop too, registered a positive compound growth rate of 7.22 per cent per annum. Results showse that area and productivity equally contributed in the growth of the guar production.

This table A1 shows that area of guar in Bikaner district during the study period 2001-2015 registered a compound growth rate of 15.95 per cent per annum, Production of the crop in Bikaner district also increased

at a compound growth rate of 21.45 per cent per annum. Like the production growth of Rajasthan, the productivity of crop in Bikaner district too, registered a positive compound growth rate of 4.74 per cent per annum. Thus, the increased area under the crop in Bikaner district could increase the production of guar crop.

The results showed that in 21.45 per cent growth in the production of guar. It is growth in area, which contributed a major share of 15.95 per cent per annum. Where as growth in productivity contributed 4.74 per cent.

The comparison of state of Rajasthan and Bikaner district shows that growth in production in the state is vertical, whereas it is horizontal in Bikaner district.

Section – B

Spatio-temporal Growths and Trends in Prices of guar in Bikaner district

In this section, spatio-temporal growths and trends in wholesale prices of guar have been discussed.

4B.1 Compound Growth Rates of Wholesale prices

The estimated compound growth rates of wholesale prices of guar in Bikaner district is presented in table 4B.1. The estimates of growth rates were based on data for the period 2000-01 to 2014-15 for Bikaner, Nokha and Shri dungargarh markets. It is evident from the table that the compound growth rates varied from 14.19 per cent per annum in Nokha and Shri dungargarh market to 14.42 per cent per annum in Bikaner market during the period 2000-01 to 2014-15. In case of Bikaner market it increased at an annual compound rate of 14.42 per cent. All the growth rates were estimated to be significant at 1 per cent level of significance. Bikaner market recorded a significant growth of 14.42 per cent per annum in the wholesale prices of guar during the period 2000-01 to 2014-15. In case of Shri dungargarh, it was estimated to increase at the significant compound growth rate of 14.37 per cent per annum during the study period. As regards the district, it recorded a significant growth of 14.42 per cent per annum (significant at 1 per cent level) during the study period. A scrutiny of the table reveals that in all the selected markets the increase in the wholesale prices of guar was highly significant (significant at 1 per cent level) irrespective of the periods of study implying that the wholesale price of guar had increased overtime and space.

From the ongoing discussion it may be concluded that the wholesale prices of guar recorded significant growth in the selected

markets of the district with no exception. The magnitude of growth of wholesale prices varied from 14.19 per cent in Nokha and Shri dungargarh markets to 14.42 per cent in Bikaner market.

Table 4B.1 : Estimates of compound growth rates of wholesale prices of guar in Bikaner districts

Market	Compound growth rate	Standard error	Coefficient of determination(R^2)
Bikaner	14.42	2.4060	0.759523
Nokha	14.19	2.4226	0.750527
Shri Dungargarh	14.37	2.3799	0.761946

4B.2 Trend in Prices

Price movements were studied by analysing the time series data on prices. On *a priori* basis four time components viz.; trend, cyclical, seasonal and irregular were assumed associated in multiplicative fashion with the changes in prices. In this section, the spatio-temporal trends in wholesale prices of guar were examined for the Bikaner market of Rajasthan as a whole and its selected markets.

Analysis of trend component in annual series on prices involved ascertaining the general direction of the movement of prices over a period of several years. For examining the trend in price of guar for Bikaner district both linear and quadratic (curvilinear) functions were estimated by regressing price (wholesale price) on time using the ordinary least squares (OLS) method. The best-fit model was selected on the basis of statistical significance of the regression parameters and coefficient of determination (R^2). Presence of autocorrelation among the estimated residuals was tested with the help of Durbin-Watson'd' statistic.

Based on the statistical significance of the estimated regression parameters and the coefficients of determination, linear function was selected over quadratic function for further discussion.

4B.2.1 Linear Trend in Annual Wholesale Prices of guar in Bikaner district

The estimates of linear trend in wholesale prices of guar for the Bikaner market of Rajasthan are presented in table 4B.2. The table indicates that the regression coefficient β_1 associated with the time element (T) was positive and highly significant at 1 per cent level of significance for all the markets. The value regression coefficient for time was estimated to be highest for Shri dungargarh (6.328) followed by Nokha (5.769). It was noted to be the lowest for Bikaner (5.701). The estimates of the coefficient of determination (R^2), as a measure to map the goodness of fit of the regression line to the given data, ranged from 0.600 for Nokha market to 0.712 for Shri dungargarh district indicating that the time element alone explained 60.0 per cent to 71.2 per cent variation in the wholesale prices of guar in the markets under study. The values of adjusted coefficient of determination (R^2), adjusted for degrees of freedom, were also quite high ranging from 0.650 to 0.548 for various markets and $0.\overline{58}5$ for the markets as a whole indicating that there was linear relationship between the time and wholesale price of guar. The highly significant values of calculated F statistics also supported the contention that time element was a significant explanatory factor of the variation in the wholesale prices of guar.

The Durbin-Watson test ('d' statistic) revealed that there was no autocorrelation among the residuals in all the selected markets.

Table 4B.2 Estimates of linear trend in wholesale prices of guar in Bikaner districts

Market	Intercept β_o	Regression coefficient β_1	R^2	$(\bar{R}^2)$	d statistics	F statistics
Bikaner	451.757	5.701	0.645	0.585	1.163	10.884
Nokha	494.516	5.769	0.600	0.569	1.336	19.513
Shri Dungargarh	467.894	6.328	0.712	0.650	1.112	32.210

4B.3 Seasonal Price Behaviour of GUAR

Price fluctuations within a year introduce an element of uncertainly and demand heavily on the marketing decision of the farmers. The up and down swing in prices that occur with some regularity during the year are termed as seasonal price variations. They resemble a short of intra year cycle. The extent of price rise during the year reflects intra year price margin in determine, the stocking behaviour of traders and returns to storage. For seasonal analysis of prices, prices of monthly wholesale prices of guar for Bikaner markets were obtained from the period January 2001 to December 2015. A multiplicative model of the following form was assumed.

