An Economic Analysis of Sorghum (*Sorghum bicolor*) Cultivation in Bhilwara district of Rajasthan

jktLFkku ds HkhyokM+k ftys esa Tokj ¼*lksjxe ckbdksyj*½ dh [ksrh dk ,d vkfFkZd fo'ys"k.k

SITHA PATEL B

Thesis

Master of Science in Agriculture

(Agricultural Economics)

2019

DEPARTMENT OF AGRICULTURAL ECONOMICS & MANAGEMENT

RAJASTHAN COLLEGE OF AGRICULTURE

MAHARANA PRATAP UNIVERSITY OF AGRICULTURE AND TECHNOLOGY

UDAIPUR (RAJASTHAN)

An Economic Analysis of Sorghum (*Sorghum bicolor*) Cultivation in Bhilwara district of Rajasthan

jktLFkku ds HkhyokM+k ftys esa Tokj ¼*lksjxe ckbdksyj*½ dh [ksrh dk ,d vkfFkZd fo'ys"k.k

Thesis

Submitted to

Maharana Pratap University of Agriculture and Technology, Udaipur

in partial fulfillment of the requirements for the Degree of

Master of Science in Agriculture

(Agricultural Economics)

BY

SITHA PATEL B

2019

Maharana Pratap University of Agriculture and Technology
Rajasthan College of Agriculture, Udaipur

CERTIFICATE-I

Dated: / / 2019

This is to certify that **Miss. Sitha Patel B** has successfully completed the comprehensive examination held on / /2019 as required under the regulation for the degree of **Master of Science in Agriculture (Agricultural Economics)**.

(Dr. Hari Singh)
Assistant Professor and Incharge Head
Department of Agricultural Economics
& Management
Rajasthan College of Agriculture
Udaipur (Rajasthan)

Maharana Pratap University of Agriculture and Technology
Rajasthan College of Agriculture, Udaipur

CERTIFICATE-II

Dated: …/ …/ 2019

This is to certify that the thesis entitled **"An Economic Analysis of Sorghum (*Sorghum bicolor*) Cultivation in Bhilwara district of Rajasthan"** submitted for the degree of **Master of Science in Agriculture** in the subject of **Agricultural Economics**, embodies bonafide research work carried out by **Miss. Sitha Patel B** 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 this thesis was approved by the advisory committee on / /2019.

(Dr. Hari Singh)
Assistant Professor and Incharge Head
Department of Agricultural Economics
& Management
Rajasthan College of Agriculture
MPUAT, Udaipur

(Dr. G.L. Meena)
Major Advisor

(Dr. Arunabh Joshi)
Dean
Rajasthan College of Agriculture
Udaipur (Rajasthan)

Maharana Pratap University of Agriculture and Technology, Udaipur
Rajasthan College of Agriculture, Udaipur

CERTIFICATE-III

Dated: …/ …/ 2019

This is to certify that the thesis entitled,**" An Economic Analysis of Sorghum (*Sorghum bicolor*) Cultivation in Bhilwara district of Rajasthan"** submitted by **Miss. Sitha Patel B** to Maharana Pratap University of Agriculture and Technology, Udaipur in partial fulfillment of the requirements for the degree of **Master of Science in Agriculture** in the subject of **Agricultural Economics** after recommendation by the External Examiner was defended by the candidate before the following members of the Examination Committee. The performance of the candidate in the oral examination of her thesis has been satisfactory; we therefore, recommend that the thesis be approved.

(Dr. G.L. Meena)
Major Advisor

(Dr. Latika Sharma)
Advisor

(Dr. H.K. Jain)
Advisor

(Dr. Shalini Pilania)
DRI, Nominee

(Dr. Hari Singh)
Assistant Professor and Incharge Head
Department of Agricultural Economics
& Management
Rajasthan College of Agriculture
MPUAT, Udaipur

(Dr. Arunabh Joshi)
Dean
R.C.A., Udaipur (Rajasthan)

Approved

(Dr. B.P. Nandwana)
Director Resident Instructions
Maharana Pratap University of Agriculture and Technology,
Udaipur (Rajasthan)

Maharana Pratap University of Agriculture and Technology
Rajasthan College of Agriculture, Udaipur

CERTIFICATE-IV

Dated: / / 2019

This is to certify that **Miss. Sitha Patel B** student of **Master of Science in Agriculture, Department of Agricultural Economics**, Rajasthan College of Agriculture, Udaipur has made all corrections/modifications in thesis entitled, **"An Economic Analysis of Sorghum (*Sorghum bicolor*) Cultivation in Bhilwara district of Rajasthan"** which were suggested by the External Examiner and the Advisory Committee in the oral examination held on / /2019. The final copies of the thesis duly bound and corrected submitted on / / 2019.

(Dr. Hari Singh)
Assistant Professor and Incharge Head
Department of Agricultural Economics
& Management
Rajasthan College of Agriculture
MPUAT, Udaipur

(Dr. G.L. Meena)
Major Advisor

ACKNOWLEDGEMENT

I humble place before the throne of the Almighty, my most sincere gratitude. His grace and tender mercies have renewed me everyday, all the way on the journey through my life.

I would like to convey my deep sense of gratitude to my beloved parents, ***Mr. Budha Ram Patel*** *and* ***Mrs. Hanja Devi*** *for their never ending love, affection, support and encouragement throughout my life and study period. I am indebted to my brother* ***Dinesh Patel*** *and Sisters* ***Sugantha*** *and* ***Kelki*** *for their love and affection towards me. This work is a gift to my beloved parents and family.*

With immense pleasure and deep respect, I express my heartfelt gratitude to my respected major advisor ***Dr. G. L. Meena****, Assitt. Prof., Dept. of Agricultural Economics and Management, RCA, Udaipur for his excellent guidance, constant support, close counsel and valuable suggestions throughout the period of my study. His enthusiasm, interest, concern, perfection and constructive criticism have always aroused my spirits to do more, to achieve higher.*

I am overwhelmed with sincere feeling of indebtedness to the members of my advisory committee, minor advisor ***Dr. Latika Sharma****, Assitt. Prof.,* ***Dr. H. K. Jain****, Professor and* ***Dr. Shalini Pilania****, Assitt. Prof. and DRI Nominee for unceasing interest and constructive efforts during the entire period of investigation.*

I express my sincere thanks to ***Dr. S.S. Burark****, Emeritus Prof. and* ***Dr. Hari Singh****, Assitt. Prof. and Incharge Head, Dept. of Agricultural Economics for being lighthouses in this hard journey.*

I wish to express my cordial thanks to ***Sri. G.D. Vyas, Sri. C.P. Singh, Sri. Bansi Lal,*** *agriculture supervisors and other officials for their support and help during data collection.*

I place my thanks to ***Prof. Arunabh Joshi****, Dean, RCA, Udaipur for providing necessary facilities required in conducting the present investigation.*

A special of thanks to my dear seniors, ***Anju Yadav****,* ***Shailza****,* ***Kailash Chand Bairwa****,* ***Arjun Singh Rajput****, and* ***Tanuja*** *for their soothing love and care.*

I use this opportunity to sincerely thank my dearest classmates ***Sarla Meena****,* ***Lalchand Yadav*** *and* ***Rajesh Choudhary*** *for making the two year study very much enjoyable.*

A personal note of gratitude to my lovable friends ***Vinayak V Savanoor****,* ***Sanjana Santosh Shet****,* ***Suresh Babu****,* ***Sindhu Reddy****,* ***Radhika****,* ***Priyanka Choudhary****,* ***Pooja Khoraniya****,* ***Keerti*** *and* ***Monica Jat*** *for their moral support, encouragement and valuable help.*

I also thank my caring junior friends ***Kavya, Shalini, Nesara*** *and* ***Akash*** *for their kind co-operation.*

I express my sincere thanks to all the staff members of the Dept. of Agricultural Economics and Management and to all the faculty members of Student Section for providing necessary help whenever required.

Any omission in this brief acknowledgement does not mean lack of gratitude.

Place: Udaipur
Date: / /2019 ***(Sitha Patel B)***

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1. INTRODUCTION

Sorghum (*Sorghum bicolor*) is the 5th most important cereal crop of the world. Many poor people in the semi-arid tropics (SAT) of Asia and Africa largely depends on sorghum as the staple food. In addition, the fodder and stover is fed to millions of animals providing milk and meat for human. It is also used as industrial raw material in various agro based industries.

Sorghum ranks third in the major food grain crops of India. It has potential to compete effectively with maize crop under good environment and management conditions. The greatest merit with sorghum is that it has capacity to withstand drought. Its performance is better than maize in marginal lands under moisture stress or excessive conditions. It is one of the most widely grown dryland crop in India. It does well even in low rainfall areas. It makes comparatively quick growth and gives not only good yields of grain but also very large quantities of fodder.

Sorghum grain eaten by human beings in India either by breaking the grain and cooking it in the same way as rice or by grinding it into flour and preparing '*chapattis*'. To some extent, it is also eaten as parched and popped grain. The grain is also fed to cattle, poultry and swine. Sorghum grain contains about 10-12 % protein, 3 % fat and 70 % carbohydrates. Therefore, it can satisfactorily replace other grains in the feeding programme for dairy cattle, poultry and swine.

Cultivated sorghum probably originated in East Central Africa, in or near Ethiopia or Sudan because of the great diversity of types growing in that region and it reached India in 1500 B.C. Being a short-day C4 plant and its easy adaptability to hot and dry agro-ecologies, it has become a climate change-compliant crop hence considered as 'Camel of Desert' for its capacity to withstand drought. Sorghum cultivation is said to be ecologically sustainable as comparatively lesser magnitude purchased inputs are used in its cultivation. Besides grain, it is an important source of feed, fodder and bio-fuel. In India, it is commonly known as *Jowar*. Sorghum is cultivated as staple food for the people of Rajasthan, Maharashtra, Karnataka,

Gujarat etc. It is cultivated mostly as fodder crop in Haryana, Punjab and Western UP.

It is grown in both the *monsoon* and *winter* season and too little extent in summer under irrigation condition. It is grown both in Northern and Southern parts of India during *kharif* season and while mainly cultivated during *rabi* season in the deccan plateau of Southern India. It is grown in *rabi* season on black swelling and shrinking soils where high amount of rainfall is received during the monsoon months of September and October.

The utilization of *kharif* sorghum grain as a raw material in various agro-based industries is increasing, given the limited prospects of rainy season (*kharif*) sorghum for human consumption. Post-rainy season sorghum is a highly valued food grain and too expensive to be used as industrial raw material. The mainly poultry feed, animal feed, alcohol distilleries and starch industries are currently using sorghum in India. Some species of sorghum can contain high levels of hydrogen cyanide, hordenine and nitrates in the early stages of the plants' growth, which are lethal to grazing animals.

The total area under sorghum cultivation in world was 44.29 million hectares with production of 63.37 million metric tonnes and yield of sorghum was 1430 kg/ha. in 2016-17 (FAS reports and databases, world agricultural production, USDA). Among the sorghum growing countries, India ranks first in acreage but second in production, the USA being the largest producer in the world. The other important sorghum growing countries are China, Nigeria, Sudan and Argentina.

Total area under sorghum cultivation in India was 5.65 million hectares with production of 4.41 million tonnes and the average productivity was 780 Kg/ ha in 2015-16. The area under sorghum in Rajasthan was 0.63 million hectares (11.15 % to all India sorghum area) with a production of 0.34 million tonnes (7.71 % to all India sorghum production) and productivity was 545 Kg/ha in 2015-16. Maharashtra, Andhra Pradesh, Karnataka, Madhya Pradesh, Gujarat, Tamil Nadu, Rajasthan and Uttar Pradesh are the important sorghum growing states. Among all states of India, Rajasthan stands third position with respect to area and fifth position with respect to production (Agriculture Statistics at a Glance-2016, 4th Advance Estimates, DES, GOI).

Total area under sorghum cultivation in Bhilwara was 43047 hectares with production of 12081 metric tonnes and productivity was 281 Kg/ha in 2015-16 (Agriculture Statistics at Glance- 2015-16, DES, GOR).

Rationale of the study

Growth in area, production, and productivity of sorghum crop plays an important role in understanding changes over the years in any region or state. Identifying trend in itself is a great informative work because it provides the historical background of how sorghum cultivation influenced the life of farmers either in positive or negative way through which we will get to know when there was highest and lowest area, production and productivity under sorghum cultivation. As we all know that our farmers' conditions are so pathetic nowadays hence this information may help policymakers in framing new measures regarding area, production and productivity of sorghum in future days. Hence, it is important to find out growth in area, production and productivity of sorghum crop in study area.

Production cost, at given level of prices, plays an important role in portraying economic viability of sorghum cultivation. It is a critical economic indicator for sorghum growers, consumers and policy makers in order to provide an effective linkage between the sorghum producers and consumers for fixing the price of sorghum rationally. Generally, a sorghum grower or farmer can increase his income in two ways either by increasing the sorghum productivity or by reducing per unit cost of sorghum production. Cost of sorghum cultivation often becomes a policy issue, when sorghum producers complain that the price of sorghum crop they are getting does not even cover cost of cultivation of sorghum. Therefore, an attempt was made in the present study to estimate the cost and returns of sorghum production.

Sorghum production is governed by number of controllable and uncontrollable factors. Controllable factors are seed, fertilizer, pesticide, human labour, machine labour, irrigation etc. while uncontrollable factors are sunlight, climate, rain, temperature, humidity, wind etc. The present study is confined to controllable factors. It is important to know that which factors have most impact on sorghum output. Hence, it is necessary to study the relationship between physical input and output.

Department of Agriculture, Government of Rajasthan and KVK, Bhilwara were working in study area which provide various facilities in time to time and also give advice to sorghum farmers, still many of farmers were facing the various constraints related to inputs, production and marketing of sorghum etc. It helps researchers, extension agencies and governmental agencies to frame a good policy for this crop. Therefore, an effort was made in the present research study to identify the various problems faced by sorghum growing households.

Though, several studies regarding economic analysis of sorghum cultivation in different parts of country have been carried out by the researchers. Yet, no concerted efforts have so far been made on the economics of sorghum cultivation in general in Rajasthan and in particular in Bhilwara district of Rajasthan, especially with reference to various important economic parameters like cost and return, growth in area, production and productivity, various factors affecting sorghum output and various production, marketing and Minimum Support Price (MSP) constraints faced by sorghum growers.

In view of the overwhelming importance of the sorghum cultivation under crop sector in devising the rural economy of Rajasthan, a research study entitled **"Economic Analysis of Sorghum (*Sorghum bicolor*) Cultivation in Bhilwara district of Rajasthan"** was undertaken with the below mentioned specific objectives:

1. To study the growth in area, production and productivity of sorghum.
2. To work out the cost and returns of sorghum cultivation.
3. To examine input-output relationship, and
4. To identify the constraints faced by sorghum growers.

Limitations of study

The study is based on the micro level data obtained from very few sorghum growers of Bhilwara district for the year 2018-19. Hence, the findings of the study may not be generalized and result may not be equally applicable to the entire region or state. The data collected was on the basis of respondent's memory because they do not maintain any farm records and hence presence of memory bias should not be

ignored, due to the limitation of time and resources in hand, it would not be possible to cover a fairly large area for the purpose of investigation. Therefore, only a very limited number of 60 respondents are covered for detailed study to arrive at meaningful conclusions.

Plan of the thesis

The present study is presented under the following chapters:

1. Introduction: Problem statements along with the specific objectives are stated.
2. Review of Literature: Some relevant research studies are discussed.
3. Research Methodology: It deals with the highlights of the study area, sampling procedure, data collection methods and analytical tools and techniques.
4. Results and Discussion: The results of the study along with their interpretations have been presented in the form of tables.
5. Summary and conclusions: Whole study has been summarized with its main findings and related policy implications.
6. References: The list of the referred sources has been presented in this chapter. At the end of thesis, abstract (English and Hindi) and appendices are presented.

2. REVIEW OF LITERATURE

A brief knowledge about review of literature is crucially important for any research endeavor. It helps in developing a better understanding about the topic. Attempts have been made here to review briefly the specific and relevant literature, which has direct or indirect bearing on the objectives of the present study. Accordingly, relevant literature of various cereal crops has been reviewed and presented in chronological order under following sub-heads

2.1 Growth of area, production and productivity

2.2 Costs and returns

2.3 Input output relationship

2.4 Constraints faced by growers

2.1 Growth of area, production and productivity

Shankaran (1994) conducted study on prospects for coarse grains in India. The study period was divided into before-green revolution (1950-51 to 1964-65) and after-green revolution (1967-68 to 1992-93) period. In first sub-period both area and productivity of sorghum crop had increased at the rate of 0.91 % and 2.9 % per annum, respectively due to which production of sorghum increased at the rate of 2.2 % per annum. The results further showed that the area under sorghum crop decreased by 0.94 % per annum during the post-green revolution period, whereas it grew up to 1.84 %, which neutralized the decline in area and finally the rate of growth in production of sorghum crop was observed to be 1.2 % per annum. By noticing the entire period (1950-51 to 1992-93), it was found that the area under sorghum crop decreased by 0.47 % per annum while production and productivity increased at the rate of 1.51 % and 1.27 % per annum, respectively.

Hiremath *et al.* (1996) studied the economics of pulse production present status and future strategies in Karnataka for the period 1984-85 to 1993-94 for important pulse crops. The CAGR in area under redgram crop decreased slowly (0.06%) over the long period from 1984 to 1994 where as in other pulse crops it

showed increasing trend. The area under blackgram pulse crop showed the highest CAGR of 6.51 % followed by greengram (5.40%) and bengalgram (1.12%). With respect to production, blackgram registered a higher growth rate (12.15%) followed by greengram (2.23%). Production of bengalgram and redgram decreased over a period of time by 1.31 % and 1.57 % respectively. With respect to productivity, blackgram showed the highest growth rate (5.50%) followed by greengram (4.90%) and both were statistically significant. The growth rate of bengalgram was 0.38 % and that of redgram was 3.25 %.

Vani and Vasulu (1996) studied the growth, variability and instability of three major cereal crops in Karnataka. The cereal crops were namely rice, jowar and ragi in the three sub- periods 1955-56 to 1964-65, 1965-66 to 1979-80 and 1980-81 to 1989-90. The results indicated that, in the case of rice there was a positive growth rate in the production and yield over the entire period and a negative growth rate in area. In case of ragi, the growth rate of production was higher than that of rice. A positive growth rate in area and production over the entire period with the highest growth in the second sub period was reported. In the case of jowar, there was a high growth rate in area and production in most of the districts. Productivity in most of the districts was high in the second period compared to the first and third sub periods.

Dingar *et al.* (1998) studied the production performance of pulses in Uttar Pradesh and observed that the production of pulses in Uttar Pradesh had been declining, due to lower area of these crops, and to their production on marginal and sub-marginal land. Production of pulses as a group in the state declined during 1969-78 at the rate of -3.21 %, but increased at the rate of 0.18 % during 1980-93. Production of chickpea (*Cicer arietinum*) and pea (*Pisum sativum*) decreased at the rate of -3.81 % and -9.47 %, respectively, whereas pigeon pea (*Cajanus cajan*) and lentil (*Lens culinaris*) increased, respectively at the rate of 0.94 % and 2.45 % from 1969 to 1978. Lentil production increased at a CAGR of 7.06 % in 1980-93, and pea production by 5.95 %, whereas chickpea production continued to decline.

Basavaraja *et al.* (2005) studied economics of *kharif* sorghum crop in Karnataka state and revealed that the area under *kharif* sorghum crop had decreased during 1970-71 and 1997-98. The reduction during the study period in *kharif* sorghum area was mainly due to the diversion of *kharif* sorghum crop area to more

remunerative crops like pulses, peanut and cotton. The main reasons for the substitution of *kharif* sorghum by other remunerative crops were not favorable prices, decreasing yields, no sufficient credit and unfavourable climatic conditions.

Tingre *et al.* (2009) examined changes in cropping pattern and the trend in crop diversification in Amravati district of Vidarbha. The study was based on secondary data collected from various Government publications and pertains to a period of 30 years i.e. from 1970-71 to 2000-2001. The CAGR of area, production and productivity of major crops were estimated for two sub-periods. The first period was 1970-71 to 1985-86 (Period I) and second period was 1986-87 to 2001-02 (Period II). Production growth rate in majority of the cereal crops increased significantly and higher during period I as compared to period II. Gram and other pulses recorded significant positive growth rate of productivity during period I, while rice and other cereals recorded growth of 3.51 % and 5.04 %, respectively during period II.

Acharya *et al.* (2012) conducted a study on growth in the area, production and productivity of majorily growing crops in Karnataka state by using the compound growth function. The necessary secondary data were collected for a period of 26 years from 1982-83 to 2007-08. Growth rate showed a significant positive growth in area under pulses, vegetables and spices and fresh fruits and nuts while for cereals growth rate showed significant and negative growth. Similarly, the total production of cereals, pulses, fruits and vegetables found to be significant and showed positive growth. The productivity of different crops showed significant growth in case of fruits, cereals and pulses.

Maikasuwa and Ala (2013) conducted a study to estimate growth rate in area and productivity of sorghum crop in Sokoto, Nigeria from 1993 to 2012. Exponential trend equations were fitted to area and productivity to examine their patterns of growth. The results of the research study revealed that the compound growth rate for area under sorghum crop was found to be negative (-0.015) and significant ($P<0.05$) and for the productivity it was positive (0.035) and significant ($P<0.01$). However, the quadratic time term indicated a stagnated growth in area and an accelerated growth in productivity.

Ahmad *et al.* (2015) conducted a study to examine trends in area, production and yield of cereals in India as well Nigeria from period 1982-2012. The secondary

data collected from the FAO STAT data base for the period and were used for the study. The average area, production and productivity in India under cereals was 99,787,727.63 ha, 215,096,746.9 tonnes and 2.156 tonnes/ha respectively and from Nigeria was 77,547,885 ha, 101,037,721 tonnes and 1.30 tonnes/ha for area, production and productivity, respectively. The computed growth trend for cereals in India was negative (-0.0750) and significant (P-0.01), for area and production, it was positive (0.84) and significant (P-0.01) and for productivity also positive (0.94) and significant (P-0.01). However, from Nigeria the computed growth were positive (1.056), (1.247) and (0.189) and significant for area, production and productivity, respectively. Although higher productivities were recorded in India for rice, wheat and maize than Nigeria except millet and sorghum.

Ayalew and Sekar (2016) conducted study on trends, instability and regional variations of maize production in major producing states of India. Compounded Annual Growth Rate (CAGR), Cuddy Della Valley Index (CDVI), and decomposition analysis were used to examine the data ranging from 1980 to 1981 and 2011 to 2012. The study revealed that area under maize in India has increased from 5.89 to 9.19 million hectare and production has increased from 6.49 to 21 million tonnes between the period TE 1981 to 1982 and TE 2011 to 2012. Such increase in production of maize has been possible mainly due to increase in yield from 1,100 to 2,279 kg/ha. For all India, area has expanded at 1.88 % per annum between 1982 to 1983 and 2011 to 2012, while yield increase at a rate of 2.28 % per year in the same period. As a result, production of maize has risen by 4.2 % per annum. The area expansion of maize was the highest in Maharashtra (9.19 %) followed by Karnataka (7.98 %). Production increase of maize was also the highest in Maharashtra (12.24 %), which was followed by Karnataka (8.48 %) and Andhra Pradesh (8.68 %). The growth of yield in Andhra Pradesh was the highest (3.99 %) followed by Maharashtra (2.80 %).

Yadav and Kalola (2016) studied growth and trends in area, production and productivity of sorghum and bajra crops in middle Gujarat zone. The growth in the area, production and productivity of sorghum and bajra crops was estimated by using different linear, nonlinear and time series (ARIMA) models. A data from 1960-61 to 2012-13 on area, production and yield of sorghum and bajra crops for middle Gujarat zone was considered for study. In case of polynomial models, exponential and linear model was found fitted for the productivity trends of sorghum and bajra crop,

respectively. In case of ARIMA models, ARIMA (0, 1, 1) was evolved as the best fitted trend functions for productivity trends of both the crops. None of the model was found fitted for the trends in area and production of sorghum as well as bajra crop. Productivity of sorghum was witnessed of technological and varietal improvement as it had positive and significant growth rate of 5.93 % per annum with decreasing area (-7.96 % per annum) and production (-3.17 % per annum). The area of bajra crop also have negative growth rate of -1.83 % per annum, but the production had positive growth rate of 2.80 % due to improvement in productivity by 4.95 % per annum.

