Performance of Oilseed Crops in Rajasthan

राजस्थान में बीजीय मसालों का उत्पादन और निर्यात का निष्पादन

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Thesis

Master of Science in Agriculture

(Agricultural Economics)

2021

DEPARTMENT OF AGRICULTURAL ECONOMICS & MANAGEMENT

RAJASTHAN COLLEGE OF AGRICULTURE

MAHARANA PRATAP UNIVERSITY OF AGRICULTURE AND TECHNOLOGY

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Thesis

Submitted to the

Maharana Pratap University of Agriculture and Technology, Udaipur

In partial fulfillment of the requirement for the Degree of

Master of Science in Agriculture

(Agricultural Economics)

BY

Lalasab Allasab Nadaf

2021

CERTIFICATE-I

CERTIFICATE OF ORIGINALITY

The research work embodied in the thesis titled **"Performance of Oilseed Crops in Rajasthan"** submitted for the award of degree of **Master of Science in Agriculture** in the subject of Agricultural Economics to Maharana Pratap University of Agriculture and Technology, Udaipur (Raj.), is original and bonafide record of research work carried out by me under the supervision of **Dr. Latika Sharma,** Assistant Professor, Department of Agricultural Economics and Management, Rajasthan College of Agriculture, Udaipur. The contents of the thesis, either partially or fully, have not been submitted or will not be submitted to any other institute or university for the award of any degree or diploma.

The work embodied in the thesis represents my ideas in my own words and where others' ideas or words have been included. I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the University and can also evoke panel action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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CERTIFICATE-II

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This is to certify that this thesis entitled **"Performance of Oilseed Crops in Rajasthan"** submitted for the degree of Master of Science in Agriculture in the subject of Agricultural Economics, embodies bonafide research work carried out by **Mr. Lalasab Allasab Nadaf** 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 also approved by the advisory committee on 07/08/2021.

The manuscript has been subjected to plagiarism check by software Urkund. It is certified that as per the check, the similarity index of the content is 3% and is within permissible limit as per the MPUAT guidelines on checking Plagiarism.

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This is to certify that **Mr. Lalasab Allasab Nadaf** student of **Master of Science in Agriculture, Department of Agricultural Economics** has made all corrections / modifications in the thesis **"Performance of Oilseed Crops in Rajasthan"** which were suggested by the external examiner and the advisory committee in the oral examination held on / /2021. The final copies of the thesis duly bound and corrected were submitted on / / 2021.

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Acknowledgement

It is my pleasure to glance back and recall the path I travelled during the days of hard work and perseverance. It is a golden opportunity for me to express my deepest sense of gratitude to all of those who directly and indirectly helped me in this endeavour.

First and foremost, I humbly bow my head before my parents. I submit this small venture to my beloved father ***Mr. Allasab Nadaf*** *with all my heart, with all my soul and with all my mind.*

With immense pleasure and deep respect, I express my heartfelt gratitude to my major advisor ***Dr. Latika Sharma****, Assistant Professor), Department of Agricultural Economics and Management for her excellent guidance, constant support, keen interest, fatherly affection and sense of forgiveness throughout the period of my study.*

I am indebted to ***Dr. Dilip Singh****, Dean, Rajasthan College of Agriculture, Udaipur for his due attention and encouragement during the study period and also providing me the necessary facilities during the course of research.*

I humbly express my intense gratitude to ***Dr, G. L. Meena*** *(Assistant Professor)****, Dr. Hari Singh*** *(Assistant Professor), Department of Agricultural Economics and Management and* ***Dr.Shalini Pilania****, Professor, Department of Horticulture, for their constructive suggestions, friendly approach and constant support in the tenure of my research.*

I avail this opportunity to express my deep sense of reverence to my seniors ***Shivalika Mam, Jainuddin sir, Kashinath sir, Kiran sir, Ajay sir, Umesh sir, Arun sir, Shubham sir, Gouthami akka,*** *my friends* ***Manohar, Hanamanth, Suresh, Sachin, Arun, Sarvesh, Shubha, Arvind, Narendra, Rajat, Shashank*** *and my beloved juniors****, Shreyana, Satish, Chaithra, Pallavi,*** *for their unforgettable help and cooperation which enabled me to accomplish this course work with ease.*

Also, I am Sincerely thankful to ***Akash sir, Manohar and lovely bro Akhilesh*** *for their exceptional assistance in every aspect of my degree programme right from credit seminar to the completion of my research work, I am indebted for your support. Thank you so much!*

My sincere thanks and deep sense of honour and affection goes to my beloved ***Mother Smt. Noorjan,*** *my brother* ***Malik,*** *my sister* ***Kairun Didi, Abdul mamu*** *and all* ***family members*** *who constantly inspired, guided, prayed and supported me morally and financially to the present position. The love and patience of my family have been instrumental for me to achieve anything in life.*

Date: / / 2020

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1. INTRODUCTION

Indian agriculture was practiced way back from Indus valley civilization or bronze age which carried diverse practices in modern India. Many technological advancements made Indian agriculture as competing agriculture to the globe. Ever since India got independence from colonial rule, its food grain production has been registered to increase about five fold to 292 million tonnes in 2019-20. In food grains, India has attained largely self sufficiency. Green revolution in 1960's benefitted Indian agriculture to attain its self sufficiency by increase in area under irrigation and use of high yielding varieties and hybrids. India produces all crops such as cereals, pulses, oilseed crops, fruits, vegetables, spices, horticultural crops etc. which contribute to attain nutritional sufficiency for it's population. Oilseeds being beneficial crops contains 18 essential amino acids, carbohydrates, fatty acids, vitamin A.D,E,K and ot her trace elements which concludes oilseeds as nutritionally important crops. Oilseeds can used as cover, pasture, green manure and also as fodder crop in silage. Oilseed cakes with 40-60 per cent protein is good for animal feed and green manure and direct export of these oilseed cakes earned foreign exchange of INR 2,200 crore in 2016-17. Oilseed crops contains energy rich elements in equation 1 Kg of oil = 1.66 g of protein =2.37 g of carbohydrates (Laxminarayan, 2018).

Scenario of Oilseeds in India

India is the largest producer of oilseeds in the world and oilseed sector occupies an important position in the agricultural economy of the country. Oilseeds are among the major crops that are grown in our country apart from cereals. Oilseed cultivation is undertaken across the country in about 26.00 million ha, largely under rainfed areas covering 72 percent of marginal land and producing around 30.00 million ton of oilseeds in 2019-20 as per the data of Directorate of Economics and Statistics, Ministry of Agriculture, Cooperation and Farmers Welfare, Government of India. Nine oilseeds are the major source of vegetable oil in the country i.e. Groundnut, Soybean, Rapeseed and Mustard, Sunflower, Sesamum, Safflower, Niger, Castor and Linseed. Among nine major oilseeds Soybean (39%), Groundnut (26%) and Rapeseed &Mustard (24%), contribute to more than 88 percent of total oilseeds production in the country However in terms of vegetable oil production Rapeseed

and Mustard, Soybean and Groundnut contribute 31 percent, 26 percent and 25 percent respectively. Madhya Pradesh, Rajasthan, Maharashtra and Gujarat are the major oilseeds producing states contributing more than 78 percent of oilseeds production in the country.

Scenario of Oilseeds in Rajasthan

Rajasthan is currently the largest state of India covering 10.41 percent of total geographical area of the country. Rajasthan has total cultivable land of 17.90 million hectare (Department of Agriculture, Government of Rajasthan). Rajasthan state occupies a prominent place i.e. second place after Madhya Pradesh in the oilseeds production of India. Among total cultivable land of 17.90 million hectare, 5.80 million hectare land is under oilseed production with 7.33 million ton of oilseed production in 2019-20 (4^{th} Advance estimates, Department of Agriculture, Government of Rajasthan). The important oilseed crops of Rajasthan state are Groundnut, Soybean, Rapeseed & Mustard, Sesamum and Taramira. Rajasthan is the leading producer of Rapeseed and Mustard with production of 4.30 million ton and second largest producer of Groundnut and third largest producer of Soybean with production of 1.61 million ton and 0.52 million ton respectively (Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare).

Government Efforts for Promotion of Oilseeds in India

Regardless of the fact that India is the world's largest producer of oilseeds, it is unable to meet domestic demand for edible vegetable oils because edible oil is such a vital element of our everyday diet. Consumption of edible oils in India has increased steadily throughout the years and reached to 36.7 million tonnes in 2019-20. (GAIN Report, 2020). The rise in domestic edible oil production (30 million tonnes in 2019-20) has not kept up with the increase in consumption demand and the gap between production and consumption is being bridged with imports. As a result, the Indian government launched many programmes, schemes and policy regulations for reducing burden of imports and to boost the country's oilseed sector. To achieve this goal the Indian government was spending millions of rupees on programmes and policies of oilseeds such as Yellow revolution (1986), National Oilseed Development Project (1985), Technology Mission on Oilseeds (1986), Oil Palm Development Programme (1991) under TMO, Integrated Scheme on Oilseeds, Pulses, Oil Palm and Maize (ISOPOM) in 2004, National Mission on Oilseeds and Oil Palm (NMOOP) during 2014-15 and it was included later in 2018-19 under National food security

Mission (NFSM) on oilseeds to achieve the demand and supply gap of oilseeds and also foster oilseed sectors growth in our country.

Sam Pitroda's Yellow revolution in 1986-87 had significant effect on increase in production of edible oil in which nine oilseed crops were shown significant in area under oilseed crops. Yellow revolution had an impact with use of modern technology inputs such as cultivars and hybrid seeds of Mustard and Sesame, incentives for farmers. It also takes the involvement of many boards such as National Dairy Board, National oilseeds and vegetable oils development board etc. to enhance the production of edible oilseed in India. The huge drain of country's wealth on the import bill due to lower domestic production led to establishment of Technology Mission on Oilseeds (TMO) in 1986 for enhancing the domestic production of edible Oils. Later that, pulses were brought under the ambit of Technology Mission in 1990. Oil palm in 1992-93 and Maize in 1995-96 were also brought under the Technology Mission. Setting up of Technology Mission on Oilseeds consequently shows a major breakthrough in increasing Oilseed production and it was achieved through an integrated approach of introduction of new crop production technologies, supply of inputs and extension services support for post-harvest technologies, marketing and excellent cooperation between various concerned organizations/ departments and Ministries. As a result of concerned efforts by the TMOP, the production of Oilseeds increased from 108.3 lakh tonnes in 1985-86 to 327.49 lakh tonnes in 2013-14. This brought not only increase in area but also improvement in productivity from 570 kg/ha to 1193 kg/ha during 2010-11 (Directorate of Oilseeds Development).

Integrated Scheme on Oilseeds, Pulses, Oil Palm and Maize (ISOPOM) was an integrated approach started in 2004 during the tenth five year plan. In order to increase the production, this approach suggested to implement annual action plan with the coordination of state government. Based on the constraints of production strategy to support the potential for increasing production & productivity, input supply and support service to farmers and development/extension agencies were provided under ISOPOM for oilseed, pulse and maize crops. Through annual action plan under tenth five year plan, it was targeted to increase the production of nine oilseeds by 6 per cent i.e. from 23.3 million tonne in 2002-03 to 29.4 million tonne in 2006-07 (Directorate of pulse development). Recently in 2014-15 National Mission on Oilseeds and Oil Palm (NMOOP) was an important mission implemented to enhance the production oilseeds under three mini missions. Under Mini Mission-I on oilseeds, target fixed to achieve production of 35.51 million tones and productivity of 1328

kg/ha of oilseeds from the average production & productivity of 28.93 million tonnes and 1081 kg/ha during the 11th Plan period respectively. In Mini Mission-II on Oilpalm, target fixed to increase the production through area expansion i.e. to bring the additional 0.12 million hectare under Oil palm cultivation by the use of wastelands (Ministry of Agriculture and Farmers Welfare, Government of India).The Mini Mission-III was on tree borne oilseeds. The NMOOP, the Central Sector Scheme implemented by the Oilseeds division has been merged with National Food Security Mission in 2018-19 & interventions of NMOOP are taken as sub-components of NFSM. The 3-sub-divisions are Mini Mission-I as NFSM-Oilseeds, Mini Mission-II as NFSM-Oil palm & Mini Mission-III as NFSM-Tree Borne Oilseeds.

Overview of Selected Oilseed Crops

Groundnut (*Arachis hypogeae.*) is a species of Leguminosae or Fabaceae family. It is cultivated in kharif, rabi and summer season in various cropping system. Day neutral Groundnut is grown in tropic and subtropical region and average rainfall required is 50-100 cm with temperature ranging 25-35°C**.** It is one among most important oilseed due to its high percentage of oil content. It contains 48-50% oil and 26-28% protein, and is a rich source of dietary fiber, minerals, and vitamins (ICRISAT, India). In Rajasthan, Groundnut is largely cultivated in Bikaner district in 0.24 million hectare land with 0.52 million tonnes production followed by Jodhpur, Churu, Jaisalmer etc. and with highest productivity is in Jodhpur district with 2.6 tonne/ha (Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare).

Soybean (*Glycine max*.) is an leguminous crop been called as miracle crop which is considered oilseed crop as well as pulse crop having 20 per cent oil and 40 per cent protein. Soybean is a short day plant grown in tropic and subtropical region where the average rainfall required is 60-75 cm with temperature ranging from 26-32 °C (ICRISAT, India). It is one of the major oilseed crop produced in India. In Rajasthan soybean is largely cultivated in Baran District with 0.25 million hectares and 0.13 million tonnes production followed by Jhalwara, Kota, Pratapgarh . highest productivity recorded in 2019-20 was in 1.23 ton/ha in Sawai madhopur district (Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare).

Sesamum (*Sesamum indicum*) belongs to the family Pedaliaceae.It is grown in warm regions of tropics and subtropics with temperature ranging from 25-27 °C. Average rainfall

required by the crop is 45-50 cm. Sesamum is a important oilseed crop which contains 46-52 % oil content used usually as edible oil and medicinal use (ICRISAT, India). In Rajasthan Sesamum is cultivated largely in Pali district with 0.05 million hectare land and 0.01 million tonnes production followed by Sawai madhopur, Tonk, Karauli etc. and recorded highest productivity in Bharatpur district with 0.47 ton/ha. (Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare).

Rapeseed and mustard (*Brassica spp.*) belongs to the family Brassicaceae. It is mainly grown in subtropical region with required average temperature 20-25 °C. Rainfall required for the better growth is 30-40 cm. It is major oilseed crop with 30-48 per cent oil content (ICRISAT, India). In Rajasthan Rapeseed and mustard is largely grown in the Tonk district with 0.28 million hectare land and 0.48 million tonnes production followed by Alwar, Bharatpur, Ganganagar etc. with recorded highest productivity of 1.85 ton/ha in Alwar district. (Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare).

Justification of the Study:

Indian agriculture has made considerable progress, particularly in respect of food crops such as wheat and rice in irrigated areas, however the performance has not been so good in case of other crops particularly oilseeds, pulses, and coarse cereals. Therefore, after achieving self-sufficiency in food grains the government is focusing attention on these agricultural commodities thereby attaining nutritional sufficiency also. Rajasthan is being largest state by area and one of highest oilseed producing state having more acreage under oilseed crops has done remarkably well in terms of output growth despite price risk, low rainfall, other weather effects. Rajasthan exhibits certain decreasing trend in production of oilseed crop from long years and trying to attain sufficiency for exponential growth of population. Therefore growth of oilseed crops over the year and extent variation has been calculated. Finding source of growth of production will helps policy makers to take need based action such as policies to area increase or intensive input use for crop production to obtain more production through productivity in available area.

Oilseed crop acreage may affected by many factors such as irrigation availability, rainfall, price of oilseeds, more profitability for other crops which hinders the growth of acreage under oilseed crops. Based on supply response elasticities policy can be recommended to the farmers for growth and development of oilseed scenario in the state.

(Kanwar and Sadoulet, 2008) reported that the success of public policy in promoting agricultural production depends, on the producer's response to variations in expected profit, irrigation and infrastructure and relevant risks. Need based policy measures will enhance the production more rapidly than general measures.

Keeping in view the above consideration, research study entitled **"Performance of oilseed crops in Rajasthan"** was planned with the specific objectives:

1. To estimate the growth and instability in area, production and yield of major oilseed crops in Rajasthan,
2. To measure relative contribution of area and yield in the growth of production of oilseeds,
3. To study the profitability of major oilseed crops,
4. To find out the factors responsible for acreage under oilseed crops in the state.

Limitation of the Study:

i. The study is completely based on the secondary sources of data and hence the accuracy of results depends on the accuracy with which the secondary data were generated.

ii. Due to non availability of certain district wise data of rainfall, prices, irrigated area under each crop, cost of cultivation and gross income, therefore third and fourth objectives were analysed by data of state as whole. So relatability between the objectives is limited.

iii. The factors affecting the growth and variability of oilseed crops mostly depends on past studies. As this analysis is based on district wise data and other factors responsible for change may unearthed.

Because of the aforementioned circumstances, the study's findings may be subject to the usual limitations.

Plan of the Thesis Work

This thesis is presented in five chapters. The first chapter covers introduction, objectives and limitations of the study and the second chapter pertaining to literature of the study is grouped into four sections namely growth and instability, decomposition analysis, profitability and acreage response in oilseed crops. The third chapter is on material and

methods which briefly describes the oilseed crops selected for the study, the source of data utilised for investigation and selection of its study period, study area selected for the study and analytical tools and techniques employed for the analysis have been described. The fourth chapter deals with results and discussion presented and discussed. The final fifth chapter is focus the summary and conclusion of the study and its major findings along with suitable policy measures for future research work. Literature cited has been given at the end of the thesis.

2. REVIEW OF LITERATURE

In any research, it is necessary to look into the previous studies pertaining to the issue. This helps to know the present status of research in the area and identify the gaps if any. Such a review would facilitate to develop a comprehensive knowledge on the objectives and enable to draw meaningful conclusions. The literature reviewed is classified and presented under the following headings:

2.1. Growth and instability in area, production and yield of oilseed crops,

2.2. Decomposition analysis of production of oilseed crops,

2.3. Profitability of oilseed production,

2.4. Acreage response function.

2.1. Growth and Instability in Area, Production and Yield of Oilseed Crops

Rahane and Joshi (1993) studied on growth rates in area, production and productivity of some important oilseeds and pulses in Maharashtra estimated the compound growth rates in area, production and productivity for the period 1966-67 to 1991-92. The study revealed that the area, production and productivity of sesamum, sunflower, gram, tur had increased significantly. But in case of groundnut there was an increase in its production and productivity only. The study further showed that among the various oilseeds and pulse crops, the highest growth in area was found for sesamum (2.97 per cent per annum), while in production and productivity, it was higher in safflower i.e. 8.26 per cent and 5.74 per cent per annum respectively.

Purbia (2002) investigated the growth, instability in production of major crops in Rajasthan. The secondary data for 1970 to 2000 were used Compound growth rate, coefficient of variation were used for the analysis. It was revealed that growth rate of area of Wheat, Rapeseed and Mustard ,Maize, Groundnut, Rice, Dry Chillies, Coriander and Guar were positive and Maize was found to be highly stable crop in area while Wheat emerged highly stable crop in both production and productivity. It was concluded that production

strategy for the crops must aim to enhance the production and productivity growth without causing much inter year instability.

Swain (2007) studied the growth and variability in the growth of oilseeds production in Rajasthan, India using time series data from 1980-81 to 1999-2000.The growth rate had been estimated with the help of exponential function and variability was appreciated with the help of co-efficient of variation. For the purposes of comparison, the total period was divided into two sub-periods. The study reveals that highest growth rate in area of Rapeseed and Mustard was observed in period II i.e. 7.82 per cent, in production was in overall period i.e. 7.19 per cent and in yield by o.48 percent in overall period. The study also reveals that area under rapeseed mustard crop was recorded highest variation during overall decade (53.39 per cent) followed by decade II (30.15 per cent) and it was recorded least during decade I (21.40 per cent), respectively. The variation in area of rapeseed mustard was ranging from 53.39 per cent to 21.40 per cent, which is wide fluctuation range during the study period.

Paliwal (2011) examined growth and instability of soybean production in Jhalawar district of Rajasthan. The study was based on secondary (1991-92 to 2006-07) data on area, production and yield of soybean in the Jhalawar district and Rajasthan state as whole. Compound growth rate and coefficient of variation analysis was performed to achieve the stated objectives. The study showed that the area, production and yield under soybean registered a significant and positive growth rate in the study period (1991-2007) as well as in two different sub-periods. It also indicates that Soybean production in the district was increased with a compound growth rate of 8.05 per cent per annum in production during overall period of the study. the study showed that the variability in area under soybean cultivation was around 33.14 per cent during overall period of study at district level. The study showed that higher variability in area, production and yield of Soybean was around at 33.14 percent, 45.90 percent and 28.26 percent respectively during the study period 1991-92 to 2006-07.

Agarwal *et al*. (2014) conducted a study on growth rates in area, production and productivity of Soybean in Madhya Pradesh. The study measured the growth performance, instability and decomposition analysis of growth in area, production and productivity of Soybean based on secondary data during 1996-97 to 2013-14. The area, production and productivity of Soybean registered positive and significant growth trend during the study

period. The study revealed that the compound growth rate of area under Soybean was 1.9 percent per annum while that for production and yield was 3.8 percent per annum and 1.8 percent per annum respectively. And the coefficient of variation analysis tells highest annual fluctuation in Soybean production followed by area and yield throughout the period.

Pardhi *et al.* (2016) studied the growth and instability by the use of compound growth rate, coefficient of variation and Coppock's instability index of Soybean in Amravati region with taking secondary data from 1993-94 to 2012- 13 with two equal periods. The study revealed that compound growth rate for area and production of soybean was observed very high during period I. The co-efficient of variation with regards to area and production (37.59% and 22.23 %) were lowest in Amravati district. However, Coppock's instability index with regards to area and productivity (13.01% and 18.84 %) were lowest in Amravati division as a whole.

Simal *et al*. (2017) analysed district wise growth and instability of all oilseed in comparison with Groundnut in Odisha by using CAGR, Covariance and Cuddy Della Valle index from Period 1(1995-96 to 2004-05) and Period 2 (2005-06 to 2014-15) .Here Groundnut and oilseed crops experienced negative growth rate in 1st period in districts as well as state level following the positive growth rate in 2nd period except 9 districts. In 2nd period there was an improvement in instability in all districts except 13 districts with high level of instability.

Kumar *et al.*(2018) studied growth and instability of oilseed crops in Uttar Pradesh by using secondary data from 1981-82 to 2011-12 which divided into three equal periods . They used compound growth rate and coefficient of variation. The study reveals that oilseed area and production of all major oilseeds have decreased except mustard which increased from 2.521 % in II period to 12.82% in III period. The variability is higher in initial phase as compared to later phase showing more stability in the production of oilseeds. The variability in area of total oilseeds in the state as a whole was 8.80, 7.70 and 5.55 percent in first, second and third phase of production, respectively.

Laxminarayan (2018) analysed state wise growth and instability for five major oilseed crops Groundnut, Sesamum, Soybean, Rapeseed and Mustard and Taramira in Rajasthan from 1985-86 to 2015-16 by using the compound growth rate, coefficient of variation analysis. Here production and yield of selected oilseed crops was observed growing at faster

rate than growth in area under those oilseed crops. And highest variability was seen in case of production and yield as compared to variation in area.

Kolar P *et al*. (2020) studied Growth performance of oilseeds among leading states of India from the secondary data from 1995-96 to 2017-18 by using the compound growth rate and Cuddy Della Valle index for instability index was used. Study reveals that area and production of Soybean in Maharashtra and Madhya Pradesh increased at high rate with more instability and production and productivity of Rapeseed & Mustard in Rajasthan, Haryana, Madhya Pradesh increased at high rate and area was in negative growth in Uttar Pradesh (–2.93). Instability of area in Haryana and Uttar Pradesh was seen low and production instability was seen moderate in four states except Haryana.

2.2. Decomposition Analysis of Production of Oilseed Crops

Sharma and Jain (2006) examined the variability, growth trends and contribution of area, yield and their interaction on production of soybean in Madhya Pradesh, India. All the major Soybean growing districts of Madhya Pradesh were considered the secondary data from 1984-85 to 2003-04 which divided into two sub-periods i.e., period-I (1984-85 to 1993-94) and period-II (1994-95 to 2003-04). It was observed that Ujjain, Indore, and Dewas being the most important Soybean production districts contributed more than 24.2% of area and 26.0% of production of soybean in the state with an average productivity of 1207 kg per ha. Six districts, namely Indore, Dhar, Shajapur, Sehore, Sagar and Betul fall under the category of low risk prone districts. The area, yield and interaction effect were also positive in almost all districts of Madhya Pradesh. In period II, area effect was negative in Betul districts, while yield effect and interaction effect were negative in Dhar, Ujjain and Sagar districts of Madhya Pradesh.

Shende *et al*. (2011) worked on decomposition analysis and acreage response of Soybean in Western Vidarbha by using time series secondary data. This study tell us that area was the prime factor responsible for increasing production with 46.98% where as yield effect and interaction effect was positive 1.91 % and 51.41 % respectively.

Narayan Sharma *et al.* (2015) analysed the patterns and sources of growth in pulses production in India. The study has observed an increasing trend in pulses production, driven mainly by yield improvements. They also reported that contributions of area expansion and prices to pulses growth have been erratic, suggesting that these cannot be the sustainable

sources of growth in pulses. Further study shows that the farmers' area allocation decisions to pulses are not price-dependent, but depend on nonprice factors, mainly rainfall.

Sandeep *et a*l. (2015) studied on decomposition analysis and acreage response of chickpea in Western Vidarbha, where compound growth rate for area and production of chickpea recorded high during I period (1983-84 to 1992-93) in all districts and during II period (1993-94 to 2002-03) area and productivity recorded almost negatively and in III period (2003-04 to 2012-13) all area, production and productivity recorded positive compound growth rate. And area effect with 37.44% was the major factor responsible for production change than interaction effect.

Singh *et al*. (2015) analysed the growth rate and decomposition of output components of oilseeds in North Eastern states from the published secondary data from 1982-82 to 2011-12 which was divided into three periods. The study reveals that sources of output growth in all the three period was similar in which yield was the major source of growth of output followed by the area in all eight states of north east India.