$P_{it} = T \times C \times S \times I$

Where,

P_{it} = Monthly price for i^{th} month of the i^{th} year,

T = Trend component,

C = Cyclical component,

S = Seasonal component and

I = Irregular component

Price observation for an individual month (P_{it}) is composed of four elements as shown above 'Twelve months' centered moving average (CMA) was considered to be the representative trend and cyclical

components. Therefore, ratio of original price to CMA for the corresponding month was calculated to correct the monthly price series for trend and cycle. Thus, this ratio repressed seasonal and irregular components only. Irregular component was eliminated by computing the average (over the year) for each month separately. These average seasonal indices were adjusted to make their total as 1200.

To know whether the seasonal price indices underwent any change during the period under study, two sub-periods situated far apart consisting of initial two years (2001-02 to 2002-03) and last two years (2013-14 to 2014-15) of the monthly time series on the prices were demarcated on the entire study period. The monthly prices related to the agricultural year i.e. July to June. Seasonal price indices were worked out for each of these two sub periods, separately following the percentage of centered 12 months moving average method. The differences in seasonal price indices for these two sub periods were compared with the help of 'F' statistic.

4B.3 Seasonal Price Indices

The results of seasonal indices of wholesale prices of guar in the selected markets of Bikaner district for the entire study period are presented in table 4B.3 and of intra year price rise in table 4B.4. Whether these seasonal price indices underwent any change during the period of study was examined by selecting two distinct sub-period comprising initial three years price and last three years data as discussed above. The results of seasonal price indices for the two distinct sub-periods were presented in appendices I and II and of intra year price rise in appendices III and IV. The significance of difference in seasonal price (wholesale) indices of guar over the two-sub period was tested through 'F' statistic (Appendix V). The appendix table (Appendix V) reveals that there were no statistical differences between the seasonal price indices of guar for the two sub-periods as none of the calculated values of 'F' statistic (that varied from 0.26 to 0.99) was more than the tabulated values of F statistic being 4.46 at 1 per cent level.

This implied that the seasonal indices did not undergo any change over the period of study. The results (Table 4B.1) show that guar prices remained lowest during the months of December and highest in the month of June in all markets of Bikaner district during the study period. This was true of the Bikaner district as a whole. After reaching the peak in the month of June, the seasonal price indices started and continued to decline upto the month of October. Thereafter it started increasing up to the month of June. Such movements of seasonal price indices were observed for all the selected markets including the region as a whole irrespective of the differences in the total number of observations arising because of non-uniformity of the initial years of the monthly time series.

Table 4B.3 : Indices of seasonal price variation of guar in Bikaner district (2000-01 to 2014-15)

S. No.	Months	Bikaner	Nokha	Shri Dunagargarh
1	January	97.48	98.67	98.15
2	February	97.69	99.20	96.91
3	March	95.23	98.28	96.55
4	April	105.68	104.70	101.38
5	May	s102.95	102.43	101.4
6	June	104.04	102.65	106.12
7	July	104.55	104.86	102.81
8	August	101.15	101.52	105.08
9	September	99.90	99.53	105.32
10	October	100.70	98.32	100.74
11	November	97.95	95.60	95.16
12	December	92.68	94.24	90.38

Guar is grown as a *kharif* season crop in the region. Sowing of the crop generally start in July or rainy season under normal sown conditions. Moreover, by the end of October its harvest season begins.

Unlike food crops, the principal consumers of guar are the gum mills and cattle feed industries, which purchase it in bulk for operating the mills round the years. Higher magnitude of seasonal price indices for the months of May and June was probably the result of high competitive purchases by the mill owners and wholesalers. Downward trend in the indices from October to December. shows low demand for guar in the open market. Thereafter the demand got momentum through of the months up to July.

The results of intra year price rise (Table 4B.2) revealed that the magnitude of lowest seasonal price index ranged from 90.38 for Shri dungargarh market to 94.24 for Nokha market with December as the month registering lowest indices for all the markets including the region as a whole. As regards highest seasonal price index, it's magnitude ranged from 106.74 for shri dungargarh market to 104.86 for Nokha market with 105.68 for the district as a whole. The extent of intra year price rise (IPR) varied from 11.26 per cent in Nokha to 14.03 per cent in Bikaner market. In case of Shri dungargarh market the IPR was 14.78 percent. The results of coefficient of average seasonal price variation were in tune with that of the coefficient of variation (C.V.). The coefficient of variation for all the markets including the district ranged from 3.32 per cent to 4.89 per cent. The smaller magnitude of CV or the mean coefficient of dispersion revealed that there was greater consistency or smaller verifiability in the monthly prices of guar in the selected markets.

Form the foregoing discussion it may be concluded that the prices of guar were highest in the month of June and lowest in the month of December in all the selected markets of Bikaner district. The prices of guar started increasing after reaching lowest in the month of December and continued to increase up to the month of June. There after it started to decrease to attain the lowest in the month of December.

Smaller magnitude (3.32 per cent to 3.95 per cent) of coefficient of variation for the seasonal price indices indicated that there were grater consistencies (less variability) in the monthly prices of guar in selected markets of the Bikaner except Shridungargarh market. The probable reason for this may be attributed that to the availability of processing technology and facilities in Bikaner district.