Pavithra *et al.* (2018) examined growth rate in area, production and productivity of food grains in Karnataka state and results revealed significant and positive growth rate in case of both cereals and pulses. In case of cereals, the highest positive Compound Annual Growth Rate (CAGR) was observed in area and production of maize. The growth of area, production and productivity of paddy and sorghum were found to be non-significant. Among the pulses, chickpea and pigeon pea exhibited a significant positive growth rate in case of area, production and productivity. Field bean showed significant positive growth in case of production and productivity. Horse gram, black gram and green gram were found to be non-significant.

Based on above studies, few generalized conclusions can be drawn as under:

- In general the annual growth rate in area and productivity of a crop had a significant impact on the growth of production of respective crop in different parts of the country.
- The fluctuating trend was observed in area, production and productivity over the years.

2.2 Cost and returns

Singh (2013) examined the economics of wheat cereal crop cultivation in irrigated and unirrigated regions of Banswara district, Rajasthan. The cost of cultivation of wheat was found to be ₹ 22300.08 per hectare for irrigated condition and ₹ 14975.34 per hectare for unirrigated condition. The net return was found to be ₹ 29181.25 per hectare for irrigated condition and ₹ 12039.66 per hectare for

unirrigated condition. Results showed that wheat cultivation in irrigated condition was more remunerative than wheat cultivation in unirrigated condition.

Sureshkumar *et al*. (2014) estimated input use, cost, return and resource use efficiency of wheat in Southern parts of Gujarat. A sample of 240 Wheat farmers was selected from study area. Results showed that per hectare total cost was highest (₹ 48288.01) on large farms and lowest (₹ 41140.42) on small farms with an overall total cost of ₹ 45784.31. High cost on large farms was due to relatively more utilization of human labours, fertilizer and manure and irrigation charges as compared to other farm size groups. Another the major contributor on cost of wheat cultivation was human labour with 14.99 % of the total cost. The other per hectare expenditure were irrigation cost (13.40 %), fertilizer charges (11.79 %), managerial costs (10.00 %), tractor/ machine charges (6.38 %), seed cost (6.20 %), Bullock labour charges (4.80 %), interest on working capital (2.34 %), depreciation (2.00 %), manures and cakes (1.97 %), weedicide charges (1.47 %), interest on fixed capital (1.00 %), miscellaneous cost (0.96 %) and insecticides/pesticide cost (0.37 %). The input output ratio was found to be the lowest (1: 1.35) on small farms and the highest (1: 1.48) on large farms.

Ayalew and Sekar (2015) examined the profitability of coarse cereal production in India during TE 2010-11. The average total cost for sorghum cultivation had found to be highest in Andhra Pradesh state (₹ 15,569/ha) and found lowest in Rajasthan state (₹ 6,209/ha). Among the variable inputs, human labours was found to be highest in Maharashtra state (519 man hrs) and lowest in Rajasthan state (298 man hrs). Gross return was found to be the highest in Andhra Pradesh state (₹ 16,521/ha) and found lowest in Rajasthan state (₹6,133/ha). Net return was highest of Andhra Pradesh i.e. ₹ 952/ha. In Madhya Pradesh, sorghum production was at a loss of ₹ -1,456/ha. Total Gross return and total cost of cultivation from sorghum crop from period 1999-2000 to 2010-11 increased in both Maharashtra and Andhra Pradesh states of India, but it was mainly highest for Andhra Pradesh state. The yearly total net return from A2 increased for Andhra Pradesh (14 %) then followed by Maharashtra (3.21 %), mainly due to increase in real price of sorghum crop in Andhra Pradesh (5.89 %) state whereas there was seen lesser increase in Maharashtra (1.66 %) state.

Chowti and Basavaraja (2015) studied economics of maize production in Haveri district and found that per hectare cost of cultivation of different varieties was maximum in NK-6240 (₹ 37,494) as compared to CP-818 (₹ 34,369) and Sunny (₹36,120). In the study area, cultivation of CP-818 was found to be more profitable than the other two hybrids. Per hectare cost of maize (₹ 35,716) was high in *kharif* season compared to *rabi* season (₹ 30,157) but the BC ratio was more in *rabi* (2.28) than in *kharif* season (1.80).

Kumar and Singh (2015) studied economic analysis of scientific sorghum fodder production technology and its comparative impact on farmers' livelihood for the period of *kharif* 2011-12 to *kharif* 2012-13 in Datia, Madhya Pradesh. The total working capital was ₹ 14907.03 per hectare and total variable cost was ₹ 15354.24 which was 67.53 % of total cost. The total cost was found as ₹ 22738.20 per hectare. Thus the highest expenditure in percentage term was incurred on labour followed by manures and seed cost and draft power. On per hectare basis the average fodder production was 523.89 quintals. The average rate of green fodder was taken as ₹ 100 per quintal. It was the rate at which the farmers sell their green fodder in the market. The total value of green fodder was found as ₹ 52388. The net return was ₹ 29650.68 per hectare.

Murthy *et al.* (2015) studied cost and return structure of maize production in North Karnataka and found that total variable cost incurred per acre by medium farmers was highest followed by small farmers and marginal farmers. The cost of human labour, fertilizer, FYM, seeds and bullock labour were the items of cost with major share in the variable cost. For per acre of cultivated land cost of cultivation (COC) was ₹ 12532.78 in Dharwad and ₹ 12529.28 in Haveri and the net return were ₹ 7582.86 in Dharwad district and ₹ 7831.96 in Haveri district.

Dhomne and Raghuwanshi (2016) conducted a study on the resource use efficiency of hybrid maize production in Chhindwara district of Madhya Pradesh. It was observed that the total cost incurred in cultivation of hybrid maize on the overall farm level was ₹ 34700 per hectare which was higher in small farm (₹ 37180/ha) and lowest in large farm (₹ 32281/ha) showing the inverse relationship of the cost of cultivation with the farm size. The operational cost was estimated to be ₹ 13864, which was nearly 40 % of the total cost of cultivation and the total fixed cost was

found ₹ 9058, which accounted around 26.10 % of the total cost of cultivation. The labour cost on an average accounted to be 39.95 % of the total cost which varied from 40.31 % in small farm to 41.35 % in large farm. Among material cost, seed alone contributed to about one-tenth of the total cost which was found to be lowest in large farms (₹2700/ha) and highest being in small farms (₹ 3600/ha). Manure and fertilizer together contribution was 11.88 to 12.67 % of the total cost for different size groups. Plant- protection measure cost was around 0.44 % of the total cost.

Kumar *et al.* (2016) conducted study to analyze the economics and ecological sustainability associated with *rabi* sorghum cultivation in comparison with bengalgram crop in Bijapur district of Karnataka, The results revealed that the cost of production for per quintal of grain output was higher in bengalgram (₹ 2427/quintal) compared to *rabi* seasons sorghum crop (₹ 1834/quintal). Total net return per acre of land was found to be higher in bengalgram (₹ 1930) compared to *rabi* sorghum crop (₹ 1252). The results clearly indicated that the bengalgram was more profitable than the *rabi* sorghum. Inspite of this, *rabi* sorghum holds a prominent position in the cropping pattern of the district as it is the staple food item in the consumption basket of the population.

Kumar *et al.* (2017) conducted study to analyse the economics of sorghum seed production crop for the period *Kharif* 2010-11, *Kharif* 2011-12 and *Kharif* 2012-13 in IGFRI, Jhansi. The results showed that highest cost was incurred on harvesting and pooling of mature crop which was ₹ 4933.3 (17.28 % of total cost). The total variable cost was ₹ 19645.5 which was 68.82 % of total cost. The total cost was found as ₹ 28544.1 per hectare. The average total labour used per hectare was 84.64 man days. The total expenditure incurred on labour was ₹ 12120.28 (42.46 %) which was found as highest expenditure in total cost. The highest expenditure in percentage term was incurred on labour followed by manures, draft power and seed cost. On per hectare basis, the average quality seed production was 857 kilogram. The average rate of quality seed was ₹ 35 per kilogram. The total return was found as ₹ 51899.41 per hectare. The average net return was ₹ 22161.33 per hectare. The benefit cost ratio was found as 1.72. The cost of production of seed (when only main product quality seed only) was considered for selling was ₹ 35.11 per kilogram of seed. The cost of production of seed when both main product (quality seed only) and other by products (dry fodder, rejected seed etc.) was considered for selling was ₹ 11.18 per

kilogram of seed. Thus, it is clear from the study that seed production of sorghum was highly profitable and has wide market available for it.

Choudhri *et al*. (2018) conducted study on costs and income analysis of maize cultivation in Bahraich district of Uttar Pradesh, India. A sample of 100 respondents was chosen through purposive cum proportionate random sampling and were categorised as marginal, small and medium size group of farms. It was found that costs of cultivation of maize was highest on medium farms (₹51066.44), followed by small farms (₹49891.28) and marginal farms (₹47097.44) respectively. The overall average costs of cultivation was observed (₹48591.25) on sample farms. The major component of the cost were human labour (34.17 %), Machinery charge (18.18 %), manure and fertilizers (16.18 %), rental value of owned land (12.35 %), seed cost (5.90 %), plant protection chemicals (1.71 %) and irrigation charge (1.32 %) of the total costs of cultivation of maize crop. The total cost of cultivation per hectare was increased with the increase in farm size holdings of farmers. Costs of plant protection and irrigation were too less because the crop was not affected by insect pest and it was grown in *kharif* season. The cost increases with an increase in farm size was due to higher expenditure on human labour, seed and irrigation charges on medium size of farms, compared to small and marginal size of farm. On an average, gross income was recorded ₹61245.96 and net income came to ₹12654.71. On medium farms, gross income was highest, which was recorded ₹62974.00, followed by small farms ₹ 61920.40 and it was lowest for marginal farms ₹ 60360.00, respectively. The total net income was found highest on marginal farms (₹ 13262.56), followed by the small farms (₹ 12029.12) and lastly medium farms (₹ 11907.56) in the study area.

Based on above studies, few generalized conclusions can be drawn as under:

- Cultivation of a crop in irrigated condition was more remunerative than unirrigated conditions.
- Per hectare total cost was highest on large farms and lowest on small farms due to relatively more utilization of variable inputs; however some studies showed inverse relationship of cost of cultivation with the farm size.
- The cost of cultivation and returns were found to be different in different parts of our country and also varied from season to season.

- Various studies showed the comparison of profitability of different crops in respective study area.
- Most of the studies showed highest expenditure incurred in percentage term on seeds and labour.

2.3 Input-output relationship

Suresh and Reddy (2006) undertaken a study in the Peechi command area of Thrissur district in the Kerala state and examined the resources productivity and allocative efficiency and technical efficiency of rice (paddy) production. The elasticity coefficients for area under paddy cultivation, human labour, fertilizer and supplementary irrigation provided were 0.65, 0.55, 0.17 and 0.24, respectively. The elasticity of coefficients for fertilizers, FYM and human labours was found significant and positive.

Chapke *et al.* (2011) studied the resource-use efficiency of jowar crop production in paddy-fallows in Andhra Pradesh, India and found that regression coefficients for fertilizers, labourers and agrochemicals had positive and significant impact on sorghum output; similarly irrigation had negative and significant impact on sorghum output. Regression coefficient for seed found to be negative and non significant.

Patil and Khobarkar (2013) studied the resource use efficiency in wheat crops production of Vidharbha region of Maharasthra state in India. The results revealed that seed rate, human, machine and bullock labour and nitrogen fertilizers like urea, had elasticity of 0.46, 0.03, 0.14, 0.12 and 0.07 respectively, which were found positive and significant. It interprets that a unit increase in these resource inputs will leads to increase in wheat yield.

Sani *et al.* (2013) studied the economics of sorghum production in Bauchi Local Government Area of Bauchi State, Nigeria and found that the regression coefficients for herbicides, labour, fertilizer had positive and significant impact on sorghum output. This implies that an increase in units of the same inputs will result in increase in sorghum output but in the case of implements, it was found not to be significant. Regression coefficient of seed had negative and significant impact on sorghum output.

Sureshkumar *et al.* (2014) estimated input use, cost, return and resource use efficiency of wheat in southern regions of Gujarat state, India. The study revealed that regression co-efficients of seed rate (Kg.), Nitrogen, irrigation, human labour, number of weedings, phosphate fertilizer, F.Y.M, Bullock labour, and number of sprays were positive and statistically significant. The machine hour was non-significant because use of harvester increased the waste of grain during the cutting process.

Laxmi and Mundinamani (2015) studied the resource use efficiency of major crops in Dharwad district. Major crops grown in the district such as chickpea, cotton, paddy, soybean, maize and chilli were selected for the study. Cobb-Douglas production technique was employed. Results of the study revealed that seed, fertilizers, plant protection chemicals and machine labour were over utilized and human labour and bullock labour were underutilized by the chickpea farmers. Cobb-Douglas production function for cotton under rainfed condition revealed that seed, plant protection chemicals, human labour and bullock labour were over utilized and FYM, fertilizer and machine labour were underutilized. In case of paddy production, seed, fertilizers, FYM, bullock labour and machine labour were over utilized and human labour and plant protection chemicals were underutilized by the farmers. FYM and plant protection chemicals were underutilized and seed, fertilizers, human labour, bullock labour and machine labour were underutilized by farmers in cultivation of soybean. Resource use efficiency under rainfed chilli production revealed that seed, plant protection chemicals, bullock labour and machine labour were over utilized and FYM, fertilizer and human labour were under utilized by the farmers.

Dhomne and Raghuwanshi (2016) conducted a study on the resource use efficiency of hybrid maize production in Chhindwara district of Madhya Pradesh. The regression coefficient of human labour was found significant in large size category. The regression coefficients of machine labour and seed, for all the three size groups was significant. The regression coefficients of insecticide and pesticide in medium and large size groups were negative and non significant but in small group size it was positive and significant. The regression coefficient of fertilizer was negative and significant in case of medium and large group of farmer, while in case of small farmer it was positive and significant.

Gautam *et al.* (2017) attempted to examine resource use efficiency of wheat crop in Betul district of Madhya Pradesh. The study was conducted in 2013-14 and the results revealed that human labour was found significant for large (0.419) and overall (0.156) farm, while it was non-significant for small and medium farms. Machine labour was found significant for all size of farms i.e. small (0.551) medium (0.526), large (0.370) and overall (0.687) farm size. Seed and fertilizer was found significant for small and overall farm.

Sapkota *et al.* (2018) studied the profitability and resource use efficiency of maize seed production in Palpa district of Nepal and found that the regression coefficients for seed, labour, FYM and tillage bullock had negative and significant impact on sorghum output whereas chemical fertilizer had positive and significant impact on maize output and tillage tractor found not to be significant and had negative impact on maize output.

Based on above studies, few generalized conclusions can be drawn as under:

- Most of the studies observed significant and positive elasticity coefficients for area, manure, fertilizers and human labour.
- Usage of plant protection chemicals was non-significant and negative in middle and large size groups but positive and significant in small size groups.
- Human labour was significant for large farms compared to small farms.

2.4 Constraints faced by growers

Thyagarajan and Vasanthakumar (2000) conducted a study on constraints to high yields in rice at farm level in South Arcot district of Tamil Nadu. The lack of reasonable support price was found to be the foremost constraint faced by 36.33 % of the respondents followed by high cost of inputs constraint (34%).

Gaddi *et al*. (2002) studied the yield gaps in productivity and problems in the cultivation and production of *rabi* sorghum crop in Bijapur and Gulbarga districts of Karnataka state and found that low quality standard and high cost of fertilizer and plant chemical nutrients, labour unavailavility or shortage, very less availability of desired and required variety seed, unpredictable climatic conditions and attack of pest and diseases lowered sorghum productivity on respondents fields were the major

constraints faced by the farmers in study area.

Joshi *et al.* (2005) studied the maize in India: production systems, constraints, and research priorities and found that major biotic production constraints were *Echinocloa crusgalli, Cynodon dactylon*, rats, and termites, which reduced maize production levels by more than 50 %. Other important abiotic and biotic stresses listed in descending order of importance were caterpillars, water stress, stem borers, weevils, zinc deficiency, rust, seed/seedling blight, cutworm, and leaf blight. Non-availability of improved seeds, inadequate input markets, ineffective technology dissemination, and lack of collective action were the principal socio-economic constraints.

Tanveer (2006) conducted a study on economic analysis of paddy based farming systems in Mandya district of Southern Karnataka and found that high cost of inputs, fluctuation in the prices of the produce, shortage of organic manures/FYM, lack of transportation, marketing facilities and scarcity of funds were the major constraints faced by paddy farmers in the study area.

Chahal and Kataria (2010) studied the constraints in the production and marketing of maize in Punjab and found that the institutional, marketing and socio-economic constraints were found to be impediments in the production of maize. More specifically the sample farmers suffered on account of non-availability of credit, poor marketing facilities, lack of storage facilities, and non-availability of seed suitable to the local needs, late sowing of crop etc. The detailed analysis of the constraints impediment to production and marketing of maize reflect the urgent need for overhauling of the entire marketing system.

Sani *et al.* (2013) conducted a study on economics of sorghum production in Bauchi state- Nigeria. Study revealed that high cost of inputs (98.3%) and low prices of produce (98.3%) were identified as the major constraints to sorghum production. Other factors such as lack of adequate storage (66%), disbursement of loans (83.3%) and inadequate provision of credit limits (87.7%) identified as major problems impeding expansion. Also, untimely delivery of inputs (75%), incidence of striga (75%), small farm size (21.7%) and poor extension services in the study area.

Ghuge and Kadam (2015) studied the constraints faced by *kharif* sorghum growers in adoption of recommended technology in Maharashtra state during the year

2014-15. The results of the study depicted that high cost of chemical fertilizer, high cost of tractor charges for tillage, non-availability of seed at proper time, high cost of FYM, non-availability of labour at the time of harvesting, high cost of pesticide or insecticide, inadequate knowledge about scientific plant protection, inadequate knowledge about the proper NPK dose were the major constraints faced by sorghum growers.

Dhaka *et al.* (2016) examined yield gaps and problems faced in wheat production under field conditions. The study was conducted in Bundi district of Rajasthan. Preferential ranking technique was used to identify the constraints. The major constraints faced by wheat growers were lack of knowledge, high cost of inputs, poor credit facilities and inadequate input supply.

Rao *et al.* (2017) made an attempt to study an economic analysis of improved *rabi* sorghum cultivars in rainfed situation of Maharashtra, India. Phule Vasudha, Phule Chitra, Phule Revati abd Phule Anuradha were the four sorghum cultivars selected for the study purpose. Primary data was collected from three districts of Maharashtra namely, Solapur, Ahmednagar and Pune for the year 2013-14 and found lack of irrigation facilities, human shortage and low mechanisation as the major constraints faced by farmers in the study area.

Gautam *et al.* (2017) attempted to examine resource use efficiency of wheat crop in Betul district of Madhya Pradesh and also identify of the constraints encountered in production of wheat by the farmers to achieve the potential yield of wheat. The study was conducted in 2013-14. The study found out that high price of quality seed was reported by 68 % wheat farmers followed by lack of knowledge about nutrient content (67 %), high price of fertilizer (60 %), lack of knowledge of seed treatment (55%) in the study area.

Lakra *et al*. (2017) conducted a study on economic analysis of production, marketing and constraints of paddy in Dantewada district of Chhattisgarh, India. The study revealed that lack of sufficient soil testing facilities was the major constraints and it was perceived by 82 % of farmers. Scarcity of labour during the peak season was also another major problem faced by 81.25 %. As much as 68.75 % farmers of the study area faced the problem of lack of irrigation water and problem in financing fund for crop cultivation. About 72.50 % and 77.50 % farmers of the study area told

about the lack of recommended doses of different chemical fertilizers, insecticide and pesticides in the crop. About 62.50 % farmers reported that they faced the lack of sufficient fund to purchase the different inputs for crop.

Based on above studies, few generalized conclusions can be drawn as under:

- Constraints faced by the farmers were differed across the crops and regions.
- High cost of inputs, lack of reasonable support prices, fluctuations in the prices of produce were found to be the foremost and common constraints faced the farmers.
- Weeds problem, incidence of pest and diseases, non-availability of labour at peak harvesting time, unfavorable climatic conditions were found to the major production constraints.

It is apparent from the foregoing review of literatures that a large number of studies have been conducted to assess the economics of sorghum cultivation in various parts of the country. Different research workers have reported different findings in their studies due to wide variations in resource endowments in various parts of the country. But no such systematic study has been carried out for Rajasthan in general and Bhilwara in particular to serve as a guideline for examining the economic analysis of sorghum cultivation. The present study, therefore, is an attempt to provide necessary information and fill the existing information gap on the subject. Moreover, the findings of the present investigation are expected to prove useful to the policymakers and planners while taking important decision regarding sorghum production in the future.

3. MATERIAL AND METHODS

This chapter deals with the brief description of the selection of study area, data collection, sampling procedure and analytical methods used to achieve the stated objectives of the present study. The present investigation is designed to examine the CAGR (Compound Growth Rate) of area, production and productivity for a period of 25 years from 1991-92 to 2015-16, costs and returns analysis, input-output relationship and various constraints faced by sample households in sorghum cultivation, all in relation to Bhilwara district and one parameter in relation to state of Rajasthan. For further understanding the detailed methodological framework of the research study has been concisely presented and divided into four sub-sections in this chapter.

3.1. A brief informative explanation about the study area

3.2. Sample selection procedure

3.3. Data collection

3.4. Various statistical tools and techniques employed in research study

3.1 A brief informative explanation about the study area

A research programme requires thorough knowledge about the study area where an investigation is being carried out. Therefore, this section provides the general characteristics of the study area. The present study was conducted in the Bhilwara district of Rajasthan state during the kharif season of 2018-19 agriculture year. MPUAT service area consists of seven districts, namely Udaipur, Chittorgarh, Banswara, Bhilwara, Pratapgarh, Dungarpur and Rajsamand. Bhilwara district was selected based on highest area and production in MPUAT service area for the study purpose. Sorghum production of Bhilwara district was 12081 metric tonnes which was 55.6 % of MPUAT service area during the 2015-16. Area of sorghum of this district was 43047 hectares of sorghum cultivation which was 57.9 % of MPUAT service area during the year 2015-16. District wise area of MPUAT service area has been depicted in *Appendix-I*. Bhilwara is a small town in the Mewar region of

Rajasthan. To know the general characteristics of the study area, a brief description about location, soil and topography, climate and rainfall, human population, productivity of major crops and demographic features of the study area is presented in this chapter.

3.1.1 Geographical location

Bhilwara district (Fig 3.1) is situated in the southern part of Rajasthan state of India. It is located at 25.35°N latitude 74.65°E longitude. It has an average elevation of 421 metres (1381 feet). It is 152 km away from Udaipur. It falls between the districts of Ajmer (in north) and Chittorgarh and Udaipur (in south). Northern border of the district touches district Ajmer, north-west border touches district Rajsamand, south & south-east border touches district Chittorgarh and east & east-north touches district Bundi & Tonk. Major rivers flowing through the district are Banas, Bedach, Kothari, Khari, Mansi, Menali, Chandrabhaga and Nagdi.

Fig 3.1 District wise map of Rajasthan

3.1.2 Climate and rainfall

Bhilwara has a local steppe climate. The average temperature is 25.4°C. The average annual rainfall is 766 mm. Most rainfalls is seen in July and August. On average, July is the wettest month and March is the driest month. Fog is common in the winter, while hot dry winds, called loo, blow in the summer.

3.1.3 Soil and topography

Soils of the district are classified as follows: (1) Clay loam or medium black: This type of soil is found in the hilly areas in the central parts of the district. (2) Loam: This type of soil is found in the entire district. (3) Sand and sandy loam: This type of soil is found mostly near the banks of rivers and nallahs. (4) Loam pebby and stony: These types of soils are met within the hilly areas of the eastern blocks of the district. Bhilwara district consists of fairly open plains in the north and southeast with a few hillocks and undulating plains & hills in the south and northeastern part. Occasional inselberg, low-lying hillocks and chains of ridges break the monotony of peneplained tract. The area of the district generally slopes gently except in western & northwestern part where slope is high.