Pardhi *et al.* (2016) studied the decomposition analysis of Soybean by using Minhas(1964) decomposition model in Amravati region with taking secondary data from 1993-94 to 2012- 13 with two equal periods. This study reveals that yield effect was the major factor for the change in production in I and II period which was 44.80% and 174.38% respectively and in overall period 95.20 % was the area effect which results change in growth of production of Soybean in Amravati.

Kumar *et al*.(2018) worked on decomposition analysis of oilseed crops in four regions of Uttar Pradesh by taking secondary data of thirty years from 1981-82 to 2011-12 which divided into 3 equal periods. Study shows that in contribution of area in change of production was found positive in all regions and state as a whole in first period. The contribution of yield and interaction in change of production was found positive in western, Bundelkhand, eastern regions and state as a whole. The interaction effects of area and yield was found to be negative in Western and Eastern region and in the state as a whole, while it was positive in Central and Bundelkhand region. (45.52%). In Western and Eastern region effect of yield was found positive. Overall effect of yield on production of oilseeds in UP was observed to be negative (34.31 percent). The interaction effects in Western region was found positive i.e. 1.47 percent.

Meena *et al*. (2018) studied source of growth to Indian Groundnut, A state level decomposition analysis with the secondary data from the published sources from 1985-86 to 2014-15. The study reveals that the largest source of growth to Indian Groundnut was yield (15%) followed by price (7.53%) and by area (0.97%). In Tamil Nadu yield contributed 55% of total growth of Indian Groundnut which is highest in all states.

Mohammad *et al*. (2018) worked decomposition analysis of cotton production in Gujarat for finding the source of growth in production of Cotton by using Hazell's decomposition model for the time series data from 1980-81 to 2015-16. The study reveals that area and yield were jointly contributed for growth in production in overall period and Hazell's decomposition method reveals that yield variance was the major factor responsible with percentage variance of 50.9% in period I and 83.34 % in period II.

Kumar *et al.* (2019) studied growth and instability in area, production, and productivity of Soybean in India. The secondary data from 1996-2016 growth was analysed by compound growth rate and relative contribution of area and productivity for the output was analysed by decomposition analysis. Relative change in area was maximum in the year 2004-05 which was 15.51 % and maximum decrease in the year 2014-15 which is 6.88% and maximum increase in production and productivity were found to be 69.98 and 56,56% respectively.

2.3 Profitability of Oilseed Crops:

Narayanmoorthy (2013) studied on Profitability on crops cultivated in India for major 6 crops Rice, Wheat, Sugarcane, Groundnut, Gram and Cotton crops with selection of states which have highest area and production for each crop from 1975-76 to 2006-07. For Groundnut they selected Gujarat which was major Groundnut producing state. Here we can see increase in Cost C2 of 1463/- per hectare in 1975-76 to 15974/- per hectare in 2006-07 with value of output increased from 1861/- per hectare in 1975-76 to 20464/- per hectare in 2001-02 with growth rate of 1.28% which indicates real returns from the cultivation of Groundnut in Gujarat was increased.

Agarwal *et al.* (2014) analysed cost of cultivation of Soybean in Narsinghpur district of Madhya Pradesh in the study year of 2011-12. Primary data required for the study was taken from 20 farmers and divided into small, medium and large farmers. The study reveals

that cost C2 was higher for medium farmers i.e. Rs.26185.73 per hectare and net income per hectare over cost C2 was held high for medium famers i.e. Rs. 22504.33.

Dubey *et al.* (2014) studied on cost and returns of Rapeseed and Mustard in Bharatpur district of Rajasthan based on CACP concept. Primary data required was collected from 36 small,15 medium and 9 large farmers. This study analysed that net returns over cost A2 and cost C2 was higher for small farmers i.e. Rs.15,728 and Rs. 9,304 per hectare respectively. Cost A2 was comparatively higher for medium farmers i.e. Rs. 13,859 per hectare and cost C2 was high for large famers i.e. Rs.24,651 per hectare.

Raut *et al*. (2015) worked on returns and cost of cultivation of kharif Groundnut in Sabarkantha district of Gujarat by selecting 108 random medium, small and large farmers. This work observed that net income over cost C2 was higher for large farmers i.e. Rs.25998 per ha) followed by medium and small farmers i.e. Rs 25952, Rs.25699 respectively. Whereas average net income was observed Rs.25813.

Purushottam Sharma (2016) worked on Costs, returns and profitability of Soybean cultivation in India with special emphasis on Madhya Pradesh, Rajasthan and Maharashtra by analysing data from CACP of Directorate of Economics and Statistics, Ministry of Agriculture Farmers Welfare, Government of India from 1980-81 to 2012-13. The total costs and returns of Soybean cultivation was calculated in comparison with growth rate. In Madhya Pradesh the paid out cost i.e. Cost(A2) is increased from 3295/- per hectare in 1983-84 to 7857/- per hectare in 2011-12 with growth in cost of 2.3% per annum .The gross return of Soybean cultivation increased with growth rate of 1.8% per annum which indicates that there was an decreasing trend in net returns from the cultivation of Soybean.

Dinesh Kumar *et al*. (2018) studied Growth performance and economics of Rapeseed and mustard cultivation in Rajasthan by using both primary and secondary data from (1996-97 to 2016-17) which was divided into two periods. Study reveals that cultivation of Rapeseed and Mustard provides an net return of 40000/- per hectare with total operational cost of 37,254/- per hectare. Major operational activities such as irrigation charges (16.80%), harvesting (12%), field preparation (11.2%), chemical fertilizers (6.5%), threshing (5%) were the main items of cost of cultivation for Rapeseed and Mustard.

Mahendra *et al.* (2018) studied on cost of cultivation of Soybean crop in Rajnandagaon district of Chhattisgarh. Primary data was collected from 120 Soybean growers

in which 54 small, 37 medium and 29 large famers were classified. In this study net returns per hectare was recorded high for large farmers i.e. Rs. 16,734.04 followed by medium and small farmers. Here cost A was higher for large farmers i.e. Rs. 15,343.76 per hectare followed by medium and small farmers where as cost C was higher for small farmers i.e. Rs. 27,290.5 per hectare followed by medium and large farmers.

Sahu *et al.* (2018) studies cost of cultivation of Mustard crop in Fatehpur district of Uttar Pradesh from the primary data collected from interview method. Here they divided farmers into marginal, small and medium farmers based on land holding. In this study per hectare cost A2 and cost C2 were comparatively more for medium farmers i.e. Rs. 18807.35 and Rs. 29596.31 respectively. Gross income for medium farmers of Mustard crop was Rs.43626.88.

Shivalika *et al.* (2018) worked on cost of cultivation of major pulse crop in Rajasthan by analysing secondary data from 2001-02 to 2013-14 which divided into two periods. This study reveals that net returns of Chickpea over cost A2 was increased from Rs. 6,813.67 per hectare in first period to Rs. 23494.41 per hectare in second period. And net returns over cost C2 was increased from Rs. 1397.58 per hectare in first period to Rs. 9440.58 per hectare in second period.

Sunandini *et al*. (2020) worked on Economic analysis of Groundnut production in Andhra Pradesh from the published data of Directorate of Economics and Statistics for two periods (2007-08 to 2011-12) and (2012-13 to 2016-17). The analysis reveals that cost of cultivation of Groundnut in two periods observed by 40% and that of increase in gross return by 25%. Study reveals that Andhra Pradesh has more cost of cultivation than the other major Groundnut producing states like Tamil Nadu and Gujarat.

2.4 Acreage Response Function:

Tripaty *et al*. (1993) analysed area response of Groundnut in Orissa by using Nerlovian lagged adjustment model by taking time series data from 1979 to 1990 which divided into two equal sub periods . The study reveals that lagged area, lagged price and irrigation has positive effect on area of Groundnut whereas rainfall was turned out to be the negative effect and also statistically nonsignificant in the area of Groundnut in Orissa.

Jain *et al*. (2005) conducted study in risk in output growth of oilseed in the Rajasthan state where they used Nerlovian lagged adjustment model for acreage response function by

using secondary data from 1981 to 2001 regarding data of area, production, and productivity of selected as well as competing crops, farm harvest price of both selected and competing crops ,irrigated area, seasonal rainfall were collected. This study reveals that price elasticities in both long run and short run found positive except Soybean which shows instability in price for the Soybean production in Rajasthan.

Pandey *et al.* (2005) conducted a study on instability, supply response and insurance in oilseeds production in India and reported that the productivity of oilseeds has increased while the prices have decreased during Period II (1994-95 to 2001-02) as compared to those in Period I (1986-87 to 1993-94). It was also reported that the price elasticities of production have been found positive and varied between 0.26 and 0.88 for major oilseeds in India.

Tuteja (2006) worked on growth performance and acreage response of pulse crop at state level. The study presents on the extent of responsiveness of price and non-price factors to acreage of Black gram, Pigeon pea, Gram, Lentil and total pulses in India and major growing states varied widely in different background. The results revealed that acreage allocation in rabi pulses, *i.e.* Gram and Lentil got influenced by lagged acreage followed by relative price in most of the analysed cases whereas in kharif pulses *i.e.* in allocating land to Pigeon pea, Gram and Black gram farmers considered lagged acreage and magnitude of pre-sowing rainfall as the most important factors.

Birla (2014) worked on acreage response of chickpea in India to study the factors influencing the acreage response in three major gram producing state, namely Madhya Pradesh, Maharashtra and Rajasthan for the period 1974-75 to 2008-09. Acreage analysis revealed that price factors were important in Madhya Pradesh and Rajasthan whereas non-price factors were important in Maharashtra.

Dudhat *et al*. (2014) worked on hectareage response study of wheat crop using Nerlovian model for Gujarat state with the secondary data 1980-81 to 2007-08. Work reveals that lagged hectareage, lagged price, expected price, expected yield and price risk were positive impact on hectareage of Wheat crop and negative correlation was observed in current hectareage of competing crop. Current hectareage had significant influence from price risk, while no influence or little influence was observed for yield risk of wheat crop in the state.

Gangwar *et al*. (2015) worked on supply response of Rapeseed and Mustard in different regions of Uttar Pradesh by Nerlovian lagged adjustment model with 20 years

secondary data obtained from various sources from 1989-90 to 2008-09. This study reveals that acreage response of Rapeseed and Mustard to the price of main crop was found positive and significant in all regions except Bundelkhand region whereas to the price of competing crop(gram) was positive and significant only in Central region and lagged yield was in Bundelkhand region.

Sandeep *et a*l. (2015) studied acreage response of chickpea in Western Vidarbha by using regression model of Nerlovian lagged adjustment model from the time series secondary data from 1983-84 to 2012-13 which divided into three equal periods. The study reveals that price effect was negative for all regions by observing negative coefficients and other factors responsible for acreage were positive except rainfall effect in Amaravati and akola region.

Sadiq *et al*. (2017) studied Supply Response of Cereal Crop Farmers to Price and Non-Price Factors in Rajasthan state for the cereal crops Jowar, Maize, Bajra, Wheat and Barley with Nerlovian model for the secondary data from 1981 to 2014. The study reveals that the farmers were influenced by nonprice factors for the acreage except for Maize crop, lagged area and lagged price of competing crop were the major factors responsible for acreage allocation. And lagged price influenced the Maize acreage and lagged yield influenced the Barley crop area allocation.

Devi *et al*. (2018) studied the acreage response to weather, yield, price of Groundnut and Sesamum growers in Gujarat. In this study secondary data from 1985-86 to 2014-15 was taken and analysed by the Nerlovian partial adjustment model. Competitive crop was selected by calculating correlation coefficient between crop areas. Here sowing seasonal rainfall was the positively responsible for acreage and price was negatively responsible for acreage for Groundnut. For Sesamum crop lagged area and seasonal rainfall positively and yield of competing crop (Cotton) negatively responsible for acreage.

3. RESEARCH METHODOLOGY

In order to scientifically investigate into the framed objectives of the study, it is necessary to spell out the plan of work to be adopted. The methodology for the present study is described as under three sections, the first section describes the sampling design, the second section deals with the collection of data and the third section give the details of analytical frame work used for achieving different objectives of the study.

3.1 Sampling Design

The sampling design followed in the present investigation includes the aspects like selection of major oilseed crops, selection of study area and reference period of the study.

3.1.1 Selection of Major Oilseed Crops

Among all oilseed crops being produced in the state of Rajasthan, four oilseed crops which contributes major share in area were selected thus Groundnut, Sesamum, Soybean, Rapeseed and Mustard were selected.

3.1.2 Selection of Study Area

The state of Rajasthan occupies second place after Madhya Pradesh in oilseed production in India. It accounts for 5.82 million ha area, 7.33 million ton of production and 1259 kg/ha productivity, respectively (4^{th} Advance estimates 2019-20 of Department of Agriculture, Government of Rajasthan) under oilseed crops. Therefore state hold a key role in the production of oilseeds in the country that's why state of Rajasthan has been purposively selected for the present study. For the study five districts having highest area under each selected oilseed crop were selected. First and second objective analysis will be done at the district level for five selected districts and for third and fourth objective analysis will be done at the state level. Districts selected for each oilseed crop for first and second objectives were listed below.

Table 3.1. Selection of Districts for each Oilseed Crop

Districts/ Crops	GROUNDNUT	SESAMUM	SOYBEAN	R &M
District 1	BIKANER	PALI	JHALAWAR	ALWARA
District 2	JODHPUR	S MADHOPUR	BARAN	TONK
District 3	CHURU	JODHPUR	KOTA	BHARATPUR
District 4	JAIPUR	KARAULI	BANSWARA	GANGANAGAR
District 5	JAISALMER	TONK	CHITTORGARH	JODHPUR

3.1.3 Reference Period of Study

Twenty years data has been considered for the analysis of the growth, instability, decomposition analysis from 2000-01 to 2019-20 which divided into two periods i.e. Period I (2000-01 to 2009-10) and Period II = (2010-11 to 2019-20). For profitability of selected, due to non availability of data of 2018-19 and 2019-20, the analysis was done for 18 years from 2000-01 to 2017-18 in two periods, Period I = (2000-01 to 2009-10) and Period II = (2010-11 to 2017-18). The analysis of acreage response function of selected major oilseed crops was done from 2000-01 to 2019-20 as whole period.

3.2 Collection of Data

The study is based on secondary data. The secondary data required for the study is obtained from various publications and official websites of Government of Rajasthan, Directorate of economics and statistics, Ministry of Agriculture and Farmers Welfare, Government of India and Indiastat.com *etc*.

3.2.1 Sources of Data

The secondary data required on area, production, yield, cost of cultivation, profit, prices, rainfall and irrigated area of past years were collected from various published and unpublished sources:

- Year wise Statistical Abstract of Rajasthan (Directorate of Economics & Statistics, Rajasthan, Jaipur).
- Year wise Rajasthan Agricultural Statistics at a Glance (Directorate of Agriculture, Rajasthan, Jaipur).

- Publication of Ministry of Agriculture, GOI, New Delhi, on Cost of Cultivation of Major Crops. (http://eands.dacnet.nic.in/)

- Website (https://www.indiastat.com/).

3.3. Analysis of Data

The secondary data collected from various sources are scrutinized, compiled, systematically arranged, organized and finally subjected to tabular analysis for drawing inferences. The collected data is analysed by using suitable tools and techniques to achieve the stated objectives.

1. Tabular Analysis

Tabular analysis was carried out for the assessment of growth rate and instability in area, production and yield of oilseed crops.

Estimation of Growth Rate:

Using compound growth rate CAGR of individual oilseed crops will be calculated by Exponential function.

$$Y=AB^t \qquad \text{……. (1.0)}$$

$$\log Y = \log A + t \log B$$

Where,

Y=Area, production or yield of oilseeds

A=constant,

B= regression coefficient,

t= time in years

Then, the compound growth rate (per cent per year)

$$r = [(\text{Antilog } B) - 1] \times 100$$

Measurement of Instability:

Deviation from the trend will be measured by coefficient of variation for all selected oilseed crops and CUDDY-DELLA-VALLE Index.

Instability Index:

$$CV = SD \div AM \times 100 \quad \ldots\ldots\ldots(2.0)$$

CV= Coefficient of variation.

SD=Standard deviation.

AM= Arithmetic mean.

The instability index of Cuddy-Della Valle index is given by the expression;

$$CDI = CV \sqrt{(1 - R^2)} \quad \ldots\ldots\ldots\ldots(2.1)$$

Where,

CV=Coefficient of variation (in percent)

R^2=Coefficient of determination from a time trend regression adjusted by the number of degrees of freedom.

Decomposition Analysis of Production of Oilseed Crops

Oilseed production in Rajasthan state has witnessed significant changes in terms production, area and yield. To find out the sources of growth and instability in oilseeds production in state, Hazell's decomposition model will be employed (Hazell, 1982). The area and yield data for major oilseeds in districts of Rajasthan were detrended and these detrended series will be using as the basic data for decomposition of changes in average production and changes in variance of oilseeds production. The Hazell's decomposition procedure is given below.

Let P is taken as production, A and Y denotes the area sown under a particular crop and yield per hectare. Then total output for each crop in the state is P = A * Y. The variance of production, V(P) can be expressed as

$$V(P) = \bar{A}^2 V(Y) + \bar{Y}^2 V(A) + 2\bar{A}\,\bar{Y} \text{cov}(A,Y) - \text{cov}(A,Y)^2 + R \quad \ldots\ldots\ldots\ldots(3.1)$$

Where $\bar{A}$ *and* $\bar{Y}$ and R denotes mean area, mean yield and residual term respectively. Change in any one of these components will lead to a change in V(P) between two periods in time. Similarly, average production, E(P) can be expressed as:

$$E(P) = \bar{A}\bar{Y} + \text{cov}(AY) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(3.2)$$

E(P) is affected by changes in the covariance between area and yield and by changes in mean area and mean yield. The objective of the decomposition analysis is to partition the changes in V(P) and E(P) between the first and the second periods into constituent parts, which can be attributed separately to changes in the means, variances and covariances of area and yield.

Method of Decomposition of Average Production

Using eq. (3.2), average production in the first period and second periods are

E (P_1) = $A_1^- Y_1^- + cov\,(A_1 Y_1)$……..(3.3)

E (P_2) = $A_2^- Y_2^- + cov\,(A_2 Y_2)$……..(3.4)

Each variable in the second period can be expressed as its counterpart in the first period plus the change in the variable between the two periods.

For example, $A_2^- = A_1^- + \Delta A^-$

$$Y_2^- = Y_1^- + \Delta Y^-$$

$$Cov\,(A_2, Y_2) = Cov\,(A_1, Y_1) + \Delta\, Cov\,(A_1, Y_1)$$

Equation (3.4) can, therefore be rewritten as:

E (P_2) = $(A_1^- + \Delta A^-)(Y_1^- + \Delta Y^-) + cov\,(A_1 Y_1) + \Delta\, cov\,(A, Y)$

$= A_1^- Y_1^- + A_1^- \Delta Y^- + Y_1^- \Delta A^- + \Delta A^- \Delta Y^- + cov\,(A_1 Y_1) + \Delta\, cov\,(A, Y)$ …..(3.5)

The change in average production $\Delta E(P)$ is then obtained by subtracting equation (3.1) from equation (3.3). Thus, ΔE (P) = E (P_2) - E(P_1) ……. (3.6)

$$= A_1^- \Delta Y^- + Y_1^- \Delta A^- + \Delta A^- \Delta Y^- + \Delta\, cov\,(A, Y)$$

Hence, there are four sources of change in average production resulted from this equation (3.6) which are arranged and listed below. The first two terms, change in the mean yield and change in mean area are called as ‘pure effects’ which arise even if there were no other source of change. The third term is an interaction effect, which arise from the simultaneous occurrence of changes in mean yield and mean area. The fourth term in the equation represents interaction between area and yield covariance.

Table 3 2: Components of Change in Average Production

Sources of Change	Symbol	Components of Change
Change in mean yield	ΔY^{-}	$A_1^{-}\Delta Y^{-}$
Change in mean area	ΔA^{-}	$Y_1^{-}\Delta A^{-}$
Interaction between changes in mean yield and mean area	$\Delta A^{-}\Delta Y^{-}$	$\Delta A^{-}\Delta Y^{-}$
Change in area–yield covariance	$\Delta\, cov\,(AY)$	$\Delta\, cov\,(A,Y)$

Profitability of Oilseed Crops:

For estimating the profitability of oilseed crops published time series data from cost of cultivation surveys, Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India has been used. Here for profitability of oilseed crops cost A2 and cost C2 has been used.

Gross Income =Value of Main Product+ Value of By Product

Farm Business Income = Gross Income- Cost A2

Net Income = Gross Income- Cost C2

Here Per cent change of Value of Main product, Value of By Product, Gross Income, Cost A2 and Cost C2 were calculated.

Estimation of Acreage Response Function

To work out the acreage response pattern of major oilseed crops to find out effects of several factors on the change of acreage in cultivation, the following acreage response function has been estimated:

$A_t = f\ (A_{t-1}, Y_{t-1}, P_{t-1}, Y_{ct-1}, P_{ct-1}, R_t, R_{t-1}, I_t, I_{t-1}, Sp_{t-1}, Sy_{t-1}, e_t)$ …….(5.1)

Where,

A_t = Current year area of the oilseed crops

A_{t-1} = One year lagged area of the oilseed crops

Y_{t-1} = One year lagged yield (average) of the oilseed crops

P_{t-1} = One year lagged price (average) of the oilseed crops

Y_{ct-1} = One year lagged yield (average) of competing crop

P_{ct-1} = One year lagged price (average) of the competing crop

R_t = Rainfall in the t^{th} year

R_{t-1} = One year lagged rainfall

I_t = Total irrigated area in t^{th} year

I_{t-1} = Total irrigated area in $(t-1)^{th}$ year

Sp_{t-1} = Standard deviation of prices for preceding 3 years

Sy_{t-1} = Standard deviation of yield for the preceding 3 years

e_t = Error term

Keeping in mind the likely multicollinearity between explanatory variables backward elimination method has adopted to retain the significant variables after eliminating the problems of multicollinearity.

Selection of Competing Crops

Selection of competing crop will be made based on correlation coefficient between areas under different crops for the period 2000-01 to 2019-20. Those crops having highest negative correlation coefficient between these areas under these crops will be chosen as competing crops.

Elasticities from Estimated Acreage Response Function

When, Y = f(X) is a function, the elasticity of Y with respect to X is given by:

$$e_{yx} = \frac{\%\ \text{Change in Y}}{\%\ \text{Change in X}} \qquad (5.2)$$

$$= \frac{\Delta Y / Y}{\Delta X / X}$$

$$= \frac{\Delta Y}{Y} \cdot \frac{X}{\Delta x}$$

$$= \frac{\Delta Y}{\Delta X} \cdot \frac{X}{Y}$$

$$= \frac{dY}{dX} \cdot \frac{\overline{X}}{\overline{Y}} \text{ for the average situation}$$

When $Y = \hat{a} + \hat{b}\ X$ is the estimated equation

$$e_{yx} = b\frac{\overline{X}}{\overline{Y}}$$

Test of Significance

i. To test the significance of estimated coefficients, 't' test was used.

Where; Calculated 't' $= \frac{b}{Se(b)}$

b = Estimated coefficient of the model

$Se(b)$ = Standard error of the estimated coefficient

ii. To test the overall significance of estimated model 'F' test was used:

$$\text{Calculated 'F'} = \frac{\text{Sum of squares due to model / d.f}}{\text{Error sum of squares / d.f.}}$$

4. RESULTS AND DISCUSSION

This chapter focuses on the results of the present study. The results of the study are based on published secondary data collected for present investigation. The data has been processed and tabulated in the lights of the pre-determined objectives. This chapter contains presentation and interpretation of results pertaining to the study. The study is organized into the following heads for easy understanding and convenience:

4.1 Overview of Study Area,

4.2 Growth and instability in area, production and yield of oilseed crops,

4.3 Decomposition analysis of production of oilseed crops,

4.4 Profitability of oilseed production,

4. 5 Acreage response function.

4.1 Overview of Study Area

Rajasthan has a prominent position in the production of oilseed crops in India. Being the largest state in the country, it has varied climatic conditions and diversified cropping pattern. The major oilseed crops grown in the state are Groundnut, Sesamum, Soybean and Rapeseed & Mustard. In Rajasthan among total cultivable land of 17.90 million hectare, 5.80 million hectare land was under oilseed production with 7.33 million ton of oilseed production in 2019-20 (4^{th} Advance estimates, Department of Agriculture, Government of Rajasthan). In 2019-20, Rajasthan produced 4.30 million tonne of Rapeseed and Mustard from 2.71 million hectares area and emerged as the highest Rapeseed and Mustard producing state in the country. Production of Groundnut in Rajasthan was 1.61 million tonne from 0.73 million hectares area (2019-20) and emerged as second highest Groundnut producing state of India. Rajasthan is the third highest Soybean producing state with production of 0.52 million tonne from 1.11 million hectares area and the production of Sesamum was 0.091 million tonne from 0.27 million hectares area during the same year (4^{th} Advance estimates 2019-20, Department of Agriculture, Government of Rajasthan). The yield of total oilseeds in Rajasthan was lower i.e. 1.25 tonne per hectare compared yield at national level (1.28 tonne per hectare) in 2019-20 (DES. MOA. GOI). The yield of Groundnut, Sesamum and Rapeseed & Mustard was

higher in Rajasthan compared to national level while Soybean has lower yield in Rajasthan (0.46 tonne per hectare) compared to national level (0.92 tonne per hectare) in 2019-20. The production of oilseed crops in Rajasthan can further increased as there is potential in improvement in yield of these oilseed crops.

4.2 Growth and Instability in Area, Production and Yield of Oilseed Crops

Production of any crop is influenced by many technological, climatic and policy factors which affect the production positively or negatively. Therefore it is important to measure the growth pattern and extent of instability in area, production and yield of crops. Growth in production is mainly influenced and result of growth in area as well as yield. Extent of instability shows the extent of risk associated with activities related to production. In this study the growth rate was analysed by compound growth rate functions and instability by coefficient of variation and Cuddy Della Valle index.