Chapter – C

COSTS AND MARGIN IN PROCESSING OF GUAR

Processing is the transformation of products from their less usable form to more usable form either for direct consumption or for creation of new products. The processing of agricultural products is essential because very few farm products such as milk, eggs, fruits and vegetables are consumed more or less directly in the form in which they are obtained by the producer-farmer. In the modern era, a greater part of the produce sold by the producer-farmer is now subject to further processing before it reaches the final consumer into a form acceptable for consumption. At present, consumers are dependent upon processing for most of their requirements. Many technological changes have occurred in the recent past such as the introduction of refrigeration, modern methods of milling, new processing methods for dairy products, and modern methods of packing and preservation. These technological changes have a significant impact on the standard of living of the consumers. on the economic and social organizations of society, and on the growth of trade in the country.

Processing has many advantages as it converts the raw material into finished form and thereby bringing the products one degree nearer to human consumption. Processing is important, both for the producer-sellers as well as for consumers. It increases the total revenue of the producer by regulating the supply against the prevailing demand. Processing makes it possible for the consumer to have commodities in the form liked by him. The specific advantages of the processing are:

(i) It changes raw food and other farm products into edible, usable and palatable forms.

(ii) The processing function makes it possible for us to store perishable and semi-perishable agricultural commodities which otherwise would be wasted and facilitates the use of the surplus produce of one season in another season or year.

(iii) The processing activity generates employment.

(iv) Processing satisfies the needs of consumers at a lower cost. It saves the time of the consumers and relieves them of the difficulties and botherations experienced in processing.

(v) Processing serves as an adjunct to other marketing functions, such as transportation, storage and merchandising.

(vi) Processing widens the market.

(vii) It reduces cost of transportation and storage

Of late, guar has acquired the status of a commercial crop due to its processing into guar gum which has many uses. Commercial exploitation of guar gum started in 1953. The guar gum industries in India are mostly located in Rajasthan. In Jodhpur and Bikaner alone about two to three dozen units in the small and medium sized plants are under operation and three or four units are in the large scale sector. Some guar processing units are also located in Churu and Sriganganagar districts of Rajasthan. These units process guar seed and supply guar splits or guar gum or both for domestic markets as well as for export.

The information pertaining to the processing costs and margin help in exploring the way of increasing the efficiency of the processing plant through modernization, by utilization of the intake capacity and other methods. High fixed cost, technical competence and booms and slumps in the market were some of the limitations. These limitations restricted guar processing business only to entrepreneurs having large amount of capital at their command.

For presenting the results in a proper manner, the chapter has been divided into two sections:

i) Costs and margin in the processing of guar for medium size industry; and

ii) Costs and margin in the processing of guar for large size industry.

4C.1 Costs and Margin in the Processing of Guar for Medium Size Industry

The installed capacity of the plant is 1,20.000 quintals per annum. The plant runs on an average for 200 days per annum. The average operational hours per day of the plant are not fixed, it depends upon availability of raw material, prices of raw material and processed products etc.

The plant has a processing capacity of 1,20,000 quintals per annum but only 60,000 quintals of guar seeds was processed by the plant during the year 2014-2015. The cost of processing of guar by the plant was worked out on the basis of actual quantity processed during the year i.e. 50,000 quintals per annum. the costs and margin in processing of guar are given in Table . The details of these costs are given in Appendix- VI

Interest on term loan, taxes and insurance, and salary of permanent labourers were the three major cost components accounting for 90.23 per cent of the total fixed costs. The salary of permanent staff amounted to Rs 12,00000 per year. Taxes and insurance expenditure amounted to Rs 2,00000 per year. Rs 531000 per year has been the interest on term loan. Rs 1,50000 per year has been the repair and maintenance charges of the plant. The wages of temporary labourers amounted to Rs. 1,00,000 per year. Rs 3,20,000 per year has been the packing charges of the processed product. Fuel charges (diesel) amounted to Rs 4,50,000 per year. Sales tax amounted to Rs 7680000

which was main component of the total variable costs in processing of guar seed. Rs 1,50,000 per year has been the miscellaneous charges (phone, fax, postal charges etc.) of the office.

Thus, the total costs of running the plant in processing of guar have been Rs 11,59,0000 per year, of this fixed and variable costs accounted to Rs 21,40000 and 94,50000 i.e. 18.46 per cent and 81.54 per cent of the total costs, respectively. The total processing costs (excluding the cost of raw material) has been amounted Rs 193.17 per quintal of guar seeds.

Table 4C.1 Costs and margin in processing of guar by medium size industry

(Per Annum)

S.No.	Particulars	Units
1.	Full processing capacity	120000 qtls
2	Actual processed quantity	60000 qtls
3	Processing costs	
A.	Fixed costs (Rs)	2140000
B.	Variable costs (Rs)	9450000
C.	Total costs (excluding the cost of raw material) (Rs)	11590000
4.	Total costs (including the cost of 50,000 quintals raw material) (Rs)	203590000
5.	Total receipts (Rs)	205920000
6.	Processing margin (profit) (Rs)	2330000
7.	Processing margin (profit) Rs/quintal of guar seed	38.83

The recovery of guar gum and guar churi was 28 per cent and 68 per cent, respectively in processing of guar seeds. Total receipts from processing of 60,000 quintals of guar seed was Rs 20,59,20,000 as against the total processing costs (including the cost of raw material) of Rs. 20,35,90,000. As such the guar processing plant gets a profit of Rs

23,30000 in processing of 60,000 quintals of guar seeds i.e. a profit of Rs. 38.83 per quintal.

4C.2 Costs and Margin in the Processing of Guar for Large Size Industry

The installed capacity of the plant is 1,50,000 quintals per annum. The plant runs on an average for 210 days per annum. The average operational hours per day of the plant are not fixed as it depends upon availability of raw material, prices of raw material and processed products etc.