3.1.4 Productivity of major crops

Bhilwara district has suitable agro-climatic conditions for various food grains, pulses, oilseeds and horticultural crops. There is also very good scope for development of dairy farming. In kharif season, maize is the most widely cultivated crop followed by sorghum, groundnut and cotton. During Rabi season, wheat is cultivated in large area followed by gram, mustard and barley crops. The average productivity of Kharif crops; maize, sorghum, groundnut and cotton was 783, 387, 414 and 332 kg/ha, respectively. In rabi season, the average productivity for wheat, gram, mustard and barley was 2119, 969, 797 and 1729 kg/ha, respectively. The productivity of both seasons crops is rated as low in comparison to national average. There is wide scope for technological interventions to improve the productivity of crops. Harnessing of productive potentials of natural resources up to their full extent is the fundamental key which can be achieved through agricultural land use planning.

3.1.5 Demographic features

According to the Census (2011), Bhilwara district has a population of 24, 08,523 this gives it a ranking of 184th in India (out of a total of 640). The district has a population density of 230 inhabitants per square kilometre. Its population growth rate over the decade 2001-2011 was 19.6%. Bhilwara has a sex ratio of 973 females for every 1000 males, and a literacy rate of 61.37%. This district also called Textile City or Manchester of Rajasthan. The land area of this district is 10455 Sq. Km. The demographic features of Bhilwara district has been given in Table 3.1.

Table 3.1 Demographic features of Bhilwara district

Demographic features	Numbers
Area (Sq. km.)	10455
Human Population	
I. Male	1220736
II. Female	1187787
III. Total	2408523
Literacy rate (%)	
I. Male	75.27
II. Female	47.21
III. Average	61.37
Sex ratio (per 1000 male)	969

Source- District Outline 2015, Bhilwara.

3.2 Sampling procedure

The detailed sampling procedure employed for selection of tehsils, villages, and final households has been presented below.

Selection of Tehsils:

Bhilwara district (Fig 3.2) consists of 16 tehsils. Out of 16 tehsils (Basic Statistics of Rajasthan-2014), two tehsils, *viz.*, Shahpura (13132 ha) and Jahazpur (10471 ha) were selected for the present study on the basis of maximum area under sorghum crop during 2018-19. Tehsil wise area of Bhilwara district has been depicted in *Appendix- II.*

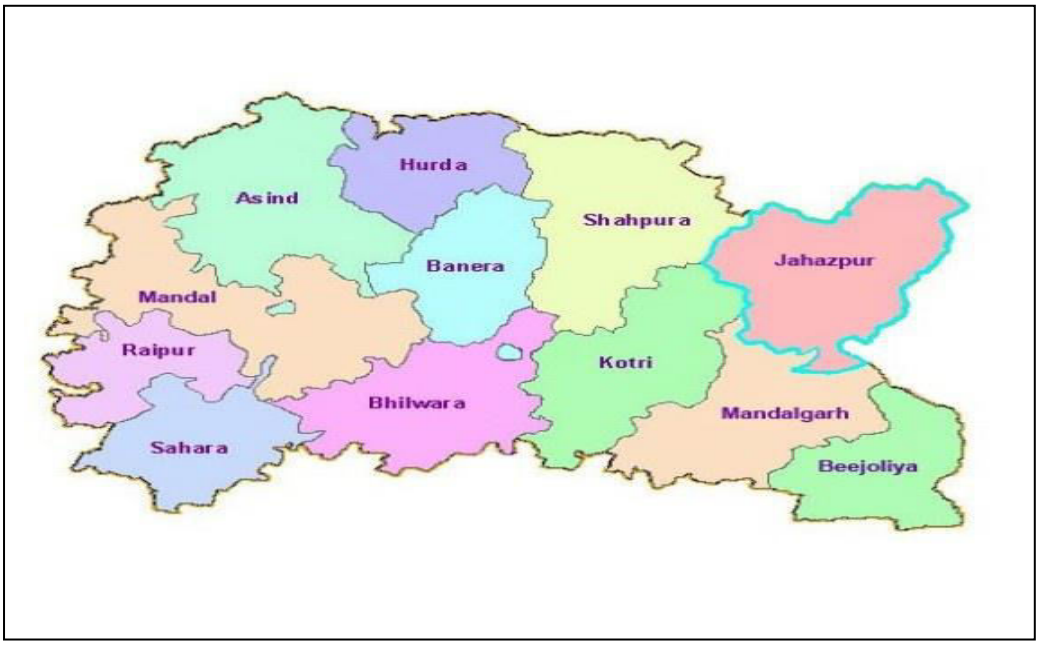

Fig 3.2 Tehsil wise map of Bhilwara district

Note: Tehsil wise map of Bhilwara district is not available for 16 tehsils.

Selection of Villages:

There are 102 villages in Shahpura tehsil and 246 villages in Jahazpur tehsil as per District Outline 2015, Bhilwra. Out of these villages, two villages from each tehsil based on maximum area under sorghum were selected. Shahpura (1932 ha) and Tehnaal (705 ha) from Shahpura tehsil and Baavdi (535 ha) and Pander (530 ha) from Jahazpur tehsil were selected. Thus, total 4 villages were finally selected for the present study.

Selection of Households:

A comprehensive list of all sorghum growers was prepared from each selected village with the help of Agriculture Supervisors, Sarpanch and Patwari of respective villages. The preliminary information was collected on land holdings, family size and education status of head of the family, main occupation *etc*. Only those farmers were retained in final sample who has allocated atleast 0.5 hectare area under sorghum crop during kharif season 2018-19. All the sorghum growers' were classified into three categories according to size of their operational land holdings. The farmer were classified into small farmers, medium farmers and large farmers having operational land holding between less than 2 hectare, 2 to 5 hectare and more than 5 hectare, respectively by using cumulative frequency square root technique (Delenius and

Hodges, 1950). Thereafter, a sample of 15 sorghum growers were randomly selected from each village based on probability proportion to number of household in each category. Finally, a sample of 60 sorghum growers was selected from the above mentioned villages. Thus, the sample comprising of 30, 17 and 13 farmers in small, medium and large land size category, respectively. The land size category wise distribution of farmers has been presented in table 3.2. It was observed that small, medium and large farmers ranged from <2, 2-5 and >5 ha, respectively. The distribution of the land holding of small (<2 ha), medium (2-5 ha) and large (>5 ha) category of farmers was observed to be 1.24, 2.94 and 6.35 ha respectively. Out of 60 households, maximum farmers (50 %) fall under small category followed by medium (28.33 %) and large category (21.67%).

Table 3.2 Distribution of sorghum growing households across various land size category

(No. of households)

Land size category	Shahpura tehsil		Jaaazpur tehsil		Total households	Average size of land holding
	Shahpura village	Tehnaal village	Baavdi village	Pander village		
Small (<2 ha)	6	9	8	7	30 (50.00)	1.24
Medium (2-5 ha)	5	3	5	4	17 (28.33)	2.94
Large (>5 ha)	4	3	2	4	13 (21.67)	6.35
Total	15	15	15	15	60 (100.00)	3.51

Source: Field Survey, 2019

3.3 Data collection

3.3.1 Primary data collection

The primary data were collected during March of 2019 from sample households by survey method using well structure schedule through personal interview. The data on various aspects of sorghum growers like composition of

household, occupation, gender, family size, education, operational holding, area under sorghum crop, expenditure on human/machine labour, seed, manures and fertilizer, irrigation and plant protection measures, machinery and equipment used in sorghum production, miscellaneous expenses, market price of inputs, wage rates *etc.* were collected. Moreover the information on various constraints faced by farmers in production and marketing of sorghum were also collected. The detailed questionnaire used for data collection has been given in *Appendix-III*.

3.3.2 Secondary data collection

Secondary data regarding total geographical area of the district, human population, agroclimatic features, cropping pattern, area, production and productivity of sorghum were collected from Agriculture Statistics at a Glance, Basic Statistics and District Outline- Bhilwara.

3.4 Analytical tools and techniques employed

The primary and secondary data collected were scrutinized, compiled, systematically arranged, tabulated and finally subjected to analysis for drawing inferences to commensurate with the objectives of the study.

3.4.1 Growth Rate analysis

3.4.2 Cost and return analysis

3.4.3 Multiple regression analysis

3.4.4 Garrett ranking technique

3.4.1 Growth rate analysis

CAGR(Compound Growth Rate) for area, production and productivity of jowar crop in Rajasthan and Bhilwara were calculated using time series data for 25 years from 1991-92 to 2015-16 by fitting the exponential function ($Y_t = ab^t u_t$) . To arrive at convenient interpretation of the results, bi-annual average of data has been taken into account. Following exponential function was used in order to analyze the growth in area, production and productivity of sorghum in Bhilwara and Rajasthan.

$$Y = ab^t u \qquad \ldots(1)$$

Where,

Y= area/production/productivity

a= constant

b= regression coefficient

t= Years considered

u= error term

The equation (1) was transformed into log linear form for estimation purpose and was estimated using Ordinary Least Square (OLS) technique. The compound growth rate (g) in percentage was then computed from the relationship,

g= (Antilog of ln b-1)*100

The significance of the regression coefficient was tested by using the‘t’ test which defined as,

$t= b_i/SE (b_i)$

Where, b_i= elasticity of coefficients

SE= Standard Error of the regression coefficient

Cost and return analysis:

Cost concepts

The cost concepts approach to farm costing is widely used in India. To calculate the cost of cultivation (COC), standard method of cost concepts employed by CACP, DES, GOI was adopted. It comprises Cost A_1, Cost A_2, Cost B_1, Cost B_2, Cost C_1, Cost C_2 and Cost C_3. Various costs have been worked out by applying following method:

Cost A_1 includes following 14 costs items:

1. Hired human labour (permanent & casual)

2. Owned bullock labour

3. Hired bullock labour

4. Owned machinery labour

5. Hired machinery charges

6. Fertilizers

7. Manure (produced on farm and purchased)

8. Seed (both farm-produced and purchased)

9. Insecticides, pesticide and fungicides

10. Irrigation charges (both owned and hired tube wells, pumping sets etc.)

11. Canal-water charges

12. Land revenue, cesses and other taxes

13. Depreciation on farm implements (both bullock drawn & worked with human labour, farm building and farm machinery)

14. Interest on the working capital

Cost A_2 is equal to Cost A_1+ Rent paid for leased in land

Cost B_1 is equal to Cost A_2+ Int. on value of owned fixed capital assets (excluding land)

Cost B_2 is equal to Cost B_1+ Rental value of owned land

Cost C_1 is equal to Cost B_1 + family labour (imputed value)

Cost C_2 is equal to Cost B_2 + family labour (imputed value)

Estimation procedure of cost items

1. **Labour expenses:** Expenditure on labour include human labour, bullock and machine labour. The value of family labour and hired human labour used for various operations in Sorghum production was assessed. The Labour (Family) was imputed at the wage rates prevailing in the area. The expenditure on machine labour (owned and hired) used on farm for sorghum production was taken into account.
2. **Seed:** Both owned and purchased seeds were used for sorghum production. The cost of home grown and hybrid seeds was calculated at the market rates prevailing in the area at the time of sowing.
3. **Manures:** Farm yard manures produced on the farm are valued at the prevailing rates in

the locality (*i.e*. per tonne basis). Purchased manures are charged at the actual prices paid plus transportation cost.

4. **Fertilizers:** Fertilizer (urea) was charged at the actual price paid plus transportation cost.
5. **Plant protection charges:** This includes the actual cost of insecticides, pesticides, fungicides used plus the hiring charges of appliances.
6. **Int. on fixed capital:** It was calculated at the rate of 10 % p.a. for one crop period.
7. **Interest on working capital:** It was also calculated at the rate of 10 % p. a. for one crop period.
8. **Rental value of owned land:** Evaluated on the basis of prevailing rates in the village for identical type of land or on the basis of responses obtained from the village farmers, it is calculated for one crop period.
9. **Depreciation:** It was calculated for tractor, thresher, seed drill, store house, home etc. by straight line method.

$$\text{Depreciation (₹)} = \frac{\text{Purchase price of the asset (₹)} - \text{Junk value(₹)}}{\text{Number of useful year of life (expected life)}}$$

Allocation of joint costs

The expenditure incurred on, or imputed for, some of the cost items related to the farm as a whole. Such joint costs are allocated to individual enterprises. Depreciation on farm buildings and implements, land rents, land revenue, cesses and taxes, interests on owned fixed capital are such costs which are allocated to individual crop enterprises in proportion to their area.

Return measures

The income measures used in the study make it possible to assess return over cost at various levels. The income measures are:

A. **Gross Return:** Value of farm output (main product and by product) whether sold or utilized by the farm family was calculated by referring market prices in respective villages during harvesting period.

Gross return (GR) = Qg × Pg + Qd × Pd

Where,

GR is gross return from sorghum crop

Qg is qty. of sorghum grain

Pg is price of sorghum grain

Qd is qty. of dry fodder of sorghum

Pd is price of dry fodder of sorghum

B. Net Return: It is the difference between gross return and total cost, *i.e.* gross return minus Cost C2.

Net return was calculated in two ways;

1. Net Return = Gross Return- (Cost A_2 + Family Labour)
2. Net Return = Gross Return- (Cost C_2)

Nowadays Government of India announcing MSP by considering the Cost A_2 + Family labour and its 50% while farmers always demands for MSP on the basis of Cost C_2 + 50 % of cost C_2. Hence, net return measured in both the ways.

3.4.3 Multiple Regression Analysis

Sorghum production is influenced by various factors, like seed, fertilizer, manure, machine labour, area, human labour, insecticides *etc.* The influence of these factors on sorghum production was assessed with the help of multiple regression analysis. The production function shows the physical relationship between output (sorghum grain) and inputs (explanatory variables) used in the production process. Production function model was used to examine the input-output relationship in sorghum production and it is given as;

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7)$$

Where, Y- sorghum output (quintal)

X_1- Area under sorghum cultivation (ha)

X_2- Qty. of seeds (both hybrid and local) (Kg.)

X_3- Qty. of FYM (tonnes)

X_4- Qty. of urea (Kg.)

X_5- Qty. of PPC (litre)

X_6- Hired and family labour (man-days)

X_7- Machinery and equipment labour (machine hrs)

Choice and specification of model:

The analysis of multiple regression requires specification of a specific functional form. In the present study two forms of production function, namely, Linear and Cobb-Douglas were tried to determine the relationship between the sorghum output and various factors affecting it. Their functional forms are given as under

Linear form $Y = a + \sum_{i=1}^{n} b_i x_i + u$

Cobb-Douglas form $\ln y = \log a + b_i \sum_{i=1}^{n} \log x_i + u$

Where,

Y= sorghum output

X_i's= input variables, i=1, 2, -------7

a = constant term

Finally, linear production function was found more appropriate to study the relationship between the sorghum output and various factors (input variables) based on appropriate sign and statistical significance of parameters estimated accompanied by highest coefficient of multiple determination (R^2).

3.4.4 Garrett Ranking Technique:

Information regarding the problems faced by the farmers in production of sorghum was collected. Constraints were identified after consultation with the farmers and were asked to rank the constraints. Garrett's Ranking Technique was used to priorities the constraints encounter by farmers/ producers. Garrett's Ranking Technique provides the change of orders of constraints and advantages into numerical scores. The prime advantage of this technique over simple frequency distribution is that the constraints are arranged based on their severity from the point of view of farmers. Hence, the same number of farmers on two or more constraints may have given different rank.

Ranks were converted into per cent position by using Garrett's formula as follows:

Per cent Position = $100 * (Sij – 00.5)/V_j$

S_{ij} is rank decided for i^{th} constraint by j^{th} individual farmer

V_j is number of constraints ranked by j^{th} individual farmer

The per cent position of every rank at first converted to scores from the table given by the statistician Garrett and Woodworth (1969). For each and every factor, the scores of single farmers were summed up together and then divided by the total number of farmers. The mean scores of all problems then arranged in descending order, and then constraints were accordingly ranked.

4. RESULTS AND DISCUSSION

Commensurate with the objectives set worth for the current study, the outcomes of the research study on "An economic analysis of sorghum cultivation in Bhilwara district of Rajasthan" have been set in the forms of tables in this chapter as given below:

4.1 Social-economical features of sampled households
- 4.1.1 Family size and composition
- 4.1.2 Educational status of head of household
- 4.1.3 Age of head of household
- 4.1.4 Consumption of sorghum *chapatti*
- 4.1.5 Herd size category

4.2 CAGR (Compound Growth Rate) for area, production and yield of sorghum in Bhilwara and Rajasthan
- 4.2.1 Compound growth rate in area of sorghum
- 4.2.2 Compound growth rate in production of sorghum
- 4.2.3 Compound growth rate in productivity of sorghum

4.3 Cost and returns of *kharif* sorghum cultivation
- 4.3.1 Cost of sorghum cultivation
- 4.3.2 Profitability of sorghum cultivation
- 4.3.3 Standard cost concepts
- 4.3.4 Returns compared with MSP of sorghum-2018
- 4.3.5 Comparision of cost concepts

4.4 Resource use structure in sorghum cultivation

4.5 Labour cost in different operations of sorghum cultivation

4.6 Cost and return analysis of green fodder cultivation of sorghum

4.7 Input – output relationship

4.8 Various constraints faced by sorghum growers
- 4.8.1 Constraints faced by farmers in sorghum cultivation
- 4.8.2 Constraints faced by farmers in marketing of sorghum produce
- 4.8.3 Constraints faced by farmers related to Minimum Support Price (MSP)

4.1 Social-economical features of sample households

The objective of this section is to examine the basic characteristics of the sample households that may have a profound influence on the decision-making process and profitability of the sorghum cultivation. Rural households in a typical village community in India exhibit great heterogeneity in socio-economic characteristics and Rajasthan is no exception to this rule. The data for the study were collected from 60 farming households in Bhilwara district of Rajasthan. An attempt has made in this section to document the important socio-economic characteristics of the sample households. It includes family size and composition, educational status of head of the household, age of head of household, consumption of sorghum *chapatti* and livestock inventory.

4.1.1 Family size and composition

Family size and its composition is an important contributory factor in agricultural occupation, because it's a labour intensive activity, and much of the labour requirements are met from the family itself. The particulars relating to this factor are presented in table 4.1. The average family size was found to be 7.63 in the study area. Proportion of males (3.03) was higher than females (2.37) in sample households. The average family size was highest for large (7.82) farmers followed by small (7.69) and medium (7.37) category. In the study area it was observed that there was no such difference in family size according to their land size category.

Table 4.1 Average family size and composition of sorghum producers

(Number)

Land size category	Adult males	Adult females	Children	Total
Small (<2 ha.)	3.26	2.42	2.01	7.69
Medium (2-5 ha.)	2.86	2.55	1.96	7.37
Large (>5 ha.)	2.97	2.14	2.71	7.82
Overall	3.03	2.37	2.23	7.63

4.1.2 Educational status of head of household

Education is the main pillar for development in any community. Better education enables better comprehension of farming techniques and their possible

adoption in farm enterprises. The distribution of sample households according to the education of head of the household is presented in Table 4.2. It was observed that, on an average 83.33 % of the total sample households were found to be literate in the study area. The distribution of sorghum growing households as per their education level shows that, out of total number of households, 28 had primary school education accounting about 46.67 % of the total sampled households, 9 had education of middle school accounting about 15 % of the total number of sampled households, 6 were having upto higher secondary which nearly constitutes 10 % of the total households and 7 farmers were having education upto graduation or post graduation which constitues 11.67 % of the total households and only 10 farmers were found to be illiterate constituting 16.66 % of the total respondents. The literacy (%) was found to be highest in the large size category followed by medium and small farmer's category accounting about 92.30, 88.24 and 76.67 %, respectively. It was observed that literacy level of households was increased with the increase in land size category.

Table 4.2 Distribution of households according to educational status

(Number)

Education level	Small (< 2ha.)	Medium (2-5 ha.)	Large (> 5 ha.)	Overall
a. Illiterate	7 (23.33)	2 (11.76)	1 (7.69)	10 (16.66)
b. Primary school (Class 1 to 6)	14 (46.67)	9 (52.94)	5 (38.46)	28 (46.67)
c. Middle school (Class 7 to10)	4 (13.33)	2 (11.77)	3 (23.07)	9 (15.00)
d. Higher secondary (Class 11 to 12)	3 (10.00)	1 (5.88)	2 (15.39)	6 (10.00)
e. Graduation/post graduation	2 (6.67)	3 (17.65)	2 (15.39)	7 (11.67)
Total households	30 (100)	17 (100)	13 (100)	60 (100)
Rate of literacy (%)	76.67	88.24	92.30	83.33

Figures in parentheses indicate the percentages to total number of households.

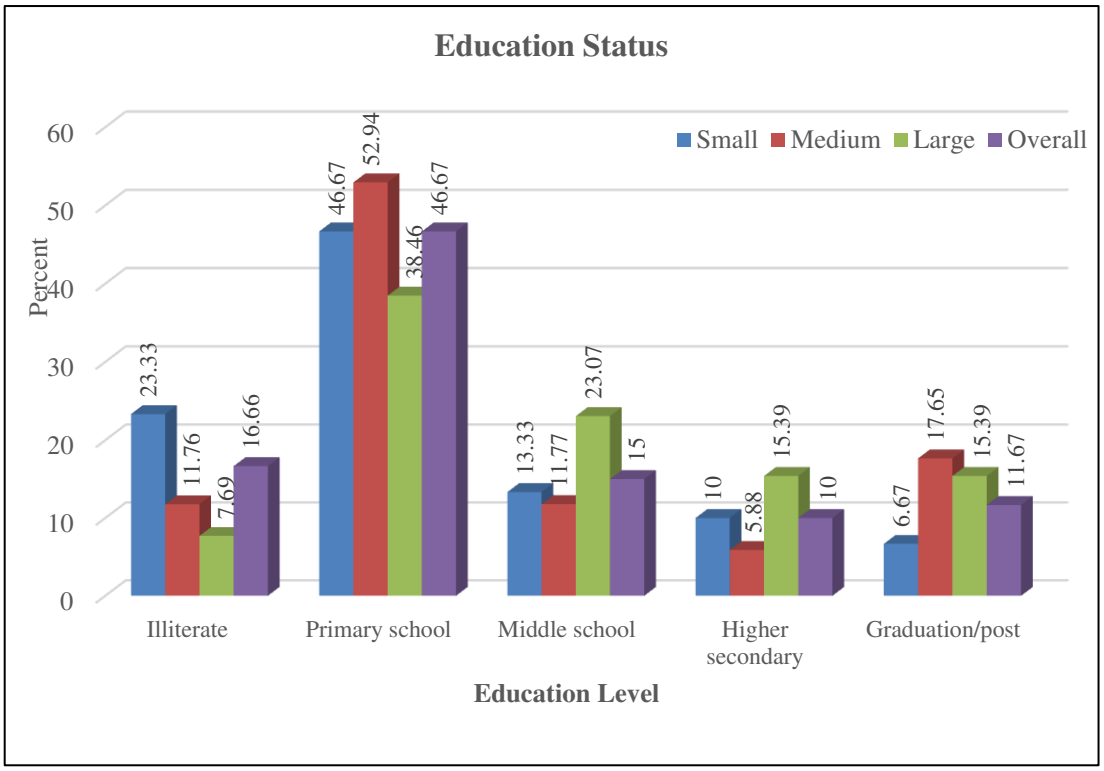

Fig. 4.1 Educational status of sample households

4.1.3 Age of head of household

The distribution of sample households according to the age of head of the household is presented in Table 4.3. The age of the sample households were divided into 3 category *i.e.,* farmers ageing between 21 to 35 years, 36-50 years and 51to 65 years. Out of the total households, 16 farmers were aged between 21 to 35 years, 24 farmers were aged between 36 to 50 years and 20 farmers were aged between 51 to 65 years, which constitutes nearly 26.67, 40.00 and 33.33 % of the total no. of sampled households, respectively. On an average, age of head of family was 33, 47 and 58 years for households aged between 21-35, 36-50 and 51-65 years group, respectively. On an average, age of the jowar growing households was found to be 46 years. It was found that farmers ageing between 36-50 years were engaged more in sorghum cultivation as compared to other age groups in the study area.