4.2.1 Compound Growth Rates of Area, Production and Yield of Groundnut in Selected Districts of Rajasthan.

In Rajasthan, area under groundnut cultivation was 520.82 thousand hectares in 2015-16 which has continuously increased to 739.02 thousand hectare in 2019-20. The area under groundnut cultivation in all five selected districts and per cent share of each district to the total area under Groundnut cultivation in Rajasthan is given in table 4.1. In 2019-20 these five districts together contributed 74.15 per cent share of total area under groundnut cultivation in Rajasthan. The district having highest share of ground area in the state was Bikaner (33.16 per cent) followed by Jodhpur (20.51 per cent) in 2019-20. Between 2015-16 to 2019-20, area under groundnut had decreased in Jaipur district while it increased in Jaisalmer district.

Table 4.1 Area and Percent Contribution of Area of Groundnut in Selected Districts of Rajasthan (Area in Th.ha)

Districts	2015-16		2016-17		2017-18		2018-19		2019-20	
	Area	PCA	Area	PCA	Area	PCA	Area	PCA	Area	PCA
1. BIKANER	165.54	31.79	174.94	31.18	220.55	34.13	238.85	35.47	245.06	33.16
2. JODHPUR	113.44	21.78	115.44	20.58	129.42	20.03	111.78	16.60	151.57	20.51
3. CHURU	47.16	9.06	52.50	9.36	63.45	9.82	72.91	10.83	72.69	9.84
4. JAIPUR	38.20	7.34	33.41	5.95	32.18	4.98	31.00	4.62	37.37	5.06
5. JAISALMER	17.28	3.32	19.79	3.53	25.66	3.97	34.47	5.12	41.21	5.58
RAJASTHAN	520.82	100	561.08	100	646.15	100	673.36	100	739.02	100

(Th.ha- Thousand hectare, PCA- Percent contribution of Area. Source: DES, MOA, GOI)

The production of Groundnut in all five selected districts and per cent share of each district to the total production of Groundnut in Rajasthan from previous five year is given below in table 4.2. Among the districts, Bikaner district contributed about one third of total groundnut production of the state between 2015-16 to 2019-20. In 2019-20, Jodhpur district contributed 24.85 per cent and Churu district contributed 10.22 per cent of total groundnut production of Rajasthan.

Table 4.2 Production and Percent Contribution of Production of Groundnut in Selected Districts of Rajasthan **(**Production in Th.tons)

Districts	2015-16		2016-17		2017-18		2018-19		2019-20	
	Prod	**PCP**	**Prod**	**PCP**	**Prod**	**PCP**	**Prod**	**PCP**	**Prod**	**PCP**
1. BIKANER	402.45	38.16	467.35	40.72	514.09	40.73	531.09	38.41	529.06	32.67
2. JODHPUR	267.12	25.33	198.43	17.29	241.97	19.17	214.70	15.53	402.46	24.85
3. CHURU	101.19	9.59	134.04	11.68	144.68	11.46	178.80	12.93	165.52	10.22
4. JAIPUR	57.76	5.48	60.72	5.29	54.43	4.31	65.32	4.72	83.93	5.18
5. JAISALMER	31.23	2.96	26.08	2.27	42.20	3.34	55.29	4.00	77.43	4.78
RAJASTHAN	1054.74	100	1147.78	100	1262.21	100	1382.86	100	1619.23	100

(Prod-Production, Th.tons-Thousand tonne, PCP- Percent contribution of Production. Source: DES, MOA, GOI)

The production of Groundnut in Rajasthan was successively increased from past few years which in return resulted into Rajasthan as the second highest Groundnut producing state of India with the production of 1619.23 thousand tonne in 2019-20. Compound growth rate of area, production and yield in selected five district is presented below in table 4.3. The growth in area in first period was positive in all districts except Jaipur district. In Jodhpur district growth in area was highest with compound growth rate of 38.82 per cent. This acceleration might be due to gradual rise in price of crop from previous years which made farmers to grow Groundnut for better profit. In second period Jaisalmer district has highest growth in area under groundnut with compound growth rate of 14.73 per cent. The increase in production of Groundnut in first period (2000-2010) was observed more in all districts in which highest was in Jodhpur district with compound growth rate of 44.19 per cent which was mainly due to rapid increase in area under Groundnut cultivation in that period. In second period (2011-20), the highest increase production was observed in Jaisalmer district which was contributed by rapid increase in area under cultivation even though lesser increase in yield. Jaipur district in first period and Jaisalmer district in second period have highest increase in yield with compound growth rate of 4.78 per cent, 4.93 per cent significant at 1 per cent and 5 per cent level of significance respectively. These results obtained are in line with (Vijay Gupta, 2014)

Table 4.3 Compound Growth Rates of Area, Production and Yield of Groundnut in Selected Districts of Rajasthan

Districts	Compound growth rate of Groundnut (Per cent)					
	Area		Production		Yield	
	Period I (2000-2010)	Period II (2010-20)	Period I (2000-2010)	Period II (2010-20)	Period I (2000-2010)	Period II (2010-20)
1. BIKANER	14.19	12.7	16.62	11.66	2.13*	-0.85
2. JODHPUR	38.82	11.99	44.19	16.76	3.88**	4.27*
3. CHURU	18.11	11.72	23.48	15.93	4.54*	3.74
4. JAIPUR	-0.11	-4.43	4.62	-3.99	4.78**	0.45
5. JAISALMER	36.58	14.73	39.30	20.47	2.0**	4.93*

*Significant at 5 per cent level of significance, ** Significant at 1 per cent level of significance

4.2.2 Compound Growth Rates of Area, Production and Yield of Sesamum in Selected Districts of Rajasthan

In Rajasthan, the area under sesamum cultivation was 366.78 thousand hectares in 2015-16 which has continuously decreased to 242.27 thousand hectare in 2018-19. The area under Sesamum cultivation in all five selected districts and per cent share of each district to the total area under Sesamum production of Rajasthan is given below in table 4.4. Among all districts of Rajasthan, Pali district has the highest share of 20.65 per cent of total area under sesamum cultivation followed by S Madhopur district (12.07 per cent) total area in 2019-20.

Table 4.4 Area and Percent Contribution of Area of Sesamum in Selected Districts of Rajasthan

(Area in Th. ha)

Districts	2015-16		2016-17		2017-18		2018-19		2019-20	
	Area	PCA	Area	PCA	Area	PCA	Area	PCA	Area	PCA
1. PALI	92.35	25.18	66.34	24.85	64.16	25.47	50.39	20.80	57.74	20.65
2.S MADHOPUR	40.06	10.92	27.83	10.43	25.53	10.14	28.65	11.83	33.76	12.07
3. JODHPUR	39.76	10.84	28.54	10.69	21.03	8.35	23.46	9.68	16.75	5.99
4. KARAULI	21.80	5.94	14.18	5.31	14.52	5.76	17.60	7.27	21.65	7.74
5. TONK	10.59	2.89	11.23	4.21	7.35	2.92	10.20	4.21	25.65	9.17
RAJASTHAN	366.78	100	266.97	100	251.92	100	242.27	100	279.69	100

(Th.ha- Thousand hectare, PCA- Percent contribution of Area. Source: DES, MOA, GOI)

The production of Sesamum in Rajasthan showed fluctuations from past few years. The production of Sesamum in Rajasthan was 91.64 thousand tonne in 2019-20. The Pali district was the major district contributing 18.0 per cent share of total production of sesamum in Rajasthan followed by S Madhopur (13.6 per cent) in 2019-20. (4^{th} Advance estimates 2019-20, Department of Agriculture, Government of Rajasthan). The production of Sesamum in all five selected districts and per cent share of each district to the total production of Sesamum in Rajasthan is given in table 4.5.

Table 4.5 Production and Percent Contribution of Production of Sesamum in Selected Districts of Rajasthan

(Production in Th. tons)

Districts	2015-16		2016-17		2017-18		2018-19		2019-20	
	Prod	PCP	Prod	PCP	Prod	PCP	Prod	PCP	Prod	PCP
1. PALI	25.75	22.33	21.74	23.44	12.49	18.41	21.23	25.19	16.76	18.0
2. S MADHOPUR	20.78	18.02	12.93	13.94	9.87	14.55	11.45	13.58	12.79	13.6
3. JODHPUR	17.26	14.97	10.11	10.91	9.10	13.42	9.11	10.81	7.35	8.02
4. KARAULI	9.84	8.54	7.83	8.44	6.95	10.24	7.72	9.16	8.61	9.40
5. TONK	3.80	3.30	3.90	4.21	3.21	4.74	5.12	6.08	7.22	7.89
RAJASTHAN	115.31	100	92.74	100	67.87	100	84.30	100	91.64	100

(Prod-Production, Th.tons-Thousand tonne, PCP- Percent contribution of Production. Source: DES, MOA, GOI)

Compound growth rates of area, production and yield in selected five district is presented below in table 4.6. In first period, the increase in area under cultivation was observed in all districts. The highest growth was recorded in Tonk district with positive compound growth rate of 23.39 per cent. Except S Madhopur district in second period remaining four districts shows decrease in area under cultivation in which Tonk district

shows highest decrease with negative compound growth rate of -12.06 per cent. This decrease in growth rate might due to low rainfall in previous years and lower prices for Sesamum crops in previous years may leads to shift to other crops (As per acreage responsive factors). These results are in line with the (Jainuddin *et al*.2018) of Groundnut performance in Bangalore division of Karnataka in second period. In First period (2000-01 to 2009-10), the rapid increase in production was observed in all five selected districts in which highest increase was in S Madhopur district with compound growth rate of 40.80 per cent which was majorly due to the increase in area and yield in the same period. In second period except S Madhopur district all districts observed decrease in production of Sesamum which was due to drastic decrease in area under cultivation. In first period highest increase in yield was observed in S Madhopur district with compound growth rate of 18.56 per cent and highest growth in Jodhpur district with compound growth rate of 4.71 per cent which is might due to use of high yielding seeds and improved technologies.

Table 4.6 Compound Growth Rates of Area, Production and Yield of Sesamum in Selected Districts of Rajasthan

Districts	Compound growth rate of Sesamum (Percent)					
	Area		Production		Yield	
	Period I (2000-2010)	Period II (2010-20)	Period I (2000-2010)	Period II (2010-20)	Period I (2000-2010)	Period II (2010-20)
1. PALI	8.77	-9.80	4.44	-11.12	-5.03	-1.5
2. S MADHOPUR	18.68	0.48	40.80	0.98	18.56	0.39
3. JODHPUR	10.04	-7.36	5.03	-2.89	-5.06	4.71
4. KARAULI	18.86	-1.62	37.23	-1.72	15.53	-0.18
5. TONK	23.39	-12.06	30.79	-8.44	5.89	4.01

*Significant at 5 per cent level of significance, ** Significant at 1 per cent level of significance

4.2.3 Compound Growth Rates of Area, Production and Yield of Soybean in SelecteD Districts of Rajasthan.

In Rajasthan the area under soybean cultivation was 1204.8 thousand tonne in 2015-16 which fluctuates over the year leading to 1118.56 thousand hectares in 2019-20. Among

all districts of Rajasthan, Baran district has the highest area of 250.35 thousand hectare land with percentage share of 22.38 per cent to the total area under soybean cultivation in 2019-20 followed by Jhalawar district (22.23 per cent). Between 2015-16 to 2019-20 area under soybean had decreased in Chittorgarh district while it had increased in Banswara district. The area under Soybean cultivation in all five selected districts and per cent share of each district to the total area under Soybean cultivation in Rajasthan is given in table 4.7.

Table 4.7 Area and Percent Contribution of Area of Soybean in Selected Districts of Rajasthan

(Area in Th. ha)

Districts	2015-16		2016-17		2017-18		2018-19		2019-20	
	Area	PCA	Area	PCA	Area	PCA	Area	PCA	Area	PCA
1.JHALAWAR	266.38	22.11	219.28	20.77	209.39	23.62	220.07	23.61	248.62	22.23
2.BARAN	274.45	22.78	236.44	22.40	154.29	17.41	185.89	19.95	250.35	22.38
3.KOTA	194.33	16.13	164.98	15.63	120.76	13.62	127.92	13.73	180.33	16.12
4.BANSWARA	50.01	4.15	61.82	5.86	69.13	7.80	69.41	7.45	75.41	6.74
5.CHITTORGARH	144.03	11.95	118.32	11.21	116.61	13.15	106.07	11.38	102.67	9.18
RAJASTHAN	1204.8		1055.6		886.49		931.91		1118.56	

(Th..ha- Thousand hectare, PCA- Percent contribution of Area. Source: DES, MOA, GOI)

The production of Soybean in Rajasthan was in increased from past few years which in return resulted into Rajasthan as the third largest Soybean producing state of India with the production of 525.05 thousand tonne in 2019-20. The production of Soybean was highest in Baran i.e. 134.46 tonne with per cent share of 25.61 per cent to the total production under Soybean followed by other districts in 2019-20 (4th Advance estimates 2019-20, Department of Agriculture, Government of Rajasthan). The production of Soybean in all five selected districts and per cent share of each district to the total production in Rajasthan is given in table 4.8.

Table 4.8 Production and Percent Contribution of Production of Soybean Selected Districts of Rajasthan

(Production in Th. tons)

Districts	2015-16		2016-17		2017-18		2018-19		2019-20	
	Prod	PCP	Prod	PCP	Prod	PCP	Prod	PCP	Prod	PCP
1.JHALAWARA	140.96	17.53	228.04	20.15	282.41	26.40	271.82	23.26	68.95	13.13
2.BARAN	155.78	19.37	246.59	21.79	209.80	19.61	229.65	19.65	134.46	25.61
3.KOTA	145.42	18.09	167.54	14.80	150.55	14.07	150.56	12.88	115.75	22.05
4.BANSWARA	429.36	5.34	84.55	7.47	82.28	7.69	80.45	6.89	57.02	10.86
5.CHITTORGAH	79.67	9.91	96.15	8.50	96.67	9.04	139.38	11.93	42.84	8.16
RAJASTHAN	804.08	100	1131.82	100	1069.83	100	1168.57	100	525.05	100

(Prod-Production, Th.tons-Thousand tonne, PCP- Percent contribution of Production. Source: DES, MOA, GOI)

Compound growth rate of area, production and yield in selected five district is presented below in table 4.9. In first period area under soybean cultivation in Banswara district shows highest accelerated growth rate of 12 .19 per cent followed by Baran and Jhalawar which might due to better yield in the previous years and increased irrigated area made farmers to cultivate in more area. In second period, area under soybean cultivation in Banswara district shows highest compound growth rate (19.49 per cent) followed by Chittorgarh and Kota which was mainly due increase in irrigation facilities (As per acreage responsive function). In first period (2000-2010), except Chittorgarh district all four districts shows increased production in which Baran district has highest growth rate of 13.94 per cent which was due to increased area and yield of the Soybean production. In second period (2011-2020) highest increased growth rate (20.90 per cent) was in Banswara district. This was due to the increased area under cultivation (As per decomposition analysis). Except Chittorgarh district, all four districts shows significant increase in yield of Soybean in which Jhalwara district has highest growth rate i.e. 7.16 per cent in first period where as in second period only Banswara district shows significant increase in yield i.e. 1.15 per cent.

Table 4.9 Compound Growth Rates of Area, Production and Yield of Soybean in Selected Districts of Rajasthan

Districts	Compound Growth Rate of Soybean (Per cent)					
	Area		Production		Yield	
	Period I (2000-2010)	Period II (2010-20)	Period I (2000-2010)	Period II (2010-20)	Period I (2000-2010)	Period II (2010-20)
1. JHALAWAR	3.37	-1.62	10.74	-10.10	7.16**	-8.74*
2. BARAN	7.43	-1.36	13.94	-9.47	6.02*	-8.29*
3. KOTA	-0.41	0.35	3.95	-4.98	4.35*	-5.30*
4. BANSWARA	12.19	19.49	7.94	20.90	-3.77**	1.15**
5. CHITTORGARH	-8.09	11.88	-3.38	2.19	5.24**	-8.76**

*Significant at 5 per cent level of significance, ** Significant at 1 per cent level of significance

4.2.4 Compound Growth Rates of Area, Production and Yield of Rapeseed and Mustard in Selected Districts of Rajasthan

In Rajasthan area under Rapeseed and Mustard was 2532.33 thousand hectare in 2015-16 and 2712.60 thousand hectare in 2019-20.The district showing highest share of area in the state was Tonk (10.41 per cent) followed by Alwar district (9.79 per cent). Between 2015-16 to 2019-20 area under Rapeseed and Mustard had increased in Jodhpur district. The area under Rapeseed and Mustard cultivation in all five selected districts and per cent share of each district to the total area under Rapeseed and Mustard production of Rajasthan from previous five year is given below in table 4.10.

Table 4.10 Area and Percent Contribution of Area of Rapeseed and Mustard in Selected Districts of Rajasthan

(Area in Th.ha)

Districts	2015-16		2016-17		2017-18		2018-19		2019-20	
	Area	PCA	Area	PCA	Area	PCA	Area	PCA	Area	PCA
1.ALWARA	234.42	9.26	229.71	9.18	229.01	10.49	250.19	9.05	265.69	9.79
2.TONK	250.91	9.91	244.21	9.76	186.64	8.55	270.12	9.77	282.44	10.41
3.BHARATPUR	203.22	8.03	201.28	8.04	200.01	9.16	218.33	7.90	245.20	9.04
4.GANGANAGAR	239.94	9.48	230.49	9.21	198.71	9.10	247.69	8.96	231.95	8.55
5.JODHPUR	119.20	4.71	143.63	5.74	149.41	6.84	170.79	6.18	176.25	6.50
RAJASTHAN	2532.33	100	2503.28	100	2183.05	100	2765.25	100	2712.60	100

(Th.ha- Thousand hectare, PCA- Percent contribution of Area. Source: DES, MOA, GOI.)

Total production of Rapeseed and Mustard in Rajasthan was 4302.78 thousand tonnes. In 2019-20. Among all districts of Rajasthan, Tonk district has the highest area of 282446 hectare land contributing per cent share of 10.41 per cent to the total area in 2019-20 and Tonk district contributed 11.27 per cent of total Rapeseed and Mustard production in Rajasthan (4th Advance estimates 2019-20, Department of Agriculture, Government of Rajasthan). The production of Rapeseed and Mustard in all five selected districts and per cent share of each district to the total production in Rajasthan from previous five year is given in table 4.11.

Table 4.11 Production and Percent Contribution of Production of Rapeseed and Mustard in Selected Districts of Rajasthan

(Production in Th.tons)

Districts	2015-16		2016-17		2017-18		2018-19		2019-20	
	Prod	PCP	Prod	PCP	Prod	PCP	Prod	PCP	Prod	PCP
1.ALWAR	340.28	10.44	446.94	11.74	468.87	13.30	534.46	11.18	492.85	11.45
2.TONK	310.19	9.52	409.66	10.76	296.76	8.42	444.99	9.31	485.07	11.27
3.BHARATPUR	309.03	9.49	390.28	10.25	384.75	10.92	485.59	10.16	403.11	9.36
4.GANGANAGAR	365.58	11.22	347.48	9.13	344.34	9.77	463.20	9.69	380.72	8.84
JODHPUR	130.67	4.01	168.37	4.42	196.45	5.57	232.36	4.86	251.14	5.83
RAJASTHAN	3257.98	100	3808.02	100	3524.11	100	4779.04	100	4302.78	100

(Prod-Production, Th.tons-Thousand tonne, PCP- Percent contribution of Production. Source: DES, MOA, GOI)

Compound growth rate of area, production and yield in selected five district is presented below in table 4.12. All five districts in first period shows increase in area under Rapeseed and Mustard cultivation in which Tonk district has highest compound growth rate of 16.87 per cent. This increase might be due to increased yield in previous years and better

price for the crop in the previous years made famers to allot more land to Rapeseed and Mustard cultivation. In second period lower growth was observed in all districts compared to first period in which Jodhpur district shows highest compound growth rate of 11.58 per cent. This low growth might due to low rainfall in previous years and lower price for produce made famers to shift to other crops (As per acreage responsive factors). In first period (2000-2010) production of Rapeseed and Mustard was accelerated in all five districts in which Tonk district has the highest growth rate in production i.e. 18.35 per cent. This positive growth might be due to increase in area under cultivation even though there was less increase in yield. In second period, except Ganganagar district all four districts shows positive growth in production and Jodhpur district has highest compound growth rate 14.3 per cent which was mainly due to increase in yield of Rapeseed and Mustard (As per decomposition analysis). Yield was significantly increased in both periods in which second period shows comparatively more increase in yield which may be due to the government initiative viz., ISOPOM (2004) and NMOOP (2014) programme to increase the productivity of oilseeds in country.

Table 4.12 Compound Growth Rates of Area, Production and Yield of Rapeseed and Mustard in Selected Districts of Rajasthan

Districts	Compound growth rate of Rapeseed & Mustard (Percent)					
	Area		Production		Yield	
	Period I (2000-2010)	Period II (2010-20)	Period I (2000-2010)	Period II (2010-20)	Period I (2000-2010)	Period II (2010-20)
1. ALWARA	3.53	-0.24	7.60	3.89	3.89**	4.13*
2. TONK	16.87	1.5	18.35	3.78	1.3**	2.24**
3. BHARATPUR	3.47	0.74	8.19	2.5	4.56**	1.71*
4. GANGANAGAR	2.56	-1.96	3.79	-0.20	1.16**	1.78*
5. JODHPUR	12.15	11.58	13.47	14.31	1.14*	2.40**

*Significant at 5 per cent level of significance, ** Significant at 1 per cent level of significance

4.2.5 Instability of Area, Production and Yield of Groundnut in Selected Districts of Rajasthan

Instability analysis is one of the important decision tools that measures the degree of uncertainty and risks involved in crop production and adversely affect farmer's decisions to adopt modern technologies and investment in farming. Growth and instability of area and yield have a direct effect on growth and instability of production. Therefore instability of the four oilseed crops were analysed in selected five districts during the study periods; period I (2000-2010), period II (2011-2020) by using Cuddy Della Valle Instability Index which takes into account Coefficient of Variation and adjusted R^2. The simple Coefficient of Variation over estimates the variation in the time series data (Deb *et al*, 1999), therefore both the have been used. Here we assumed if instability ranges >30 per cent is termed as high instability and if instability ranges <30 per cent is termed as low instability. Table 4.13 represents coefficient of variation and Cuddy Della Valle index of area, production and yield of Groundnut in major five groundnut producing districts of Rajasthan. Variability in area, production and yield in terms of coefficient of variation and Cuddy Della Valle index was observed more in first period compared to second period which conveyed that more instability existed in first period than second period. This results are in corroboration with (Rao, 2003) who reported inter period comparison of Groundnut in which instability of area, production and yield was high during period II than period I. Instability in area in terms of Cuddy Della Valle index results lower instability in both periods in which Jaisalmer district showed highest 21.38 per cent variability in second period. Instability of area in terms of coefficient of variation was higher in both period in all districts except Jaipur district. Highest instability was observed in Jodhpur district in first period i.e. 80.95 per cent. Instability in production also followed the same pattern as instability of area. Instability in production in terms of CDI values revealed that all districts showed lower variability in both periods except Churu district (31.17 per cent) in first period and Jaisalmer district (33.17 per cent) in second period. Instability in yield was highest in terms of CDI in Bikaner district (31.14 per cent) in first period and remaining all districts showed lower variability in both periods. Instability of yield in terms of CV was higher in first period than second period in which Bikaner district showed highest instability in first period i.e. 31.83 per cent.

Table 4.13 Instability in Area, Production and Yield of Groundnut in Selected Districts of Rajasthan

(In Percent)

Districts	Instability in Area				Instability in production				Instability in Yield			
	CV		CDI		CV		CDI		CV		CDI	
	Period I	Period II	Period I	Period II	Period I	Period II	Period I	Period II	Period I	Period II	Period I	Period II
1.Bikaner	39.83	34.68	10.76	5.90	47.89	32.52	29.04	8.96	31.83	9.57	31.14	9.15
2.Jodhpur	80.95	32.99	19.39	10.73	78.70	48.89	21.67	25.45	21.38	21.34	18.92	17.4
3.Churu	40.76	32.51	13.19	6.30	61.54	42.52	31.17	11.72	30.54	16.46	27.75	12.86
4.Jaipur	9.22	16.71	9.21	9.32	28.08	21.34	25.69	17.20	24.95	11.45	21.43	11.33
5.Jaisalmer	63.21	49.27	7.06	21.38	63.33	68.01	28.40	33.17	26.65	22.47	26.19	17.46

(CV=Coefficient of variation, CDI=Cuddy Della Valle Index, Period I =2000-01 to 2009-10, Period II =2010-11 to 2019-20)

4.2.6 Instability in Area, Production and Yield of Sesamum in Selected Districts of Rajasthan

Instability in area in terms of CDI values were more in first period than second period showing higher variability. Highest variability in terms of CDI value was observed in Tonk district i.e. 59.90 per cent in first period and 48.85 per cent in second period (Table 4.14). Instability of area of Sesamum in terms of coefficient of variation shows higher variability in all districts in first period (2000-2010) in which Tonk district shows highest variability of 89.85 per cent. In second period except Pali and Tonk districts all three districts shows lower instability in area. These results are in line with (Kumar, 2015) who reported drastic decrease in variability. Instability in production in terms of CDI values reveals that more variability was seen in first period compared to second period. Highest instability of production was in Jodhpur district (86.59 per cent) followed by Tonk district (76.70) in first period and highest instability was in Tonk district in second period. Instability of production in terms of CV also shows more variability in first period compared to second period. All districts shows higher instability in production. It is evident from the analysis that instability of production in terms of CV was higher than instability of area and yield. These results obtained are in line with (Paul *et al*., 2015) who reported instability in production was higher compared to instability of area and yield of Groundnut in Andhra Pradesh. Instability in yield in terms of CDI values also recorded more variability in first period than second period in which Jodhpur district shows highest instability of yield i.e. 79.34 per cent in first period. These results are in line with (Swain, 2007) who reported high degree variability in area, production and yield of

oilseed crops in Rajasthan. Instability in yield in terms of CV shows more variability in first period compared to second period. Jodhpur district shows highest instability (79.42 per cent) in first period. Jodhpur (32.91 per cent) and Tonk (32.37 per cent) districts only have higher instability in second period.