The plant has a processing capacity of 1,50,000 quintals of guar seeds per annum but only 86400 quintals of guar seeds was processed by the plant during the year 2014-15. The cost of processing of guar by the plant was worked out on the basis of actual quantity processed during the year that is 86400 quintals per annum. The costs and margin in processing of guar are given in Table. The details of these costs are given in Appendix-

Interest on term loan, taxes and insurance, and salary of permanent labour of plant were the three major cost components accounting for 88.47 per cent of the total fixed costs. Interest on term loan amounted to Rs 1485000 per year. Rs 6,00,000 per year has been the taxes and insurance costs. The salary of permanent staff amounted to Rs 2,40,0000 per year. Rs 3,50,000 per year has been the repair and maintenance charges of the plant. Sales tax and electricity charges were the two main component of the total variable cost amounted to Rs 11059200 and Rs 1500000 per year, respectively. Fuel charges (diesel) amounted to Its 1000000 per year. Packing charges amounted to Rs 600000 per year. Rs 3,00,000 per year has been the miscellaneous charges (phone, fax, postal charges etc.) of the office.

Thus, the total cost of running the plant in processing of guar has been Rs 20078450 per year. Of this, fixed and variable costs accounted to Rs 5069250 and Rs 15009200 i.e. 25.25 per cent and 74.75 per cent of the total costs, respectively. The total processing costs (excluding the

cost of raw material) has been amounted to Rs 232.39 per quintal of guar seeds.

The recovery of guar gum and guar churi was 28 per cent and 68 per cent, respectively in processing of guar seeds. Total receipts from processing of 86,400 quintals of guar seeds was Rs. 301363200 as against the total costs (including the cost of raw material) of Rs. 296558450. As such the guar processing plant got a profit of Rs 4804750 in processing of 86400 quintals of guar seeds i.e. a profit of Rs 58.61 per quintal.

Both types of processing plants are running in profit. but profit is less as compare as returns per rupee investment. The probable reasons that's why the entrepreneurs continuing the business may be:

Table 4c.2 Costs and margin in processing of guar by large size industry (Per Annum)

S.No.	Particulars	Units
1.	Full processing capacity	150000 qtls
2	Actual processed quantity	86400 qtls
3	Processing costs	
A.	Fixed costs (Rs)	5069250
B.	Variable costs (Rs)	15009200
C.	Total costs (excluding the cost of raw material) (Rs)	20078450
4.	Total costs (including the cost of 50,000 quintals raw material) (Rs)	296558450
5.	Total receipts (Rs)	301363200
6.	Processing margin (Rs)	4804750
7.	Processing margin Rs/qt. of guar seed	58.61

First, the plants profit are low due to lower price of guar gum which is regulated/controlled by international market. The guar gum market is going through depression. The entrepreneur continuing the business in the hope that in future they will get better price of their produce.

Second, the entrepreneurs purchase raw material (guar seed) directly from producer-farmers/middlemen rather than the regulated market. Hence they do not pay sales tax. Sales tax which is an important component of cost, reduces the total cost of processing (if not paid) ultimately the processing activity becomes profitable.

It is inferred from the foregoing discussions that both the guar processing plants under study were operating at far below their intake capacity. Interest on term loan, and taxes and insurance charges were the main cost components of the total fixed cost for both the plants. For medium size plant, fixed and variable costs accounted for 18.46 and 81.54 per cent of the total costs, respectively. Whereas, for large size plant, fixed and variable costs accounted for 25.25 and 74.75 per cent of the total costs, respectively. The total processing costs (excluding the cost of raw material) for medium and large size plants have been amounted Rs 193.17 and Its 232.39 per quintal of guar seed, respectively. The recovery of guar gum and guar churi for both the plants was 28 per cent and 68 per cent, respectively in processing of guar-seeds. The medium size guar processing plant got a profit of Rs 38.83 per quintal whereas. The large size plant got a profit of Rs 58.61 per quintal.

Section-D

Problems faced by the processors

The various problems related to Guar gum processors have been summarized as under:

Research and Development:

The issues pointed out by the processors 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.

Marketing of Guar and its Products:

The issues observed during discussions with processors 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.

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.

Sales tax and government polices:

The issue identified relating to sales tax and government policy for guar industry were high rate of sales tax at rate of 4% and the crop not included in government price policy so far as high fluctuation in prices of guar.

Table4B.4: Intra year prices (Wholesale) Rise in guar in Bikaner districts of Rajasthan

Market	Lowest seasonal price index		Highest seasonal price index		Intra year price rise (percent)	Coefficient of Average SPV	Coefficient of variation
	Month	Seasonal index	Month	Seasonal index			
Bikaner	December	92.68	April	105.68	14.03	13.11	3.95
Nokha	December	94.24	July	104.86	11.26	10.67	3.32
Sridungargath	December	90.38	June	106.12	14.78	16.60	4.89

Chapter-5

Summary, Conclusions and Policy Implication

This chapter deals with the summary of the introduction to the problem, methodology used, results obtained and conclusion drawn followed by policy implications recommended. The contents of the chapter are presented under the following heads:

5.1 Summary

5.1.1 Introduction

Guar or cluster bean (*Cyamopsis tetragonoloba*) is believed to have originated from Africa. but it has been grown throughout southern Asia. India and Pakistan have distinct advantage of agro-climatic conditions for the cultivation of guar though it is also successfully grown in U.S.A., South Africa, Australia, Brazil, Zaire and Sudan. Guar is a drought-tolerant, multi-purpose annual arid legume crop cultivated mainly during *kharif* season and used for extracting gum from seeds, animal fodder from vegetative part, and also used as green manure. In India the major guar producing areas are Rajasthan, Gujarat and Haryana. The major producing areas are also important processing areas of guar and its derivatives. Major portion of Guar is recovered as Guar meal/Korma/ Churi during the process of seeds into Guar gum split. Guar Korma /Churi/meal is used as cattle feed or animal feed. It is high in demand. There is around 50-52 % Protein content in Guar meal / Guar Korma / Guar Churi. Generally, there is 70 % recovery of guar Meal from Guar Korma. Rest 30 % is recovered as Guar Gum split. In India guar crop is cultivated during Kharif season, with an annual production of 25 to 28 M tones. India is the largest producer of guar and contributes 80% of total guar production in the world. In India, cluster

bean is mostly grown in Rajasthan, Haryana, Punjab, Uttar Pradesh and Madhya Pradesh. Rajasthan occupies first position in India both in area and production. It accounts for almost 82.1 per cent area and 70% production in India. Haryana and Gujarat has second and third position respectively. Rajasthan has an area of 46.25 lakh hectare, production of 27.43 M tones with a productivity of 593 kg/ha. (Anonymous 2014-15). In Rajasthan, guar is mainly grown in Barmer, Churu, Sriganganagar, Nagaur, Jalore, Sikar, Jaisalmer, Bikaner, Jaipur, Jhunjhunu and Alwar districts.

Agriculture commodities have exhibited seasonal price movements that are tied to the annual nature of the crop cycle. Crop prices in the cash and future markets are usually the lowest near harvest due to supply pressure. Conversely, they are usually the highest near the end of the marketing year when supplies are less abundant. Seasonal price patterns can be used as a guide for developing a marketing plan when they are examined along with supply and demand information. Plan can be made about selling a portion of the crop in cash market or the future market. Price analysis in the study of post price movements and the supply and demand factors associated with them. Price analysis, thus, explains how and why prices have behaved in a particular manner. It also explains whether there is consistency in the price behaviour of commodities over time and space.

The seasonality in production causes fluctuations in prices from season to season. The fluctuation in prices causes wide variation in the income of guar growers form year to year. Hence, the objective of this study is to know whether variability in the prices of guar has intensified; such a study is useful for the government in regulating the available supplies, stabilizing the prices of guar, bringing the stability in the income of guar growers.

5.1.2 Objectives

1 To estimate the growth rate in area, production and productivity of Guar in the study area.

2 To study the price behavior of guar in the study area.

3 To study the economics of processing of guar seed into guar gum.

4 To identify the problems faced by the Guar gum processors.

5.1.3 Methodology

In the present investigation both primary and secondary data were collected and used for achieving the objective oriented results. Guar as a study crop and Bikaner district as the study area were selected for investigation Bikaner districts (comprises Bikaner, Nokha and shridungargarh markets) having maximum area under guar. The primary data required for the study were collected through personally interviewing the respondents guar processors with the help of schedule. To study the pattern of growth in area, production and productivity of guar, secondary data from 2000-01 to 2014-15 were collected from the agriculture, Department of Rajasthan.

Growth rates of area, production and productivity of guar for the period of 2000-01 to 2014-15 were calculated for the Bikaner district and the Rajasthan state as a whole with the help of exponential function of the form $Y = ab^t$.

Time series secondary data for wholesale prices of guar were collected for the period 2000-01 to 2014-15. These data were then subjected to computer analysis and the results so obtained were discussed.

For measuring compound growth rates were estimated on the basis of standard errors and coefficients of determination (R^2). Price movements over time were studied by analyzing the time series data on

prices by assuming on priori basis four time components viz.; Trend(T), Cyclical(C), Seasonal(S) and Irregular(I) to be associated in multiplicative fashion with the changes in prices. Trend was isolated by regressing price on time. Both linear and quadratic function were fitted to the price data by resorting to ordinary least square (OLS) method. Linear model was selected on the basis of R^2 and standard errors of the regression parameters. For studying the cyclical behavior o guar prices, cyclical indices were computed using three years centered moving averages of the detrended price series.

For seasonal analysis of prices, index number of monthly wholesale prices of guar for the selected markets of Bikaner district were calculated from the raw data (2000-01 to 2014-15) in monthly prices related to the agriculture year, i.e. july to june. Seasonal indices were worked out assuming P = T X C X S X I from of the model. Percentage of centered 12 months moving average method was used for analyzing the seasonal behaviour of prices of the crop. The difference in seasonal price indices for these two sub periods were compared with the help of F statistic.

5.1.4 Results

The results of compound growth rates of area, production and productivity of guar for Bikaner and Rajasthan state as a whole were calculated and results indicated that area, production and productivity of guar were positively increased at a growth rates of 15.95, 21.45 and 4.74 percent per annum in Bikaner and 7.76, 15.54 and 7.22 percent per annum in Rajasthan during the 2000-01 to 2014-15 study period, respectively.

The compound growth rates revealed that wholesale prices of guar recorded significant growth rates in all the markets of district. The rate of growth however, ranged from 14.19 percent per annum in Nokha

and 14.37 percent per annum in Shridungargarh markets to 14.42 percent per annum (significant at 1 percent level) in Bikaner at wholesale prices, respectively during the period 2000-01 to 2014-15.

The estimate of linear trend equation revealed that the regression coefficient (B_1) associated with the time element (T) was positive and highly significant at 1 percent level of significance for all the markets. The value of regression coefficient for time was estimated to be highest for Shridungargarh (6.328). Bikaner recorded the lowest value of regression coefficient for time (5.701). The estimates of the coefficient of determination (R^2) ranged from 0.712 to 0.600 indicating that the time element alone explained 71.20 percent to 60.0 percent variation in wholesale prices of guar in selected markets during the study period. The highly significant values of calculated F statistic also justified the findings that time element was a significant explanatory factor of the variation in wholesale prices of guar in the district during study period. The durbin- Watson test (d statistic) for autocorrelation revealed the absence of autocorrelation among the estimated residual in all the markets as well as whole district.