Table 4.3 Distribution of households according to age of head of household

(Years)

Category (age)	Small (< 2ha.)	Medium (2-5 ha.)	Large (> 5 ha.)	Total	Average age (year)
a. 21-35	8 (26.67)	4 (23.53)	4 (30.77)	16 (26.67)	33
b. 36-50	12 (40.00)	7 (41.18)	5 (38.46)	24 (40.00)	47
c. 51-65	10 (33.33)	6 (35.29)	4 (30.77)	20 (33.33)	58
Grand total	30 (100)	17 (100)	13 (100)	60 (100)	46

Figures in parentheses indicate the percentages to total number of households.

4.1.4 Consumption of sorghum *chapatti*

Sorghum is a coarse cereal crop. Consumption of sorghum *chapatti* by sample households is given in table 4.4. It could be seen that, only 12 farmers (20 %) were preferring sorghum *chapatti* occasionally out of 60, while rest of farmers were not preferring sorghum *chapatti*, because they prefer to consume wheat as the major diet component. Out of 12 farmers, 66.67 % preferred due to taste and 33.33 % due to nutritive value, while none of farmer give preference to sorghum *chapatti* on the basis of less price. Moreover, among 12 farmers, 2 farmers (16.66 %) were preferred sorghum *chapatti* for once in a week, 5 (41.67 %) farmers were preferred alternate days in a week and remaining 5 farmers (41.67 %) were preferred sorghum *chapatti* fifteen days in a month. It was found that there was no daily consumption of sorghum *chapatti* by any sample households in the study area.

Table 4.4 Consumption of sorghum *chapatti* by sample households

1	How many farmers preferred sorghum *chapatti*	
	(I) Yes	12 (20.00)
	(II) No	48 (80.00)
2	Reason for preference of sorghum *chapatti*	
	(I) Taste	8 (66.67)
	(II) Nutritive value	4 (33.33)
	(III) Less price	0 (0.00)
3	Consumption pattern towards sorghum *chapatti*	
	(I) Daily	0 (0.00)
	(II) Once in a week	2 (16.66)
	(III) Alternate days in a week	5 (41.67)
	(IV) Fifteen days in a month	5 (41.67)

Figures in parentheses indicate the percentages to total number of households.

4.1.5 Livestock inventory

Herd size wise distribution of animals is presented in table 4.5. On an average, a sorghum grower household maintained a herd size of 3.78 standard animal units. Small, medium and large sorghum producing sample households maintained a herd size of 2.37, 3.79 and 5.19 standard animal unit, respectively. Further it was found that the standard animal units maintained by households increased with increase in land size holdings. Only adult animals were considered in forming Standard Animal Unit.

Table 4.5 Herd size distribution of animals

(Standard Animal Unit)

Herd size category	Crossbred cow	Local cow	Buffalo	Total
Small (1-2)	1.12	0.64	0.61	2.37
Medium (3-4)	1.45	1.23	1.11	3.79
Large (5-6)	2.01	1.84	1.34	5.19
Overall	1.53	1.24	1.02	3.78

4.2 CAGR (Compounded Annual Growth Rate) for area, production and productivity of jowar crop in Bhilwara and Rajasthan

The CAGR of area, production, and productivity of jowar for Bhilwara district and for the Rajasthan state was calculated separately for both state and district for 25 years from the period 1991-92 to 2015-16. The annual growth rates in area, production and productivity of sorghum both in Bhilwara and Rajasthan were found to be positive and significant.

4.2.1 Compound annual growth rate in area of sorghum

CAGR for area in jowar crop in Rajasthan and Bhilwara are given in table no. 4.6. The outcomes of the calculation revealed that there has seen a positive growth in area under sorghum cultivation both in Rajasthan and Bhilwara. The total area allocated by the farmers in the state under sorghum cultivation had decreased from 707669 hectares to 631188 hectares during 1991-92 to 2015-16, but still there was an growth of 2.20% in sorghum area. The total area allocated by the farmers under sorghum cultivation in Bhilwara district had increased from 26788 hectares to 43047 hectares during 1991-92 to 2015-16 with growth of 1.02% in area under sorghum cultivation.

The positive growth rates of sorghum area in both Rajasthan state and Bhilwara district were found to be significant. The expansion of area under this crop was mainly due to its important features like capacity to withstand drought conditions, very good adaptability in marginal lands and even well in low rainfall areas and it makes comparatively quick growth and gives not only good yields of grain but also very large quantities of fodder.

4.2.2 Compound growth rate in production of sorghum

It was observed from table 4.6 that the production of sorghum in Rajasthan and Bhilwara had increased from 157427 metric tonnes to 344287 metric tonnes and 657 metric tonnes to 12081 metric tonnes during 1991-92 to 2015-16, respectively. During study period (1991-92 to 2015-16), production of jowar at district and in state level found positive growth rate of 12.54 and 3.21% per year respectively. It shows that the total production also revealed increasing trend year by year in both Rajasthan and Bhilwara.

The significant positive growth in production of sorghum in Rajasthan state and Bhilwara district could be explained by the effect of positive growth in productivity of sorghum. It was productivity led growth.

4.2.3 Compound growth rate in productivity of sorghum

The results presented in table 4.6 indicated that, the productivity of sorghum in Rajasthan and Bhilwara had increased from 222 to 545 kg/ha. and 25 to 281 kg/ha. during 1991-92 to 2015-16, respectively. The growth analysis for sorghum productivity indicates that it was growing with a CAGR of 3.34 and 11.42% per year at state and district level, respectively in the course of same time period.

The positive growth rate in sorghum productivity in Rajasthan and Bhilwara district was found significant. It might be due to shift from local seeds usage to hybrid seeds for cultivation purpose and adoption of improved agronomic practices like intercropping and crop rotation with other crops.

Table 4.6 Growth in area, production and productivity of sorghum

S.No	Year	Area (hectare)		Production (metric tonnes)		Productivity (Kg/ha.)	
		Bhilwara	Rajasthan	Bhilwara	Rajasthan	Bhilwara	Rajasthan
1	1991	26788	707669	657	157427	25	222
2	1992	31281	775419	21980	411519	703	531
3	1993	33118	660624	143	160479	4	243
4	1994	36651	678602	34914	273065	953	402
5	1995	31545	593507	2510	139447	80	235
6	1996	31694	62263	22678	290851	716	467
7	1997	27069	56127	26197	267120	967	476
8	1998	28602	535285	51	153760	1.78	287
9	1999	29612	555954	7167	173226	242	312
10	2000	36069	673989	254	134525	7.04	200
11	2001	39185	614653	30109	254398	768	414
12	2002	38232	532393	57	68484	2	129
13	2003	44780	738999	27761	527422	619	714
14	2004	38671	568639	25160	263900	650	464
15	2005	38176	592092	1539	169732	40	287
16	2006	37990	662055	33451	367816	881	556
17	2007	30933	625646	19121	394746	618	631
18	2008	27987	576569	11792	332939	421	577
29	2009	40080	718457	4870	104192	122	145
20	2010	54236	726911	34793	508901	642	700
21	2011	36746	553754	27861	410114	758	741
22	2012	35308	680375	53613	420393	1518	618
23	2013	33025	579615	29175	356672	883	615
24	2014	32327	660969	30270	504560	936	763
25	2015	43047	631188	12081	344287	281	545
	CAGR (%)	1.02*	2.20*	12.54*	3.21*	11.42*	3.34*

Source- Agriculture Statistics at a Glance- 1991-92 to 2015-16, Directorate of Economics and Statistics GOR, Jaipur

Note: * Significant @ 1%

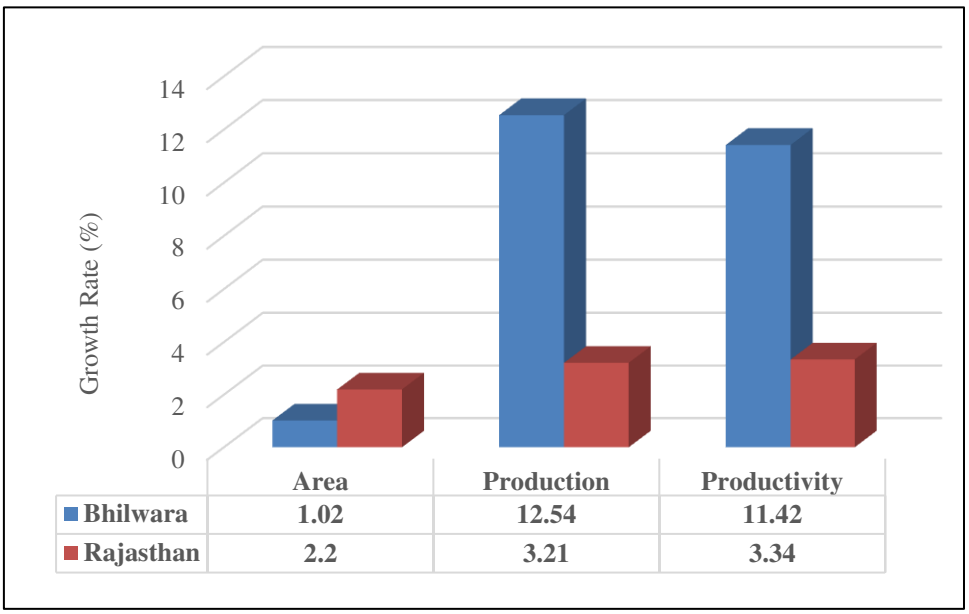

Fig. 4.2 Growth in area, production and productivity of sorghum during the period 1991-92 to 2015-16

4.3 Economics of sorghum production

In order to understand sorghum cultivation from its economic perspective, it is essential to study the costs, be it implicit or explicit that goes into its cultivation. Generally, a farmer can increase his production in two ways i.e., (I) by increasing sorghum production and (II) by reducing cost of sorghum cultivation. The second factor can be achieved through judicious use of various factors of production. Among 60 sample households, 52 households were growing sorghum for grain purpose *i.e.,* it includes 27 small farmers, 14 medium farmers and 11 large farmers.

4.3.1 Cost of sorghum cultivation

The per hectare cost incurred in sorghum cultivation is presented in table 4.7. It was found out that, the overall total cost of cultivation was ₹ 24784.40 which constitute 80.33 % of variable cost (₹ 19908.47) and 19.67 % of fixed cost (₹ 4875.90). Machinery and equipment labour was revealed to be the main item of the working cost which nearly constitutes 27.14 % of the total cost of cultivation (COC) of jowar crop, because in Bhilwara district, machine was used in ploughing, sowing, harvesting and post-harvesting operations. Seeds, human labour, manures, plant protection chemicals and fertilizers were the next major cost items of the overall variable cost accounting for 15.04, 14.61, 10.22, 3.54 and 2.48 % of total cost of

cultivation, respectively. Bullock labour cost was zero *i.e.,* not a single farmer was found using bullock power for land preparation and sowing operations in study area. By this it can be concluded that farmers are interested towards mechanization. Rental value of owned land followed by depreciation of the farm implements and machineries were found to be the major contributors of total fixed cost accounting about 14.78 and 3.11 %, respectively. It was found that per hectare total cost of cultivation was highest for small farmers followed by medium and large farmers *i.e.,* ₹ 25142.73, ₹ 24804.43 and ₹ 24406.05, respectively. For small farmers, due to small piece of land under sorghum cultivation which lead to more per hectare total cost of cultivation. In overall total variable cost and total fixed cost, small farmers were the major contributors followed by medium and large farmers accounting variable cost of about ₹ 20192.73, ₹19944.63 and ₹ 19588 respectively and fixed cost of about ₹ 4950, ₹ 4859.80 and ₹ 4818 respectively.

Labour (Machine) and hired human labour cost were highest among large farmers followed by medium and small farmers due to more mechanized nature of farming in comparison to small size group of farmers. Family labour, manure and fertilizer application cost was highest among small farmers followed by medium and large farmers. Depreciation cost was more for small farmers and less for large farmers; it might be due to heavy machineries used year round by large farmers' hence good care and maintenance was done by them. Thus it may be concluded from the results of study that total cost decreased with increase in land size category of households. The same trend was also true for variable and fixed cost across the various land size categories. The share of hired human labour, total human labour and Labour (Machine) was increased with increase in land size categories while opposite trend was observed in case of family labour. Prevailing market prices of important inputs and wage rates employed in sorghum cultivation in *Annexure V*.

Table 4.7: Cost of Sorghum cultivation across different land size categories

(`/ha.)

S.No	Cost items	Small (< 2ha.)		Medium (2-5 ha.)		Large (> 5 ha.)		Overall	
		Amount	Per Cent	Amount	Per cent	Amount	Per Cent	Amount	Per Cent
1	Labour (Family)	2941.34	11.70	2796.97	11.28	2642.60	10.83	2793.64	11.27
2	Labour (Hired)	652.50	2.60	835.00	3.37	995.00	4.08	827.50	3.34
	Total labour (human)	3593.84	14.29	3631.97	14.64	3637.60	14.91	3621.13	14.61
3	Labour (Machine)	6470.00	25.73	6580.00	26.53	7130.00	29.21	6726.67	27.14
4	Seed	3712.80	14.77	3756.48	15.14	3712.80	15.21	3727.36	15.04
5	Manure	3196.49	12.71	2609.98	10.52	1788.90	7.33	2531.78	10.22
6	Fertilizer	666.91	2.65	597.05	2.41	582.09	2.39	615.38	2.48
7	Plant protection Charges	717.00	2.85	956.00	3.85	956.00	3.92	876.33	3.54
8	Int. on working capital	1835.70	7.30	1813.14	7.31	1780.70	7.29	1809.47	7.30
	Subtotal (variable cost)	20192.73	80.31	19944.63	80.41	19588.00	80.26	19908.47	80.33
9	Rental Value of owned land	3675.00	14.62	3662.00	14.76	3650.00	14.96	3662.33	14.78
10	Depreciation on farm implements	825.00	3.28	756.00	3.05	730.00	2.99	770.33	3.11
11	Interest on fixed capital	450.00	1.79	441.80	1.78	438.00	1.79	443.27	1.78
	Subtotal (fixed cost)	4950.00	19.69	4859.80	19.59	4818.00	19.74	4875.90	19.67
	Total Cost	25142.73	100	24804.43	100	24406.05	100	24784.40	100

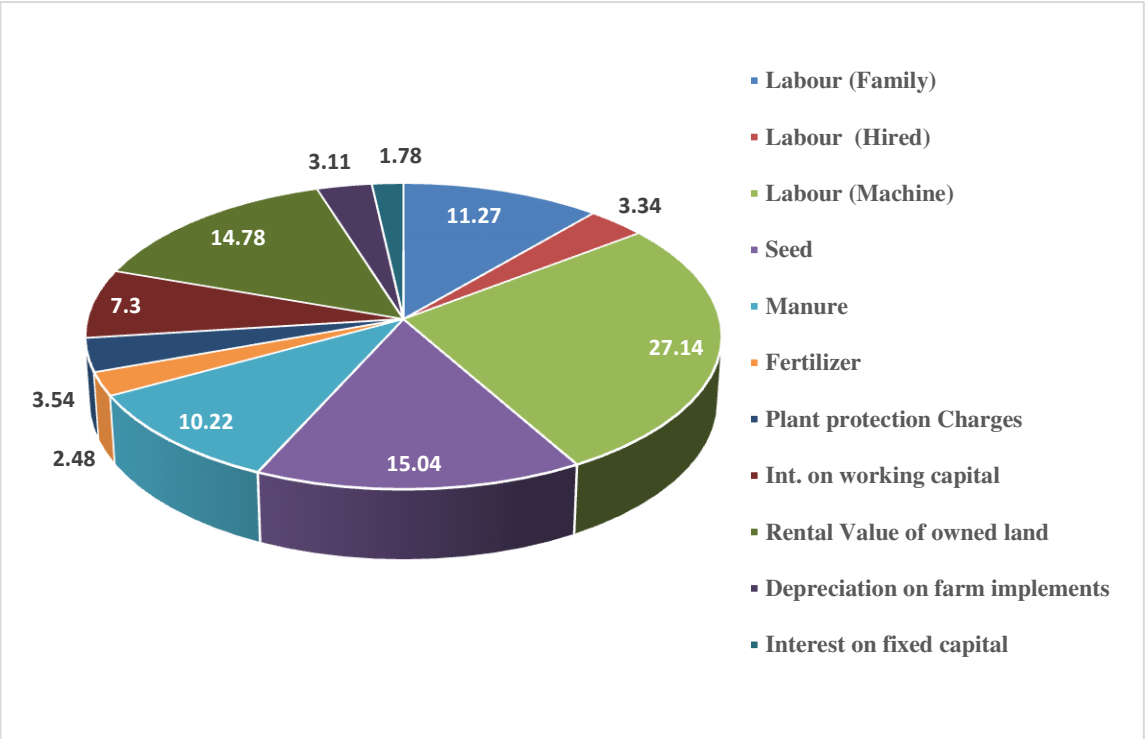

Fig. 4.3 Share of Cost in Kharif Sorghum cultivation (per hectare)

4.3.2 Profitability of sorghum cultivation

Category wise returns from sorghum cultivation are presented in table 4.8. It was observed that overall grain yield and dry fodder yield per hectare of sorghum cultivation was 19.41 quintal, and 60.50 quintal, respectively. It was observed that highest yield was seen in large farmers category (19.99 qtl/ha.) followed by medium (19.56 qtl/ha.) and small farmers (18.69 qtl/ha.). It is clear from the table that yields of sorghum increased with increase in size of land holdings. This increase may occur due to the fact that larger holdings enable farmers to use qualitative inputs in more efficient way than farmers with small holdings.

The gross return per hectare was observed to be ₹ 47476.13. The gross return was found to be highest for large farmers (₹ 48945.78) followed by medium (₹47617.69) and small farmers (₹ 45864.93). Similarly the net returns was highest for large (₹ 24539.73) followed by medium (₹ 22812.26) and small (₹ 20722.22) farmers. The higher value of output on large farmers might be associated with higher expenditure on modern farm inputs like hybrid seeds, tractor, reaper, thresher etc. The overall per hectare cost for sorghum cultivation was found to be ₹ 24784.40

which was highest for small (₹25142.73) followed by medium (₹ 24805.43) and large farmers (₹ 24406.05).The overall per hectare cost of production in sorghum cultivation was found to be ₹ 1278.09 which was highest for small (₹ 1345.25) followed by medium (₹ 1268.12) and large farmers (₹1221.00). Thus it can be concluded from the analysis that cost of production of sorghum was decreased with increase in land size categories.

Table 4.8 Category wise returns from sorghum cultivation

S.No	Particulars	Small (< 2ha.)	Medium (2-5 ha.)	Large (> 5 ha.)	Overall
1	Gross return (₹/ha.)	45864.93	47617.69	48945.78	47476.13
2	Total cost (₹/ha.)	25142.73	24805.43	24406.05	24784.40
3	Net return (₹/ha.)	20722.22	22812.26	24539.73	22691.73
4	Yield (qtl) – a. Main product b. By-product	 18.69 59.56	 19.56 60.40	 19.99 62.00	 19.41 60.50
5	Cost of production (₹/qtl)	1345.25	1268.12	1221.00	1278.09

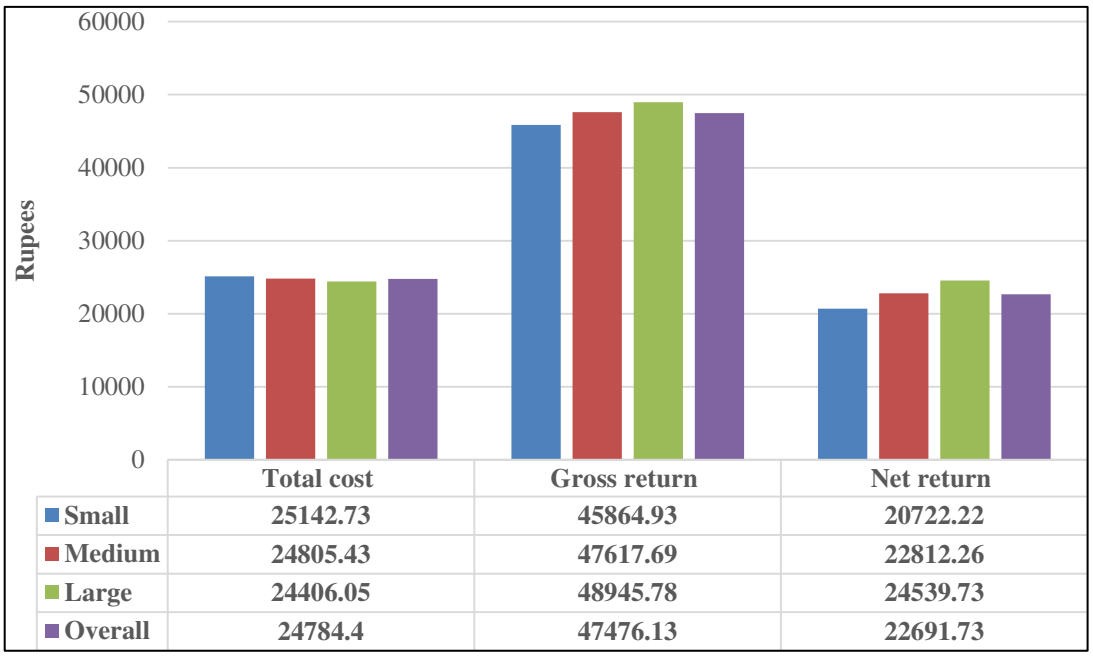

Fig. 4.4 Comparative cost and returns of *kharif* sorghum across various land size categories

4.3.3 Standard cost concepts

The standard cost concepts are presented in table 4.9. It was observed that, the overall cost A1 for per hectare sorghum cultivation was ₹17885.18. The cost A_1 and cost A_2 were found to be same, because there was no land taken on lease. The cost B_1, cost B_2, cost C_1 and Cost C_2 were found to be ₹18328.45, ₹ 21990.78, ₹ 21122.08 and ₹ 24784.40, respectively. The cost C_3 which takes into account the managerial function performed by farmers was ₹ 27262.84. All costs were comparatively higher for small farmers followed by medium and large farmers. It means that capital spending on production was decreased with the increase in land size categories. Because once the farm mechanized equipments purchased by the large farmers were used continuously season after season, hence no need to hire machineries which reduce the cost.

Table 4.9 Cost structures across various land size categories

(₹/ha.)

S.No	Cost items	Small (< 2ha.)	Medium (2-5 ha.)	Large (> 5 ha.)	Overall
1	Cost A_1	18076.40	17903.65	17675.49	17885.18
2	Cost A_2	18076.40	17903.65	17675.49	17885.18
3	Cost B_1	18526.40	18345.45	18113.49	18328.45
4	Cost B_2	22201.40	22007.45	21763.49	21990.78
5	Cost C_1	21467.74	21142.42	20756.09	21122.08
6	Cost C_2	25142.73	24804.43	24406.05	24784.40
7	Cost C_3	27657.00	27284.87	26846.65	27262.84

4.3.4 Returns from sorghum produce at market price compared with Minimum Support Price (MSP) of sorghum-2018

The returns at market price and MSP for per quintal of sorghum produce are presented in table 4.10. The overall market price per quintal of sorghum produce was ₹ 1511.15, which varied from ₹1501.15 on small category to ₹ 1521.15 on large category. Irrespective of the land size holding, MSP was found to be same for all category farmers about ₹ 2430 per quintal. The net return was calculated in two different ways both at market price and at MSP by considering cost items as cost A_2 plus family labour and cost C_2 separately. The overall net return at market price by

considering cost A2 plus FL as total cost of production was observed to be ₹ 445.78 per quintal, which increased with increase in land size category and if cost C_2 is considered as total cost the net return was observed to be ₹ 234.26 per quintal which also increased with increase in land size category. Similarly the overall net return at MSP by considering cost A_2 plus FL as total cost was found to be ₹ 1364.63 per quintal and if cost C2 is considered as total cost then net return was observed to be ₹ 1153.11. The difference between the net returns at MSP and market price was observed to be ₹ 918.85 per quintal, which decreased with increase in land size category. Hence as per the comparison done in table 4.10, it can be concluded that all category farmers in the study area will be benefitted if Government purchase the entire quantity of sorghum produce at MSP from the sorghum producers. Hence this step may contribute towards doubling the farmers income.