Table 4.14 Instability in Area, Production and Yield of Sesamum in Selected Districts of Rajasthan

(In Percent)

Districts	Instability in Area				Instability in production				Instability in Yield			
	CV		CDI		CV		CDI		CV		CDI	
	Period I	Period II	Period I	Period II	Period I	Period II	Period I	Period II	Period I	Period II	Period I	Period II
1.Pali	38.14	32.22	30.24	14.33	74.68	41.45	74.53	21.40	74.13	27.65	74.07	27.21
2.S.Madhopur	83.60	25.07	54.56	25.06	88.37	30.40	51.89	30.28	48.95	14.69	43.52	14.67
3.Jodhpur	38.96	28.18	36.48	19.37	86.65	44.60	86.59	42.57	79.42	32.91	79.34	31.59
4.Karauli	76.13	25.52	48.42	24.87	91.26	24.38	44.01	23.38	41.29	14.03	23.78	14.01
5.Tonk	89.85	64.76	59.90	48.85	92.52	71.90	76.70	59.71	67.27	32.37	67.15	29.89

(CV=Coefficient of variation, CDI=Cuddy Della Valle Index, Period I =2000-01 to 2009-10, Period II =2010-11 to 2019-20)

4.2.7 Instability in Area, Production and Yield of Soybean in Selected Districts of Rajasthan

Table 4.15 represents instability in terms coefficient of variation and Cuddy Della Valle index of area, production and yield of Soybean in two periods i.e. period I (2000-2010) and period II (2011-2020). Instability of area in terms of CDI values shows that more variability was observed in first period than second period in which Chittorgarh district has highest instability in first period where as in second period all districts shows lower instability. The results are in corroboration with (Kumar, 2015) who reported decrease in variability in second period. Instability of area in terms of CV was highest in Banswara district i.e.38.76 per cent in first period and 49.59 per cent in second period. Instability of production in terms of CDI values reveals that Chittorgarh district has the highest instability in both periods. Instability in production in terms of CV reveals that Jhalawar, Banswara and Baran district has more variability in second period than first period in which Banswara district has highest instability of 58.06 per cent in second period and Chittorgarh district has highest instability in first period i.e. 42,29 per cent. Instability of yield of Soybean in terms of CDI values showed that highest instability was in Baran district (35.82 per cent) in first period and Jhalawar district (36.50 per cent) in second period. The results are in line with (Jha *et al*., 2006). Instability of yield in terms of CV revealed that more variability existed in

both period and highest instability of yield in first period was observed in Baran district i.e. 37.36 per cent and 42.13 per cent in second period.

Table 4.15 Instability in Area, Production and Yield of Soybean in Selected Districts of Rajasthan

(In Percent)

Districts	Instability in Area				Instability in production				Instability in Yield			
	CV		CDI		CV		CDI		CV		CDI	
	Period I	Period II	Period I	Period II	Period I	Period II	Period I	Period II	Period I	Period II	Period I	Period II
1.Jhalawar	16.73	10.19	13.48	8.98	35.28	40.67	23.56	31.52	29.70	41.49	24.79	36.50
2.Baran	32.65	26.18	34.58	25.84	41.77	46.14	31.32	32.83	37.36	42.13	35.82	32.93
3.Kota	19.01	22.07	18.94	22.07	36.08	25.39	35.70	19.89	33.90	25.77	32.90	20.45
4.Banswara	38.76	49.59	18.69	10.28	30.25	58.06	22.45	30.36	35.49	20.81	32.59	20.40
5.Chittorgarh	37.54	35.91	34.86	24.66	42.29	37.63	42.14	36.74	27.08	37.70	24.28	29.26

(CV=Coefficient of variation, CDI=Cuddy Della Valle Index, Period I =2000-01 to 2009-10, Period II =2010-11 to 2019-20)

4.2.8 Instability in Area, Production and Yield of Rapeseed and Mustard in Selected Districts of Rajasthan.

Table 4.16 represents instability in terms coefficient of variation and Cuddy Della Valle index of area, production and yield of Rapeseed and Mustard in two periods i.e. period I (2000-2010) and period II (2011-2020).It is evident from the table 4.16 that area, production and yield has more variability in first period compared to second period. The results are in line with (Swain, 2007) who reported high degree variability in area, production and yield of oilseeds in Rajasthan. Instability in area of Rapeseed and Mustard shows more variability in terms of CDI in first period than second period in which higher instability was only observed in Tonk district (45.79 per cent). Instability in area in terms of CV also showed that there exists more variability in first period compared to second period in which Tonk district has highest instability i.e. 54.63 per cent in first period and Jodhpur in second period i.e. 32.72 per cent. Instability in production in terms of CDI values shows that there was more instability in first period. Tonk district registered highest instability (56.01 per cent) followed by Ganganagar (31.76 per cent). There exists low instability in production in terms CDI in all districts in second period. Instability in production in terms of coefficient of variation shows that there exists more instability in first period compared to second period. Tonk district shows highest instability in production i.e. 64.15 per cent followed by Jodhpur and Ganganagar in first period and in second period Jodhpur district only shows high instability in production i.e. 42.67 per cent. Instability in yield in terms of

CDI was recorded low in all five districts of Rajasthan in both periods. Instability of yield of Rapeseed and Mustard in terms of CV shows that in both periods low instability was observed in all districts. From the table 4.16 it is evident that there exists more instability in production than instability of area and yield. These results are in line with (Paul *et al*., 2015) who reported instability in production was more than instability in area and yield of Groundnut in Andhra Pradesh.

Table 4.16 Instability in Area, Production and Yield of Rapeseed and Mustard in Selected Districts of Rajasthan

(In Percent)

Districts	Instability in Area				Instability in production				Instability in Yield			
	CV		CDI		CV		CDI		CV		CDI	
	Period I	Period II	Period I	Period II	Period I	Period II	Period I	Period II	Period I	Period II	Period I	Period II
1.Alwar	15.74	5.72	12.34	5.67	28.01	18.16	19.18	13.53	20.64	17.86	17.36	12.79
2.Tonk	54.63	15.77	45.79	15.21	64.15	20.60	56.01	16.90	14.07	16.23	13.69	14.69
3.Bharatpur	16.35	7.37	13.79	6.97	26.00	16.53	14.07	14.45	17.33	14.91	10.52	13.85
4.Ganganagar	25.18	12.28	24.55	10.53	33.07	22.76	31.76	22.63	26.23	16.56	25.60	16.03
5.Jodhpur	36.48	32.72	19.62	8.56	39.56	42.67	23.67	13.97	13.75	12.95	13.34	10.70

(CV=Coefficient of variation, CDI=Cuddy Della Valle Index, Period I =2000-01 to 2009-10, Period II =2010-11 to 2019-20)

4.3 Decomposition Analysis of Production of Oilseed Crops

The pure effects for change in average production for each oilseed crop in five major districts of Rajasthan were calculated and analysed. The effects of change in mean area, change in mean yield, interaction effect of change in mean area and mean yield, covariance between area and yield were analysed by Hazell's Decomposition Model. The decomposition analysis was carried out to find the source of growth of oilseed production and percentage contribution of each component towards the change in average production of each oilseed crop for five major oilseed producing districts of Rajasthan in two periods i.e., period I (2000-01 to 2009-10) and period II (2010-11 to 2019-20).

4.3.1 Source of Growth of Groundnut Production in Period I (2000-01 to 2009-10)

Table 4.17 and table 4.18 represents decomposition analysis results by using Hazell's method for change in average production of Groundnut in five major districts of Rajasthan in period I (2000-01 to 2009-10). In Bikaner district the positive change in mean yield (3.13 per cent) was the major contributor to the change in average production with negative change in mean area (-8.93 per cent) and interaction effect between mean area and mean yield (-0.09 per cent), Change in area-yield covariance was -6.03 per cent. In Jodhpur district, analysis reported that change in mean area (94.46 per cent) was the major contributor to the production followed by positive effect of change in mean yield (1.63 per cent), interaction effect of mean area and mean yield and negative effect on production was by change in area-yield covariance (-22.13 per cent). In Churu district both change in mean area (7.22 per cent) and change in mean yield (6.05 per cent) were major factors responsible for production of Groundnut followed by positive interaction effect of mean area and mean yield (0.14 per cent). In Jaipur district yield was the major source responsible for growth in production of Groundnut with positive effect of 6.19 per cent and negative contribution of change in mean area (-2.60 per cent), interaction effect (-0.05 per cent), change in area-yield covariance (-3.08 per cent). In Jaisalmer district change in mean yield was the major factor for change in average production of Groundnut with positive value 5.55 per cent followed by positive effect of change in mean area (1.61 per cent), interaction effect of mean area and mean yield (0.03 per cent) and negative effect of area-yield covariance (-4.67 per cent).

Table 4.17 Components of Change in Average Production of Groundnut in period I

Districts	Change in mean yield	Change in mean Area	Interaction effect	Change in area yield covariance
BIKANER	0.010	-0.03	-0.0003	-0.02
JODHPUR	0.005	0.322	0.002	-0.07
CHURU	0.020	0.024	0.0005	0.011
JAIPUR	0.021	-0.008	-0.0001	-0.01
JAISALMER	0.018	0.005	0.0001	-0.015

Table 4.18 Per cent Contribution of Change in Average Production of Groundnut in period I

Districts	Change in mean yield	Change in mean Area	Interaction effect	Change in area yield covariance
BIKANER	3.13	-8.93	-0.09	-6.03
JODHPUR	1.63	94.46	0.78	-22.13
CHURU	6.05	7.22	0.14	3.48
JAIPUR	6.19	-2.60	-0.05	-3.08
JAISALMER	5.55	1.61	0.03	-4.67

4.3.2 Source of Growth of Groundnut Production in Period II (2010-11 to 2019-20).

Table 4.19 and table 4.20 represents decomposition analysis results by using Hazell's method for change in average production of Groundnut in five districts of Rajasthan in period II (2010-11 to 2019-20). The study reveals that in Bikaner district the change in mean area was the main factor responsible for change in average production i.e. 15.05 per cent and change in mean yield (-22.33 per cent), interaction effect of mean area and mean yield (0.66 per cent), change in area-yield covariance (3.72 per cent). In Jodhpur district change in mean yield (9.57 per cent) was the major contributor of production with positive effect in change in area-yield covariance (1.54 per cent) and interaction effect of mean area and mean yield (0.07 per cent) and negative effect of change in mean area (-4.10 per cent). In Churu district change in mean area (22.60 per cent) was the major source responsible for change in average production and change in mean yield (-17.18 per cent), interaction effect (0.76 per cent), area

yield covariance (1.12 per cent). In Jaipur district change in mean yield (27.04 per cent) was the prime factor responsible for production of Groundnut followed by positive effect of change in mean area (6.53 per cent) and negative effect of area-yield covariance (-3.38 per cent), interaction effect (-0.033 per cent). The similar results were obtained by (Jainuddin, 2018) who reported that yield as the prime factor responsible for production of Groundnut in Mysore division of Karnataka in whole period followed by negative interaction effect and covariance of area-yield. In Jaisalmer district change in mean area (83 per cent) was the major source responsible for growth in production of Groundnut with positive effect of area-yield covariance (26.50 per cent), interaction effect of mean area and mean yield (6.34 per cent) and negative effect of change in mean yield (-42.12 per cent).

Table 4.19 Components of Change in Average Production of Groundnut in period II

Districts	Change in mean yield	Change in mean Area	Interaction effect	Change in area yield covariance
BIKANER	0.044	-0.029	-0.001	-0.07
JODHPUR	-0.01	0.008	-0.0001	-0.003
CHURU	0.03	-0.04	-0.001	-0.002
JAIPUR	-0.01	-0.05	-0.01	0.0006
JAISALMER	0.083	-0.164	-0.012	-0.052

Table 4.20 Per cent Contribution of Change in Average Production of Groundnut in period II

Districts	Change in mean yield	Change in mean Area	Interaction effect	Change in area yield covariance
BIKANER	-22.33	15.05	0.66	3.72
JODHPUR	9.57	-4.10	0.07	1.54
CHURU	-17.18	22.60	0.76	1.12
JAIPUR	27.04	6.53	-0.033	-3.38
JAISALMER	-42.12	83.00	6.34	26.50

Table 4.21 Major Sources of Change in Production of Groundnut

Districts	Major Source of Change							
	Period I				Period II			
	Yield effect	Area effect	Interaction effect	Covariance effect	Yield effect	Area effect	Interaction effect	Covariance effect
BIKANER								
JODHPUR								
CHURU								
JAIPUR								
JAISALMER								

4.3.3 Source of Growth of Sesamum Production in Period I (2000-01 to 2009-10).

Table 4.22 and table 4.23 represents decomposition analysis results by using Hazell's method for change in average production of Sesamum in five districts of Rajasthan in period I (2000-01 to 2009-10). The study reveals that in Pali district change in area-yield covariance (3.54 per cent) was the main source of change in average production of Sesamum followed by change in mean yield (2.07 per cent), change in mean area (0.39 per cent) and negative interaction effect of mean yield and mean area (-0.05 per cent). In S. Madhopur district of Rajasthan the mean area (20.33 per cent) was the prime entity for change in average production of Sesamum followed by interaction effect (0.43 per cent), change in mean yield (-0.67 per cent), change in area-yield covariance (-4.07 per cent). The results of decomposition revealed that in Jodhpur district the area-yield covariance has been recorded as main source of change in average production of Sesamum with change in area-yield covariance (3.95 per cent) followed by yield effect (3.17 per cent), interaction effect (0.05 per cent) and negative change in mean area effect (-0.25 per cent). In Karauli district the area has been recorded as main factor responsible for change in average production of Sesamum with change in mean area (9.14 per cent) followed by change in area-yield covariance (1.98 per cent), interaction effect of mean area and mean yield (0.66 per cent) and negative change in mean yield effect (-1.47 per cent). These results are coincides with results of (Laxminarayan, 2018) who reported that area was the main factor followed by negative yield effect on production of Taramira in Rajasthan. Lastly in Tonk district area was main source with change in mean area (123.64 per cent) followed by change in mean yield effect (29.58 per

cent) and negative effect of interaction between mean area and mean yield (-26.97 per cent), change in area-yield covariance (-70.25 per cent).

Table 4.22 Components of Change in Average Production of Sesamum in Period I

Districts	Change in mean yield	Change in mean Area	Interaction effect	Change in area yield covariance
PALI	-0.159	-0.030	0.004	-0.273
S MADHOPUR	0.05	-1.568	-0.033	0.314
JODHPUR	-0.244	0.0198	-0.004	-0.305
KARAULI	0.113	-0.705	-0.050	-0.152
TONK	-2.281	-9.534	2.080	5.417

Table 4.23 Per cent Contribution of Change in Average Production of Sesamum in Period I

Districts	Change in mean yield	Change in mean Area	Interaction effect	Change in area yield covariance
PALI	2.07	0.39	-0.05	3.54
S MADHOPUR	-0.67	20.33	0.43	-4.07
JODHPUR	3.17	-0.25	0.05	3.95
KARAULI	-1.47	9.14	0.66	1.98
TONK	29.58	123.64	-26.97	-70.25

4.3.4 Source of Growth of Sesamum Production in Period II (2010-11 to 2019-20)

Table 4.24 and table 4.25 represents decomposition analysis results by using Hazell's method for change in average production of Sesamum in five districts of Rajasthan in period II (2010-11 to 2019-20). The results of Hazell's decomposition analysis revealed that in Pali district of Rajasthan the yield effect was major source of change in average production of Sesamum between 2010-11 to 2019-20 with change in mean area (5.85 per cent) followed by change in area-yield covariance (1.84 per cent) and negative effect of mean area (-11.22 per cent), interaction between mean area and mean yield (-0.46 per cent). These results are in line with (Laxminarayan, 2018) who reported that yield as major source followed by negative effect of area and interaction of area yield for the production of Sesamum in Rajasthan. In S Madhopur district of Rajasthan area was the main source of change in average production of Sesamum with change in mean area (22.13 per cent) followed by change in area-yield

covariance (5.61 per cent) and negative effect of change in mean yield (-0.98 per cent), interaction effect of mean area and mean yield (-0.17 per cent). In Jodhpur district yield has been analysed as prime factor for change in average production of Sesamum with change in mean yield (15 per cent) followed by change in covariance of area-yield (2.28 per cent) and negative effect of change in mean area (-2.49 per cent), interaction effect of mean area and mean yield (-0.17 per cent) on production of Sesamum. In Karauli district the area has more or equal contribution as yield to the change in average production of Sesamum with change in mean area (7.72 per cent), change in mean yield (5.43 per cent) followed by interaction effect of mean area and mean yield (0.31 per cent) and negative effect of change in area-yield covariance (-1.81 per cent). In Tonk district area effect was the main factor responsible for change in average production of Sesamum with change in mean area (42.11 per cent) followed by change in mean yield (23.09 per cent), interaction of mean area and mean yield (8.18 per cent) and negative effect of area-yield covariance (-39.61 per cent).

Table 4.24 Components of Change in Average Production of Sesamum in Period II

Districts	Change in mean yield	Change in mean Area	Interaction effect	Change in area yield covariance
PALI	0.042	-0.081	-0.003	0.013
S MADHOPUR	-0.007	0.160	-0.001	0.040
JODHPUR	0.108	-0.018	-0.002	0.016
KARAULI	0.039	0.056	0.002	-0.013
TONK	0.167	0.305	0.059	-0.287

Table 4.25 Per cent Contribution of Change in Average Production of Sesamum in Period II

Districts	Change in mean yield	Change in mean Area	Interaction effect	Change in area yield covariance
PALI	5.85	-11.22	-0.46	1.84
S MADHOPUR	-0.98	22.13	-0.17	5.61
JODHPUR	15.00	-2.49	-0.28	2.28
KARAULI	5.43	7.72	0.31	-1.81
TONK	23.09	42.11	8.18	-39.61

Table 4.26 Major Sources of Change in Production of Sesamum

Districts	Major Source of Change							
	Period I				Period II			
	Yield effect	Area effect	Interaction effect	Covariance effect	Yield effect	Area effect	Interaction effect	Covariance effect
PALI								
S MADHOPUR								
JODHPUR								
KARAULI								
TONK								

4.3.5 Source of Growth of Soybean Production in Period I (2000-01 to 2009-10)

Table 4.27 and table 4.28 represents decomposition analysis results by using Hazell's method for change in average production of Soybean in five districts of Rajasthan in period I (2000-01 to 2009-10). The results of Hazell's decomposition revealed that in Jhalawar district area was the prime factor responsible for change in average production of Soybean with change mean area (87.40 per cent) followed by area-yield covariance (12.62 per cent) and negative effect of change in mean yield (-80.61 per cent), interaction effect of mean area and mean yield (-3.72 per cent). These results are in line with the (Paliwal, 2011) who reported that area was the prime factor responsible for production of Soybean with low yield effect in Jhalawar district of Rajasthan. In Baran district production of Soybean was majorly contributed by change in mean area (67.21 per cent) and negative effect of change in area-yield covariance (72.28 per cent). The Kota district also followed the same pattern as Baran district in which area as prime factor with change in mean area (23.35 per cent) and negative effect of change in area-yield covariance (-78.99 per cent), change in mean yield (-32 per cent). The interaction effect of mean area and mean yield was very low (-0.39 per cent). In Banswara district change in area-yield covariance (186.88 per cent) was the major source of production of Soybean followed by change in mean area (120.73 per cent) and higher negative effect of change in mean yield (-292.24 per cent) on production, interaction effect of mean area and mean yield (-17.63 per cent). In Chittorgarh district the production of Soybean was largely affected by change in mean area (257.47 per cent) and negative effect of change

in mean yield (-160.22 per cent), interaction effect of mean area and mean yield (-22.37 per cent), change in area-yield covariance (-13.84 per cent).

Table 4.27 Components of Change in Average Production of Soybean in Period I

Districts	Change in mean yield	Change in mean Area	Interaction effect	Change in area yield covariance
JHALAWAR	-0.042	0.046	-0.001	0.006
BARAN	-0.027	0.035	-0.0009	-0.38
KOTA	-0.016	0.012	-0.0002	-0.041
BANSWARA	-0.154	0.063	-0.009	0.098
CHITTORGARH	-0.084	0.135	-0.011	-0.007

Table 4.28 Per cent Contribution of Change in Average Production of Soybean in Period I

Districts	Change in mean yield	Change in mean Area	Interaction effect	Change in area yield covariance
JHALAWAR	-80.61	87.40	-3.72	12.62
BARAN	-52.87	67.21	-1.87	-72.28
KOTA	-32.00	23.35	-0.39	-78.99
BANSWARA	-292.24	120.73	-17.63	186.88
CHITTORGARH	-160.22	257.47	-22.37	-13.84

4.3.6. Source of Growth of Soybean Production in Period II (2010-11 to 2019-20)

Table 4.29 and table 4.30 represents decomposition analysis results by using Hazell's method for change in average production of Soybean in five districts of Rajasthan in period II (2010-11 to 2019-20). The results of Hazell's decomposition analysis revealed that in Jhalawar district production of Soybean was highly influenced by yield i.e. effect of change in mean yield (72.45 per cent) and negative effect of change in mean area (-16.85 per cent), interaction effect of change in mean area and mean yield (-2.88 per cent), change in area-yield covariance (-6.47 per cent). In Baran district change in mean yield (40.69 per cent) followed by mean area (16.04 per cent),were the main sources of change in production and negative effect of area-yield covariance was -26.64 per cent. These results are in line with (Sharma & Jain,2006) who claimed area, yield and interaction effect were the major source of

growth in Soybean in all districts of Madhya Pradesh. In Kota district yield was responsible for change in average production of Soybean i.e. change in mean yield (14.67 per cent) and negative effect of change in mean area (-13.68 per cent), change in area-yield covariance (-14.77 per cent), minimum interaction effect of mean area and mean yield (-0.46 per cent). In Banswara district for change in average production of Soybean the change in mean yield (18.63 per cent) was the main source of growth followed by change in area-yield covariance (7.51 per cent), change in mean area (6.55 per cent), interaction effect of mean yield and mean area (0.28 per cent). In Chittorgarh district change in mean area (47.87 per cent) was the main source of change in average production of Soybean and negative effect of change in mean yield (-29.22 per cent) followed by change in area-yield covariance (-19.33 per cent). The interaction effect of mean yield and mean area was -3.35 per cent.

Table 4.29 Components of Change in Average Production of Soybean in Period II

Districts	Change in mean yield	Change in mean Area	Interaction effect	Change in area yield covariance
JHALAWAR	0.169	-0.039	-0.006	-0.015
BARAN	0.095	0.037	0.003	-0.062
KOTA	0.034	-0.031	-0.001	-0.034
BANSWARA	0.043	0.015	0.0006	0.017
CHITTORGARH	-0.068	0.111	-0.007	-0.045

Table 4.30 Per cent Contribution of Change in Average Production of Soybean in Period II

Districts	Change in mean yield	Change in mean Area	Interaction effect	Change in area yield covariance
JHALAWAR	72.45	-16.85	-2.88	-6.47
BARAN	40.69	16.04	1.62	-26.64
KOTA	14.67	-13.68	-0.46	-14.77
BANSWARA	18.63	6.55	0.28	7.51
CHITTORGARH	-29.22	47.87	-3.35	-19.33

Table 4.31 Major Sources of Change in Production of Soybean

Districts	Major Source of Change							
	Period I				Period II			
	Yield effect	Area effect	Interaction effect	Covariance effect	Yield effect	Area effect	Interaction effect	Covariance effect
JHALAWAR								
BARAN								
KOTA								
BANSWARA								
CHITTORGARH								

4.3.7. Source of Growth of Rapeseed and Mustard Production in Period I (2000-01 to 2009-10)

Table 4.32 and table 4.33 represents decomposition analysis results by using Hazell's method for change in average production of Rapeseed and Mustard in five districts of Rajasthan in period I (2000-01 to 2009-10). The results of Hazell's decomposition analysis reveals that in Alwar district the area was the main source responsible for change in average production of Rapeseed and Mustard i.e. change in mean area (14.53 per cent) and change in mean yield (-93.89 per cent) acts as hindering source of production followed by change in area-yield covariance (-18.83 per cent), interaction effect of mean yield and mean area (-0.72 per cent). In Tonk district area acts as superior source of average change in production of Rapeseed and Mustard i.e. change in mean area (271.71 per cent) followed by change in area-yield covariance (77.85 per cent) and negative effect of change in mean yield (-34.32 per cent) followed by interaction effect of mean yield and mean area (-5.47 per cent). In Bharatpur district change in area-yield covariance (14.40 per cent) had major impact on change in average production of Rapeseed and Mustard followed by interaction effect of mean yield and mean area (0.51 per cent) and production had negative effect from change in mean yield (-72.95 per cent) followed by change in mean area (-13.29 per cent). In Ganganagar district also follows same effect as Bharatpur district i.e. change in area-yield covariance (11.75 per cent) was main source of change in average production of Rapeseed and Mustard followed by interaction effect (0.58 per cent) and major negative effect from change in mean area (-88.52 per cent) followed by change in mean yield (-12.54 per cent). In Jodhpur district the change in average production of Rapeseed and Mustard was mainly

contributed by change in mean area (271.05 per cent) and negatively affected by change in mean yield (-112.51 per cent) followed by interaction effect of mean area and mean yield (-17.38 per cent), change in area-yield covariance (-4.16 per cent).