The results of seasonal indices displayed that price of guar remained at the lowest during the month of December in all the markets. Highest seasonal indices in Bikaner in the month of April and in Nokha markets highest seasonal indices in the month of July and in case of Shridungargarh highest seasonal indices were in the month of June. After reaching the peak in the month of July, the seasonal price indices started and continued to decline up to the month of December. Thereafter, it continuously increased up to the month of July. Such movements of seasonal price indices were observed for all the selected markets.

The extent of intra year price rise (IPR) varied from 11.26 percent in Nokha market to 14.78 in shri dungargarh market.

The results of coefficient of average seasonal price variation were in agreement with that of the coefficient of variation (C.V.). The coefficient of variation for all the selected markets ranged from 3.32 per cent to 4.89 per cent. The smaller magnitude of C.V. revealed that there was greater consistency or smaller variability in the monthly prices of guar in the selected markets of the district.

The study of the economics of processing of guar into guar gum revealed that both the guar processing plants under study were operating at far below their intake capacity. Interest on term loan, and taxes and insurance charges were the main components of the total fixed cost for both the plants. Other important fixed cost components were salary of permanent staff and depreciation of the plant. Important variable cost items were sales tax, electricity charges, fuel charges, packing charges, repair and maintenance charges and the temporary labour charges. For medium size plant, fixed and variable costs accounted for 18.46 and 81.54 per cent of the total costs, respectively. Whereas, for large size plant, fixed and variable costs accounted for 25.25 and 74.75 per cent of the total cost, respectively. The total processing costs (excluding the cost of raw material) for medium and large size plants have been amounted Rs 193.17 and 232.39 per quintal of guar seed, respectively. The recovery of guar gum and churi for both the plants were 28 per cent and 68 per cent, respectively in processing of guar seeds. The medium size guar processing plant incurred a profit or Rs 38.83 per quintal where as, the large size plant incurred a profit of Rs 58.61 per quintal of guar seed during 2014-15.

Results of opinion survey under taken to know the problems faced by the processors in production and marketing of guar gum revealed that,

lack of high viscosity contain varieties and high yielding varieties. Lack of transport facility for processed product from processing point to port of export. Processors also faced technical problem like lack of certification laboratories at processing centre. Poor linkage of buyers to and development of value added product of gum for use in different industries.

5.2 Conclusions

Following conclusion may be drawn on the basis of the study results:

1. The compound growth rates of area, production and productivity were 7.76, 15.54 and 7.22 respectively in the Rajasthan state during the period of 2000-01 to 2014-15.
2. The compound growth rates of area, production and productivity were 15.95, 21.45 and 4.74 respectively in the Bikaner district during the period of 2000-01 to 2014-15.
3. The compound growth rates in wholesale prices of guar were positively increasing during study period 2000-01 to 2014-15.
4. Annual wholesale prices of the crop exhibited significant linear trend in all selected markets and the district as a whole. The time element alone explained 60.0 per cent 71.20 per cent variation in annual wholesale prices in the selected markets.
5. Seasonal indices revealed that guar prices remained of the lowest in the month of December and at the highest in the month of April in Bikaner market. In Nokha and Shridungargarh markets highest prices were observed in the months of July and June, respectively.
6. The extent of intra year price rise (IPR) varied from 11.26 per cent in Nokha market to 14.78 in Shridungargarh market. The smaller magnitude of CV (3.32 per cent to 4.89 per cent) indicated that there

was greater consistency in the monthly prices of guar in the selected markets of the district.

7. Both the medium size and large size guar processing plants under study were operating at far below their intake capacity.
8. For medium size plant, fixed and variable costs accounted 18.46 and 81.54 per cent of the total costs, respectively. Whereas, in case of large size plant, fixed and variable costs accounted for 25.25 and 74.75 per cent of the total costs, respectively.
9. The total processing costs (excluding the cost of raw material) for medium and large size plants worked out to be Rs. 193.17 and Rs. 232.39 per quintal of guar seed, respectively.
10. The medium size guar processing plant incurred a profit of Rs. 38.83 per quintal where as, the large size plant incurred a profit of Rs. 58.61 per quintal of guar seed during 2014-15.
11. Processors reported to have the most important problems of lack of high viscosity varieties. Lack of transport facility for processed product from point of production to port of export.

5.3 Requirement/recommendation:-

(1) Guar is the principal kharif season crop of the state. The crop has not been included in the minimum support price programme so far, keeping in view multifarious uses and variation in price. It should be brought under the scheme of administered prices.

(2) The requirement of the processors 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.

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Processing and Marketing of Guar (*Cyamopsis tetragonoloba*) in Bikaner District of Rajasthan