Table 4.10 Returns from sorghum produce at market price compared with Minimum Support Price

Particulars	Small (< 2ha.)	Medium (2-5 ha.)	Large (> 5 ha.)	Overall
1. Market price per quintal (₹)	1501.15	1511.15	1521.15	1511.15
2. Net return (market price) at Cost A_2 plus Family Labour	376.61	452.84	504.73	445.78
3. Net return (market price) at Cost C_2	155.89	243.03	300.24	234.26
4 MSP per quintal (₹)	2430	2430	2430	2430
5. Net return (MSP) at Cost A_2 plus Family Labour	1305.45	1371.69	1413.59	1364.63
6. Net return (MSP) at Cost C_2	1089.75	1161.88	1209.08	1153.11
Difference in net return (5-2)	928.85	918.85	908.85	918.85

4.3.5 Comparison of cost concepts

It is shown in table 4.11. As suggested by CACP procedure, if we calculate sorghum price for Bhilwara district it found to be ₹ 1598.05 which was found to be less than its MSP by ₹831.95. Similarly if we calculate sorghum price for Bhilwara district as per farmers demand it found to be ₹ 1915.33, which was also less than its

MSP by ₹514.67. Hence, it can be strongly concluded that sorghum growing households in the study area will definitely benefit if GOR start to purchase the produce at MSP in markets as per suggestion of GOI.

Table 4.11 Comparison of different cost concepts

(₹/ qtl)

S. No.	Particulars	Small (< 2ha.)	Medium (2-5 ha.)	Large (> 5 ha.)	Overall
1	Cost A_2	967.17	915.32	884.22	921.44
2	Owned Labour (FL)	157.37	142.99	132.19	143.93
3	50% of (Cost A_2+FL)	562.27	529.56	508.21	532.68
4	(Cost A_2+FL) + 50% of (Cost A_2+FL)	1686.82	1587.47	1524.62	1598.05
5	Cost C_2	1345.25	1268.12	1220.92	1276.89
6	50% of cost C_2	672.63	634.06	610.46	638.44
7	Cost C_2 + 50% of cost C_2	2017.88	1902.18	1831.37	1915.33
8	MSP of Sorghum-2018	2430.00	2430.00	2430.00	2430.00

4.4 Resource use structure in sorghum cultivation

For sorghum cultivation mainly human labour, machine labour, FYM, fertilizer, plant protection chemicals and seed were used as inputs in the study area. An attempt is made here to know how much quantity of variable inputs is used for per hectare sorghum cultivation.

I. Labour (Human)

It can be observed from the table 4.12 that, on an average 17.24 man days human labour was used for sorghum cultivation, comprising 13.93 family labour man-days and 3.31 hired labour man-days. The use of human labour was found to be maximum (17.29 man-days) for medium and minimum (17.16 man-days) for large size category of holdings. The use of family labour was found to be maximum for small (14.67 man-days) and minimum for large (13.18 man-days) size of holdings, because nearly all family members of small farmer were engaged themselves on farm to perform various agricultural operations. The use of hired labour was found

to be maximum for large (3.98 man-days) and minimum for small (2.61man-days) size of holdings, because of their large land holdings. The exact opposite relationship was found between the usage of family labour and hired labour among the sample households across various land size categories.

II. Labour (Machine)

As per the table 4.11 overall uses of Labour (Machine) was observed to be 13.45 hrs. for sorghum cultivation. The per hectare utilization of Labour (Machine) was observed maximum (14.26 hrs.) in case of large farmers followed by medium (13.16 hrs.) and small size farmers (12.94 hrs.). The use of machine power showed an increasing trend with the increase in size of holding, due to high labour cost of machine per hour, which cannot be afforded by small farmers. Hence some of the operations like harvesting, threshing and ploughing were performed by small farmers only.

III. Seed

Both hybrid and local seeds were used in the production of jowar. Nearly 25.6 kg of seed rate of sorghum was found to be used by sample households in a hectare. Nearly 25 kgs of seed was used by all category of land holding for per hectare sorghum cultivation.

IV. Manures

The overall usage of manure for per hectare sorghum cultivation was found to be 1.73 tonnes which was highest for small (2.18 tonnes/ha.) followed by medium (1.78 tonnes/ha.) and lowest for large (1.22 tonnes/ha.) farmers. Per hectare use of manure showed decreasing trend with land size holding, because manure becomes a scarce resource for application as size of land holding increases.

V. Fertilizers

On an average, the per hectare use of chemical fertilizer (urea) was observed to be 93.37 Kg./ha. The usage of fertilizer was highest for small (101.21 kg/ha.) followed by medium (90.60 kg/ha.) and large (88.33 kg/ha.) farmers.

VI. Plant protection charges

The overall plant protection chemicals usage was observed to be 0.92 ltr/ha. The large and medium size farmers used more plant protection chemicals than small farmers. Because plant protection chemicals are costly and might not be afforded by all small farmers.

Thus it can be concluded from the analysis of physical quantities of input use that use of family labour (man-days), manure (tonnes), urea (kg) was found to be decreased with increase in land size categories while hired labour (man-days), machine labour (hrs.) and plant protection charges (litres) were increased with increase in land size categories.

Table 4.12 Input utilization pattern in sorghum cultivation

(Quantity per hectare)

S.No	Inputs	Small (< 2ha.)	Medium (2-5 ha.)	Large (> 5 ha.)	Overall category
A	Family labour (man-days)	14.67	13.95	13.18	13.93
B	Hired labour (man-days)	2.61	3.34	3.98	3.31
1	Human labour (man-days) (a+b)	17.28	17.29	17.16	17.24
2	Machine Labour (hrs)	12.94	13.16	14.26	13.45
3	Seed (kg)	25.50	25.80	25.50	25.60
4	Manure (tonnes)	2.18	1.78	1.22	1.73
5	Fertilizer Urea (kg)	101.21	90.60	88.33	93.37
6	Plant protection (litre)	0.75	1.00	1.00	0.92

4.5 Labour cost in different operations of sorghum cultivation

Operation wise labour cost was presented in the table 4.13. The calculated labour cost include, family labour cost, hired labour cost and Labour (Machine) cost. The total per hectare labour cost was found to be ₹ 10347.80 which accounts 42.02

% of the total cost. Highest labour cost was incurred in harvesting then followed by threshing, sowing and ploughing operations which accounts 15.71, 15.06, 15.00 and 14.85 % to the total labour cost. The overall least labour cost was found in plant protection application (3.73 %) followed by transportation (5.39 %) and FYM and fertilizer application (8.30 %). The total labour cost was highest for large farmers (₹ 10767.59) followed by medium (₹ 10211.79) and small (₹ 10063.84) farmers. Because more hired labour utilization due to larger holdings.

Table 4.13 Operation wise labour cost of sorghum cultivation across different land size categories

(₹/ha.)

S.No	Operations	Small (< 2ha.)	Medium (2-5 ha.)	Large (> 5 ha.)	Overall
1	Ploughing	1500.00 (14.90)	1560.00 (15.28)	1550.00 (14.40)	1536.67 (14.85)
2	Sowing	1540.00 (15.30)	1550.00 (15.18)	1565.00 (14.53)	1551.67 (15.00)
3	FYM and fertilizer application	922.53 (9.17)	862.48 (8.45)	792.48 (7.36)	859.16 (8.30)
4	Weeding	1200.00 (11.92)	1154.99 (11.30)	1089.57 (10.12)	1148.18 (11.10)
5	Monitoring field	1150.87 (11.44)	1072.68 (10.50)	1148.87 (10.67)	1124.14 (10.86)
6	Plant protection	106.26 (1.06)	367.27 (3.60)	685.00 (6.36)	386.18 (3.73)
7	Harvesting	1625.75 (16.15)	1644.99 (16.11)	1606.34 (14.92)	1625.69 (15.71)
8	Threshing	1592.29 (15.82)	1558.25 (15.26)	1524.83 (14.16)	1558.46 (15.06)
9	Transportation	426.14 (4.24)	441.14 (4.32)	805.50 (7.48)	557.59 (5.39)
10	Total labour cost	10063.84 (100.00)	10211.79 (100.00)	10767.59 (100.00)	10347.80 (100.00)

Note: The parentheses values in the table indicate the percentage values to the total labour cost.

Thus, it can be concluded from the results of study that total labour cost which includes human and Labour (Machine) was increased with increase in land size categories. The % share of ploughing, sowing, FYM and fertilizer application, weeding, harvesting and threshing in total labour cost was decreased with increase in land size category while share plant protection chemical and transportation was increased with increase in land size category.

4.6 Cost and return analysis of green fodder cultivation of sorghum

Among 60 sample households, 8 farmers were growing sorghum for green fodder purpose. Table 4.14 presents the cost and return of per hectare green fodder sorghum cultivation. The total cost incurred for producing green fodder was ₹12715.09. The working cost was ₹8833.19 and overhead cost was ₹3881.9 which accounted nearly 69.47 and 30.53 % of total cost of cultivation of jowar green fodder crop, respectively. Owned labours, Labour (Machine) and seed cost were found to be the major items in working cost which constitutes nearly for 29.17, 13.76 and 13.19% of the overall cost of cultivation (COC), respectively.

Table 4.14 Cost and return analysis for green fodder sorghum cultivation

(₹/ha.)

S.No	Particulars	Amount	%
I	Variable cost		
1	Labour (family)	3709.25	29.17
2	Labour (machine)	1750.00	13.76
3	Seed	1677.72	13.19
4	FYM and Urea	893.27	7.03
5	Int. on working capital	803.02	6.32
	Subtotal variable cost	8833.19	69.47
II	Fixed cost		
1	Rented value of owned land	2786.00	21.91
2	Depreciation on implements	743.00	5.84
3	Int. on fixed cost	352.90	2.78
	Subtotal fixed cost	3881.90	30.53
III	Cost of cultivation (COC)	12715.09	100.00
IV	Returns from sorghum green fodder	23040.00	
V	Net returns	10324.91	
VI	Cost of productions (₹/qtl)	165.56	
VII	Returns per quintal	134.44	

FYM and fertilizers cost accounted nearly 7.03 % of the total cost of cultivation green fodder jowar crop. Rental value of owned land and depreciation on farm implements found to be the main factors of overhead cost which constitutes nearly 21.91 and 5.84 % of the overall COC, respectively. The cost of production a quintal of green fodder of jowar was found to be ₹165.56. Gross return was ₹ 23040. A farmer had got net return of ₹ 10324.91 per hectare by cultivating sorghum for green fodder purpose. On an average, 76.8 qtl of green fodder was obtained from one hectare of land. None of the farmer used hired labour for green fodder sorghum cultivation.

4.7 Input – output relationship

Linear production function for small, medium, large and overall farmers has been estimated and presented in table 4.15 by considering the effect of seven independent variables on sorghum output in the study area. A close observation of the table revealed that the coefficient of multiple determination (R^2) for overall sample households was 0.63 which indicated that 63 % of total variation in sorghum output was explained by the variables included in the linear multiple regression model. Similarly for small, medium and large farmer's category it was found to be 0.94, 0.90, 0.89, respectively.

For overall category the values of regression co-efficient of area (0.309), seed (0.338) and fertilizer (0.097) were observed as positive and significant at 5%, whereas manure (0.121), plant protection (0.041), human labour (0.061) and machine labour (0.095) were observed to be positive and statistically non-significant at overall level. This indicated that per unit increase in area, seed and fertilizer results in increase in sorghum output quantity by their respective coefficients values.

For small farmers' category, the values of coefficient of seed (0.282) and fertilizer (0.128) were found to be positive and significant, whereas manure (0.026), plant protection (0.027), area (0.844) and machine labour (0.014) were found to be positive and statistically non-significant. The value of coefficient of human labour (-0.053) was found to be negative and non-significant.

Table 4.15 Input-output relationship for sorghum crop under different land size category

Category	Intercept	Regression co-efficients							R^2
		X_1 (Area)	X_2 (Seed)	X_3 (Manure)	X_4 (Fertilizer)	X_5 (Plant Protection)	X_6 (Human Labour)	X_7 (Machine Labour)	
Small (< 2 ha.)	0.551 (1.824)	0.844 (0.419)	0.282* (0.072)	0.026 (0.268)	0.128* (0.026)	0.027 (0.083)	-0.053 (0.014)	0.014 (0.067)	0.94
Medium (2-5 ha.)	8.351 (0.772)	0.915** (0.265)	0.398** (0.098)	0.066 (0.178)	0.026 (0.012)	-0.208 (0.118)	0.020 (0.056)	0.090 (0.079)	0.90
Large (> 5 ha.)	65.355 (12.312)	2.323** (0.723)	0.189 (0.692)	0.083 (1.666)	1.116** (0.316)	4.944 (9.523)	1.368 (0.698)	-0.264 (0.353)	0.89
Overall	0.595 (3.133)	0.309** (0.117)	0.338** (0.099)	0.121 (0.520)	0.097** (0.047)	0.041 (0.198)	0.061 (0.115)	0.095 (0.133)	0.63

Figures in parentheses shows the standard error of concerned regression coefficients

(** and * indicates 5 and 1 % level of significance, respectively.)

For medium farmers category, the values of coefficient of area (0.915) and seed (0.398) were found to be positive and highly significant, whereas manure (0.066), human labour (0.02), fertilizer (0.026) and machine labour (0.09) were found to be positive and non-significant. The value of coefficient plant protection chemicals (-0.208) was found to be negative and non-significant.

For large size category, the values of coefficient of area (2.323) and fertilizer (1.116) were found to be positive and significant, whereas seed (0.189), manure (0.083), plant protection (4.944) and human labour (1.368) were found to be positive and non-significant. The value of coefficient of machine labour (-0.264) was found to be negative and statistically non-significant.

4.8 Various constraints faced by sorghum growers

The opinions of sample household, regarding the constraints faced by the farmers in the production of sorghum are presented. Mainly 3 types of constraints were faced by sorghum growers, namely production, marketing and MSP related constraints. The details of identified constraints are presented as follows:

4.8.1 Constraints faced by farmers in sorghum production

The constraints faced by farmers in sorghum cultivation in the study area have been depicted in table 4.16. As reported by most of the farmers, crop damaged by wild animals (especially Neelgai or Rozda) was the major constraint (with Garrett Score 77.00) in sorghum production and therefore this problem was assigned first rank followed by damage of crop due to pests and diseases (with Garrett Score 64.00), high labour cost at peak period (with Garrett Score 46.73), lack of knowledge about seed treatment(45.80), non-availability of labour during the peak period (44.63) and non-availability of quality seed material (23.00) which were given second, third, fourth, fifth and sixth ranks respectively, by the sample households.

Table 4.16 Constraints faced by farmers in sorghum production

S.No	Production constraints	Score	Rank
1	Crop damaged by wild animals (Neelgai)	77.00	I
2	Incidence of pest and diseases	64.00	II
3	High cost of labour at peak period	46.73	III
4	Lack of knowledge about seed treatment	45.80	IV
5	Non availability of labour during peak period	44.63	V
6	Non availability of quality seed material	23.00	VI

4.8.2 Constraints faced by farmers in marketing of sorghum produce

The constraints faced by farmers in marketing of sorghum produce in the study area have been depicted in table 4.17. Among 8 marketing constraints, price fluctuations was the major constraint (with Garrett Score 79.00) faced by the majority of farmers and hence it was assigned first rank followed by non-availability of market related information (with Garrett Score 56.90), poor transport facility (with Garrett Score 52.18) high cost of transportation (with Garrett Score 50.40), malpractice in weighing (with Garrett Score 48.56), small quantity of marketable surplus (with Garrett Score 46.65), market places are far away (with Garrett Score 46.40), and delayed payment by traders (with Garrett Score 21.00) which were given second, third, fourth, fifth, sixth, seventh and eighth rank respectively.

Table 4.17 Constraints faced by farmers in marketing of sorghum produce

S.No	Constraints	Score	Rank
1	Price fluctuations	79.00	I
2	Non-availability of market related information	56.90	II
3	High cost of transportation	50.40	IV
4	Malpractice in weighing	48.56	V
5	Small quantity of marketable surplus	46.65	VI
6	Market places are faraway	46.40	VII
7	Poor transport facility	52.18	III
8	Delayed payment by traders	21.00	VIII

4.8.2 Constraints faced by farmers related to MSP

None of the sorghum producers showed their interests to reply on constraints related to minimum support price namely; MSP purchasing centres located at distant places, entire quantity of sorghum produce not purchased by MSP centre, more time required to sale produce at MSP purchasing centres and delayed in opening of MSP purchasing centres and untimely payment through cheque mode, because purchasing centre for sorghum produce at MSP was not opened by Government of Rajasthan till today.

4. RESULTS AND DISCUSSION

Commensurate with the objectives set worth for the current study, the outcomes of the research study on "An economic analysis of sorghum cultivation in Bhilwara district of Rajasthan" have been set in the forms of tables in this chapter as given below:

4.1 Social-economical features of sampled households
- 4.1.1 Family size and composition
- 4.1.2 Educational status of head of household
- 4.1.3 Age of head of household
- 4.1.4 Consumption of sorghum *chapatti*
- 4.1.5 Herd size category

4.2 CAGR (Compound Growth Rate) for area, production and yield of sorghum in Bhilwara and Rajasthan
- 4.2.1 Compound growth rate in area of sorghum
- 4.2.2 Compound growth rate in production of sorghum
- 4.2.3 Compound growth rate in productivity of sorghum

4.3 Cost and returns of *kharif* sorghum cultivation
- 4.3.1 Cost of sorghum cultivation
- 4.3.2 Profitability of sorghum cultivation
- 4.3.3 Standard cost concepts
- 4.3.4 Returns compared with MSP of sorghum-2018
- 4.3.5 Comparision of cost concepts

4.4 Resource use structure in sorghum cultivation

4.5 Labour cost in different operations of sorghum cultivation

4.6 Cost and return analysis of green fodder cultivation of sorghum

4.7 Input – output relationship

4.8 Various constraints faced by sorghum growers
- 4.8.1 Constraints faced by farmers in sorghum cultivation
- 4.8.2 Constraints faced by farmers in marketing of sorghum produce
- 4.8.3 Constraints faced by farmers related to Minimum Support Price (MSP)

4.1 Social-economical features of sample households

The objective of this section is to examine the basic characteristics of the sample households that may have a profound influence on the decision-making process and profitability of the sorghum cultivation. Rural households in a typical village community in India exhibit great heterogeneity in socio-economic characteristics and Rajasthan is no exception to this rule. The data for the study were collected from 60 farming households in Bhilwara district of Rajasthan. An attempt has made in this section to document the important socio-economic characteristics of the sample households. It includes family size and composition, educational status of head of the household, age of head of household, consumption of sorghum *chapatti* and livestock inventory.

4.1.1 Family size and composition

Family size and its composition is an important contributory factor in agricultural occupation, because it's a labour intensive activity, and much of the labour requirements are met from the family itself. The particulars relating to this factor are presented in table 4.1. The average family size was found to be 7.63 in the study area. Proportion of males (3.03) was higher than females (2.37) in sample households. The average family size was highest for large (7.82) farmers followed by small (7.69) and medium (7.37) category. In the study area it was observed that there was no such difference in family size according to their land size category.

Table 4.1 Average family size and composition of sorghum producers

(Number)

Land size category	Adult males	Adult females	Children	Total
Small (<2 ha.)	3.26	2.42	2.01	7.69
Medium (2-5 ha.)	2.86	2.55	1.96	7.37
Large (>5 ha.)	2.97	2.14	2.71	7.82
Overall	3.03	2.37	2.23	7.63

4.1.2 Educational status of head of household

Education is the main pillar for development in any community. Better education enables better comprehension of farming techniques and their possible

adoption in farm enterprises. The distribution of sample households according to the education of head of the household is presented in Table 4.2. It was observed that, on an average 83.33 % of the total sample households were found to be literate in the study area. The distribution of sorghum growing households as per their education level shows that, out of total number of households, 28 had primary school education accounting about 46.67 % of the total sampled households, 9 had education of middle school accounting about 15 % of the total number of sampled households, 6 were having upto higher secondary which nearly constitutes 10 % of the total households and 7 farmers were having education upto graduation or post graduation which constitues 11.67 % of the total households and only 10 farmers were found to be illiterate constituting 16.66 % of the total respondents. The literacy (%) was found to be highest in the large size category followed by medium and small farmer's category accounting about 92.30, 88.24 and 76.67 %, respectively. It was observed that literacy level of households was increased with the increase in land size category.

Table 4.2 Distribution of households according to educational status

(Number)

Education level	Small (< 2ha.)	Medium (2-5 ha.)	Large (> 5 ha.)	Overall
a. Illiterate	7 (23.33)	2 (11.76)	1 (7.69)	10 (16.66)
b. Primary school (Class 1 to 6)	14 (46.67)	9 (52.94)	5 (38.46)	28 (46.67)
c. Middle school (Class 7 to10)	4 (13.33)	2 (11.77)	3 (23.07)	9 (15.00)
d. Higher secondary (Class 11 to 12)	3 (10.00)	1 (5.88)	2 (15.39)	6 (10.00)
e. Graduation/post graduation	2 (6.67)	3 (17.65)	2 (15.39)	7 (11.67)
Total households	30 (100)	17 (100)	13 (100)	60 (100)
Rate of literacy (%)	76.67	88.24	92.30	83.33

Figures in parentheses indicate the percentages to total number of households.

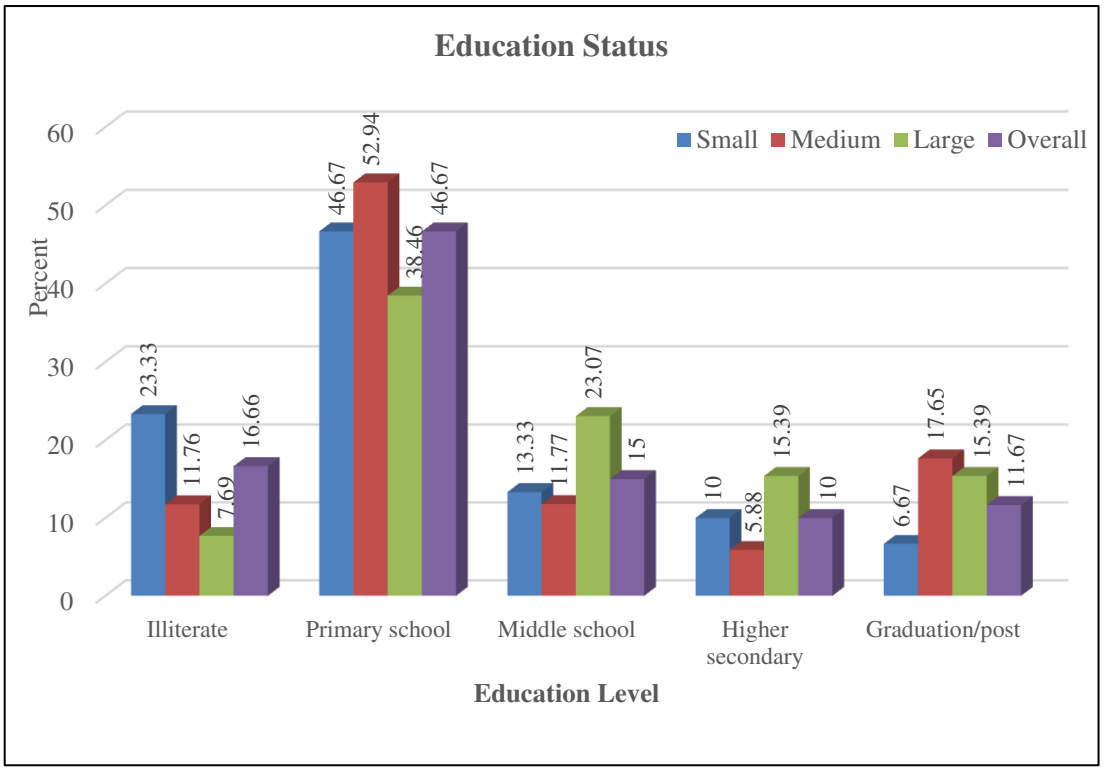

Fig. 4.1 Educational status of sample households

4.1.3 Age of head of household

The distribution of sample households according to the age of head of the household is presented in Table 4.3. The age of the sample households were divided into 3 category *i.e.,* farmers ageing between 21 to 35 years, 36-50 years and 51to 65 years. Out of the total households, 16 farmers were aged between 21 to 35 years, 24 farmers were aged between 36 to 50 years and 20 farmers were aged between 51 to 65 years, which constitutes nearly 26.67, 40.00 and 33.33 % of the total no. of sampled households, respectively. On an average, age of head of family was 33, 47 and 58 years for households aged between 21-35, 36-50 and 51-65 years group, respectively. On an average, age of the jowar growing households was found to be 46 years. It was found that farmers ageing between 36-50 years were engaged more in sorghum cultivation as compared to other age groups in the study area.