Table 4.32 Components of Change in Average Production of Rapeseed and Mustard in Period I

Districts	Change in mean yield	Change in mean Area	Interaction effect	Change in area yield covariance
ALWAR	-0.051	0.007	-0.0003	-0.01
TONK	-0.018	0.147	-0.002	0.042
BHARATPUR	-0.039	-0.007	0.0002	0.007
GANGANAGAR	-0.006	-0.048	0.0003	0.006
JODHPUR	-0.061	0.147	-0.009	-0.002

Table 4.33 Per cent Contribution of Change in Average Production of Rapeseed and Mustard in Period I

Districts	Change in mean yield	Change in mean Area	Interaction effect	Change in area yield covariance
ALWARA	-93.89	14.53	-0.72	-18.83
TONK	-34.32	271.71	-5.47	77.85
BHARATPUR	-72.95	-13.29	0.51	14.40
GANGANAGAR	-12.54	-88.52	0.58	11.75
JODHPUR	-112.51	271.05	-17.38	-4.16

4.3.8 Source of Growth of Rapeseed and Mustard Production in Period II (2010-11 to 2019-20)

Table 4.34 and table 4.35 represents decomposition analysis results by using Hazell's method for change in average production of Rapeseed and Mustard in five districts of Rajasthan in period II (2010-11 to 2019-20). The results of Hazell's decomposition analysis revealed that in Alwar district the change in mean yield (54.63 per cent) was the main source of change in average production of Rapeseed & Mustard and negative effect of change in mean yield (-12.62 per cent), change in area-yield covariance (-5.84 per cent), interaction effect of mean area and mean yield (-0.40 per cent). In Tonk district the change in average production of Rapeseed and Mustard was mainly contributed by change in mean

yield (67.94 per cent) followed by change in area-yield covariance (31.25 per cent) and higher negative effect of change in mean area (-158.66 per cent) followed by interaction effect of mean area and mean yield (-6.04 per cent). In Bharatpur district change in mean area (92.36 per cent) was the main source of change in average production of Rapeseed and Mustard and negative effect of change in mean area (-38.63 per cent) followed by change in area-yield covariance (-9.81 per cent), interaction effect of mean area and mean yield (-2.08 per cent). Both Tonk and Bharatpur districts had yield effect as major contributor to production of Rapeseed and Mustard. In Ganganagar district the change in mean area (83.70 per cent) was the main source followed by change in mean yield (40.94 per cent), interaction effect of mean area and mean yield (2.04 per cent) and negative effect of area-yield covariance (-6.70 per cent). In Jodhpur district the main source of growth of production of Rapeseed and Mustard was change in mean yield (9.33 per cent) followed by change in area-yield covariance (6.0 per cent) and higher negative effect of change in mean area (-14.06 per cent) followed by interaction effect mean area and mean yield (-0.07 per cent).

Table 4.34 Components of Change in Average Production of Rapeseed and Mustard in Period II

Districts	Change in mean yield	Change in mean Area	Interaction effect	Change in area yield covariance
ALWARA	0.031	-0.007	-0.0002	-0.003
TONK	0.039	-0.091	-0.003	0.017
BHARATPUR	0.053	-0.022	-0.001	-0.005
GANGANAGAR	0.023	0.048	0.001	-0.003
JODHPUR	0.005	-0.008	-0.004	0.003

Table 4.35 Per cent Contribution of Change in Average Production of Rapeseed and Mustard in Period II

Districts	Change in mean yield	Change in mean Area	Interaction effect	Change in area yield covariance
ALWAR	54.63	-12.62	-0.40	-5.84
TONK	67.94	-158.66	-6.04	31.25
BHARATPUR	92.36	-38.63	-2.08	-9.81
GANGANAGAR	40.94	83.70	2.04	-6.70
JODHPUR	9.33	-14.06	-0.07	6.00

Table 4.36 Major Sources of Change in Production of Rapeseed and Mustard

Districts	**Major Source of Change**							
	Period I				**Period II**			
	Yield effect	**Area effect**	**Interaction effect**	**Covariance effect**	**Yield effect**	**Area effect**	**Interaction effect**	**Covariance effect**
ALWARA								
TONK								
BHARATPUR								
GANGANAGAR								
JODHPUR								

4.4 Profitability of Oilseed Crop Production in Rajasthan

Profitability of oilseeds is an major concern for reducing import dependency through increasing domestic production of oilseed crops. There are numerous challenges for reducing import dependency to save foreign exchange or attaining self-sufficiency and to make oilseeds cultivation profitable to farmers. Improving quality and quantity of produce through research and technology diffusion in a favourable policy environment may support in achieving the goals. Earlier studies estimated farmers' income from various sectors, such as agriculture and allied sectors, as well as income from non-farm sources, along with variations in income levels through time (Chand et al., 2015). It is also important to understand the changes or trends in income or profitability of different crops or crop groups and their underlying factors in order to prepare plan and strategies to enhance profitability and income from different crops. On the basis of cost of cultivation survey data, Commission for Agricultural Costs and Prices (CACP) uses different cost concepts to work out the alternative incomes from crop production. The paid out cost, Cost A2, is widely used for analytical purposes to track the changes in the welfare of farmers, which includes all actual expenses in cash and kind incurred by producers and rent paid for leased-in land. Income earned over Cost A2 is termed as farm business income. Another cost concept, Cost A2 plus family labour i.e. Cost C2 represent real farming costs and is relevant in assessing the expenses incurred in the cultivation of a crop. Profit earned over Cost C2 is termed as Net income. In this study per hectare profitability of three major oilseed crops in Rajasthan viz. Sesamum, Soybean and Rapeseed and Mustard were calculated from 2000-01 to 2017-18. Profitability of Groundnut was excluded from the study due to non availability data of Rajasthan state from cost of cultivation survey.

4.4.1 Profitability of Sesamum

Sesamum crop is one of the major crop to oilseed economy of country as well as to the producers. Income earned by the farmers shows more fluctuation in Rajasthan over the time. The total costs and returns from the production of Sesamum is shown below in table 4.33. The study shows that there was 322.48 per cent increase in the gross income from 2000-01 to 2009-10 due to greater increase in value of main product. During second period, gross income increased from Rs. 15904.43 per hectare in 2010-11 to Rs. 17013.89 per hectare in 2017-18 showing 6.98 per cent increase. During first period farm business income was Rs. 2478.62 per hectare in 2000-01 and it increased with 459.96 per cent change to Rs. 13879.32 per hectare in 2009-2010. In second period farm business income was Rs. 13282.08 in 2010-

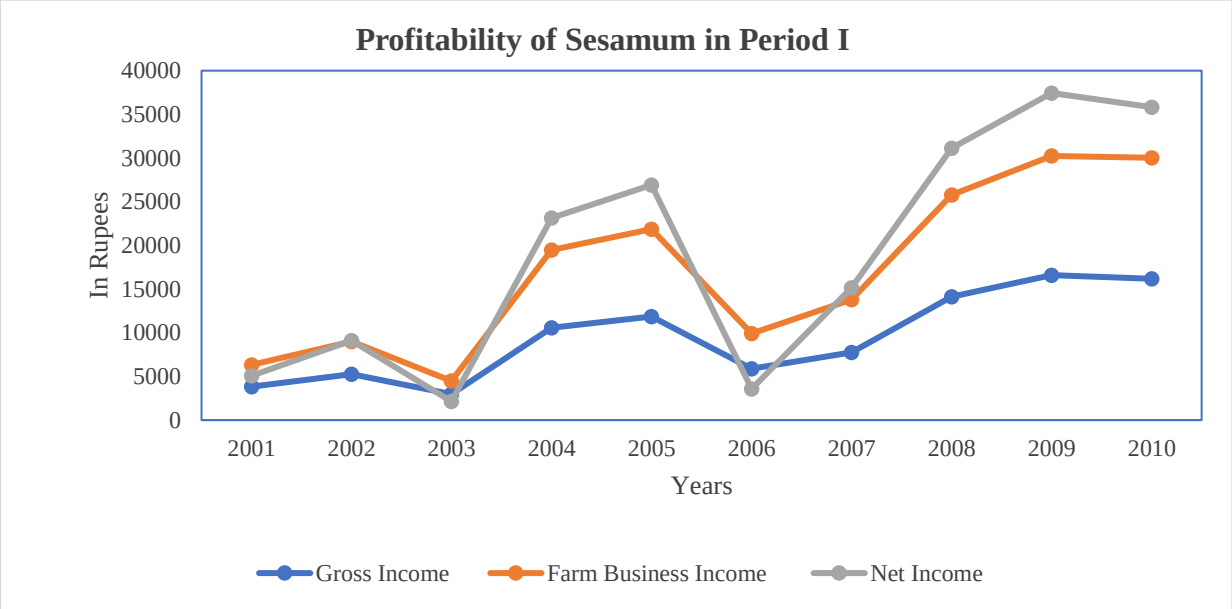
11 and it shows 28.93 per cent decrease of income to 9439.28 per cent in 2017-18. It was due to 188.85 per cent increase in the Cost A2 from 2010-11 to 2017-18 and slight increase of 6.98 per increase in gross income. There was 280.83 per cent steady increase in the farm business income from 2000-01 to 2017-18. There exists more cost of production of Sesamum over gross income in 2000-01, thus there was loss of Rs. 1221.93 per hectare. By the time in 2009-10, there was 574 per cent increase net income over total cost of production i.e. Rs. 5791.98 per hectare. This was due to increased production Sesamum and price of the produce and slight increase in cost of production.

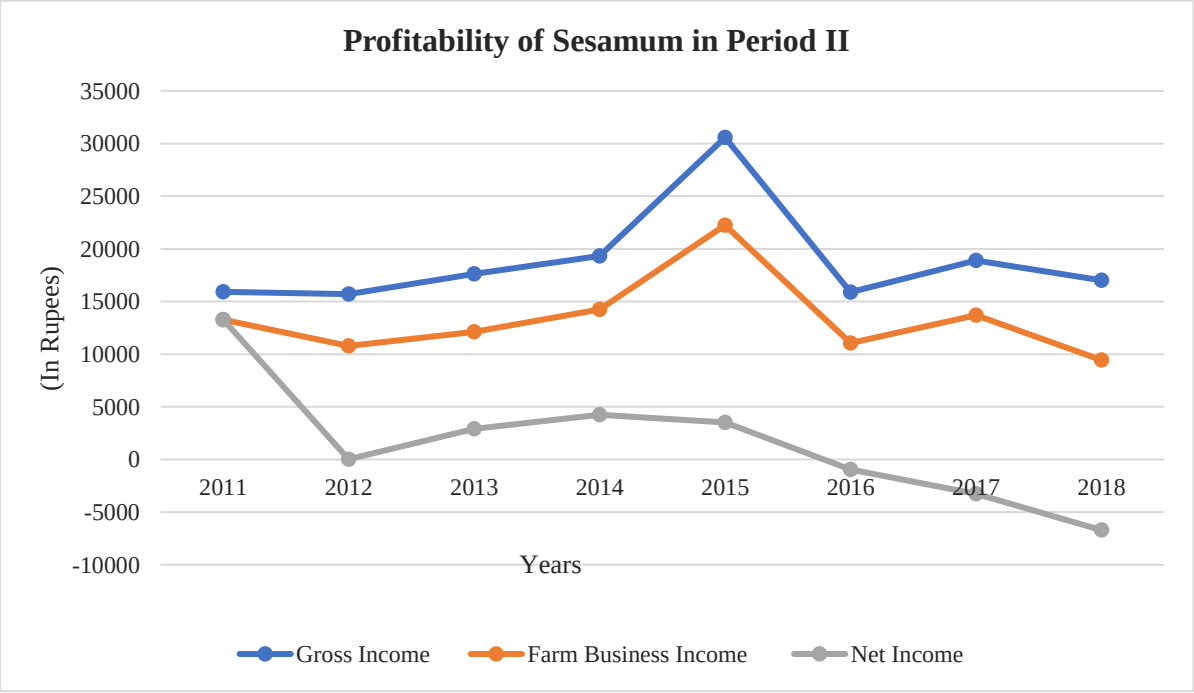
Table 4.37 Profitability of Sesamum

Particulars	Period I			Period II			Total change (per cent) (2000-01 to 2017-18)
	2000-01 (In Rs.)	2009-10 (In Rs.)	Percent change	2010-11 (In Rs.)	2017-18 (In Rs.)	Percent change	
1.Value of main product	3753.22	15600.65	315.66	15478.41	16509.11	6.66	339.87
2. Value of by product	72.45	561.98	675.68	426.02	504.78	18.49	596.73
3. Cost A2	1347.05	2283.31	69.50	2622.35	7574.61	188.85	462.31
4. Cost C2	5047.6	10370.65	105.46	2622.35	23722.338	804.62	369.97
5. Gross Income (GI)	3825.67	16162.63	322.48	15904.43	17013.89	6.98	344.73
6. Farm Business Income (GI- Cost A2)	2478.62	13879.32	459.96	13282.08	9439.28	-28.93	280.83
7. Net Income (GI- Cost C2)	-1221.93	5791.98	574.00	13282.08	-6708.448	-150.51	-449.00

(Source: Directorate of Economics and Statistics, MOA, GOI.)

Fig 4.1 Graphical Representation of Profitability of Sesamum in Rajasthan





4.4.2 Profitability of Soybean.

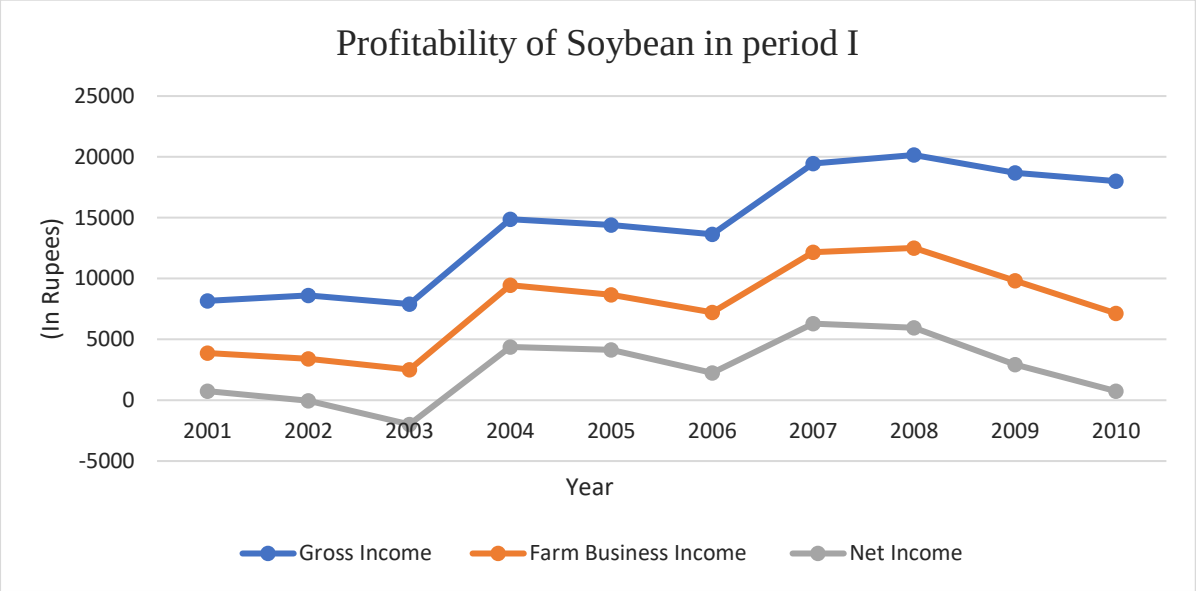
Soybean being an important oilseed crop has experienced more fluctuation of net income over time. The total costs and returns from the production of Soybean is shown below in table 4.34. In 2000-01 Soybean had farm business income over paid out cost of Rs. 3879.62 per hectare and it increased to Rs. 7144.98 per hectare with 84.17 per cent change. During second period in 2010-11, the farm business income was Rs. 12189.44 per hectare and it increased to Rs. 18974.7 per hectare. It shows 55.67 per cent increase in farm business income in second period and total per cent change of 389.09 per cent increase was observed from 2000-01 to 2017-18. These results are in line with (Narayanmoorthy, 2007). During first period net income over total cost of production shows slight decrease of 0.81 percent from Rs. 743.55 per hectare (2000-01) to Rs. 737.52 per hectare (2009-10). This was due to increase in total cost of production including frequent rise labour cost in Rajasthan (Purushottam Sharma, 2016). During second period there was rapid increase of 614.04 percent in net income over total cost from Rs.794.91 per cent in 2010-11 to 2017-18. This was due to better production of Soybean in second period supported by increasing price of Soybean over the period (DES, MOA, GOI). The total per cent change from 2000-01 to 2017-18 was observed increase of net returns by 663.36 per cent indicating Soybean as an profitable crop over the time.

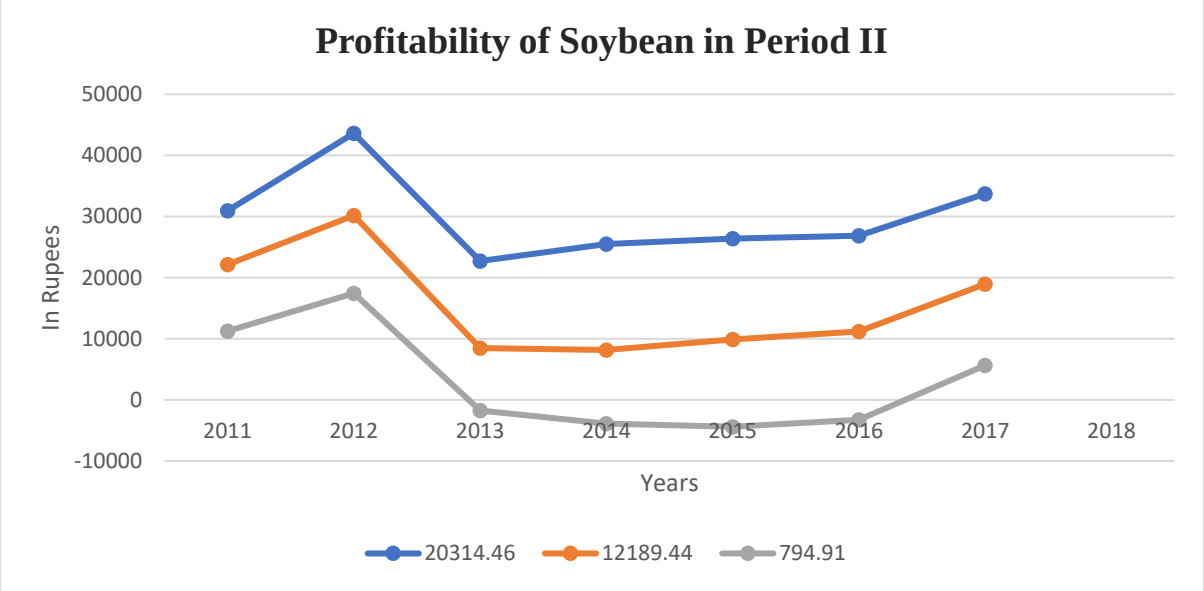
Table 4.38 Profitability of Soybean

Particulars	Period I			Period II			Total change (per cent) (2000-01 to 2017-18)
	2000-01 (In Rs.)	2009-10 (In Rs.)	Percent change	2010-11 (In Rs.)	2017-18 (In Rs.)	Percent change	
1.Value of main product	7266.41	16129.25	121.97	18412.58	31303.86	70.01	330.80
2. Value of by product	909.17	1884.98	107.33	1901.88	2438.85	28.23	168.25
3. Cost A2	4295.96	10869.25	153.01	8125.02	14767.84	81.76	243.76
4. Cost C2	7432.03	17276.71	132.46	19519.55	28066.71	43.79	277.65
5. Gross Income (GI)	8175.58	18014.23	120.34	20314.46	33742.71	66.10	312.73
6. Farm Business Income (GI- Cost A2)	3879.62	7144.98	84.17	12189.44	18974.87	55.67	389.09
7. Net Income (GI- Cost C2)	743.55	737.52	-0.81	794.91	5676	614.04	663.36

(Source: Directorate of Economics and Statistics, MOA, GOI.)

Fig 4.2 Graphical Representation of Profitability of Soybean in Rajasthan.





4.4.3 Profitability of Rapeseed and Mustard

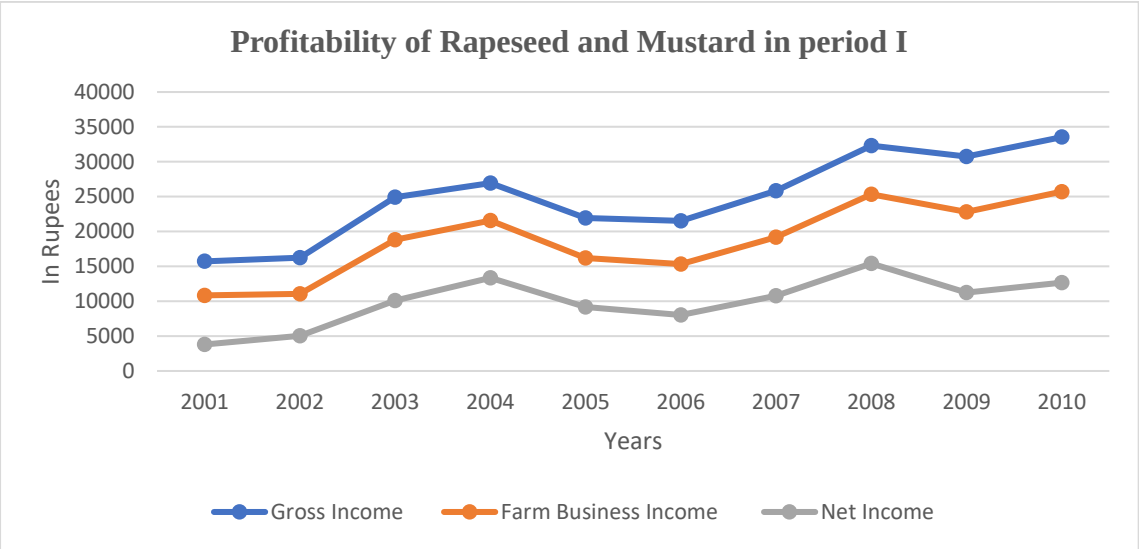
Rapeseed and Mustard crop is an important crop to oilseed economy of country as well as to the producers. Profit earned over cost of production of Rapeseed and Mustard from 2000-01 to 2017-18 is given in table 4.35 below. The study shows that increase of 113.32 per cent in gross income from Rapeseed and Mustard production was observed from 2000-01 to 2009-10 due to 100.72 per cent increase in value of main product in the same period. During second period 95.46 per cent increase from Rs. 37448.75 per hectare (2010-11) to Rs. 73196.12 per hectare (2017-18). In total gross income from 2000-01 to 2017-18 increased by 365.63 per cent. The farm business income over Cost A2 was observed the 137.17 per cent increase from 2000-01 to 2009-10. During second it increased only by 71.54 per cent from Rs.29993.39 per hectare in 2010-11 to Rs. 51449.44 per cent in 2017-18. In over all period there was 374.38 per cent increase in the farm business income over paid out cost. During first period net income calculated over total cost of production shows 233.66 per cent increase from 2000-01 to 2009-10. The total cost of production in the same period is increased by the 74.96 per cent due to the fact that increase in the labour cost was observed may be due to less availability of labour at critical stages after implementation of National Rural Employment Guarantee Act (NREP) created rise in wage rate (Purushottam Sharma, 2016). During second period the net income was increased from Rs. 16276.21 per hectare in 2010-11 to Rs. 20484.31 per hectare in 2017-18 with 71.54 per cent rise in net income. In over all period from 2000-01 to 2017-18, the net income over total cost of production has been increased by 439.06 per cent indicating Rapeseed and Mustard as profitable crop.

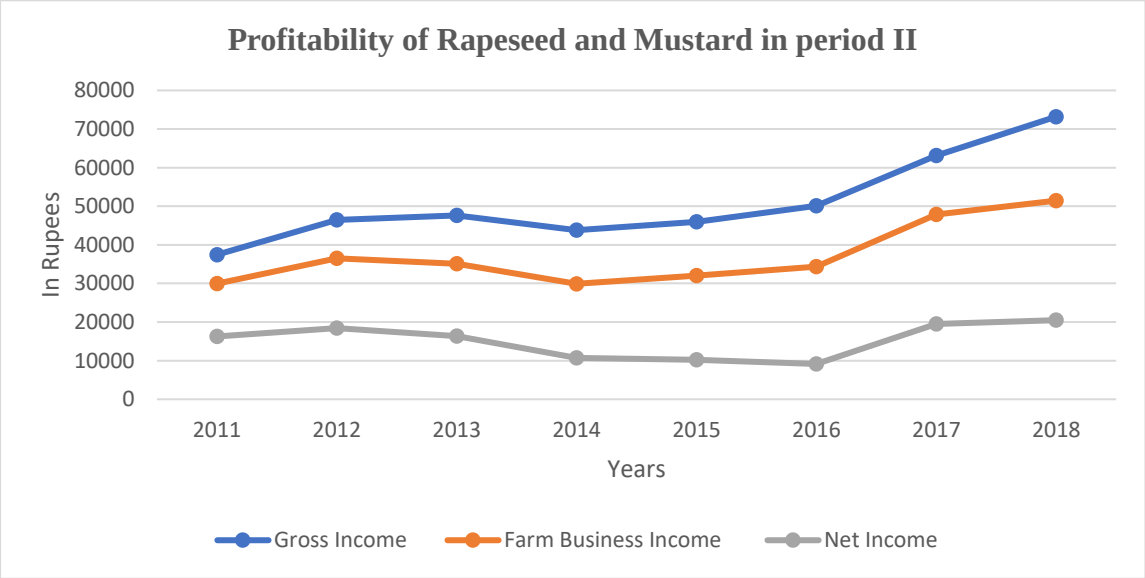
Table 4.39 Profitability of Rapeseed and Mustard

Particulars	Period I			Period II			Total change (per cent) (2000-01 to 2017-18)
	2000-01 (In Rs.)	2009-10 (In Rs.)	Percent change	2010-11 (In Rs.)	2017-18 (In Rs.)	Percent change	
1.Value of main product	15568.37	31248.99	100.72	35281.54	69811.28	97.87	348.42
2. Value of by product	151.52	2284.96	1408.03	2167.21	3384.84	56.18	2133.92
3. Cost A2	4874.37	7811.19	60.25	7455.36	21746.68	191.69	346.14
4. Cost C2	11919.88	20854.88	74.96	21172.54	52711.81	148.96	342.22
5. Gross Income (GI)	15719.89	33533.95	113.32	37448.75	73196.12	95.46	365.63
6. Farm Business Income (GI- Cost A2)	10845.52	25722.76	137.17	29993.39	51449.44	71.54	374.38
7. Net Income (GI- Cost C2)	3800.01	12679.07	233.66	16276.21	20484.31	25.85	439.06

(Source: Directorate of Economics and Statistics, MOA, GOI.)