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Abstract

Guar or cluster bean (*cyamopsis tetragonoloba*) is believed to have originated from Africa. India is the largest guar producing country in the world. In India, Rajasthan is the major guar producing state, It occupies 80 per cent of area and 70 per cent of production of the country. In Rajasthan guar is mainly grown in Bikaner, Barmer, Churu, Sriganganagar, Nagaur, Jalore, Sikar, Jaisalmer, Jaipur, Jhunjhunu and Alwar district. The present investigation was conducted with the objectives to study the growth rates in area, production and productivity in Bikaner district and Rajasthan and price behaviour of guar in Bikaner district and estimate economics of processing of guar seed into guar gum and problems faced by the guar gum processors. Compound growth rates were estimated by using the exponential function of the form $Y= ab^T$. The respective growth rates of area, production and productivity were estimated to be 15.95, 21.45, 4.74 per cent in Bikaner and 7.76, 15.54, 7.22 per cent in Rajasthan. The study revealed that compound growth rate for whole sale prices (14.19 per cent to 14.42 per cent) was highly significant in the selected markets. The regression coefficient of linear trend for wholesale prices was highly significant for all markets under study. It was observed that time element alone explained 60.0 per cent to 71.2 per cent variation in wholesale prices of crop. As regards the seasonal indices in the wholesale price, at these the lowest in the month of December and the highest in the month of April, in Bikaner district as a whole during study period. The intra year price rise was around 11.26 to 14.78 per cent. The smaller magnitude of CV revealed that there was greater consistency or smaller variability in the monthly prices of guar in the selected markets of the district. Total processing costs of guar into guar gum (excluding the cost of raw material) for medium and large size industry worked out to be ₹ 193.17 and ₹ 232.39 per quintal, respectively. Both medium and large size guar processing plants incurred a profit of ₹ 38.83 and ₹ 58.61 per quintal, respectively during the year 2014-15. Results of opinion survey undertaken to know the problem faced by the processors in production and marketing of guar gum revealed that, lack of high viscosity contain varieties and lack of transport facility for processed product from processing point to port of export.

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राजस्थान के बीकानेर जिले में ग्वार (*साइमोप्सिस टेट्रागोनोलोबा*) का प्रसंस्करण और विपणन

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अनुक्षेपण

ग्वार या क्लस्टर बीन का उदभव अफ्रीका से हुआ माना जाता है भारत दूनिया में सबसे बड़ा ग्वार उत्पादक देश हैं राजस्थान में ग्वार मुख्य रूप से बीकानेर, बाड़मेर, चूरू, श्रीगंगानगर, नागौर, जालौर, सीकर, जैसलमेर, जयपुर, झुझुन्नू और अलवर जिलों में उगाया जाता है।

प्रस्तुत अन्वेषण राजस्थान राज्य में ग्वार की कीमत व्यवहार का अध्ययन करना, क्षेत्र, उतपादन व उत्पादकता में वृद्वि का अध्ययन करना और ग्वार के बीजो का प्रसंस्करण के लागत व्यवहार का अध्ययन करना तथा ग्वार गम कों प्रसंस्करण करने मे सामने आने वाली समस्याओं का अध्ययन करना।

चक्रवृद्वि दर का आंकलन $Y= ab^T$ प्रकार के चर घातांकी फलन का उपयोग करके किया गया। अध्ययन अवधि 2000–01 से 2014–15 के दौरान राजस्थान में क्षेत्र, उत्पादन व उत्पादकता में वृद्वि क्रमश : 15.95, 21.45 तथा 4.74 प्रतिशत रही। वही बीकानेर में इस अवधि में क्षेत्र, उत्पादन वउत्पादकता में वृद्वि दर क्रमशः 7.76, 15.54, 7.22 रही।

अध्ययन के परिणामों ने यह दर्शाया की चयनित बाजारों में वृद्वि की चक्रवृद्वि दर थोक कीमत (14.19 से 14.42 प्रतिशत) में अत्यधिक रूप से सार्थक थी।

रैखिक प्रवणता के समाश्रयण गुणांक सभी चयनित जिलो में थोक कीमत के लिए अत्यधिक सार्थक थे। ऐसा देखा गया कि अकेले समय तत्व ने फसल की थोक कीमत में 60.0 प्रतिशत से 71.20 प्रतिशत विचरण को प्रकट किया।

जहॉ तक बीकानेर जिले में अध्ययन काल के दौरान ग्वार की थोक कीमत में मौसमी प्रतिमान की बात है ये दिसम्बर के महिने में सबसे कम एवं अप्रेल में सबसे अधिक पाये गये। अध्ययन के क्षेत्र में अन्तः किमत बढ़ोतरी 11.26 से 14.78 प्रतिशत लगभग थी। विचरण गूणांक के अल्प परिणाम ने यह दर्शाया कि संभाग के चयनित बाजारों में ग्वार की मासिक कीमतों में स्थिरता अधिक तथा अस्थिरता कम थी।

मध्यम तथा बडे आकार के संयेत्रों में ग्वार के ग्वार गोंद में प्रसंस्करण की कुल लागत (कच्चे माल की लागत निकालकर) क्रमशः 193.17 व 232.39 रूपये प्रति क्विटल पायी गइ। वर्ष 2014–15 में मध्यम व बड़ें दोनों आकार के ग्वार प्रसंस्करण संयेत्रों में क्रमशः 38.83 और 58.61 लाभ पाया गया।

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Appendix - I

Indices of seasonal price variation of guar in Bikaner district (2001-02 to 2002-03)

S.No.	Months	Bikaner	Nokha	Shridunagargarh
1	January	100.73	100.9	98.31
2	February	104.54	98.03	104.73
3	March	96.99	100.13	99.39
4	April	96.59	102.88	102.08
5	May	105.68	103.45	106.07
6	June	101.59	103.95	106.12
7	July	103.14	104.86	101.69
8	August	91.92	104.01	94.4
9	September	91.27	103.89	92.78
10	October	97.89	83.01	95.15
11	November	104.85	96.74	104.32
12	December	104.81	98.15	94.96

Appendix - II

Indices of seasonal price variation of guar in Bikaner district (2013-14 to 2014-15)

S.No.	Months	Bikaner	Nokha	Shridunagargarh
1	January	92.80	94.01	96.51
2	February	88.00	89.01	88.90
3	March	95.83	97.13	96.58
4	April	107.35	108.88	109.07
5	May	105.23	106.45	107.04
6	June	101.69	103.95	103.47
7	July	106.80	109.18	109.09
8	August	117.78	109.91	107.81
9	September	112.03	107.89	107.69
10	October	83.04	83.01	83.33
11	November	95.17	95.74	95.61
12	December	94.28	94.83	94.89