Table 4.3 Distribution of households according to age of head of household

(Years)

Category (age)	Small (< 2ha.)	Medium (2-5 ha.)	Large (> 5 ha.)	Total	Average age (year)
a. 21-35	8 (26.67)	4 (23.53)	4 (30.77)	16 (26.67)	33
b. 36-50	12 (40.00)	7 (41.18)	5 (38.46)	24 (40.00)	47
c. 51-65	10 (33.33)	6 (35.29)	4 (30.77)	20 (33.33)	58
Grand total	30 (100)	17 (100)	13 (100)	60 (100)	46

Figures in parentheses indicate the percentages to total number of households.

4.1.4 Consumption of sorghum *chapatti*

Sorghum is a coarse cereal crop. Consumption of sorghum *chapatti* by sample households is given in table 4.4. It could be seen that, only 12 farmers (20 %) were preferring sorghum *chapatti* occasionally out of 60, while rest of farmers were not preferring sorghum *chapatti*, because they prefer to consume wheat as the major diet component. Out of 12 farmers, 66.67 % preferred due to taste and 33.33 % due to nutritive value, while none of farmer give preference to sorghum *chapatti* on the basis of less price. Moreover, among 12 farmers, 2 farmers (16.66 %) were preferred sorghum *chapatti* for once in a week, 5 (41.67 %) farmers were preferred alternate days in a week and remaining 5 farmers (41.67 %) were preferred sorghum *chapatti* fifteen days in a month. It was found that there was no daily consumption of sorghum *chapatti* by any sample households in the study area.

Table 4.4 Consumption of sorghum *chapatti* by sample households

1	How many farmers preferred sorghum *chapatti*	
	(I) Yes	12 (20.00)
	(II) No	48 (80.00)
2	Reason for preference of sorghum *chapatti*	
	(I) Taste	8 (66.67)
	(II) Nutritive value	4 (33.33)
	(III) Less price	0 (0.00)
3	Consumption pattern towards sorghum *chapatti*	
	(I) Daily	0 (0.00)
	(II) Once in a week	2 (16.66)
	(III) Alternate days in a week	5 (41.67)
	(IV) Fifteen days in a month	5 (41.67)

Figures in parentheses indicate the percentages to total number of households.

4.1.5 Livestock inventory

Herd size wise distribution of animals is presented in table 4.5. On an average, a sorghum grower household maintained a herd size of 3.78 standard animal units. Small, medium and large sorghum producing sample households maintained a herd size of 2.37, 3.79 and 5.19 standard animal unit, respectively. Further it was found that the standard animal units maintained by households increased with increase in land size holdings. Only adult animals were considered in forming Standard Animal Unit.

Table 4.5 Herd size distribution of animals

(Standard Animal Unit)

Herd size category	Crossbred cow	Local cow	Buffalo	Total
Small (1-2)	1.12	0.64	0.61	2.37
Medium (3-4)	1.45	1.23	1.11	3.79
Large (5-6)	2.01	1.84	1.34	5.19
Overall	1.53	1.24	1.02	3.78

4.2 CAGR (Compounded Annual Growth Rate) for area, production and productivity of jowar crop in Bhilwara and Rajasthan

The CAGR of area, production, and productivity of jowar for Bhilwara district and for the Rajasthan state was calculated separately for both state and district for 25 years from the period 1991-92 to 2015-16. The annual growth rates in area, production and productivity of sorghum both in Bhilwara and Rajasthan were found to be positive and significant.

4.2.1 Compound annual growth rate in area of sorghum

CAGR for area in jowar crop in Rajasthan and Bhilwara are given in table no. 4.6. The outcomes of the calculation revealed that there has seen a positive growth in area under sorghum cultivation both in Rajasthan and Bhilwara. The total area allocated by the farmers in the state under sorghum cultivation had decreased from 707669 hectares to 631188 hectares during 1991-92 to 2015-16, but still there was an growth of 2.20% in sorghum area. The total area allocated by the farmers under sorghum cultivation in Bhilwara district had increased from 26788 hectares to 43047 hectares during 1991-92 to 2015-16 with growth of 1.02% in area under sorghum cultivation.

The positive growth rates of sorghum area in both Rajasthan state and Bhilwara district were found to be significant. The expansion of area under this crop was mainly due to its important features like capacity to withstand drought conditions, very good adaptability in marginal lands and even well in low rainfall areas and it makes comparatively quick growth and gives not only good yields of grain but also very large quantities of fodder.

4.2.2 Compound growth rate in production of sorghum

It was observed from table 4.6 that the production of sorghum in Rajasthan and Bhilwara had increased from 157427 metric tonnes to 344287 metric tonnes and 657 metric tonnes to 12081 metric tonnes during 1991-92 to 2015-16, respectively. During study period (1991-92 to 2015-16), production of jowar at district and in state level found positive growth rate of 12.54 and 3.21% per year respectively. It shows that the total production also revealed increasing trend year by year in both Rajasthan and Bhilwara.

The significant positive growth in production of sorghum in Rajasthan state and Bhilwara district could be explained by the effect of positive growth in productivity of sorghum. It was productivity led growth.

4.2.3 Compound growth rate in productivity of sorghum

The results presented in table 4.6 indicated that, the productivity of sorghum in Rajasthan and Bhilwara had increased from 222 to 545 kg/ha. and 25 to 281 kg/ha. during 1991-92 to 2015-16, respectively. The growth analysis for sorghum productivity indicates that it was growing with a CAGR of 3.34 and 11.42% per year at state and district level, respectively in the course of same time period.

The positive growth rate in sorghum productivity in Rajasthan and Bhilwara district was found significant. It might be due to shift from local seeds usage to hybrid seeds for cultivation purpose and adoption of improved agronomic practices like intercropping and crop rotation with other crops.

Table 4.6 Growth in area, production and productivity of sorghum

S.No	Year	Area (hectare)		Production (metric tonnes)		Productivity (Kg/ha.)	
		Bhilwara	Rajasthan	Bhilwara	Rajasthan	Bhilwara	Rajasthan
1	1991	26788	707669	657	157427	25	222
2	1992	31281	775419	21980	411519	703	531
3	1993	33118	660624	143	160479	4	243
4	1994	36651	678602	34914	273065	953	402
5	1995	31545	593507	2510	139447	80	235
6	1996	31694	62263	22678	290851	716	467
7	1997	27069	56127	26197	267120	967	476
8	1998	28602	535285	51	153760	1.78	287
9	1999	29612	555954	7167	173226	242	312
10	2000	36069	673989	254	134525	7.04	200
11	2001	39185	614653	30109	254398	768	414
12	2002	38232	532393	57	68484	2	129
13	2003	44780	738999	27761	527422	619	714
14	2004	38671	568639	25160	263900	650	464
15	2005	38176	592092	1539	169732	40	287
16	2006	37990	662055	33451	367816	881	556
17	2007	30933	625646	19121	394746	618	631
18	2008	27987	576569	11792	332939	421	577
29	2009	40080	718457	4870	104192	122	145
20	2010	54236	726911	34793	508901	642	700
21	2011	36746	553754	27861	410114	758	741
22	2012	35308	680375	53613	420393	1518	618
23	2013	33025	579615	29175	356672	883	615
24	2014	32327	660969	30270	504560	936	763
25	2015	43047	631188	12081	344287	281	545
	CAGR (%)	1.02*	2.20*	12.54*	3.21*	11.42*	3.34*

Source- Agriculture Statistics at a Glance- 1991-92 to 2015-16, Directorate of Economics and Statistics GOR, Jaipur

Note: * Significant @ 1%

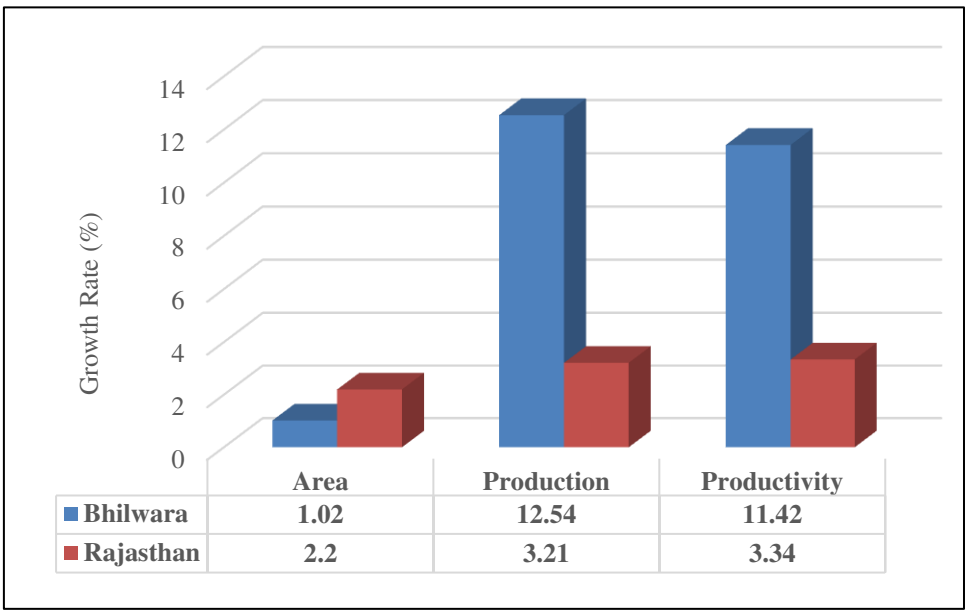

Fig. 4.2 Growth in area, production and productivity of sorghum during the period 1991-92 to 2015-16

4.3 Economics of sorghum production

In order to understand sorghum cultivation from its economic perspective, it is essential to study the costs, be it implicit or explicit that goes into its cultivation. Generally, a farmer can increase his production in two ways i.e., (I) by increasing sorghum production and (II) by reducing cost of sorghum cultivation. The second factor can be achieved through judicious use of various factors of production. Among 60 sample households, 52 households were growing sorghum for grain purpose *i.e.,* it includes 27 small farmers, 14 medium farmers and 11 large farmers.

4.3.1 Cost of sorghum cultivation

The per hectare cost incurred in sorghum cultivation is presented in table 4.7. It was found out that, the overall total cost of cultivation was ₹ 24784.40 which constitute 80.33 % of variable cost (₹ 19908.47) and 19.67 % of fixed cost (₹ 4875.90). Machinery and equipment labour was revealed to be the main item of the working cost which nearly constitutes 27.14 % of the total cost of cultivation (COC) of jowar crop, because in Bhilwara district, machine was used in ploughing, sowing, harvesting and post-harvesting operations. Seeds, human labour, manures, plant protection chemicals and fertilizers were the next major cost items of the overall variable cost accounting for 15.04, 14.61, 10.22, 3.54 and 2.48 % of total cost of

cultivation, respectively. Bullock labour cost was zero *i.e.,* not a single farmer was found using bullock power for land preparation and sowing operations in study area. By this it can be concluded that farmers are interested towards mechanization. Rental value of owned land followed by depreciation of the farm implements and machineries were found to be the major contributors of total fixed cost accounting about 14.78 and 3.11 %, respectively. It was found that per hectare total cost of cultivation was highest for small farmers followed by medium and large farmers *i.e.,* ₹ 25142.73, ₹ 24804.43 and ₹ 24406.05, respectively. For small farmers, due to small piece of land under sorghum cultivation which lead to more per hectare total cost of cultivation. In overall total variable cost and total fixed cost, small farmers were the major contributors followed by medium and large farmers accounting variable cost of about ₹ 20192.73, ₹19944.63 and ₹ 19588 respectively and fixed cost of about ₹ 4950, ₹ 4859.80 and ₹ 4818 respectively.

Labour (Machine) and hired human labour cost were highest among large farmers followed by medium and small farmers due to more mechanized nature of farming in comparison to small size group of farmers. Family labour, manure and fertilizer application cost was highest among small farmers followed by medium and large farmers. Depreciation cost was more for small farmers and less for large farmers; it might be due to heavy machineries used year round by large farmers' hence good care and maintenance was done by them. Thus it may be concluded from the results of study that total cost decreased with increase in land size category of households. The same trend was also true for variable and fixed cost across the various land size categories. The share of hired human labour, total human labour and Labour (Machine) was increased with increase in land size categories while opposite trend was observed in case of family labour. Prevailing market prices of important inputs and wage rates employed in sorghum cultivation in *Annexure V*.

Table 4.7: Cost of Sorghum cultivation across different land size categories

(`/ha.)

S.No	Cost items	Small (< 2ha.)		Medium (2-5 ha.)		Large (> 5 ha.)		Overall	
		Amount	Per Cent	Amount	Per cent	Amount	Per Cent	Amount	Per Cent
1	Labour (Family)	2941.34	11.70	2796.97	11.28	2642.60	10.83	2793.64	11.27
2	Labour (Hired)	652.50	2.60	835.00	3.37	995.00	4.08	827.50	3.34
	Total labour (human)	3593.84	14.29	3631.97	14.64	3637.60	14.91	3621.13	14.61
3	Labour (Machine)	6470.00	25.73	6580.00	26.53	7130.00	29.21	6726.67	27.14
4	Seed	3712.80	14.77	3756.48	15.14	3712.80	15.21	3727.36	15.04
5	Manure	3196.49	12.71	2609.98	10.52	1788.90	7.33	2531.78	10.22
6	Fertilizer	666.91	2.65	597.05	2.41	582.09	2.39	615.38	2.48
7	Plant protection Charges	717.00	2.85	956.00	3.85	956.00	3.92	876.33	3.54
8	Int. on working capital	1835.70	7.30	1813.14	7.31	1780.70	7.29	1809.47	7.30
	Subtotal (variable cost)	20192.73	80.31	19944.63	80.41	19588.00	80.26	19908.47	80.33
9	Rental Value of owned land	3675.00	14.62	3662.00	14.76	3650.00	14.96	3662.33	14.78
10	Depreciation on farm implements	825.00	3.28	756.00	3.05	730.00	2.99	770.33	3.11
11	Interest on fixed capital	450.00	1.79	441.80	1.78	438.00	1.79	443.27	1.78
	Subtotal (fixed cost)	4950.00	19.69	4859.80	19.59	4818.00	19.74	4875.90	19.67
	Total Cost	25142.73	100	24804.43	100	24406.05	100	24784.40	100

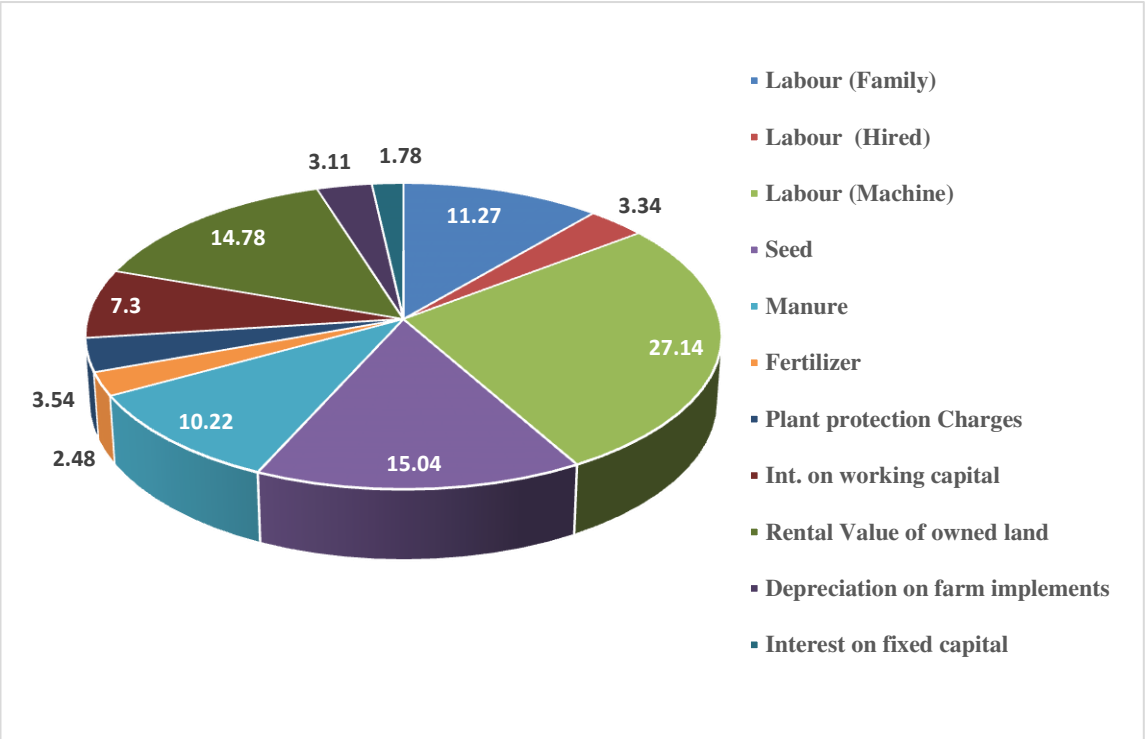

Fig. 4.3 Share of Cost in Kharif Sorghum cultivation (per hectare)

4.3.2 Profitability of sorghum cultivation

Category wise returns from sorghum cultivation are presented in table 4.8. It was observed that overall grain yield and dry fodder yield per hectare of sorghum cultivation was 19.41 quintal, and 60.50 quintal, respectively. It was observed that highest yield was seen in large farmers category (19.99 qtl/ha.) followed by medium (19.56 qtl/ha.) and small farmers (18.69 qtl/ha.). It is clear from the table that yields of sorghum increased with increase in size of land holdings. This increase may occur due to the fact that larger holdings enable farmers to use qualitative inputs in more efficient way than farmers with small holdings.

The gross return per hectare was observed to be ₹ 47476.13. The gross return was found to be highest for large farmers (₹ 48945.78) followed by medium (₹47617.69) and small farmers (₹ 45864.93). Similarly the net returns was highest for large (₹ 24539.73) followed by medium (₹ 22812.26) and small (₹ 20722.22) farmers. The higher value of output on large farmers might be associated with higher expenditure on modern farm inputs like hybrid seeds, tractor, reaper, thresher etc. The overall per hectare cost for sorghum cultivation was found to be ₹ 24784.40

which was highest for small (₹25142.73) followed by medium (₹ 24805.43) and large farmers (₹ 24406.05).The overall per hectare cost of production in sorghum cultivation was found to be ₹ 1278.09 which was highest for small (₹ 1345.25) followed by medium (₹ 1268.12) and large farmers (₹1221.00). Thus it can be concluded from the analysis that cost of production of sorghum was decreased with increase in land size categories.

Table 4.8 Category wise returns from sorghum cultivation

S.No	Particulars	Small (< 2ha.)	Medium (2-5 ha.)	Large (> 5 ha.)	Overall
1	Gross return (₹/ha.)	45864.93	47617.69	48945.78	47476.13
2	Total cost (₹/ha.)	25142.73	24805.43	24406.05	24784.40
3	Net return (₹/ha.)	20722.22	22812.26	24539.73	22691.73
4	Yield (qtl) – a. Main product b. By-product	 18.69 59.56	 19.56 60.40	 19.99 62.00	 19.41 60.50
5	Cost of production (₹/qtl)	1345.25	1268.12	1221.00	1278.09

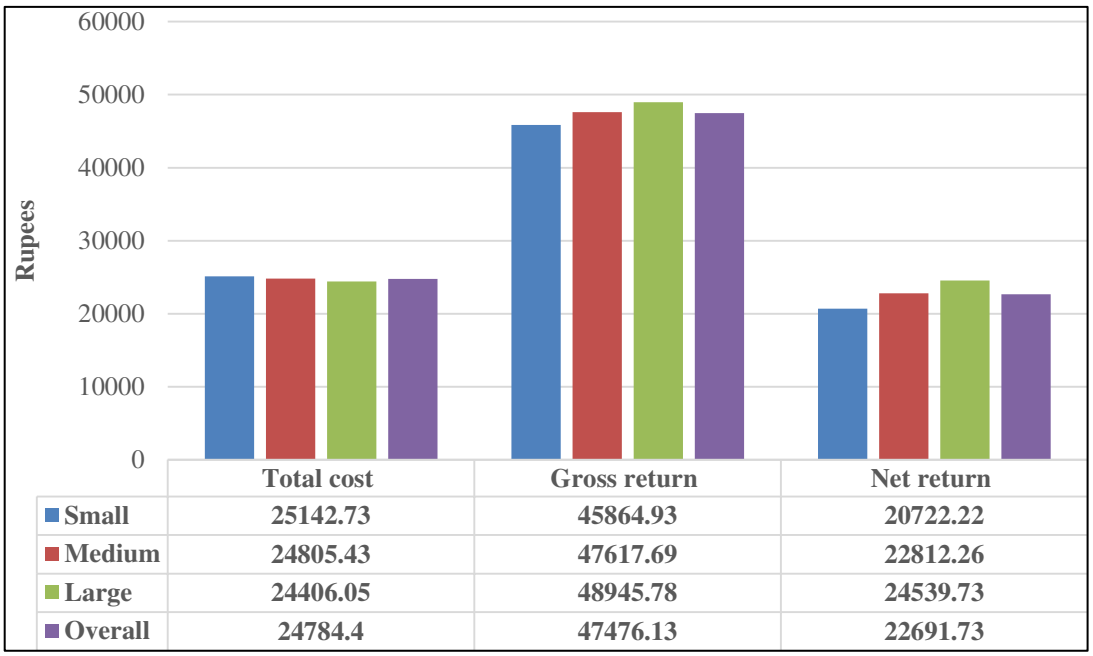

Fig. 4.4 Comparative cost and returns of *kharif* sorghum across various land size categories

4.3.3 Standard cost concepts

The standard cost concepts are presented in table 4.9. It was observed that, the overall cost A1 for per hectare sorghum cultivation was ₹17885.18. The cost A_1 and cost A_2 were found to be same, because there was no land taken on lease. The cost B_1, cost B_2, cost C_1 and Cost C_2 were found to be ₹18328.45, ₹ 21990.78, ₹ 21122.08 and ₹ 24784.40, respectively. The cost C_3 which takes into account the managerial function performed by farmers was ₹ 27262.84. All costs were comparatively higher for small farmers followed by medium and large farmers. It means that capital spending on production was decreased with the increase in land size categories. Because once the farm mechanized equipments purchased by the large farmers were used continuously season after season, hence no need to hire machineries which reduce the cost.

Table 4.9 Cost structures across various land size categories

(₹/ha.)

S.No	Cost items	Small (< 2ha.)	Medium (2-5 ha.)	Large (> 5 ha.)	Overall
1	Cost A_1	18076.40	17903.65	17675.49	17885.18
2	Cost A_2	18076.40	17903.65	17675.49	17885.18
3	Cost B_1	18526.40	18345.45	18113.49	18328.45
4	Cost B_2	22201.40	22007.45	21763.49	21990.78
5	Cost C_1	21467.74	21142.42	20756.09	21122.08
6	Cost C_2	25142.73	24804.43	24406.05	24784.40
7	Cost C_3	27657.00	27284.87	26846.65	27262.84

4.3.4 Returns from sorghum produce at market price compared with Minimum Support Price (MSP) of sorghum-2018

The returns at market price and MSP for per quintal of sorghum produce are presented in table 4.10. The overall market price per quintal of sorghum produce was ₹ 1511.15, which varied from ₹1501.15 on small category to ₹ 1521.15 on large category. Irrespective of the land size holding, MSP was found to be same for all category farmers about ₹ 2430 per quintal. The net return was calculated in two different ways both at market price and at MSP by considering cost items as cost A_2 plus family labour and cost C_2 separately. The overall net return at market price by

considering cost A2 plus FL as total cost of production was observed to be ₹ 445.78 per quintal, which increased with increase in land size category and if cost C_2 is considered as total cost the net return was observed to be ₹ 234.26 per quintal which also increased with increase in land size category. Similarly the overall net return at MSP by considering cost A_2 plus FL as total cost was found to be ₹ 1364.63 per quintal and if cost C2 is considered as total cost then net return was observed to be ₹ 1153.11. The difference between the net returns at MSP and market price was observed to be ₹ 918.85 per quintal, which decreased with increase in land size category. Hence as per the comparison done in table 4.10, it can be concluded that all category farmers in the study area will be benefitted if Government purchase the entire quantity of sorghum produce at MSP from the sorghum producers. Hence this step may contribute towards doubling the farmers income.