Fig 4.3 Graphical Representation of Profitability of Rapeseed and Mustard in Rajasthan





4.5 Acreage Response Function

The production of any crop had direct influence from yield and area under that crop. In order to enhance the production, either area or yield or both has to be increased. In order to increase or decrease the area under any crop at farm, district, state, country level, the number of factors such as price factors and non price factors influencing the area must taken into account. In the present study, current year area (A_t) is assumed to be influenced by the following factors:

(i) One Year Lagged Area (A_{t-1})

Farmers usually do not change the area under any crop. Any crop's acreage fluctuates with time. A year lagged area of a specified oilseed crop was incorporated in the model to determine whether there was a positive or negative change in area under oilseed crops over time.

(ii) One Year Lagged Yield (Y_{t-1})

It is one of the most important non-price factors that influences the decrease or increase in crop area. Any crop's one-year lagged average yield is calculated by dividing total production by the crop's area under cultivation in that year. For most crops, studies have proven that a one-year lagged average yield has a reasonable effect on area allocation. Agricultural technologies were tend to have influence on the lagged yield which in turn affects the acreage in current year.

(iii) One Year Lagged Price (P_{t-1})

In this acreage response model farm harvest price were used because majority of farm produce is sold soon after the harvest of crop due to lack of facilities required for bulk storage. Farm harvest price is defined as average wholesale price at which farm produce is sold off by the farmers to the traders in the market within 6-8 weeks after the harvesting period. The farm harvest price is the actual price realized by the farmers. The explanatory variable, one year lagged farm harvest price of selected crop was included for current year acreage (A_t), as acreage decision are likely governed by the price or profit of the crop during previous year.

(iv) One Year Lagged Yield of the Competing Crop (Y_{ct-1})

The average yield of the competing crop in previous year is also one of the important non-price factor which affects acreage allocation for any crop by the farmers. Low yield of any

alternative or competitive crop in the lagged year made farmers shift their acreage into targeted crop. The current year acreage and one year lagged yield of the competing crop **(**Y_{ct-1}) were expected to have negative influence in normal situation.

(v) One Year Lagged Price of Competing Crop (P_{ct-1})

In this acreage response model one year lagged farm harvest price was used, which is based on the above logic. Farmers acreage allocation decisions for a given crop are likely to be influenced by the pricing of competing crops. Better price for alternative crop may cause to shift to that crop.

(vi) Rainfall in Current Year (R_t)

The weather conditions plays an important role in agriculture. In this acreage allocation decision of farmers rainfall was taken as one of the key variable. The annual rainfall of that current agricultural year is used as a variable for estimating the acreage response function. It might have a positive or negative influence depending on crops yield-water relationship for *kharif* crops and positive influence for *rabi* oilseed crops because rainfall always have positive or no effect in *rabi* season.

(vii) One Year Lagged Rainfall (R_{t-1})

The irrigation facilities in current year is dependent on the water availability. Rainfall in the lagged or previous years might have supplemental effect on irrigation. It is expected to have influence on the acreage response of the farmers particularly in well irrigated areas. A positive influence is expected for one year lagged rainfall.

(viii) Current Year Irrigated Area (I_t)

The better irrigation facility is expected to have positive effect on both yield and area for most of the crops. Therefore, the impact assessment of irrigation on the acreage allocation under oilseed crops. In this model, the total irrigated area under each oilseed crop indicates the irrigation potential of that year was considered as explanatory variables to measure the extent of influence on the current year acreage under that crop.

(ix) One Year Lagged Irrigated Area (I_{t-1})

The previous year irrigated area will have supplemental effect on the acreage allocation in current year by the means of better production and yield of that crop. One year lagged irrigated area is used as an explanatory variable for estimating the acreage response function.

(x) Variability in Lagged Price (S_{pt-1})

Variability in prices was included in the model to capture the impact of the farmers' risk taking attitude. The standard deviation of absolute prices for the previous three years of the crops was used to determine variability. According to researchers, the justification behind using the previous three years' price in the standard deviation calculation was that farmers do not look further back than the previous three years for price fluctuations.

(xi) Variability in Yield (S_{yt-1})

Farmers' yield risk is represented by yield variability. The standard deviation of yield over the previous three years is used to compute the yield variability. The reason for adopting three years was that farmers do not consider yield changes in the last three years. Variability in yield (Syt-1) is used as the explanatory variable in this acreage response model.

Selection of Competing Crops

Selection of competing crop were made based on correlation coefficient between areas under different crops for the period 2000-01 to 2019-20. Those crops having highest negative correlation coefficient between these areas under these crops were chosen as competing crops. The competing crops for the selected oilseed crop are given in Table 4.36.

Table 4.40: Competing Crops for the Selected Oilseed Crops

S. No.	Major Oilseed Crops	Competing Crop
1.	Groundnut	Arhar (Pigeonpea)
2.	Sesamum	Urad bean
3.	Soybean	Maize
4.	Rapeseed and Mustard	Wheat

For all selected oilseed crops, initially the acreage response function was estimated keeping all the explanatory variables in the model. Since existence of multicollinearity between explanatory variables in most of the cases, the acreage response function using backward elimination method was used to get the final acreage response functions, with statistically significant variables in the model.

4.5.1 Acreage Response Function of Groundnut

The parameters of estimated acreage response function for Groundnut keeping all the explanatory variables in the model is given in the table 4.37. The analysis revealed that the explanatory variables like total irrigated area in current year had significantly positive influence on area under groundnut cultivation in current year and variability in yield had significantly negative effect on area under groundnut cultivation. The factors like one year lagged area, one year lagged yield, one year lagged price, lagged yield of competing crop Arhar, rainfall in current year and irrigated area were had positive influence on acreage in current year. Other explanatory variables like One year lagged price of the competing crop Arhar, One year lagged rainfall, lagged irrigated area and variability in price and yield were negatively affects the acreage in current year. The estimated multiple acreage model was also statistically significant as evidenced from the F value

The parameters of estimated acreage response function of Groundnut using backward elimination method and the elasticity coefficient of Groundnut with respect to significant variables in the acreage response function were given in table 4.38. These parameters revealed that explanatory variable like total irrigated area in current year had significantly positive influence on acreage of groundnut in current year. The positive sign of coefficient of total irrigated area in current area (I_t) indicates that as the irrigation potential increases, farmers tend to cultivate Groundnut in more land. The explanatory variable like one year lagged price of the competing crop (Arhar) had significantly negative effect on current year acreage of Groundnut. The elasticity coefficients of significant variables of Groundnut for acreage response function revealed that acreage under Groundnut was positively elastic to total irrigated area in current year (0.64) and negatively elastic to one year lagged price of the competing crop (-0.09). Other variables like price and yield of Sesamum in previous year had positive effect and rainfall in lagged year had negative effect on current year acreage of Sesamum in Rajasthan.

Table 4.41 Parameters of Estimated Acreage Response Function of Groundnut

Sl. No	Variables	Parameter estimates	
		'b' value	Standard error
1.	Acreage (A_t)	126175.741	64040.645
2.	One year lagged area (A_{t-1})	0.002	0.287
3.	One year lagged yield (Y_{t-1})	25648.861	33290.927
4.	One year lagged price (P_{t-1})	19.682	19.950
5.	One year lagged yield of competing crop Arhar (Y_{ct-1})	3641.881	39273.259
6.	One year lagged price of the competing crop Arhar (P_{ct-1})	-9.790	9.19
7.	Rainfall (R_t)	0.966	431.105
8.	One year lagged rainfall (R_{t-1})	-547.467	520.873
9.	Total irrigated area in current year (I_t)	1.021*	0.185
10.	One year lagged irrigated area (I_{t-1})	-0.206	0.350
11.	SD price (Sp_{t-1})	-54.827	39.163
12.	SD yield (Sy_{t-1})	-21157.067*	29239.750
R^2 value = 0.995		F (11,7) = 139.298 *	

(*Significant at 5 per cent level of significance)

Table 4.42 Parameters of Estimated Acreage Response Function of Groundnut Using Backward Elimination Method

Sl. No	Variables	Parameter estimates		
		'b' value	Standard error	Elasticity coefficients
1.	Acreage (A_t)	125838.42*	19570.01	-
2.	Total irrigated area in current year (I_t)	0.857*	0.092	0.647
3.	One year lagged yield (Y_{t-1})	26682.697	19441.31	-
4.	One year lagged price (P_{t-1})	20.004	15.804	-
5.	One year lagged price of the competing crop Arhar (P_{ct-1})	-12.168*	5.365	-0.099
6.	One year lagged rainfall (R_{t-1})	-606.903	424.061	-
7.	SD price (Sp_{t-1})	-54.084	30.679	-
R^2 value = 0.994		F (1,11) = 1.583		

(*Significant at 5 per cent level of significance)

4.5.2 Acreage Response Function of Sesamum

The parameters of estimated acreage response function for Sesamum keeping only 11 explanatory variables in the model is given in the table 4.39. Due to non availability of data of price of competing crop Urad, therefore variable like one year lagged price of competing crop (P_{ct-1}) was excluded from the analysis. The variables like one year lagged area, one year lagged yield, rainfall in current year had positive influence on current year acreage under Sesamum cultivation. Other explanatory variables like one year lagged price, one year lagged yield of competing crop Urad, one year lagged rainfall, total irrigated area in current year, one year lagged irrigated area and variability in price and yield had an negative influence on current year acreage of Sesamum. This analysis revealed that none of the coefficients of explanatory variables were statistically significant and F value was also not significant.

The parameters of estimated acreage response function of Sesamum using backward elimination method and the elasticity coefficient of Sesamum with respect to significant variables in the acreage response function were given in table 4.40. The analysis revealed that explanatory variable like one year lagged area was found to have significantly positive influence on acreage of Sesamum in current year. Positive influence of one year lagged area (A_{t-1}) indicates that if more area of cultivation in previous year made farmers to cultivate in same or more area under known crop. The elasticity coefficients of significant variables of Sesamum for acreage response function revealed that acreage under Sesamum was positively elastic (0.61) to one year lagged area. Other explanatory variables like One year lagged yield of Sesamum, rainfall in current year had positive influence on current year acreage of sesamum while variables like one year lagged yield of competing crop Urad and rainfall in previous year had negative influence on current year acreage of Sesamum in Rajasthan.

Table 4.43 Parameters of Estimated Acreage Response Function of Sesamum

Sl. No	Variables	Parameter estimates	
		'b' value	Standard error
1.	Acreage (A_t)	272421.223	324955.179
2.	One year lagged area (A_{t-1})	0.776	0.352
3.	One year lagged yield (Y_{t-1})	770926.822	678825.951
4.	One year lagged price (P_{t-1})	-6.722	23.961
5.	One year lagged yield of competing crop Urad (Y_{ct-1})	-280693.764	452690.052
6.	Rainfall (R_t)	1613.711	4913.104
7.	One year lagged rainfall (R_{t-1})	-3983.821	3821.094
8.	Total irrigated area in current year (I_t)	-0.781	9.626
9.	One year lagged irrigated area (I_{t-1})	-5.589	11.401
10.	SD price (Sp_{t-1})	-22.396	84.617
11.	SD yield (Sy_{t-1})	-582032.834	1016017.669
	R^2 value = 0.616	F (10, 8) =1.284	

Table 4.44 Parameters of Estimated Acreage Response Function of Sesamum Using Backward Elimination Method

Sl. No	Variables	Parameter estimates		
		'b' value	Standard Error	Elasticity coefficients
1.	Acreage (A_t)	139385.575	154769.592	-
2.	One year lagged area (A_{t-1})	0.622*	0.215	0.61
3.	One year lagged yield (Y_{t-1})	537407.535	315618.521	-
4.	One year lagged yield of competing crop Urad (Y_{ct-1})	-147205.836	190707.935	-
5.	Rainfall (Rt)	1582.023	2134.644	-
6.	One year lagged rainfall (Rt-1)	-3151.553	2510.660	-
	R2 value = 0.592	F (1, 12) = 0.695		

(*Significant at 5 per cent level of significance)

4.5.3 Acreage Response Function of Soybean

The acreage response function for Soybean was estimated keeping only 9 explanatory variables in the model as the data on prices of Soybean to the whole period were not available. Therefore the variables like One year lagged price (Pt-1) and SD price (Sp_{t-1}) were excluded from the model. The parameters of estimated acreage response function for Soybean keeping all the 9 explanatory variables in the model is given in the table 4.41. The analysis revealed that the explanatory variables like one year lagged area, one year lagged yield of competing crop Maize had significantly positive effect on acreage of Soybean in current year while rainfall in current year and one year lagged irrigated area had significantly negative influence on current year acreage of Soybean. The other explanatory variables like one year lagged yield, one year lagged price of the competing crop Maize, total irrigated area in current year had positive influence on acreage of Soybean, where as other variables such as rainfall in current year and lagged year, variability of yield were negatively affects the acreage of Soybean. F value was statistically significant which revealed that estimated multiple acreage model as significant.

The parameters of estimated acreage response function of Soybean using backward elimination method and the elasticity coefficient of Sesamum with respect to significant variables in the acreage response function were given in table 4.42. The analysis revealed that explanatory variables like one year lagged yield and one year lagged price of the competing crop Maize were found to have coefficient which were found to have significantly positive influence on current year acreage of Soybean. Positive sign of both variables indicates that better yield of Soybean in previous years might cause the increase in area in current year and low price for the competing crop like Maize in previous year may leads to shift to cultivation of soybean. The elasticity coefficients of significant variables of Soybean for acreage response function revealed that acreage under Sesamum was positively elastic to one year lagged yield (0.286) and one year lagged price of the competing crop Maize (0.545).

Table 4.45 Parameters of Estimated Acreage Response Function of Soybean

Sl. No	Variables	Parameter estimates	
		'b' value	Standard error
1.	Acreage (A_t)	263343.203*	324335.577
2.	One year lagged area (A_{t-1})	0.331*	0.368
3.	One year lagged yield (Y_{t-1})	205955.181	186125.506
4.	One year lagged yield of competing crop Maize (Y_{ct-1})	50636.946*	128256.420
5.	One year lagged price of the competing crop Maize (P_{ct-1})	376.493	220.282
6.	Rainfall (R_t)	-1549.971*	3730.840
7.	One year lagged rainfall (R_{t-1})	-5164.986	4805.032
8.	Total irrigated area in current year (I_t)	2.203	1.774
9.	One year lagged irrigated area (I_{t-1})	0.727*	1.431
10.	SD yield (Sy_{t-1})	-239288.325*	2 81137.940
	R^2 value = 0.817	F (9, 9) = 4.471*	

(*Significant at 5 per cent level of significance)

Table 4.46 Parameters of Estimated Acreage Response Function of Soybean Using Backward Elimination Method

Sl. No	Variables	Parameter estimates		
		'b' value	Standard error	Elasticity coefficients
1.	Acreage (A_t)	147233.957	126479.629	-
2.	One year lagged yield (Y_{t-1})	210883.91*	89364.267	0.286
3.	One year lagged price of the competing crop Maize (P_{ct-1})	491.933*	73.305	0.545
	R^2 value = 0.752	F (1, 15) = 1.226		

(*Significant at 5 per cent level of significance)

4.5.3 Acreage Response Function of Rapeseed and Mustard

The parameters of estimated acreage response function for Rapeseed and Mustard keeping all the explanatory variables in the model is given in the table 4.43. The analysis revealed that the explanatory variables like total irrigated area in current year and variability of yield of Rapeseed and Mustard were found to have significantly positive influence on acreage of Rapeseed and Mustard. The variables like one year lagged yield, one year lagged price, rainfall in current year, one year lagged rainfall had positive effect on acreage while other explanatory variables like one year lagged area, one year lagged yield and price of competing crop wheat, variability of price from preceding 3 years were found to have negative influence on current year acreage of Rapeseed and Mustard.The estimated multiple acreage response model was also statistically significant as evident from the F value

The parameters of estimated acreage response function of Rapeseed and Mustard using backward elimination method and the elasticity coefficient of Rapeseed and Mustard with respect to significant variables in the acreage response function were given in table 4.44. The explanatory variables like total irrigated area in current year, one year lagged irrigated area, variability of yield were held to have significantly positive influence on current year acreage while one year lagged area, one year lagged price of the competing crop Wheat were found to have significantly negative influence on current year acreage of Rapeseed and Mustard. This indicates that due to increased irrigated area in the lagged year and current year increases the yield of Rapeseed and Mustard. These increased yield and better price for the produce had an positive effect on increasing the area under cultivation. The elasticity coefficients of significant variables of Rapeseed and Mustard for acreage response function revealed that acreage under Rapeseed and Mustard was positively elastic to irrigated area in current year (0.98), lagged irrigated area (0.57) and variability in yield (0.10) of Rapeseed and Mustard. Apparently, it showed negative elasticity for acreage under Rapeseed and Mustard to one year lagged area (-0.53) and one year lagged price of the competing crop Wheat (-0.31).

Table 4.47 Parameters of Estimated Acreage Response Function of Rapeseed and Mustard

Sl. No	Variables	Parameter estimates	
		'b' value	Standard error
1.	Acreage (A_t)	556975.759	360442.402
2.	One year lagged area (A_{t-1})	-0.617	0.281
3.	One year lagged yield (Y_{t-1})	29591.001	453611.364
4.	One year lagged price (P_{t-1})	300.167	248.227
5.	One year lagged yield of competing crop Wheat (Y_{ct-1})	-112537.349	224777
6.	One year lagged price of the competing crop Wheat (P_{ct-1})	-1317.639	679.135
7.	Rainfall (R_t)	2738.829	3021.398
8.	One year lagged rainfall (R_{t-1})	2519.152	4593.754
9.	Total irrigated area in current year (I_t)	1.033*	0.131
10.	One year lagged irrigated area (I_{t-1})	0.874	0.398
11.	SD price (Sp_{t-1})	-642.028	348.466
12.	SD yield (Sy_{t-1})	2332646.716*	785892.222
	R^2 value = 0.987	F (11, 7) = 49.016*	

(*Significant at 5 per cent level of significance, **Significant at 1 per cent level of significance)

Table 4.48 Parameters of Estimated Acreage Response Function of Rapeseed and Mustard Using Backward Elimination Method

Sl. No	Variables	Parameter estimates		
		'b' value	Standard error	Elasticity coefficients
1.	Acreage (A_t)	498783.731*	136756.650	-
2.	One year lagged area (At-1)	-0.533*	0.199	-0.53
3.	One year lagged price of the competing crop Wheat (Pct-1)	-690.527*	118.405	-0.31
4.	Total irrigated area in current year (It)	1.152*	0.072	0.98
5.	One year lagged irrigated area (It-1)	0.679*	0.269	0.57
6.	SD yield (Syt-1)	1957009.044*	505216.346	0.10
7.	SD price (Spt-1)	319.237	151.818	-
	R^2 value = 0.982	F (1, 11) = 110.240		

(*Significant at 5 per cent level of significance)

5 SUMMARY AND CONCLUSION

India is the largest producer of oilseeds in the world and oilseed sector occupies an important position in the agricultural economy of the country. The fluctuations in crop production over the years is quite common in Indian Agriculture. These fluctuations adversely affect the production, income and employment, thereby affecting the economic growth of the country. Oilseeds are among the major crops that are grown in India apart from cereals and pulses. Oilseed cultivation is undertaken across the country in about 26.00 million ha, largely covering rainfed area of 72 percent of marginal land and producing around 30.00 million ton of oilseeds in 2019-20 as per the data of Directorate of Economics and Statistics, Ministry of Agriculture, Cooperation and Farmers Welfare, Government of India. Among the oilseed producing states of India, Rajasthan occupies a prominent position in production of oilseed crops and area under cultivation. The important oilseed crops of Rajasthan state are Groundnut, Soybean, Rapeseed & Mustard, Sesamum and Taramira. Rajasthan becomes the highest producer of Rapeseed and Mustard (4.30 million tonne) and second largest producer of Groundnut (1.61 million tonne) and third largest producer of Soybean (0.52 million tonne) in India. (Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare). Being the largest producer of oilseeds in the world, increased consumption demand 36.7 million tonne (GAIN Report 2020) in India doesn't cope with domestic production of 30.0 million tonne in 2019-20 making India as import dependent country. Therefore it is important to enhance the production by the means of increasing area or yield of oilseed crops. This can achieved by knowing the factors causing hinderance to the growth of oilseed production. In the present study an attempt has been made to the study the growth in area, production and yield of Groundnut, Sesamum, Soybean and Rapeseed & Mustard in five selected districts and also to identify the instability in crop production. Keeping above consideration, it is important to measure the source of growth in area, production and yield of oilseed crops in all five districts. The price and non price factors responsible for change in area under cultivation and profitability of oilseed crops.

Keeping in view the above consideration, research study entitled **"Performance of oilseed crops in Rajasthan"** was planned with the specific objectives:

1. To estimate the growth and instability in area, production and yield of major oilseed crops in Rajasthan,
2. To measure relative contribution of area and yield in the growth of production of oilseeds,
3. To study the profitability of major oilseed crops,
4. To find out the factors responsible for acreage under oilseed crops in the state.

The secondary data required such as area, production, yield, price, costs, gross income, rainfall, irrigated area of Groundnut, Sesamum, Soybean and Rapeseed & Mustard in selected five districts as well as whole state were collected from various published and unpublished source from 2000-01 to 2019-20. To fulfil the above mentioned objectives, growth rate of area, production and yield of four oilseed crops were calculated by Compound Growth Rate by using exponential function. The instability in area, production and yield were analysed using both Coefficient of Variation and Cuddy Della Valle Index. The source of change in production were analysed by using Hazell's decomposition method. The profitability of oilseed crops were analysed by considering Cost A2 and Cost C2 in production of oilseeds. Acreage response function of major oilseed crops have been worked out by use of $Y = f(X_1, X_2 \ldots\ldots, X_n)$ model where Y is dependent variable and $X_1, X_2 \ldots\ldots, X_n$ are independent variable.

5.1 RESULTS AND DISCUSSION

Growth Rate and Instability in the Area, Production, Productivity of Oilseed Crops in Selected Districts of Rajasthan.

- Compound rates of area, production and yield of groundnut were higher in first period than second period. Among all five districts, highest compound growth rate of area was in Jodhpur (38.82 per cent) in first period and highest compound growth rate in production was also in Jodhpur (44.19 per cent) which had second highest share in area (25.36 per cent) and production (19.17 per cent) to the total area and production of state. While highest significant growth rate in yield was in Jaisalmer district (4.93 per cent) in second period.

- Compound growth rate in area, production and yield of Sesamum in all five districts was higher in in first period second period. In second period it showed negative growth rate in most of districts. Highest compound growth rate in area was in Tonk district (23.39 per cent) in first period which had least share of area to the total area under cultivation among the five districts. Highest compound growth rates in production and yield were in S Madhopur district i.e. 40.80 per cent and 18.56 per cent in first period.

- Compound growth rate in area, production and yield of Soybean were also comparatively higher in first period than second period. Growth rates in second periods were observed negative in most of districts. Among all five districts, Banswara district in second period had highest compound growth rate in area (19.49 per cent) and production (20.90 per cent) while Baran district had highest compound growth rate in yield of Soybean (6.02 per cent) in first period.

- Compound growth rates in area and production of Rapeseed and Mustard were higher in first period than second period in which Tonk district had highest compound growth rate of area (16.87 per cent) and production (18.35 per cent) in first period. The significant compound growth rate in yield of Rapeseed and Mustard was highest in Bharatpur district (4.56 per cent) in first period.

- The variability in area, production and yield of Groundnut in terms of CDI values and coefficient of variation were showed higher in first period than second period indicating high instability existed in first period. Highest instability in area was observed in Jodhpur district (80.95 per cent) in first period. Highest variability in production in terms of CDI value was in Jaisalmer district (33.17 per cent) in second period indicating high instability. Highest instability in yield was in top Groundnut producing district Bikaner (31.83 per cent) in first period.

- The variability in area, production and yield of Sesamum in terms of CDI values and coefficient of variation were showed higher instability in first period than second period. Highest instability in area in terms of CDI values as well as coefficient of variation was in Tonk district (59.90 per cent, 89.85 per cent respectively). Highest instability in production and yield of Sesamum in terms of CDI value was in Jodhpur district 86.65 per cent and 79.34 per cent respectively in first period.

- The variability in area of Soybean producing districts were more in first period than second period. The variability in production of Soybean was existed in both the periods.

The highest variability in area (34.86 per cent) and production (42.14 per cent) of Soybean producing districts in terms of CDI values was in Chittorgarh district in first period indicating high instability in area and production. The highest instability in yield of Soybean was in Jhalawar district (36.50 per cent) in second period.

- The variability in area, production and yield of Rapeseed and Mustard in terms of CDI values and coefficient of variation were showed higher instability in first period than second period. The instability in area (45.79 per cent) and production (56.01 per cent) of Rapeseed and Mustard in terms of CDI values were highest in Tonk district in first period while Ganganagar district had highest instability in yield of Rapeseed and Mustard.

Source of Growth of Production of Oilseed Crops in Selected Districts of Rajasthan.

- Major source of change in production of groundnut in Bikaner, Jaipur and Jaisalmer was change in yield of groundnut in first period i.e.3.13 per cent, 6.19 per cent, 5.55 per cent respectively in first period whereas in Jodhpur and Churu district it was change in area. In second period in Bikaner, Churu and Jaisalmer district, the change in production of groundnut was due to change in area under groundnut cultivation i.e. 15.05 per cent, 22.60 per cent, 83.0 per cent respectively. While it was due to change in yield of groundnut in Jodhpur (9.57 per cent) and Jaipur district (27.04 per cent).

- Major source of change in production of Sesamum was change in area in S Madhopur, Karauli and Tonk district in first as well as second period where as area-yield covariance effect was in Pali (3.54 per cent) and Jodhpur district (3.95 per cent) in first period. The yield of Sesamum in second period was the main source of change in production of Sesamum in Pali (5.85 per cent) and Jodhpur district (15.0 per cent).

- Major source of growth in average production of Soybean was change in area under Soybean cultivation in all districts except Banswara district in which area-yield covariance was the main source of growth with 186.88 per cent change. In second period, change in yield of Soybean was the main source of growth in all district except Chittorgarh district in which 47.87 per cent change in area under Soybean cultivation was the main source of growth in production of Soybean.