Appendix – III

Intra year price (Wholesale) rise in guar in Bikaner district (2001-02 to 2003-04)

Markets	Lowest Seasonal price index		Highest seasonal price index		Extent of intra year price rise	Coefficient of average SPV	Coefficient of variation
	Month	Seasonal index	Month	Seasonal index			
1. Bikaner	September	91.27	May	105.68	15.78	9.52	5.26
2. Nokha	October	83.01	July	104.86	26.32	14.92	8.94
3. Shri Dungargarh	September	92.78	June	106.12	14.37	8.74	5.74

Appendix – IV

Intra year price (Wholesale) rise in guar in Bikaner district (2013-14 to 2014-15)

Markets	Lowest Seasonal price index		Highest seasonal price index		Extent of intra year price rise	Coefficient of average SPV	Coefficient of variation
	Month	Seasonal index	Month	Seasonal index			
1. Bikaner	October	83.04	August	117.78	41.84	21.81	10.22
2. Nokha	October	83.01	August	109.91	32.41	17.77	8.94
3. Shridungargarh	October	83.33	July	109.09	30.89	17.08	8.62

Appendix – V

Test of significance of change in seasonal variation in wholesale prices of guar crop between 2001-02 to 2013-14 in selected markets of Bikaner district of Rajasthan

S.No.	Markets	No. of observations	Variance of seasonal price indices for 2001-02 to 2003-04 (S_1^2)	Variance of seasonal price indices for 2013-14 to 2014-15 (S_2^2)	$F = S_2^2 / (S_1^2)$
1	Bikaner	12	27.67	104.37	0.265
2	Nokha	12	79.93	79.94	0.991
3	Shridungargarh	12	33.06	74.27	0.445

Appendix –VI

Costs and margin in medium size industry

Average number of days the plant runs in a year = 200 days
Fixed Cost (In Rupees per annum)

Particulars	**Total cost**	**Life in years**	**Junk value @ 5%**	**Net value**	**Depreciation per year**
Depreciation on buildings	2500000	50	125000	2375000	47500
Depreciation on machinery	3200000	20	160000	3040000	152000
Depreciation on accessories	200000	20	10000	190000	9500
Total					**209000**

1. Total depreciation = ₹ 209000
2. Interest on term loan @ 18%

$$= \frac{\text{(Total investment + Junk value)}}{2} \times \frac{12}{100}$$

=₹ 531000

3. Salary / wages of permanent labours =₹ 1200000
4. Taxes and insurance charges =₹ 200000

Total fixed cost =₹ 2140000

Variable cost (In per annum) :

1.	Repair and maintenance charges	=₹	150000
2.	Electricity charges	=₹	600000
3.	Labour (temp.) charges	=₹	100000
4.	Packing charges	=₹	320000
5.	Fuel (diesel) charges	=₹	450000
6.	Sales tax @ 4%	=₹	7680000
7.	Miscellanceous charges	=₹	150000
	Total variable cost	=₹	9450000

Total cost (fixed + variable) excluding the cost raw variable =₹11590000

Cost of raw material (60000 qtls @ 3200 ₹/ qtls) = ₹192000000

Total cost (including the cost of raw material) = ₹ 203590000

Receipts :

Gum recovery @ 28% = ₹ 16800

Churi recovery @ 68% = ₹ 40800

Value

Gum @ 5700 = ₹ 95760000

Churi @ 2700 = ₹ 110160000

Total receipt = ₹ 205920000

Processing margin

= 205920000 – 203590000 = ₹ 2330000

or ₹ profit ₹ 2330000

or 38.83 ₹/ qtls

Appendix -VII
Costs and margin in big size industry

Average number of days the plant runs in a year = 200 days
Fixed Cost (In ₹ per annum)

Particulars	Total cost	Life in years	Junk value @ 5%	Net value	Depreciation per year
Depreciation on buildings	7000000	50	350000	6650000	133000
Depreciation on machinery	9000000	20	450000	8550000	427500
Depreciation on accessories	500000	20	25000	475000	23750
Total					**584250**

3. Total depreciation = ₹ 584250

4. Interest on term loan @ 18%

$$= \frac{(\text{Total investment} + \text{Junk value})}{2} \times \frac{18}{100}$$

= ₹1485000

3. Salary / wages of permanent labours = ₹ 2400000
4. Taxes and insurance charges = ₹ 600000

Total fixed cost = ₹ 5069250

Variable cost (In Rupees per annum)

1. Repair and maintenance charges = ₹ 35000
2. Electricity charges = ₹ 1500000
3. Labour (temp.) charges = ₹ 200000
4. Packing charges = ₹ 600000

5.	Fuel (diesel) charges	=	₹ 1000000
6.	Sales tax @ 4%	=	₹ 11059200
7.	Miscellanceous charges	=	₹ 300000
	Total variable cost	=	₹ 15009200

Total cost (fixed + variable) excluding the cost raw variable =₹ 20078450

Cost of raw material (86400 qtls @ 3200 ₹/ qtls) = ₹ 276480000

Total cost including the cost of raw material = ₹ 296558450

Receipts :

Gum recovery @ 28%	=	₹ 24192
Churi recovery @ 68%	=	₹ 58752
Value		
Gum @ 5900	=	₹ 142732800
Churi @ 2700	=	₹ 158630400
Total receipt	**=**	₹ **301363200**

Processing margin

= 301363200 – 296558450 =₹ 4804750

or ₹ profit 4804750

or 58.61 ₹/ qtls