Table 4.10 Returns from sorghum produce at market price compared with Minimum Support Price

Particulars	Small (< 2ha.)	Medium (2-5 ha.)	Large (> 5 ha.)	Overall
1. Market price per quintal (₹)	1501.15	1511.15	1521.15	1511.15
2. Net return (market price) at Cost A_2 plus Family Labour	376.61	452.84	504.73	445.78
3. Net return (market price) at Cost C_2	155.89	243.03	300.24	234.26
4 MSP per quintal (₹)	2430	2430	2430	2430
5. Net return (MSP) at Cost A_2 plus Family Labour	1305.45	1371.69	1413.59	1364.63
6. Net return (MSP) at Cost C_2	1089.75	1161.88	1209.08	1153.11
Difference in net return (5-2)	928.85	918.85	908.85	918.85

4.3.5 Comparison of cost concepts

It is shown in table 4.11. As suggested by CACP procedure, if we calculate sorghum price for Bhilwara district it found to be ₹ 1598.05 which was found to be less than its MSP by ₹831.95. Similarly if we calculate sorghum price for Bhilwara district as per farmers demand it found to be ₹ 1915.33, which was also less than its

MSP by ₹514.67. Hence, it can be strongly concluded that sorghum growing households in the study area will definitely benefit if GOR start to purchase the produce at MSP in markets as per suggestion of GOI.

Table 4.11 Comparison of different cost concepts

(₹/ qtl)

S. No.	Particulars	Small (< 2ha.)	Medium (2-5 ha.)	Large (> 5 ha.)	Overall
1	Cost A_2	967.17	915.32	884.22	921.44
2	Owned Labour (FL)	157.37	142.99	132.19	143.93
3	50% of (Cost A_2+FL)	562.27	529.56	508.21	532.68
4	(Cost A_2+FL) + 50% of (Cost A_2+FL)	1686.82	1587.47	1524.62	1598.05
5	Cost C_2	1345.25	1268.12	1220.92	1276.89
6	50% of cost C_2	672.63	634.06	610.46	638.44
7	Cost C_2 + 50% of cost C_2	2017.88	1902.18	1831.37	1915.33
8	MSP of Sorghum-2018	2430.00	2430.00	2430.00	2430.00

4.4 Resource use structure in sorghum cultivation

For sorghum cultivation mainly human labour, machine labour, FYM, fertilizer, plant protection chemicals and seed were used as inputs in the study area. An attempt is made here to know how much quantity of variable inputs is used for per hectare sorghum cultivation.

I. Labour (Human)

It can be observed from the table 4.12 that, on an average 17.24 man days human labour was used for sorghum cultivation, comprising 13.93 family labour man-days and 3.31 hired labour man-days. The use of human labour was found to be maximum (17.29 man-days) for medium and minimum (17.16 man-days) for large size category of holdings. The use of family labour was found to be maximum for small (14.67 man-days) and minimum for large (13.18 man-days) size of holdings, because nearly all family members of small farmer were engaged themselves on farm to perform various agricultural operations. The use of hired labour was found

to be maximum for large (3.98 man-days) and minimum for small (2.61man-days) size of holdings, because of their large land holdings. The exact opposite relationship was found between the usage of family labour and hired labour among the sample households across various land size categories.

II. Labour (Machine)

As per the table 4.11 overall uses of Labour (Machine) was observed to be 13.45 hrs. for sorghum cultivation. The per hectare utilization of Labour (Machine) was observed maximum (14.26 hrs.) in case of large farmers followed by medium (13.16 hrs.) and small size farmers (12.94 hrs.). The use of machine power showed an increasing trend with the increase in size of holding, due to high labour cost of machine per hour, which cannot be afforded by small farmers. Hence some of the operations like harvesting, threshing and ploughing were performed by small farmers only.

III. Seed

Both hybrid and local seeds were used in the production of jowar. Nearly 25.6 kg of seed rate of sorghum was found to be used by sample households in a hectare. Nearly 25 kgs of seed was used by all category of land holding for per hectare sorghum cultivation.

IV. Manures

The overall usage of manure for per hectare sorghum cultivation was found to be 1.73 tonnes which was highest for small (2.18 tonnes/ha.) followed by medium (1.78 tonnes/ha.) and lowest for large (1.22 tonnes/ha.) farmers. Per hectare use of manure showed decreasing trend with land size holding, because manure becomes a scarce resource for application as size of land holding increases.

V. Fertilizers

On an average, the per hectare use of chemical fertilizer (urea) was observed to be 93.37 Kg./ha. The usage of fertilizer was highest for small (101.21 kg/ha.) followed by medium (90.60 kg/ha.) and large (88.33 kg/ha.) farmers.

VI. Plant protection charges

The overall plant protection chemicals usage was observed to be 0.92 ltr/ha. The large and medium size farmers used more plant protection chemicals than small farmers. Because plant protection chemicals are costly and might not be afforded by all small farmers.

Thus it can be concluded from the analysis of physical quantities of input use that use of family labour (man-days), manure (tonnes), urea (kg) was found to be decreased with increase in land size categories while hired labour (man-days), machine labour (hrs.) and plant protection charges (litres) were increased with increase in land size categories.

Table 4.12 Input utilization pattern in sorghum cultivation

(Quantity per hectare)

S.No	Inputs	Small (< 2ha.)	Medium (2-5 ha.)	Large (> 5 ha.)	Overall category
A	Family labour (man-days)	14.67	13.95	13.18	13.93
B	Hired labour (man-days)	2.61	3.34	3.98	3.31
1	Human labour (man-days) (a+b)	17.28	17.29	17.16	17.24
2	Machine Labour (hrs)	12.94	13.16	14.26	13.45
3	Seed (kg)	25.50	25.80	25.50	25.60
4	Manure (tonnes)	2.18	1.78	1.22	1.73
5	Fertilizer Urea (kg)	101.21	90.60	88.33	93.37
6	Plant protection (litre)	0.75	1.00	1.00	0.92

4.5 Labour cost in different operations of sorghum cultivation

Operation wise labour cost was presented in the table 4.13. The calculated labour cost include, family labour cost, hired labour cost and Labour (Machine) cost. The total per hectare labour cost was found to be ₹ 10347.80 which accounts 42.02

% of the total cost. Highest labour cost was incurred in harvesting then followed by threshing, sowing and ploughing operations which accounts 15.71, 15.06, 15.00 and 14.85 % to the total labour cost. The overall least labour cost was found in plant protection application (3.73 %) followed by transportation (5.39 %) and FYM and fertilizer application (8.30 %). The total labour cost was highest for large farmers (₹ 10767.59) followed by medium (₹ 10211.79) and small (₹ 10063.84) farmers. Because more hired labour utilization due to larger holdings.

Table 4.13 Operation wise labour cost of sorghum cultivation across different land size categories

(₹/ha.)

S.No	Operations	Small (< 2ha.)	Medium (2-5 ha.)	Large (> 5 ha.)	Overall
1	Ploughing	1500.00 (14.90)	1560.00 (15.28)	1550.00 (14.40)	1536.67 (14.85)
2	Sowing	1540.00 (15.30)	1550.00 (15.18)	1565.00 (14.53)	1551.67 (15.00)
3	FYM and fertilizer application	922.53 (9.17)	862.48 (8.45)	792.48 (7.36)	859.16 (8.30)
4	Weeding	1200.00 (11.92)	1154.99 (11.30)	1089.57 (10.12)	1148.18 (11.10)
5	Monitoring field	1150.87 (11.44)	1072.68 (10.50)	1148.87 (10.67)	1124.14 (10.86)
6	Plant protection	106.26 (1.06)	367.27 (3.60)	685.00 (6.36)	386.18 (3.73)
7	Harvesting	1625.75 (16.15)	1644.99 (16.11)	1606.34 (14.92)	1625.69 (15.71)
8	Threshing	1592.29 (15.82)	1558.25 (15.26)	1524.83 (14.16)	1558.46 (15.06)
9	Transportation	426.14 (4.24)	441.14 (4.32)	805.50 (7.48)	557.59 (5.39)
10	Total labour cost	10063.84 (100.00)	10211.79 (100.00)	10767.59 (100.00)	10347.80 (100.00)

Note: The parentheses values in the table indicate the percentage values to the total labour cost.

Thus, it can be concluded from the results of study that total labour cost which includes human and Labour (Machine) was increased with increase in land size categories. The % share of ploughing, sowing, FYM and fertilizer application, weeding, harvesting and threshing in total labour cost was decreased with increase in land size category while share plant protection chemical and transportation was increased with increase in land size category.

4.6 Cost and return analysis of green fodder cultivation of sorghum

Among 60 sample households, 8 farmers were growing sorghum for green fodder purpose. Table 4.14 presents the cost and return of per hectare green fodder sorghum cultivation. The total cost incurred for producing green fodder was ₹12715.09. The working cost was ₹8833.19 and overhead cost was ₹3881.9 which accounted nearly 69.47 and 30.53 % of total cost of cultivation of jowar green fodder crop, respectively. Owned labours, Labour (Machine) and seed cost were found to be the major items in working cost which constitutes nearly for 29.17, 13.76 and 13.19% of the overall cost of cultivation (COC), respectively.

Table 4.14 Cost and return analysis for green fodder sorghum cultivation

(₹/ha.)

S.No	Particulars	Amount	%
I	Variable cost		
1	Labour (family)	3709.25	29.17
2	Labour (machine)	1750.00	13.76
3	Seed	1677.72	13.19
4	FYM and Urea	893.27	7.03
5	Int. on working capital	803.02	6.32
	Subtotal variable cost	8833.19	69.47
II	Fixed cost		
1	Rented value of owned land	2786.00	21.91
2	Depreciation on implements	743.00	5.84
3	Int. on fixed cost	352.90	2.78
	Subtotal fixed cost	3881.90	30.53
III	Cost of cultivation (COC)	12715.09	100.00
IV	Returns from sorghum green fodder	23040.00	
V	Net returns	10324.91	
VI	Cost of productions (₹/qtl)	165.56	
VII	Returns per quintal	134.44	

FYM and fertilizers cost accounted nearly 7.03 % of the total cost of cultivation green fodder jowar crop. Rental value of owned land and depreciation on farm implements found to be the main factors of overhead cost which constitutes nearly 21.91 and 5.84 % of the overall COC, respectively. The cost of production a quintal of green fodder of jowar was found to be ₹165.56. Gross return was ₹ 23040. A farmer had got net return of ₹ 10324.91 per hectare by cultivating sorghum for green fodder purpose. On an average, 76.8 qtl of green fodder was obtained from one hectare of land. None of the farmer used hired labour for green fodder sorghum cultivation.

4.7 Input – output relationship

Linear production function for small, medium, large and overall farmers has been estimated and presented in table 4.15 by considering the effect of seven independent variables on sorghum output in the study area. A close observation of the table revealed that the coefficient of multiple determination (R^2) for overall sample households was 0.63 which indicated that 63 % of total variation in sorghum output was explained by the variables included in the linear multiple regression model. Similarly for small, medium and large farmer's category it was found to be 0.94, 0.90, 0.89, respectively.

For overall category the values of regression co-efficient of area (0.309), seed (0.338) and fertilizer (0.097) were observed as positive and significant at 5%, whereas manure (0.121), plant protection (0.041), human labour (0.061) and machine labour (0.095) were observed to be positive and statistically non-significant at overall level. This indicated that per unit increase in area, seed and fertilizer results in increase in sorghum output quantity by their respective coefficients values.

For small farmers' category, the values of coefficient of seed (0.282) and fertilizer (0.128) were found to be positive and significant, whereas manure (0.026), plant protection (0.027), area (0.844) and machine labour (0.014) were found to be positive and statistically non-significant. The value of coefficient of human labour (-0.053) was found to be negative and non-significant.

Table 4.15 Input-output relationship for sorghum crop under different land size category

Category	Intercept	Regression co-efficients							R^2
		X_1 (Area)	X_2 (Seed)	X_3 (Manure)	X_4 (Fertilizer)	X_5 (Plant Protection)	X_6 (Human Labour)	X_7 (Machine Labour)	
Small (< 2 ha.)	0.551 (1.824)	0.844 (0.419)	0.282* (0.072)	0.026 (0.268)	0.128* (0.026)	0.027 (0.083)	-0.053 (0.014)	0.014 (0.067)	0.94
Medium (2-5 ha.)	8.351 (0.772)	0.915** (0.265)	0.398** (0.098)	0.066 (0.178)	0.026 (0.012)	-0.208 (0.118)	0.020 (0.056)	0.090 (0.079)	0.90
Large (> 5 ha.)	65.355 (12.312)	2.323** (0.723)	0.189 (0.692)	0.083 (1.666)	1.116** (0.316)	4.944 (9.523)	1.368 (0.698)	-0.264 (0.353)	0.89
Overall	0.595 (3.133)	0.309** (0.117)	0.338** (0.099)	0.121 (0.520)	0.097** (0.047)	0.041 (0.198)	0.061 (0.115)	0.095 (0.133)	0.63

Figures in parentheses shows the standard error of concerned regression coefficients

(** and * indicates 5 and 1 % level of significance, respectively.)

For medium farmers category, the values of coefficient of area (0.915) and seed (0.398) were found to be positive and highly significant, whereas manure (0.066), human labour (0.02), fertilizer (0.026) and machine labour (0.09) were found to be positive and non-significant. The value of coefficient plant protection chemicals (-0.208) was found to be negative and non-significant.

For large size category, the values of coefficient of area (2.323) and fertilizer (1.116) were found to be positive and significant, whereas seed (0.189), manure (0.083), plant protection (4.944) and human labour (1.368) were found to be positive and non-significant. The value of coefficient of machine labour (-0.264) was found to be negative and statistically non-significant.

4.8 Various constraints faced by sorghum growers

The opinions of sample household, regarding the constraints faced by the farmers in the production of sorghum are presented. Mainly 3 types of constraints were faced by sorghum growers, namely production, marketing and MSP related constraints. The details of identified constraints are presented as follows:

4.8.1 Constraints faced by farmers in sorghum production

The constraints faced by farmers in sorghum cultivation in the study area have been depicted in table 4.16. As reported by most of the farmers, crop damaged by wild animals (especially Neelgai or Rozda) was the major constraint (with Garrett Score 77.00) in sorghum production and therefore this problem was assigned first rank followed by damage of crop due to pests and diseases (with Garrett Score 64.00), high labour cost at peak period (with Garrett Score 46.73), lack of knowledge about seed treatment(45.80), non-availability of labour during the peak period (44.63) and non-availability of quality seed material (23.00) which were given second, third, fourth, fifth and sixth ranks respectively, by the sample households.

Table 4.16 Constraints faced by farmers in sorghum production

S.No	Production constraints	Score	Rank
1	Crop damaged by wild animals (Neelgai)	77.00	I
2	Incidence of pest and diseases	64.00	II
3	High cost of labour at peak period	46.73	III
4	Lack of knowledge about seed treatment	45.80	IV
5	Non availability of labour during peak period	44.63	V
6	Non availability of quality seed material	23.00	VI

4.8.2 Constraints faced by farmers in marketing of sorghum produce

The constraints faced by farmers in marketing of sorghum produce in the study area have been depicted in table 4.17. Among 8 marketing constraints, price fluctuations was the major constraint (with Garrett Score 79.00) faced by the majority of farmers and hence it was assigned first rank followed by non-availability of market related information (with Garrett Score 56.90), poor transport facility (with Garrett Score 52.18) high cost of transportation (with Garrett Score 50.40), malpractice in weighing (with Garrett Score 48.56), small quantity of marketable surplus (with Garrett Score 46.65), market places are far away (with Garrett Score 46.40), and delayed payment by traders (with Garrett Score 21.00) which were given second, third, fourth, fifth, sixth, seventh and eighth rank respectively.

Table 4.17 Constraints faced by farmers in marketing of sorghum produce

S.No	Constraints	Score	Rank
1	Price fluctuations	79.00	I
2	Non-availability of market related information	56.90	II
3	High cost of transportation	50.40	IV
4	Malpractice in weighing	48.56	V
5	Small quantity of marketable surplus	46.65	VI
6	Market places are faraway	46.40	VII
7	Poor transport facility	52.18	III
8	Delayed payment by traders	21.00	VIII

4.8.2 Constraints faced by farmers related to MSP

None of the sorghum producers showed their interests to reply on constraints related to minimum support price namely; MSP purchasing centres located at distant places, entire quantity of sorghum produce not purchased by MSP centre, more time required to sale produce at MSP purchasing centres and delayed in opening of MSP purchasing centres and untimely payment through cheque mode, because purchasing centre for sorghum produce at MSP was not opened by Government of Rajasthan till today.

5. SUMMARY AND CONCLUSION

This chapter provides brief information on sorghum cultivation in Bhilwara district of Rajasthan. The major findings of the present study are highlighted in this section. In light of these findings, suitable suggestions and policy recommendations in the context of sorghum cultivation are presented. Sorghum (*Sorghum bicolor*) is the 5th major crucial grain crop at the global level and the fourth most important crop in India. In addition, the fodder and stover is fed to millions of animals providing milk and meat for man. Commercially the stems or fibres of the sorghum plant are used in making wall boards, solvents, biodegradable packaging materials, fences etc. It is also used in making ethanol, adhesives and papers. Due to semi-arid climatic conditions of Rajasthan, this crop is well suited and also the area under sorghum is increasing over the years in Rajasthan and Bhilwara district. The current research study was carried out on "An Economic Analysis of Sorghum Cultivation in Bhilwara district of Rajasthan" with the following specific objectives,

1. To examine the growth in area, production and productivity of sorghum.
2. To work out the cost and returns of sorghum cultivation
3. To examine input-output relationship, and
4. To identify the constraints faced by sorghum growers.

Bhilwara district of Rajasthan has been purposively selected for the study. Shahpura and Tehnaal villages from Shahpura tehsil and Baavdi and Pander villages from Jahazpur tehsil were selected. The selected households were divided into small, medium and large farmers by cumulative frequency method. From each village, 15 farmers were selected randomly. Thus, 60 farmers were selected for study.

Generally informations on social and economical conditions of sample households, total cultivable lands holding, cost and returns of jowar coarse cereal crop and related information on factors which were required for the research study etc., collected from the sampled households through pre-tested schedule by personal interview method for the Agri. year 2018-19.Data on area, production and yield of jowar crop in Rajasthan state and Bhilwara for 25 years (1991-92 to 2015-16) collected from DES, GOR, Jaipur.

Tabulation method of analysis has been used for the current research study of social and economical conditions, cost and incomes from jowar crop and green fodder, resource use pattern and labour use pattern. CAGR analysis was mainly done to know the trend in jowar cultivation. Input- output relationship was estimated by using multiple regression. Garretts' ranking technique was considered for the estimation of various problems noticed by the jowar growing households.

Major findings of the study

1. The average size of the land holding in Bhilwara was 3.51 ha.

2. The average family size was 7.63 and it was highest for large farmers followed by small and medium category in the study area. The proportion of males was higher than females in sorghum growing sample households.

3. On an average 83.33 % of the total sample households were found to be literate in the study area. Total literate farmers were more in the large farmers followed by medium and small farmers accounting about 92.30, 88.24 and 76.67 %, respectively

4. Only 12 farmers (20 %) preferred sorghum *chapatti* occasionally out of 60 sample households for consumption purpose due to its taste and nutritive value. Daily consumption of sorghum *chapatti* was not found in the study area.

5. A sorghum growing household maintained a herd size of 3.78 standard animal units.

6. The total area allocated by the farmers in the state under sorghum cultivation had decreased from 707669 hectares to 631188 hectares during 1991-92 to 2015-16, but still there was an annual growth of 2.02% in sorghum area whereas, the total area allocated by the farmers under sorghum cultivation in Bhilwara district had increased 26788 hectares to 43047 hectares during 1991-92 to 2015-16 with an annual growth of 1.02% in area under sorghum cultivation. Area under sorghum found to be significant at both state and district level.

7. The CAGR for Jowar productivity and production were noticed to be positive and significant at Rajasthan state and Bhilwara district by 3.34 and 3.21% and 11.42 and 12.54% per annum, respectively.

8. The overall total cost of cultivation (COC) was ₹ 24784.40 which constitutes 80.33 % of variable cost (₹ 19751.15) and 19.67 % of overhead cost (₹ 4875.90). The per hectare total cost of cultivation (COC) was highest for small farmers (₹ 25142.73) then followed by medium (₹ 248 04.43) and large farmers (₹ 24406.05) category.

9. Machine labour were found to be the main item of the working cost comprises of nearly 27.14 % of the total cost of cultivation (COC) of jowar. Seeds (farm produced and hybrid), human labours, FYM, PPC and Urea were the next main cost items of the working cost.

10. Overall grain yield and dry fodder yield per hectare of jowar cultivation was 19.41 quintal, and 60.49 quintal, respectively. Highest yield was seen in large farmers category (19.99 qtl/ha) followed by medium (19.56 qtl/ha) and small farmers (18.69 qtl/ha.).

11. The gross return per hectare was observed to be ₹ 47476.13. The gross return was found to be highest for large farmers (₹ 48945.78) followed by medium (₹47617.69) and small farmers (₹ 45864.93).

12. The net return was highest for large (₹ 24539.73) followed by medium (₹ 22812.26) and small (₹ 20722.22) farmers.

13. The overall per hectare cost for jowar cultivation was found to be ₹ 24784.40 which was highest for small (₹25142.73) followed by medium (₹ 24805.43) and large farmers (₹ 24406.05).

14. On an average 17.24 man-days human labour was used for sorghum cultivation, comprising 13.93 owned labour man-days and 3.31 labour man-days. An overall use of machine labour was observed to be 13.45 hrs. Both hybrid and local seeds were used in the cultivation of sorghum. The overall usage of manure per hectare for sorghum was found to be 1.73 tonnes. The per hectare use of chemical fertilizers (urea) was 93.37 Kg./ha.

15. The cost A_1 and cost A_2 were found to be same, because there was no land taken on lease. The cost B_1, cost B_2, cost C_1 and cost C_2 were found to be ₹18328.45, ₹ 21990.78, ₹ 21122.08 and ₹ 24784.40 respectively.

16. The per hectare labour cost was found to be 10347.74 ₹ which accounts 42.02 % of the total cost of cultivation. Highest labour cost was incurred in harvesting then followed by threshing, sowing and ploughing operations which accounts 15.7, 15.1, 15, and 14.8 % to the total labour cost. The overall least labour cost was found in fertilizer application followed by transport to storage house operations. The total labour cost was highest for large farmers (10767.59 ₹) followed by medium (10211.79 ₹) and small (10063.84 ₹) farmers.

17. The total cost of green fodder cultivation was ₹12715.09, the working cost was ₹8833.19 and overhead cost was ₹3881.9 which constitutes nearly 69.47 and 30.53 % of total cost of cultivation, respectively.

18. Gross return in green fodder production was ₹ 23040. A farmer has got net return of ₹ 10324.91.

19. The major constraints faced by the farmers in the study area were Crop damaged by wild animals, especially *Neelgai or Rozda* (with Garrett Score 77.00), damage of crop by pests and diseases (with Garrett Score 64.00), high labour cost at peak period (with Garrett Score 46.73), price fluctuations (with Garrett Score of 79.00), non-availability of market related information (with Garrett Score 56.90), market places are faraway (with Garrett Score 46.40) and no MSP centre for sorghum produce.