- Main source of growth in average production of Rapeseed and Mustard was change in area under cultivation in Alwar (14.53 per cent), Tonk (271.71 per cent) and Jodhpur

district (271.05 per cent) while area-yield covariance was the main cause of growth in production in Bharatpur (14.40 per cent) and Ganganagar district (11.75 per cent) of Rajasthan. In second period change in the yield of Rapeseed and Mustard was the main source of growth in production in all district except Ganganagar district (83.70 per cent) in which change in area under cultivation was the main source of growth in production of Rapeseed and Mustard.

Profitability of Oilseed Crops in Rajasthan

- From the study, it is concluded that total cost of production of Sesamum in first period was increased by 105.46 per cent and gross income from production increased by 322.48 per cent indicating cost effectiveness of technologies used as well as profitable to the farmers

- Total cost of production of Soybean in Rajasthan in first period was increased by 132.46 per cent while gross income increased by 120.34 per cent indicating decrease of net income by 0.81 per cent. It concludes Soybean as non profitable crop in first period. In second period total cost of Soybean production was increased by 43.79 per cent while gross income increased by 66.10 per cent indicating increase of net income by 614.04 per cent. In over all 18 years also net income from Soybean production increased by 663.36 per cent. It concludes Soybean as profitable crop in second and overall period.

- Total cost of production Rapeseed and Mustard in Rajasthan was increased by 74.96 per cent and gross income was increased by 113.32 per cent indicating increase in net income by 233.66 per cent. It concludes Rapeseed and Mustard as profitable crop in first period. In second period, total cost of production of Rapeseed and Mustard was increased by 148.96 per cent and gross income increased by 95.46 per cent. The net income over total cost was increased by only 25.85 per cent indicating Rapeseed and Mustard as less profitable crop in second period.

Acreage Response Function of Oilseed Crops in Rajasthan

- The variables like total irrigated area in current year was found to have significantly positive influence on acreage of groundnut cultivation. One year lagged price of competing crop Arhar had an negative effect on the area under groundnut cultivation. The acreage under groundnut cultivation was positively elastic to total irrigated area in

current year (0.647) and negatively elastic to one year lagged price of competing crop Arhar.

- One year lagged area under Sesamum was the main factors responsible for the current year acreage of Sesamum which had significantly positive influence. The acreage under Sesamum cultivation was positively elastic to one year lagged area (0.61) indicating that farmers of Rajasthan had some constraints in allocating area under Sesamum production.
- The variables like one year lagged yield of Soybean and one year lagged price of competing crop Maize were found to have significantly positive influence on acreage of Soybean in Rajasthan. The acreage under Soybean cultivation was positively elastic to both one year lagged yield (0.28) and one year lagged price of competing crop.
- The acreage under Rapeseed and Mustard was found to have significantly positive influence on total irrigated area in current area as well as lagged year and variability in yield of Rapeseed and Mustard while it had significantly negative influence on one year lagged area, one year lagged price of competing crop. The acreage under Rapeseed and Mustard cultivation was positively elastic to irrigated area in current as well as lagged year and variability in yield while it was negatively elastic to one year lagged area and one year lagged price of competing crop Wheat.

5.2 Conclusion

- All four oilseed crops showed comparatively more growth rate in area, production and yield in Period I than Period II in all five major oilseed producing districts. It indicates that effectiveness of government programmes and policies such as ISOPOM, Technology Mission on Oilseeds *etc* in the first period.
- Groundnut showed higher growth rates in area, production and yield in first period which decreased in second period. Area was the major source of change in production. Area under irrigation and better price in the previous year were the deciding factors for current acreage under groundnut.
- Sesamum also showed higher growth and instability in first period while negative growth rates observed in second period. Area was the major source of change in production in majority districts. Area under cultivation in the previous year was the major deciding factor for present acreage.
- Soybean also had high growth rate and instability in first period whereas decreased or negative growth rates observed in second period. Yield of Soybean was the major source

of change in production while better price and yield of soybean in previous year were the crucial factors for deciding current acreage.

- Rapeseed and Mustard showed lower growth rates and instability in area and production in second period while yield showed the high growth rate in second period which was the major source of change in production indicates that Rapeseed and Mustad had reached the potential yielding capacity. The area under cultivation in previous year, area under irrigation and price were the major deciding factors for current acreage of Rapeseed and Mustard.

5.3 Policy Implications

- The focus must be on increasing area under groundnut production through better price for the produce and large scale promotion of stabilization measures like crop insurance which can enhance the production of groundnut.
- In case of Sesamum, focus should be on increasing the area under Sesamum cultivation via increasing price and yield of Sesamum crop which were derived factors of area under Sesamum cultivation.
- Yield increasing technologies in Soybean such as high yielding varieties, proper nutritional management needs to be focused which in turn enhance the production and profitability.
- In case of Rapeseed and Mustard, focus should be on increasing area under cultivation. Being an rabi crop, Rapeseed and Mustard cultivation should focus on Drought Resistant Varieties to enhance production. Better price for the produce make farmers to grow profitable crop.

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Performance of Oilseed Crops in Rajasthan

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ABSTRACT

For analysis of the performance of the oilseed crops in major oilseed producing districts of the Rajasthan, the current study was conducted from 2000-01 to 2019-20. The entire period was divided into two sub-periods viz. Period I (2000-01 to 2009-10), Period II (2010-11 to 2019-20). Four major oilseed crops mainly Groundnut, Sesamum, Soybean and Rapeseed & Mustard were considered for the analysis. The study was done by analyzing the growth rate, instability, decomposition analysis, profitability and acreage response function. For this, analytical tools such as Compound Annual Growth Rate, Instability Indices (Coefficient of Variation, Cuddy-Della-Valle Index), hazell's decomposition method, per cent change of profits, regression analysis were used. The study revealed that all four oilseed crops showed comparatively more growth rate and instability in area, production and yield in Period I than Period II in all five major oilseed producing districts. Area was the major source for change in production of Groundnut and Sesamum while yield was major source for change in production in case of Soybean and Rapeseed & Mustard. The study also revealed that Soybean was more profitable crop compared to Rapeseed & Mustard and Sesamum. Acreage response function revealed that area under irrigation and better price in the previous year were the deciding factors for current acreage under groundnut while area under cultivation in the previous year was the major deciding factor for Sesamum. In Soybean, better price and yield in previous year were the deciding factors while the area under cultivation in previous year, area under irrigation and price were the major deciding factors for current acreage of Rapeseed and Mustard. The present study while giving the indication of performance of major oilseed crops in Rajasthan in the past provides adequate direction to plan for sustained growth of oilseed production.

Key words: Growth, instability, decomposition analysis, profitability, acreage response function

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राजस्थान में तिलहन फसलों का प्रदर्शन

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सारांश

राजस्थान के प्रमुख तिलहन उत्पादक जिलों में तिलहन फसलों के प्रदर्शन के विश्लेषण के लिए वर्तमान अध्ययन 2000-01 से 2019-20 तक किया गया था। पूरी अवधि को दो उप-कालों में विभाजित किया गया था। अवधि I (2000-01 से 2009-10), अवधि II (2010-11 से 2019-20)। विश्लेषण के लिए चार प्रमुख तिलहन फसलों मुख्य रूप से मूंगफली, तिल, सोयाबीन और रेपसीड और सरसों पर विचार किया गया था। अध्ययन विकास दर, अस्थिरता, अपघटन विश्लेषण, लाभप्रदता और रकबा प्रतिक्रिया समारोह का विश्लेषण करके किया गया था। इसके लिए कंपाउंड वार्षिक वृद्धि दर, अस्थिरता सूचकांक (भिन्नता का गुणांक, कडी-डेला-वेले इंडेक्स), हेज़ेल की अपघटन विधि, मुनाफे का प्रतिशत परिवर्तन, प्रतिगमन विश्लेषण जैसे विश्लेषणात्मक उपकरणों का उपयोग किया गया था। अध्ययन से पता चला कि सभी चार तिलहन फसलों ने सभी पांच प्रमुख तिलहन उत्पादक जिलों में अवधि II की तुलना में अवधि I में क्षेत्र, उत्पादन और उपज में तुलनात्मक रूप से अधिक विकास दर और अस्थिरता दिखाई। मूंगफली और तिल के उत्पादन में परिवर्तन के लिए क्षेत्र प्रमुख स्रोत था जबकि सोयाबीन और रेपसीड और सरसों के मामले में उत्पादन में बदलाव के लिए उपज प्रमुख स्रोत था। अध्ययन से यह भी पता चला कि रेपसीड और सरसों और तिल की तुलना में सोयाबीन अधिक लाभदायक फसल थी। रकबा प्रतिक्रिया समारोह से पता चला कि पिछले वर्ष में सिंचाई के तहत क्षेत्र और बेहतर कीमत मूंगफली के तहत वर्तमान रकबे के लिए निर्णायक कारक थे, जबकि पिछले वर्ष में खेती के तहत क्षेत्र तिल के लिए प्रमुख निर्णायक कारक था। सोयाबीन में, पिछले वर्ष में बेहतर कीमत और उपज निर्णायक कारक थे, जबकि पिछले वर्ष में खेती के तहत क्षेत्र, सिंचाई के तहत क्षेत्र और कीमत रेपसीड और सरसों के वर्तमान रकबे के लिए प्रमुख निर्णायक कारक थे। राजस्थान में पूर्व में प्रमुख तिलहन फसलों के प्रदर्शन का संकेत देते हुए वर्तमान अध्ययन तिलहन उत्पादन के निरंतर विकास के लिए योजना बनाने के लिए पर्याप्त दिशा प्रदान करता है।

मुख्य शब्द: विकास, अस्थिरता, अपघटन विश्लेषण, लाभप्रदता, रकबा प्रतिक्रिया समारोह

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APPENDIX I

AREA, PRODUCTION AND YIELD OF GROUNDNUT IN MAJOR DISTRICTS OF RAJASTHAN

YEAR	BIKANER			JODHPUR			CHURU			JAIPUR			JAISALMER		
	AREA (ha)	PROD (Tonne)	YIELD (Ton/ha)	AREA (ha)	PROD (Tonne)	YIELD (Ton/ha)	AREA (ha)	PROD (Tonne)	YIELD (Ton/ha)	AREA (ha)	PROD (Tonne)	YIELD (Ton/ha)	AREA (ha)	PROD (Tonne)	YIELD (Ton/ha)
2000-2001	**21871**	**28164**	**1.29**	**2854**	**2636**	**0.92**	**5485**	**7074**	**1.29**	**42187**	**45326**	**1.07**	**309**	**285**	**0.92**
2001-2002	**23866**	**31309**	**1.31**	**3741**	**4589**	**1.23**	**6178**	**9951**	**1.61**	**52191**	**67277**	**1.29**	**1546**	**1897**	**1.23**
2002-2003	**30861**	**19626**	**0.64**	**4843**	**6359**	**1.31**	**6866**	**6173**	**0.90**	**46839**	**42889**	**0.92**	**2057**	**1412**	**0.69**
2003-2004	**35095**	**66039**	**1.88**	**6147**	**10088**	**1.64**	**7730**	**18655**	**2.41**	**44740**	**76673**	**1.71**	**3311**	**5182**	**1.57**
2004-2005	**42229**	**77203**	**1.83**	**12318**	**23241**	**1.89**	**9501**	**16870**	**1.78**	**54951**	**105773**	**1.92**	**4728**	**7328**	**1.55**
2005-2006	**51987**	**74685**	**1.44**	**19971**	**36893**	**1.85**	**16431**	**30860**	**1.88**	**52842**	**97336**	**1.84**	**5767**	**8919**	**1.55**
2006-2007	**46251**	**74423**	**1.61**	**22966**	**39191**	**1.71**	**15199**	**30894**	**2.03**	**48843**	**78438**	**1.61**	**6085**	**7689**	**1.26**
2007-2008	**51292**	**109424**	**2.13**	**28869**	**47365**	**1.64**	**15839**	**32474**	**2.05**	**42069**	**83658**	**1.99**	**7298**	**12215**	**1.67**
2008-2009	**63143**	**110337**	**1.75**	**37639**	**66352**	**1.76**	**19214**	**52329**	**2.72**	**46231**	**87189**	**1.89**	**9215**	**10379**	**1.13**
2009-2010	**78547**	**65760**	**0.84**	**43892**	**53606**	**1.22**	**22664**	**29213**	**1.29**	**47016**	**58603**	**1.25**	**9241**	**8563**	**0.93**
2010-2011	**85189**	**229912**	**2.70**	**49084**	**75328**	**1.53**	**25245**	**44632**	**1.77**	**44801**	**91168**	**2.03**	**11221**	**16291**	**1.45**
2011-2012	**101429**	**255481**	**2.52**	**61761**	**114282**	**1.85**	**32892**	**73682**	**2.24**	**50905**	**101195**	**1.99**	**14246**	**17609**	**1.24**
2012-2013	**109215**	**215603**	**1.97**	**64222**	**76764**	**1.20**	**37562**	**50183**	**1.34**	**43879**	**74971**	**1.71**	**12659**	**10319**	**0.82**
2013-2014	**137139**	**307069**	**2.24**	**87173**	**190138**	**2.18**	**42674**	**93242**	**2.18**	**45159**	**89102**	**1.97**	**13559**	**18289**	**1.35**
2014-2015	**168927**	**412654**	**2.44**	**108822**	**217635**	**2.00**	**49705**	**100390**	**2.02**	**36080**	**68333**	**1.89**	**15406**	**17565**	**1.14**
2015-2016	**165547**	**402451**	**2.43**	**113442**	**267128**	**2.35**	**47163**	**101199**	**2.15**	**38207**	**57761**	**1.51**	**17286**	**31233**	**1.81**
2016-2017	**174945**	**467358**	**2.67**	**115447**	**198436**	**1.72**	**52509**	**134044**	**2.55**	**33412**	**60726**	**1.82**	**19790**	**26088**	**1.32**
2017-2018	**220552**	**514095**	**2.33**	**129423**	**241972**	**1.87**	**63452**	**144689**	**2.28**	**32185**	**54436**	**1.69**	**25665**	**42203**	**1.64**
2018-2019	**238858**	**531099**	**2.22**	**111784**	**214701**	**1.92**	**72915**	**178801**	**2.45**	**31080**	**65321**	**2.10**	**34474**	**55298**	**1.60**
2019-2020	**245062**	**529065**	**2.19**	**151579**	**402460**	**2.66**	**72692**	**165529**	**2.27**	**37379**	**83937**	**2.24**	**41216**	**77431**	**1.87**

APPENDIX II

AREA, PRODUCTION AND YIELD OF SESAMUM IN MAJOR DISTRICTS OF RAJASTHAN

YEAR	PALI			S MADHOPUR			JODHPUR			KARAULI			TONK		
	AREA (ha)	PROD (Tonne)	YIELD (Ton/ha)	AREA (ha)	PROD (Tonne)	YIELD (Ton/ha)	AREA (ha)	PROD (Tonne)	YIELD (Ton/ha)	AREA (ha)	PROD (Tonne)	YIELD (Ton/ha)	AREA (ha)	PROD (Tonne)	YIELD (Ton/ha)
2000-2001	**59806**	**4307**	**0.07**	**8262**	**1137**	**0.14**	**25752**	**719**	**0.03**	**4678**	**1611**	**0.34**	**4450**	**522**	**0.12**
2001-2002	**83676**	**26540**	**0.32**	**15543**	**5331**	**0.34**	**39319**	**15275**	**0.39**	**6066**	**774**	**0.13**	**9611**	**3011**	**0.31**
2002-2003	**50043**	**1224**	**0.02**	**9780**	**97**	**0.01**	**2266**	**153**	**0.07**	**4337**	**962**	**0.22**	**19051**	**404**	**0.02**
2003-2004	**92028**	**43819**	**0.48**	**14633**	**8751**	**0.60**	**34708**	**14981**	**0.43**	**3930**	**1849**	**0.47**	**12544**	**7662**	**0.61**
2004-2005	**148944**	**49832**	**0.33**	**12457**	**4924**	**0.40**	**38145**	**12291**	**0.32**	**9393**	**6023**	**0.64**	**25160**	**11608**	**0.46**
2005-2006	**154219**	**14487**	**0.09**	**9044**	**3838**	**0.42**	**44174**	**2118**	**0.05**	**6540**	**4013**	**0.61**	**16145**	**3206**	**0.20**
2006-2007	**84716**	**31635**	**0.37**	**9228**	**3581**	**0.39**	**24028**	**4443**	**0.18**	**8616**	**5849**	**0.68**	**9405**	**1721**	**0.18**
2007-2008	**79385**	**24429**	**0.31**	**29110**	**16581**	**0.57**	**30486**	**13389**	**0.44**	**14250**	**10120**	**0.71**	**17740**	**7297**	**0.41**
2008-2009	**141969**	**31594**	**0.22**	**39125**	**15777**	**0.40**	**43562**	**10482**	**0.24**	**11093**	**7749**	**0.7**	**47502**	**18142**	**0.38**
2009-2010	**146665**	**2021**	**0.01**	**61356**	**20629**	**0.34**	**36066**	**360**	**0.01**	**28756**	**17145**	**0.6**	**72821**	**6736**	**0.09**
2010-2011	**107074**	**47049**	**0.44**	**32523**	**11119**	**0.34**	**29577**	**12666**	**0.43**	**17723**	**8332**	**0.47**	**41855**	**16021**	**0.38**
2011-2012	**133084**	**43066**	**0.32**	**29546**	**10644**	**0.36**	**44048**	**19091**	**0.43**	**24890**	**12360**	**0.5**	**38059**	**11352**	**0.30**
2012-2013	**108938**	**33909**	**0.31**	**33648**	**15364**	**0.46**	**33777**	**5027**	**0.15**	**24839**	**9529**	**0.38**	**28989**	**6848**	**0.24**
2013-2014	**123353**	**20792**	**0.17**	**19204**	**9047**	**0.47**	**37444**	**5001**	**0.13**	**14061**	**5110**	**0.36**	**15045**	**2635**	**0.18**
2014-2015	**107502**	**36576**	**0.34**	**15704**	**7805**	**0.50**	**35994**	**14794**	**0.41**	**12165**	**6408**	**0.53**	**9090**	**1746**	**0.19**
2015-2016	**92359**	**25755**	**0.28**	**40061**	**20785**	**0.52**	**39765**	**17266**	**0.43**	**21802**	**9844**	**0.45**	**10593**	**3800**	**0.36**
2016-2017	**66344**	**21741**	**0.33**	**27835**	**12930**	**0.46**	**28548**	**10118**	**0.35**	**14186**	**7831**	**0.55**	**11232**	**3905**	**0.35**
2017-2018	**64162**	**12498**	**0.19**	**25537**	**9874**	**0.39**	**21036**	**9106**	**0.43**	**14524**	**6951**	**0.48**	**7358**	**3215**	**0.44**
2018-2019	**50390**	**21232**	**0.42**	**28650**	**11450**	**0.40**	**23462**	**9112**	**0.39**	**17609**	**7725**	**0.44**	**10209**	**5123**	**0.50**
2019-2020	**57748**	**16767**	**0.29**	**33763**	**12794**	**0.37**	**16750**	**7351**	**0.43**	**21652**	**8613**	**0.39**	**25652**	**7227**	**0.28**

APPENDIX III

AREA, PRODUCTION AND YIELD OF SOYBEAN IN MAJOR DISTRICTS OF RAJASTHAN

YEAR	JHALAWAR			BARAN			KOTA			BANSWARA			CHITTORGARH		
	AREA (ha)	PROD (Tonne)	YIELD (Ton/ha)	AREA (ha)	PROD (Tonne)	YIELD (Ton/ha)	AREA (ha)	PROD (Tonne)	YIELD (Ton/ha)	AREA (ha)	PROD (Tonne)	YIELD (Ton/ha)	AREA (ha)	PROD (Tonne)	YIELD (Ton/ha)
2000-2001	**213375**	**113288**	**0.53**	**149286**	**120467**	**0.81**	**136279**	**129419**	**0.95**	**10853**	**6673**	**0.61**	**116607**	**58671**	**0.50**
2001-2002	**201963**	**220363**	**1.09**	**138359**	**155254**	**1.12**	**145228**	**162046**	**1.12**	**9435**	**12418**	**1.32**	**112641**	**107533**	**0.95**
2002-2003	**152994**	**76203**	**0.50**	**66317**	**17766**	**0.27**	**85161**	**28325**	**0.33**	**8354**	**14746**	**1.77**	**108518**	**81823**	**0.75**
2003-2004	**138602**	**165239**	**1.19**	**91351**	**124456**	**1.36**	**105505**	**169816**	**1.61**	**8126**	**13099**	**1.61**	**101837**	**151292**	**1.49**
2004-2005	**189406**	**262696**	**1.39**	**120487**	**229364**	**1.90**	**118412**	**189518**	**1.60**	**13449**	**15323**	**1.14**	**135087**	**135094**	**1.00**
2005-2006	**205629**	**211684**	**1.03**	**147486**	**197760**	**1.34**	**127319**	**167733**	**1.32**	**15879**	**15149**	**0.95**	**163364**	**150559**	**0.92**
2006-2007	**203288**	**243222**	**1.20**	**121157**	**174412**	**1.44**	**75361**	**98649**	**1.31**	**17704**	**14654**	**0.83**	**152465**	**136564**	**0.90**
2007-2008	**224695**	**310310**	**1.38**	**200166**	**270066**	**1.35**	**124405**	**196773**	**1.58**	**22411**	**25011**	**1.12**	**140057**	**157016**	**1.12**
2008-2009	**236786**	**229662**	**0.97**	**208708**	**191400**	**0.92**	**132164**	**111617**	**0.84**	**23953**	**16776**	**0.70**	**45702**	**56526**	**1.24**
2009-2010	**243664**	**293778**	**1.21**	**194417**	**224344**	**1.15**	**122293**	**145587**	**1.19**	**18958**	**15404**	**0.81**	**37171**	**36688**	**0.99**
2010-2011	**240086**	**316766**	**1.32**	**195086**	**357107**	**1.83**	**112195**	**153568**	**1.37**	**19030**	**18316**	**0.96**	**36315**	**46432**	**1.28**
2011-2012	**252058**	**390504**	**1.55**	**234324**	**444702**	**1.90**	**147002**	**220682**	**1.50**	**20429**	**15455**	**0.76**	**48686**	**73574**	**1.51**
2012-2013	**271071**	**381933**	**1.41**	**276189**	**429819**	**1.56**	**186413**	**255065**	**1.37**	**21857**	**22829**	**1.04**	**66748**	**98986**	**1.48**
2013-2014	**288591**	**176397**	**0.61**	**307778**	**224034**	**0.73**	**219751**	**207242**	**0.94**	**27421**	**32396**	**1.18**	**93166**	**79958**	**0.86**
2014-2015	**251582**	**251230**	**1.00**	**121694**	**116008**	**0.95**	**143423**	**137311**	**0.96**	**39542**	**33399**	**0.84**	**116883**	**145787**	**1.25**
2015-2016	**266385**	**140960**	**0.53**	**274452**	**155787**	**0.57**	**194333**	**145442**	**0.75**	**50018**	**42936**	**0.86**	**144034**	**79678**	**0.55**
2016-2017	**219284**	**228049**	**1.04**	**236449**	**246590**	**1.04**	**164981**	**167544**	**1.02**	**61824**	**84552**	**1.37**	**118320**	**96155**	**0.81**
2017-2018	**209395**	**282412**	**1.35**	**154298**	**209806**	**1.36**	**120764**	**150550**	**1.25**	**69136**	**82284**	**1.19**	**116618**	**96677**	**0.83**
2018-2019	**220071**	**271821**	**1.24**	**185895**	**229651**	**1.24**	**127923**	**150568**	**1.18**	**69412**	**80459**	**1.16**	**106073**	**139384**	**1.31**
2019-2020	**248623**	**68954**	**0.27**	**250359**	**134466**	**0.53**	**180334**	**115752**	**0.64**	**75416**	**57025**	**0.75**	**102675**	**42847**	**0.41**

APPENDIX IV

AREA, PRODUCTION AND YIELD OF RAPESEED AND MUSTARD IN MAJOR DISTRICTS OF RAJASTHAN

YEAR	ALWARA			TONK			BHARATPUR			GANGANAGAR			JODHPUR		
	AREA (ha)	PROD (Tonne)	YIELD (Ton/ha)	AREA (ha)	PROD (Tonne)	YIELD (Ton/ha)	AREA (ha)	PROD (Tonne)	YIELD (Ton/ha)	AREA (ha)	PROD (Tonne)	YIELD (Ton/ha)	AREA (ha)	PROD (Tonne)	YIELD (Ton/ha)
2000-2001	**184547**	**216932**	**1.18**	**102307**	**76134**	**0.74**	**124648**	**145965**	**1.17**	**145463**	**141994**	**0.98**	**36730**	**34100**	**0.93**
2001-2002	**217687**	**276642**	**1.27**	**101544**	**62855**	**0.62**	**189985**	**199629**	**1.05**	**230184**	**295139**	**1.28**	**41948**	**43698**	**1.04**
2002-2003	**192422**	**145791**	**0.76**	**12598**	**11409**	**0.91**	**193748**	**201492**	**1.04**	**235133**	**256154**	**1.09**	**30723**	**34005**	**1.11**
2003-2004	**220253**	**336910**	**1.53**	**91331**	**87847**	**0.96**	**193092**	**281972**	**1.46**	**259695**	**404003**	**1.56**	**48964**	**58513**	**1.20**
2004-2005	**293746**	**365872**	**1.25**	**274225**	**263273**	**0.96**	**236816**	**297498**	**1.26**	**390577**	**382987**	**0.98**	**66415**	**95357**	**1.44**
2005-2006	**290252**	**305392**	**1.05**	**296889**	**298267**	**1.00**	**241978**	**310435**	**1.28**	**297139**	**427207**	**1.44**	**91212**	**111607**	**1.22**
2006-2007	**257183**	**356719**	**1.39**	**180757**	**146677**	**0.81**	**210319**	**281294**	**1.34**	**298668**	**407458**	**1.36**	**86295**	**98633**	**1.14**
2007-2008	**234517**	**285842**	**1.22**	**162829**	**132748**	**0.82**	**192125**	**242464**	**1.26**	**263838**	**150220**	**0.57**	**85165**	**79203**	**0.93**
2008-2009	**269865**	**448122**	**1.66**	**240420**	**221329**	**0.92**	**223223**	**366371**	**1.64**	**231071**	**368312**	**1.59**	**91805**	**99212**	**1.08**
2009-2010	**251375**	**392953**	**1.56**	**173695**	**133548**	**0.77**	**200126**	**346158**	**1.73**	**212656**	**313417**	**1.47**	**74197**	**94360**	**1.27**
2010-2011	**252730**	**426074**	**1.69**	**181304**	**277740**	**1.53**	**202688**	**374189**	**1.85**	**281408**	**565310**	**2.01**	**78487**	**85521**	**1.09**
2011-2012	**264822**	**339114**	**1.28**	**239290**	**318480**	**1.33**	**208018**	**340983**	**1.64**	**272238**	**287862**	**1.06**	**63350**	**85417**	**1.35**
2012-2013	**245516**	**383065**	**1.56**	**266482**	**385847**	**1.45**	**231278**	**377518**	**1.63**	**257010**	**378557**	**1.47**	**79784**	**80331**	**1.01**
2013-2014	**238293**	**350841**	**1.47**	**281439**	**413342**	**1.47**	**211103**	**307524**	**1.46**	**215406**	**338547**	**1.57**	**118103**	**134907**	**1.14**
2014-2015	**230660**	**318464**	**1.38**	**299060**	**280283**	**0.94**	**196515**	**273312**	**1.39**	**193620**	**272176**	**1.41**	**104633**	**103579**	**0.99**
2015-2016	**234421**	**340282**	**1.45**	**250912**	**310197**	**1.24**	**203222**	**309039**	**1.52**	**239948**	**365583**	**1.52**	**119204**	**130677**	**1.10**
2016-2017	**229719**	**446945**	**1.95**	**244217**	**409669**	**1.68**	**201285**	**390285**	**1.94**	**230496**	**347483**	**1.51**	**143639**	**168378**	**1.17**
2017-2018	**229013**	**468873**	**2.05**	**186641**	**296762**	**1.59**	**200016**	**384758**	**1.92**	**198714**	**344348**	**1.73**	**149410**	**196458**	**1.31**
2018-2019	**250197**	**534464**	**2.14**	**270128**	**444994**	**1.65**	**218330**	**485598**	**2.22**	**247699**	**463200**	**1.87**	**170793**	**232367**	**1.36**
2019-2020	**265693**	**492851**	**1.85**	**282446**	**485077**	**1.71**	**245203**	**403110**	**1.64**	**231954**	**380720**	**1.64**	**176250**	**251147**	**1.42**

APPENDIX V

COSTS AND RETURNS OF SESAMUM IN RAJASTHAN

YEAR	SESAMUM			(Rupees/ hectare)	
	Value of Main Product	Value of by Product	Cost A2	Cost C2	Gross Returns
2000-2001	**3753.22**	**72.45**	**1347.05**	**5047.6**	**3825.67**
2001-2002	**5123.24**	**124.34**	**1491.11**	**5146.82**	**5247.58**
2002-2003	**2847.8**	**125.12**	**1463.11**	**5315.39**	**2972.92**
2003-2004	**10387.28**	**174.85**	**1655.32**	**6902.07**	**10562.13**
2004-2005	**11721.74**	**148.46**	**1863.30**	**6814.34**	**11870.2**
2005-2006	**5778.96**	**89.88**	**1818.76**	**12207.25**	**5868.84**
2006-2007	**7608.00**	**158.61**	**1738.87**	**6419.41**	**7766.61**
2007-2008	**13869.10**	**270.82**	**2487.83**	**8809.91**	**14139.92**
2008-2009	**16298.60**	**296.07**	**2954.06**	**9384.38**	**16594.67**
2009-2010	**15600.65**	**561.98**	**2283.31**	**10370.65**	**16162.63**
2010-2011	**15478.41**	**426.02**	**2622.35**	**2622.35**	**15904.43**
2011-2012	**15158.96**	**541.25**	**4924.11**	**15690.09**	**15700.21**
2012-2013	**17187.72**	**425.29**	**5492.25**	**14718.32**	**17613.01**
2013-2014	**19013.14**	**308.93**	**5071.6**	**15088.21**	**19322.07**
2014-2015	**30113.02**	**460.47**	**8327.56**	**27066.84**	**30573.49**
2015-2016	**15313.26**	**585.26**	**4847.82**	**16840.30**	**15898.52**
2016-2017	**18269.32**	**639.57**	**5211.91**	**22167.92**	**18908.89**
2017-2018	**16509.11**	**504.78**	**7574.61**	**23722.338**	**17013.89**

APPENDIX VI

COSTS AND RETURNS OF SOYBEAN IN RAJASTHAN

YEAR	SOYBEAN			(Rupees/ hectare)	
	Value of Main Product	Value of by Product	Cost A2	Cost C2	Gross Returns
2000-2001	**7266.41**	**909.17**	**4295.96**	**7432.03**	**8175.58**
2001-2002	**7711.8**	**891.03**	**5203.77**	**8640.63**	**8602.83**
2002-2003	**6941.27**	**963.87**	**5384.04**	**9892.76**	**7905.14**
2003-2004	**14042.27**	**832.59**	**5416.59**	**10498.09**	**14874.86**
2004-2005	**12953.14**	**1448.84**	**5747.58**	**10268.42**	**14401.98**
2005-2006	**12585.13**	**1045.87**	**6412.94**	**11380.87**	**13631**
2006-2007	**17672.55**	**1787.64**	**7300.40**	**13164.21**	**19460.19**
2007-2008	**19224.72**	**929.55**	**7635.58**	**14200.63**	**20154.27**
2008-2009	**17503.32**	**1191.18**	**8871.47**	**15761.59**	**18694.5**
2009-2010	**16129.25**	**1884.98**	**10869.25**	**17276.71**	**18014.23**
2010-2011	**18412.58**	**1901.88**	**8125.02**	**19519.55**	**20314.46**
2011-2012	**29143.62**	**1799.97**	**8787.31**	**19691.81**	**30943.59**
2012-2013	**41553.29**	**2065.18**	**13451.29**	**26172.15**	**43618.47**
2013-2014	**21376.12**	**1349.96**	**14233.59**	**24482.51**	**22726.08**
2014-2015	**23754.69**	**1765.53**	**17350.91**	**29402.36**	**25520.22**
2015-2016	**24659.8**	**1752.5**	**16528.07**	**30798.06**	**26412.3**
2016-2017	**24713.04**	**2138.07**	**15630.15**	**30107.35**	**26851.11**
2017-2018	**31303.86**	**2438.85**	**14767.84**	**28066.71**	**33742.71**

APPENDIX VII

COSTS AND RETURNS OF RAPESEED AND MUSTARD IN RAJASTHAN

YEAR	RAPESEED AND MUSTARD (Rupees/ hectare)				
	Value of Main Product	Value of by Product	Cost A2	Cost C2	Gross Returns
2000-2001	**15568.37**	**151.52**	**4874.37**	**11919.88**	**15719.89**
2001-2002	**16076.15**	**161.69**	**5174.62**	**11192.83**	**16237.84**
2002-2003	**24563.81**	**360.62**	**6119.05**	**14822.69**	**24924.43**
2003-2004	**26568.78**	**393.14**	**5405.5**	**13585.61**	**26961.92**
2004-2005	**21456.18**	**492.16**	**5745.57**	**12766.04**	**21948.34**
2005-2006	**20801.68**	**739.32**	**6215.50**	**13506.41**	**21541**
2006-2007	**25009.62**	**835.99**	**6681.84**	**15059.18**	**25845.61**
2007-2008	**31124.97**	**1180.62**	**6970.55**	**16892.29**	**32305.59**
2008-2009	**28925.23**	**1811.21**	**7924.47**	**19497.66**	**30736.44**
2009-2010	**31248.99**	**2284.96**	**7811.19**	**20854.88**	**33533.95**
2010-2011	**35281.54**	**2167.21**	**7455.36**	**21172.54**	**37448.75**
2011-2012	**43822.46**	**2609.94**	**9913.52**	**28041.38**	**46432.4**
2012-2013	**45249.87**	**2327.31**	**12499.72**	**31256.29**	**47577.18**
2013-2014	**41192.04**	**2647.04**	**13928.24**	**33142.03**	**43839.08**
2014-2015	**42794.75**	**3138.98**	**13900.01**	**35713.61**	**45933.73**
2015-2016	**47145.78**	**2983.41**	**15805.97**	**40982.23**	**50129.19**
2016-2017	**59822.31**	**3277.02**	**15210.68**	**43602.36**	**63099.33**
2017-2018	**69811.28**	**3384.84**	**21746.68**	**52711.81**	**73196.12**

APPENDIX VIII

CORRELATION MATRIX OF ACREAGE BETWEEN CROPS (2000-01 TO 2019-20)

	Arhar/Tur	*Bajra*	*Barley*	*Gram*	*Jowar*	*Maize*	*Moong*	*Rice*	*Urad*	*Wheat*	*Groundnut*	*Sesamum*	*Soybean*	*R&M*
Arhar/Tur	1													
Bajra	0.5494	1												
Barley	-0.347	-0.17	1											
Gram	-0.515	0.048	0.626	1										
Jowar	0.3066	0.499	0.103	-0.052	1									
Maize	0.7017	0.747	-0.24	-0.282	0.49	1								
Moong	-0.695	-0.24	0.296	0.6926	-0.34	-0.6002	1							
Rice	-0.525	-0.28	0.432	0.5587	-0.1	-0.6985	0.793	1						
Urad	-0.667	-0.41	0.123	0.4544	-0.47	-0.6903	0.891	0.7	1					
Wheat	-0.575	-0.27	0.814	0.7534	0.02	-0.5426	0.662	0.8	0.467	1				
Groundnut	**-0.838**	-0.44	0.527	0.7286	-0.31	-0.7509	0.906	0.8	0.799	0.82	1			
Sesamum	0.2602	0.523	0.213	0.0608	0.28	0.60458	-0.26	-0.2	**-0.47**	-0.05	-0.2	1		
Soybean	-0.592	-0.34	0.691	0.6315	-0.14	**-0.6021**	0.574	0.7	0.362	0.86	0.77	0	1	
R&M	-0.257	0.107	0.071	0.3051	-0.14	0.00797	0.129	-0.1	-0.08	**0.1**	0.2	0	0.23	1

APPENDIX IX

DATA OF ACREAGE RESPONSIVE FACTORS OF GROUNDNUT IN RAJASTHAN

YEAR	GROUNDNUT												
	Area in current Year (ha)	Lagged Area (ha)	Yield (tonne/ ha)	Lagged Yield (tonne/ ha)	Irrigated Area (ha)	Lagged Irrigated Area (ha)	Rainfall (cm)	Lagged Rainfall (cm)	Lagged Price (Rupees)	Lagged Price of competing crop (Arhar) (Rupees)	Lagged Yield of Competing Crop (Arhar) (tonne/ha)	SD yield	SD price
2000-2001	**195739**	**274691**	**0.92**	**0.97**	**82000**	**97055**	**41.64**	**50.65**	**1289**	**1291**	**0.61**	**0.09**	**53.74**
2001-2002	**242627**	**195739**	**1.23**	**0.92**	**101000**	**82000**	**57.43**	**41.64**	**1358**	**1208.95**	**0.38**	**0.09**	**42.00**
2002-2003	**241832**	**242627**	**0.69**	**1.23**	**118000**	**101000**	**26.71**	**57.43**	**1255**	**1498.06**	**0.58**	**0.17**	**52.48**
2003-2004	**212040**	**241832**	**1.57**	**0.69**	**115000**	**118000**	**60.47**	**26.71**	**1550**	**1996**	**0.24**	**0.27**	**149.72**
2004-2005	**290032**	**212040**	**1.55**	**1.57**	**170000**	**115000**	**55.45**	**60.47**	**1589**	**1527**	**0.81**	**0.44**	**182.62**
2005-2006	**320765**	**290032**	**1.55**	**1.55**	**227000**	**170000**	**56.53**	**55.45**	**1662**	**1749**	**0.75**	**0.50**	**56.85**
2006-2007	**306037**	**320765**	**1.3**	**1.55**	**204000**	**227000**	**72.79**	**56.53**	**1626**	**2252**	**0.65**	**0.01**	**36.50**
2007-2008	**276345**	**306037**	**1.72**	**1.3**	**199271**	**204000**	**52.33**	**72.79**	**1955**	**2163**	**0.5**	**0.14**	**180.46**
2008-2009	**324209**	**276345**	**1.67**	**1.72**	**228002**	**199271**	**55.52**	**52.33**	**2315**	**2336**	**0.88**	**0.21**	**344.62**
2009-2010	**336177**	**324209**	**1.05**	**1.67**	**241882**	**228002**	**43.66**	**55.52**	**2154**	**3669**	**0.77**	**0.23**	**180.33**
2010-2011	**349331**	**336177**	**1.97**	**1.05**	**266915**	**241882**	**69.66**	**43.66**	**2750**	**3687**	**0.38**	**0.37**	**308.32**
2011-2012	**418110**	**349331**	**1.93**	**1.97**	**316644**	**266915**	**71.99**	**69.66**	**2586**	**3445**	**0.76**	**0.47**	**307.88**
2012-2013	**402252**	**418110**	**1.55**	**1.93**	**318421**	**316644**	**50.38**	**71.99**	**3274**	**3382**	**0.67**	**0.52**	**359.35**
2013-2014	**466313**	**402252**	**1.95**	**1.55**	**380232**	**318421**	**58.36**	**50.38**	**4444**	**3504**	**0.88**	**0.23**	**939.36**
2014-2015	**504519**	**466313**	**2.02**	**1.95**	**441966**	**380232**	**48.28**	**58.36**	**3448**	**4008**	**0.65**	**0.23**	**631.29**
2015-2016	**520824**	**504519**	**2.03**	**2.02**	**451971**	**441966**	**47.39**	**48.28**	**3740**	**4424**	**0.74**	**0.25**	**512.01**
2016-2017	**561088**	**520824**	**2.05**	**2.03**	**488869**	**451971**	**60.35**	**47.39**	**3878**	**6425**	**0.55**	**0.04**	**219.55**
2017-2018	**646154**	**561088**	**1.95**	**2.05**	**565267**	**488869**	**46.4**	**60.35**	**4127**	**4379**	**1.09**	**0.02**	**196.14**
2018-2019	**673366**	**646154**	**2.05**	**1.95**	**587510**	**565267**	**43.13**	**46.4**	**3716**	**4050**	**1.02**	**0.05**	**207.03**
2019-2020	**739022**	**673366**	**2.19**	**2.05**		**587510**	**65.76**	**43.13**	**4890**	**5675**	**0.94**	**0.06**	**595.73**

APPENDIX X

DATA OF ACREAGE RESPONSIVE FACTORS OF SESAMUM IN RAJASTHAN

YEAR	SESAMUM											
	Area in current Year (ha)	Lagged Area (ha)	Yield (tonne/ha)	Lagged Yield (tonne/ ha)	Irrigated Area (ha)	Lagged Irrigated Area (ha)	Rainfall (cm)	Lagged Rainfall (cm)	Lagged Price (Rupees)	Lagged Yield Of Competing Crop (Urad) (tonne/ha)	SD Yield	SD Price
2000-2001	231605	212356	0.14	0.07	4000	6516	41.64	50.65	2283	0.28	0.08	34.65
2001-2002	316355	231605	0.33	0.14	11000	4000	57.43	41.64	1728	0.29	0.04	335.47
2002-2003	190479	316355	0.06	0.33	9000	11000	26.71	57.43	1756	0.36	0.13	312.66
2003-2004	311818	190479	0.45	0.06	4000	9000	60.47	26.71	2222	0.18	0.14	277.48
2004-2005	446695	311818	0.33	0.45	6000	4000	55.45	60.47	2717	0.52	0.20	480.57
2005-2006	422079	446695	0.15	0.33	9000	6000	56.53	55.45	3085	0.36	0.20	433.05
2006-2007	273345	422079	0.32	0.15	11000	9000	72.79	56.53	2747	0.25	0.15	204.36
2007-2008	314873	273345	0.4	0.32	4892	11000	52.33	72.79	2927	0.29	0.10	169.12
2008-2009	521210	314873	0.29	0.4	15403	4892	55.52	52.33	3840	0.53	0.13	586.03
2009-2010	598318	521210	0.16	0.29	9106	15403	43.66	55.52	5551	0.3	0.06	1332.07
2010-2011	548011	598318	0.41	0.16	7603	9106	69.66	43.66	5814	0.26	0.12	1071.86
2011-2012	512766	548011	0.32	0.41	3940	7603	71.99	69.66	5091	0.74	0.13	365.95
2012-2013	415128	512766	0.29	0.32	1866	3940	50.38	71.99	5184	0.52	0.13	393.34
2013-2014	360654	415128	0.2	0.29	1530	1866	58.36	50.38	8191	0.57	0.06	1763.55
2014-2015	330027	360654	0.34	0.2	3362	1530	48.28	58.36	10386	0.36	0.06	2611.54
2015-2016	366780	330027	0.31	0.34	8469	3362	47.39	48.28	9429	0.56	0.07	1100.49
2016-2017	266976	366780	0.35	0.31	7245	8469	60.35	47.39	7046	0.38	0.07	1719.99
2017-2018	251952	266976	0.27	0.35	6132	7245	46.4	60.35	6649	0.64	0.02	1503.59
2018-2019	242271	251952	0.35	0.27	9411	6132	43.13	46.4	6829	0.62	0.04	198.79
2019-2020	279695	242271	0.32	0.35		9411	65.76	43.13	6249	0.5	0.05	296.87

APPENDIX XI

DATA OF ACREAGE RESPONSIVE FACTORS SOYBEAN IN RAJASTHAN

YEAR	SOYBEAN										
	Area in current Year (ha)	Lagged Area (ha)	Yield (tonne/ha)	Lagged Yield (tonne/ ha)	Irrigated Area (ha)	Lagged Irrigated Area (ha)	Rainfall (cm)	Lagged Rainfall (cm)	Lagged Price of Competing Crop (Maize) (Rupees)	Lagged Yield Of Competing Crop (Maize) (tonne/ha)	SD Yield
2000-2001	**659250**	**492406**	**0.69**	**1.22**	**18000**	**13728**	**41.64**	**50.65**	**515**	**1.04**	**0.05**
2001-2002	**655916**	**659250**	**1.09**	**0.69**	**50000**	**18000**	**57.43**	**41.64**	**521**	**1.05**	**0.33**
2002-2003	**471650**	**655916**	**0.5**	**1.09**	**3000**	**50000**	**26.71**	**57.43**	**438**	**1.45**	**0.27**
2003-2004	**493907**	**471650**	**1.4**	**0.5**	**2000**	**3000**	**60.47**	**26.71**	**588**	**0.88**	**0.30**
2004-2005	**621904**	**493907**	**1.43**	**1.4**	**46000**	**2000**	**55.45**	**60.47**	**469**	**1.86**	**0.45**
2005-2006	**744304**	**621904**	**1.15**	**1.43**	**85000**	**46000**	**56.53**	**55.45**	**535**	**1.21**	**0.52**
2006-2007	**641114**	**744304**	**1.2**	**1.15**	**33000**	**85000**	**72.79**	**56.53**	**569**	**1.1**	**0.15**
2007-2008	**797657**	**641114**	**1.34**	**1.2**	**57264**	**33000**	**52.33**	**72.79**	**751**	**1.08**	**0.14**
2008-2009	**829468**	**797657**	**0.97**	**1.34**	**27270**	**57264**	**55.52**	**52.33**	**787**	**1.86**	**0.09**
2009-2010	**778372**	**829468**	**1.18**	**0.97**	**5462**	**27270**	**43.66**	**55.52**	**752**	**1.74**	**0.18**
2010-2011	**765499**	**778372**	**1.46**	**1.18**	**3513**	**5462**	**69.66**	**43.66**	**968**	**1.04**	**0.18**
2011-2012	**897072**	**765499**	**1.54**	**1.46**	**107207**	**3513**	**71.99**	**69.66**	**949**	**1.8**	**0.24**
2012-2013	**1039838**	**897072**	**1.41**	**1.54**	**2441**	**107207**	**50.38**	**71.99**	**1028**	**1.58**	**0.18**
2013-2014	**1175502**	**1039838**	**0.83**	**1.41**	**4716**	**2441**	**58.36**	**50.38**	**1147**	**1.88**	**0.06**
2014-2015	**923205**	**1175502**	**1.04**	**0.83**	**3954**	**4716**	**48.28**	**58.36**	**1268**	**1.59**	**0.37**
2015-2016	**1204807**	**923205**	**0.67**	**1.04**	**19981**	**3954**	**47.39**	**48.28**	**1285**	**1.73**	**0.29**
2016-2017	**1055627**	**1204807**	**1.07**	**0.67**	**3368**	**19981**	**60.35**	**47.39**	**1422**	**1.31**	**0.18**
2017-2018	**886496**	**1055627**	**1.21**	**1.07**	**2997**	**3368**	**46.4**	**60.35**	**1511**	**1.5**	**0.22**
2018-2019	**931913**	**886496**	**1.25**	**1.21**	**519**	**2997**	**43.13**	**46.4**	**1294**	**2.03**	**0.28**
2019-2020	**1118568**	**931913**	**0.46**	**1.25**		**519**	**65.76**	**43.13**	**1700**	**2.23**	**0.09**

APPENDIX XII

DATA OF ACREAGE RESPONSIVE FACTORS RAPESEED AND MUSTARD IN RAJASTHAN

YEAR	RAPESEED AND MUSTARD												
	Area in current Year (ha)	Lagged Area (ha)	Yield (tonne/ ha)	Lagged Yield (tonne/ ha)	Irrigated Area (ha)	Lagged Irrigated Area (ha)	Rainfall (cm)	Lagged Rainfall (cm)	Lagged Price (Rupees)	Lagged Price of competing crop (Arhar) (Rupees)	Lagged Yield of Competing Crop (Arhar) (tonne/ha)	SD yield	SD price
2000-2001	**1403063**	**2568578**	**0.93**	**0.97**	**1129000**	**1781721**	**41.64**	**50.65**	**1224**	**1291**	**0.61**	**0.14**	**18.38**
2001-2002	**1840774**	**1403063**	**1.06**	**0.93**	**1505000**	**1129000**	**57.43**	**41.64**	**1424**	**1208.95**	**0.38**	**0.02**	**108.74**
2002-2003	**1517909**	**1840774**	**0.87**	**1.06**	**1105000**	**1505000**	**26.71**	**57.43**	**1285**	**1498.06**	**0.58**	**0.07**	**102.50**
2003-2004	**2062722**	**1517909**	**1.31**	**0.87**	**1804000**	**1105000**	**60.47**	**26.71**	**1749**	**1996**	**0.24**	**0.10**	**238.13**
2004-2005	**3681523**	**2062722**	**1.08**	**1.31**	**2702000**	**1804000**	**55.45**	**60.47**	**1872**	**1527**	**0.81**	**0.22**	**309.57**
2005-2006	**3665674**	**3681523**	**1.2**	**1.08**	**2936000**	**2702000**	**56.53**	**55.45**	**1563**	**1749**	**0.75**	**0.22**	**155.57**
2006-2007	**3211687**	**3665674**	**1.18**	**1.2**	**2693000**	**2936000**	**72.79**	**56.53**	**1499**	**2252**	**0.65**	**0.12**	**199.46**
2007-2008	**2458197**	**3211687**	**0.96**	**1.18**	**2196676**	**2693000**	**52.33**	**72.79**	**1766**	**2163**	**0.5**	**0.06**	**139.40**
2008-2009	**2737998**	**2458197**	**1.27**	**0.96**	**2351184**	**2196676**	**55.52**	**52.33**	**2451**	**2336**	**0.88**	**0.13**	**491.06**
2009-2010	**2212357**	**2737998**	**1.32**	**1.27**	**1854831**	**2351184**	**43.66**	**55.52**	**2297**	**3669**	**0.77**	**0.16**	**359.37**
2010-2011	**2489892**	**2212357**	**1.56**	**1.32**	**1968044**	**1854831**	**69.66**	**43.66**	**2305**	**3687**	**0.38**	**0.20**	**86.69**
2011-2012	**2441254**	**2489892**	**1.21**	**1.56**	**2075428**	**1968044**	**71.99**	**69.66**	**2356**	**3445**	**0.76**	**0.16**	**32.01**
2012-2013	**2724956**	**2441254**	**1.38**	**1.21**	**2438614**	**2075428**	**50.38**	**71.99**	**3322**	**3382**	**0.67**	**0.18**	**573.01**
2013-2014	**2782539**	**2724956**	**1.3**	**1.38**	**2436625**	**2438614**	**58.36**	**50.38**	**3208**	**3504**	**0.88**	**0.18**	**527.90**
2014-2015	**2433773**	**2782539**	**1.18**	**1.3**	**2192592**	**2436625**	**48.28**	**58.36**	**3166**	**4008**	**0.65**	**0.09**	**80.72**
2015-2016	**2532330**	**2433773**	**1.29**	**1.18**	**2364855**	**2192592**	**47.39**	**48.28**	**3492**	**4424**	**0.74**	**0.10**	**177.34**
2016-2017	**2503284**	**2532330**	**1.52**	**1.29**	**2322211**	**2364855**	**60.35**	**47.39**	**3826**	**6425**	**0.55**	**0.07**	**330.01**
2017-2018	**2183056**	**2503284**	**1.61**	**1.52**	**2074768**	**2322211**	**46.4**	**60.35**	**3540**	**4379**	**1.09**	**0.17**	**180.58**
2018-2019	**2765251**	**2183056**	**1.73**	**1.61**	**2626174**	**2074768**	**43.13**	**46.4**	**3584**	**4050**	**1.02**	**0.17**	**154.00**
2019-2020	**2712609**	**2765251**	**1.58**	**1.73**		**2626174**	**65.76**	**43.13**	**4200**	**5675**	**0.94**	**0.11**	**369.01**