20. A farmer in Bhilwara district can be benefitted by ₹ 918.85, if sorghum produce was procured by Government at MSP in 2018.

Suggestions and policy implications:

1. The results of cost and return analysis of sorghum cultivation was obtained in the present study suggested that the producing the sorghum grains was relatively more cost-effective than green fodder cultivation.

2. Consumption of Sorghum produce in terms of *chapattis* was preferred by few farmers. Hence, food science research and processing industries must evolve new value added nutritional products from jowar output.

3. *Neelgai* was the major constraint for farmers engaged in sorghum crop production in the study area. Hence, proper actions must be taken by Government to protect the crop from wild animals.

4. The major constraint was observed that MSP purchasing centre for sorghum produce was not opened; hence the majority of the farmers were very disappointed on this matter. Therefore, there is need of the hour to establish more number of MSP (Minimum Support Price) purchasing centres for sorghum procurement at tehsil and village level. Moreover, Govt. of Rajasthan should assure the farmers to purchase as much as quantum of sorghum produces.

5. The results of return of sorghum cultivation analyzed at market price and minimum support prices indicated that net return was quite low at prevailing market price compared to minimum support prices. Hence, Government should make efforts to provide remunerative price of produce for farmers.

LITERATURE CITED

Acharya, S. P., Basavaraja, H., Kunnal, L. B., Mahajanashett, S. B. and Bhat, A. R. S. 2012. Growth in area, production and productivity of major crops in Karnataka. *Karnataka Journal of Agricultural Sciences*, **25**(4): 431-436.

Ahmad, I. M. E., Samuel, S. A., Makama and V. R., Kiresur 2015. Trend of area, production and productivity of major cereals: India and Nigeria scenario. *Research Journal of Agriculture and Forestry Sciences*, **3**(2):10-15.

Ayalew, B. and Sekar, I. 2015. Profitability of coarse cereals production in India. *International Letters of National Sciences*, **39**:10-19.

Ayalew, B. and Sekar, I. 2016. Trends and regional disparity of maize production in India. *Journal of Development and Agriculture Economics*, **8**(9): 193-199.

Basavaraja, H., Hugar, A. Y., Mahajanshetti, S. B., Angadi, V. V. and Rao, B. D. 2005. An economic analysis of kharif sorghum in Karnataka. *Agricultural Economics Research Review*, **18**(2): 223-240.

Chahal, S. S. and Kataria, P. 2010. Constraints in the production and marketing of maize in Punjab. *Agriculture Update*, **5**(1 & 2): 228-236.

Chapke, R. R., Mondal, B. and Mishra, J. S. 2011. Resource-use-efficiency of sorghum (*Sorghum bicolor*) production in rice (*Oryza sativa*)-fallows in Andhra Pradesh, India. *Journal of Human Ecology*, **34**(2): 87-90.

Choudhri, H. P. S., Singh, G. P., Singh, R., Kushwaha, P., Kumar, R. and Ranjan, A. K. 2018. Costs and income analysis of maize cultivation in Bahraich district of Uttar Pradesh, India. *International Journal of Current Microbiology and Applied Sciences*, **7**(2): 1060-1065.

Chowti, P. S. and Basavaraja, H. 2015. Economics of maize production in Haveri district. *International Journal of Commerce and Business Management*, **8**(2): 218-223.

Delenius, T. and Hodges, Jr. J. C. 1950. The problem of optimum stratification. *Journal of American Statistical Association,* **45**: 88-101.

Dhaka, B. L., Bairwa, R. K. and Meena, N. L. 2016. Yield gap and constraints analysis in wheat production in humid south eastern part of Rajasthan. *International Journal of Agriculture Sciences*, **8**(12): 1160-1162.

Dhomne, U. K. and Raghuwanshi, R. S. 2016. Resource use efficiency of hybrid maize production in Chindwara district of Madhya Pradesh. *International Journal of Research in Applied, Natural and Social Sciences*, **4**(10): 23-31.

Dingar, S. M., Prasad, V. and Nigam, R. K. 1998. Production performance of pulses in Uttar Pradesh. *Indian Journal of Pulses Research*, **11**(2): 109-114.

Gaddi, G. M., Mundinamani, S. M. and Basavaraj, H. 2002. Yield gaps and constraints in the production of rabi sorghum in Karnataka: A path coefficient analysis. *Agricultural Economics Research Review*, **15**(1): 13-25.

Garrett, E. H. and Woodworth, R. S. 1969. *Statistics in Psychology and Education*, Feffer and Simans Private Limited, pp-329.

Gautam, A. N., Sahu, R. M. and Sirothiya, N. 2017. Resource use efficiency of wheat in Betul district of Madhya Pradesh. *Universal Journal of Agricultural Research*, **5**(1): 57-60.

Ghuge, S. N. and Kadam, R. P. 2015. Constraints faced by kharif sorghum growers in adoption of recommended technology. *Agriculture Update*, **10**(4): 312-317.

Government of India 2016. Agriculture Statistics at a Glance, Directorate of Economics & Statistics Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture, Government of India, New Delhi.

Government of Rajasthan 2014. Basic Statistics, Directorate of Economics & Statistics, Jaipur.

Government of Rajasthan 2015. Agriculture Statistics at a Glance, Directorate of Economics & Statistics, Jaipur.

Hiremath, G. K., Koppad, M. B., Amruta, C. P. and Gumgolmath, K. C. 1996. Economics of pulse production present status and future strategies in Karnataka. *Rural India*, **59**(2): 46-50.

Joshi, P. K., Singh, N. P., Singh, N. N., Gerpacio, R. V. and Pingali, P. L. 2005. Maize in India: Production systems, constraints, and research priorities. *International Maize and Wheat Improvemet Centre* (CIMMYT), Project report: 1-41.

Kumar, M. S., Prakash Kammardi, T. N. and Srikantha Murthy, P. S. 2016. Ecological sustainability in rabi sorghum cultivation: An economic analysis in Bijapur district of Karnataka. *Economic Affairs*, **61**(3): 399-404**.**

Kumar, V. and Singh, M. 2015. Economic analysis of scientific sorghum fodder production technology and its comparative impact on farmers' livelihood. *Agro Economist - An International Journal*, 2(2): 41-44.

Kumar, V., Bahukhandi, D. and Wasnik, V. K. 2017. An economic analysis of sorghum seed production: A profitable enterprise for farmers. *Agro Economist - An International Journal*, **4(1): 11-14.**

Lakra, N., Gauraha, A. K. and Banafar, K. N. S. 2017. Economic analysis of production, marketing and constraints of paddy in Dantewada district of Chhattisgarh, India. *International Journal of Current Microbiology and Applied Sciences*, **4**: 108-115.

Maikasuwa, M. A. and Ala, A. L. 2013. Trend analysis of area and productivity of sorghum in Sokoto state, Nigeria, 1993-2012. *European Scientific Journal*, **9**: 69-75.

Murthy, C., Kulkarni, V. and Kerur, P. B. 2015. Cost and return structure of maize production in North Karnataka. *International Research Journal of Agricultural Economics and Statistics*, **6**(2): 364-370.

Pavithra, N. L., Ashalatha, K. V., Megha, J., Manjunath, G. R. and Hanabar, S. 2018. Growth in area, production and productivity of food grains in Karnataka state, India. *International Journal of Current Microbiology and Applied Sciences*, **7**(8): 2532-2535.

Patil, H. A. and Khobarkar, V. K. 2013. Resource use efficiency in wheat production of Amaravati division of Vidarbha region of Maharashtra. *Indian Journal of Applied Research*, **3**(7): 10-11.

Prajneshu and Chandran, K. P. 2005. Computation of Compound Growth Rates in Agriculture: Revisited, *Agricultural Economics Research Review*, **18**(2): 317-324.

Raju, V. T. and Rao, D. V. S. 2015. *Economics of farm production and management*. pp:180-186.

Dayakar Rao, B., Narayan Mukherjee, D., Latika Devi, Y. and Tonapi, V. A. 2017. An economic analysis of improved rabi sorghum cultivars in rainfed situation of Maharashtra, India. *International Journal of Current Microbiology and Applied Sciences*, **4**: 7-15.

Sani, R. M., Haruna, R. and Sirajo, S. 2013. Economics of Sorghum (*Sorghum bicolor* (L) *Moench*) Production in Bauchi Local Government Area of Bauchi State, Nigeria. Invited paper presented at the 4th International Conference of the African Association of Agricultural Economists, September 22-25, 2013, Hammamet, Tunisia.

Sapkota, M., Joshi, N. P., Kattel, R. R. and Bajracharya, M. 2018. Profitability and resource use efficiency of maize seed production in Palpa district of Nepal.

SAARC Journal of Agriculture, **16**(1): 157-168.

Shankaran, S. 1994. Prospect for coarse grains in India. *Agric. Situ. India*, **49**(5): 319-323.

Shankhyan, P. L. 2010. Introduction to the Economics of Agriculture Production, pp-41-83.

Singh, D. P. 2013. Economics of wheat cultivation in irrigated and unirrigated areas of Banswara. *Journal of Progressive Agriculture*, **4**(2): 1-5.

Suresh, A. and Keshava Reddy, T. R. 2006. Resource use efficiency of paddy cultivation in Peechi command area of Thrissur district of Kerala: An economic analysis. *Agricultural Economics Research Review*, **19**: 159-171.

Sureshkumar, A. P., Patel, K. S., Asodiya, P. S. and Parmar, V. K. 2014. Input use, costs structure, return and resource use efficiency analysis of wheat crop in South Gujarat, India. *Indian Journal of Agricultural Extension*, **2**(1): 5-12.

Tanveer, Ahmed. 2006. An economic analysis of paddy based farming systems in Southern Karnataka- A case study of Mandya district, *M. Sc. (Agri.) Thesis* submitted to University of Agriculture Sciences, Dharwad, Karnataka (India).

Thyagarajan, S. and Vasanthakumar, J. 2000. Constraints to high yield in rice at farm level. *Journal of Extension Education*, **11**(2): 2747- 2753.

Tingre, A. S., Rathod, V. J. and Naphade, S. A. 2009. Cropping pattern changes and crop diversification in Amravati district of Vidarbha. *Journal of Soils and Crops*, **l9**(2): 310-314.

Tirlapur, Laxmi N. and Mundinamani, S. M. 2015. Resource use efficiency in cultivation of major crops of Dharwad district. *Agriculture Update*, **10**(2): 93-99.

United States Department of Agriculture, World Agricultural Production, Foreign Agricultural Service Reports and Databases.

Vani, B. P. and Vyasulu, Vinod. 1996. Growth, variability and instability of three major cereal crops in Karnataka- A district level analysis from 1955-56 to 1989-90. *Economic and Political Weekly*, **31**(26): A74-A83.

Yadav, R. L. and Kalola, A. D. 2016. Growth and trends in area, production and productivity of sorghum and bajra crops in middle Gujarat zone. *International Journal of Current Research*, **8**(4): 29470-29474.

Webliograpgy:

http://plan.rajasthan.gov.in/statistics

www.agriculture.rajasthan.gov.in

An Economic analysis of sorghum (*Sorghum bicolor*) Cultivation in Bhilwara district of Rajasthan

Sitha Patel B[1]
Research Scholar

Dr. G. L. Meena[2]
Major Advisor

ABSTRACT

The present study entitled "An Economic Analysis of Sorghum cultivation in Bhilwara district of Rajasthan" was conducted during the year 2019 with the objectives to study the growth in area, production and productivity of sorghum, cost and returns of sorghum cultivation, input-output relationship and constraints faced by sorghum producers. A sample of 60 sorghum producers was selected from Shahpura and Jahazpur tehsil of Bhilwara district. Tabular and functional analytical tools were employed for the analysis of data. The results of the study showed that there was positive growth rate in area under sorghum both in Bhilwara district and Rajasthan state by 1.02 and 2.20 per cent per annum, respectively. Sorghum production at state level and in Bhilwara district showed positive growth of 3.21 and 12.54 per cent per annum, respectively. In sorghum productivity, 3.34 and 11.42 per cent per annum growth rate was observed at Rajasthan state and Bhilwara district. Sorghum area, production and productivity were found significant at Rajasthan state and Bhilwara district. The overall cost of cultivation of sorghum was found to be ₹ 24784.40 which constitutes 80.33 per cent as variable cost and 19.67 per cent as fixed cost. Machine labour was major component of variable cost which accounted for 27.14 per cent of total cost of cultivation. The cost of cultivation was decreased with increase in land size category. The overall net return per hectare was found to be ₹ 22691.73. The net return was increased with increase in land size category. The cost of cultivation of green fodder of sorghum was ₹ 12715 per hectare and net return was ₹ 10324.91 per hectare. The regression coefficients of area, seed and fertilizer were found to be positive and statistically significant. Crop damaged by *neelgai*, incidence of pest and diseases, high cost of labour at peak period, lack of knowledge about seed treatment, price fluctuations, no purchase centre for sorghum produce at MSP were the major constraints faced by the farmers of the study area.

[1] PG scholar, Department of Agricultural Economics and Management, RCA, MPUAT, Udaipur.
[2] Assistant Professor, Department of Agricultural Economics and Management, RCA, MPUAT, Udaipur

jktLFkku ds HkhyokM+k ftys esa Tokj ¼*lksjxe ckbdksyj*½ dh [ksrh dk ,d vkfFkZd fo'ys"k.k

lhrk iVsy Ckh[1] **MkW- th-,y-ehuk**[2]
¼'kks/kdrkZ½ ¼eq[; lykgdkj½

vuq{ksi.k

o"kZ 2019 ds nkSjku orZeku v/;;u ^^jktLFkku ds HkhyokM+k ftys esa Tokj dh [ksrh dk ,d vkfFkZd fo'ys"k.k^^ 'kh"kZd ij vk;ksftr fd;k x;k Fkk] ftldk mís'; {ks= ds o`f)] mRiknu vkSj mRikndrk] pkjk mRiknu dh ykxr vkSj çfrQy] buiqV&vkmViqV laca/k dk vkSj Tokj mRikndksa dks Tokj mRiknu esa vkus okyh ck/kkvksa dk v/;;u djuk FkkA HkhyokM+k ftys dh 'kkgiqjk vkSj tkgtiqj rglhy ls 60 Tokj mRikndksa dk uewuk pquk x;kA vkdM+ksa ds fo'ys"k.k ds fy, lkj.khc) vkSj dk;kZRed fo'ys"k.kkRed midj.k dk ç;ksx fd;k x;kA v/;;u ds ifj.kkeksa ls irk pyk gS fd HkhyokM+k vkSj jktLFkku nksuksa esa Øe'k% 1-02 vkSj 2-20 çfr'kr çfro"kZ dh nj ls {ks= esa ldkjkRed o`f) nj ns[kh x;hA jkT; Lrj ij vkSj HkhyokM+k ftys esa lksj?ke mRiknu esa Øe'k% 3-21 vkSj 12-54 çfr'kr çfr o"kZ dh ldkjkRed o`f) ns[kh xbZA jkT; Lrj ij vkSj HkhyokM+k ftys esa lksj?ke mRikndrk esa Øe'k% 3-34 vkSj 11-42 izfr'kr izfro"kZ o`f) nj ns[kh xbZA Tokj dk {ks=] mRiknu vkSj mRikndrk jkT; Lrj ij vkSj HkhyokM+k ftys esa lkFkZd egRoiw.kZ ik;k x;kA Tokj dh [ksrh dh dqy ykxr ₹ 24784-40 ikbZ xbZ tks fd ifjorZuh; ykxr ds :i esa 80-33 çfr'kr vkSj fu/kZfjr ykxr ds :i esa 19-67 çfr'kr gSA e'khu Je ykxr dk çeq[k ?kVd Fkk tks

---

[1] 'kks/kdrkZ] Ñf"k vFkZ'kkL= ,oa çcU/ku foHkkx] jktLFkku Ñf"k egkfo|ky;] ,e-ih-;w-,-Vh-] mn;iqjA

[2] lg&vkpk;Z] Ñf"k vFkZ'kkL= ,oa çcU/ku foHkkx] jktLFkku Ñf"k egkfo|ky;] ,e-ih-;w-,-Vh-] mn;iqjA

dqy ykxr dk 27-14 çfr'kr FkkA Hkwfe ds vkdkj dh Js.kh esa o`f) ds lkFk [ksrh dh ykxr esa deh ns[kh xbZA

çfr gsDVs;j dqy 'kq) çfrQy ₹ 22691-73 ik;k x;kA Hkwfe ds vkdkj dh Js.kh esa o`f) ds lkFk 'kq) çfrQy esa o`f) ns[kh xbZA gjs pkjs dh [ksrh dh ykxr ₹12715 çfr gsDVs;j vkSj 'kq) çfrQy ₹ 10324-91 çfr gsDVs;j FkkA {ks=] cht vkSj moZjd ds çfrxeu xq.kkad ldkjkRed vkSj lkaf[;dh; :i ls egRoiw.kZ ik, x,A v/;;u {ks= esa uhyxk; ls Qly dks uqdlku] dhV vkSj chekfj;ksa dh ?kVuk,a] pje vof/k esa Je dh mPp ykxr] cht mipkj ds ckjs esa Kku dh deh] ewY; esa mrkj&p<+ko] ,e,lih ij Tokj mRikn ds fy, dksbZ [kjhn dsaæksa dk ugha gksuk] bR;kfn fdlkuksa dh çeq[k ck/kk,a FkhaA

APPENDIX-I

Area and production of sorghum in districts under MPUAT service area

S.No	District	Area (ha)	Production (tonnes)
1	Udaipur	7898	3295
2	Chittorgarh	12299	46
3	Rajsamand	10552	9389
4	Banswara	265	144
5	Dungarpur	254	31
6	Pratapgarh	20	11
7	**Bhilwara**	**43047**	**12081**

(Agriculture Statistics at a Glance-2015-16, DES, GOR)

APPENDIX-II

Tehsil wise area and production of sorghum in Bhilwara district, (2018-19)

S.No	**Tehsils**	**Area (ha.)**	**Production (tonnes)**
1	Aasind	4416	8832
2	Badnor	4042	8096
3	Banera	4112	1859
4	Bhilwara	1096	1096
5	Hameergadh	492	638
6	Beejoliya	3	3
7	Hurda	7449	6846
8	**Jahazpur**	**10471**	**32460**
9	Kotari	2133	1067
10	Mandal	363	363
11	Karera	361	722
12	Mandalgarh	159	8
13	Raipur	433	866
14	Sahara	2604	3906
15	**Shahpura**	**13132**	**15758**
16	Phuliyakala	4128	4128

(Collectorate Office, Department of Statistics, Bhilwara, Rajasthan)

APPENDIX-III

Detailed questionnaire used for data collection

DEPARTMENT OF AGRICULTURAL ECONOMICS & MANAGEMENT
RAJASTHAN COLLEGE OF AGRICULTURE
MPUAT, UDAIPUR 313001, RAJASTHAN

"An Economic Analysis of Sorghum (Sorghum bicolor) Cultivation in Bhilwara District of Rajasthan''

Name: *Sitha Patel B* ***Date:***

Village: *Tehsil:*

I. General information

1. Name of farmer :
2. Age (years) :
3. Education of farmer :
4. Occupation : Main-
   Subsidiary -
5. Phone number :
6. Details of family :
   Number of male -
   Number of female -
   Number of children -
7. Do you prefer Jowar roti : Yes[ ] No[ ]
   If yes, days in a month [ ]
   Reason behind preference : Taste [ ]
   Nutritive value [ ]
   Less price [ ]

II. Details of land holding

Rental value of owned land:

Total holding (ha)	Cultivable area (ha)		Land revenue & taxes (Rs.)	Leased land (ha)		Rent (Rs.)	
	Irrigated	Rainfed		Leased in	Leased out	Rent paid	Rent received

Owned capital assets

Sr. No	Fixed assets	Purchased year	Purchased value

III. Details of irrigation structure

S. No.	Type	Construction/ purchase		Present value (Rs.)	Total irrigated area (ha)	Actual irrigated area (ha)	Remaining life (yrs)	Annual repairs (Rs.)	Contribution share if common (Rs.)
		Year	Value (Rs.)						
1.	Well								
2.	Bore well								
3.	Electric motor								
4.	Diesel engine								
5.	Pipeline								
6.	Drip/Sprinkler irrigation set								

IV. Details of buildings

Sr. No.	Category	Construction/ Purchase		Present value (excluding land) (Rs.)	Remaining life (yrs)	Annual repairs (Rs.)
		Year	Value (Rs.)			
1.	Residential house					
2.	Farm house					
3.	Store (Part of house)					
4.	Cattle shed					

V. Implements and machinery

A. Implements

S.No	Category	Construction/ Purchase		Present value (Rs.)	Remaining life (yrs)	Annual repairs (Rs.)
		Year	Value (Rs).			
1.	Iron plough					
2.	Wooden plough					
3.	Harrow					
4.	Hoe					
5.	Bullock cart					
6.	Seed drill					
7.	Chopper					
8.	Spade					

B. Machinery

S.No	Category (Machinery)	Owned	Hired-charge	Construction/ Purchase		Present value (Rs.)	Remaining life (yrs)	Annual repairs (Rs.)
				Year	Value (Rs).			
1.	Tractor							
2.	Sprayer							
3.	Duster							
4.	Ridger							
5.	Other							

VI. Details of livestock

S.No.	Type	No.
1.	Adult local cattle	
2.	Adult CB cattle	
3.	Young CB cattle	
4.	Adult buffalo	

VII. Total output utilization:

S.No	Production	Quantity (kgs)
1.	Home consumption	
2.	Cattle feed requirement	
3.	Retained as seed for the next year	
4.	Kind payment	
5.	Actual quantity sold in market	

VIII. Labour use pattern in sorghum cultivation

Sr. No.	Name of the operation	Family/owned (hrs)			Hired (hrs)			Animal labour hrs	Machine hours	
		Men	Women	Child	Men	Women	Child		owned	hired
1	Land preparation /ploughing									
2	Sowing/planting									
3	Manure application									
4	Intercultivation									
5	Weeding									
6	Fertilizer application									
7	Plant protection									
8	Irrigation									
9	Harvesting									
10	Threshing									
13	Monitoring the field									
	Total									
	Prevailing charges/rates (Rs./day)									

IX. Input use pattern in jowar cultivation

S.No	Input	Owned	Purchased	Quantity	Unit (kg/qtl)	Rate (Rs.)	Amount (Rs.)
1.	Seeds						
2.	FYM						
3.	Fertilizers a. b. c.						
4.	PP chemicals						
5.	Weedicides						
6.	No. of irrigation						

X. Yield and returns

S. No	Particulars	Unit (kg/qtl)	Yield	Price (Rs.)	Total value
1	Sorghum grains				
2	Sorghum straw				
3	Green fodder				

XI. Constraints faced by sorghum growers.

Production constraints-

S.No	Constraints	Rank
1.	Non availability of quality seed material	
2.	Non availability of labour during peak period	
3.	Lack of knowledge about seed treatment	
4.	High cost of labour during peak period	
5.	Incidence of pest and diseases	
6.	Crop damage by birds/wild animals	

Marketing constraints

S.No	Constraints	Rank
1.	Poor transport facility	
2.	Market places are far away	
3.	Small quantity of marketable surplus	
4.	High cost of transportation	
5.	Malpractice in weighing	
6.	Delayed payment by traders	
7.	Non availability of market related information	
8.	Price fluctuation	

MSP constraints

S.No	Constraints	Rank
1.	Entire quantity of sorghum produce not purchased by centre at MSP	
2.	More time required to sale produce at MSP purchasing centre	
3.	Delay in opening of MSP purchasing centre	
4.	MSP purchasing centres located at distant places	
5.	Untimely payment by cheque mode	

APPENDIX-IV

Prevailing market prices of important inputs and wage rates employed in sorghum cultivation

(Rs./unit)

S.No	Particulars	Rate
1.	Family labour (man-days)	200.50
2.	Hired labour (man-days)	250.00
3.	Machine labour (hrs)	500.00
4.	Seed (kgs)	145.60
5.	Manure (tonnes)	1466.28
6.	Fertilizers (kgs)	6.59
7.	Plant protection (ltr.)	956.00
8.	Grain (qtl.)	1511.15
9.	Dry fodder (qtl.)	299.00