

**“MAPPING AND SEGMENTATION OF THE MUSTARD GROWING
AREAS FOR INTRODUCTION OF RIGHT PRODUCTS”**

BY

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**“Mapping and Segmentation of the Mustard Growing Areas
for Introduction of Right Products”**

A

PROJECT REPORT

Submitted by

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OF

Dr. Y.C. ZALA

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CERTIFICATE

This is to certify that the project entitled “*Mapping and Segmentation of the Mustard Growing Areas for Introduction of Right Products*” submitted by Pushpendra Kumar Gupta in partial fulfilment of requirements for the award of the degree of Master of Business Administration (M.B.A) in International Agribusiness Management Institute of Anand Agricultural University is a record of bonfide research work carried out by him under my guidance and supervision and the project work has not been previously submitted for the award of any degree, diploma or other similar title.

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“Mapping and Segmentation of the Mustard Growing Areas for Introduction of Right Products”

ABSTRACT

Rapeseed-Mustard is an important group of edible oilseed in India and ranks second after soybean. India is one of the largest producer of oilseeds in the world and this sub-sector occupies an important position in the agricultural economy. Oilseeds are grown mostly under rainfed conditions and important for the livelihood of small and marginal farmers in arid and semi-arid areas of the country. The production of oilseeds was increased from 24.35 million tonnes in 2004-05 to 25.30 million tonnes in 2015-16. The yield of oilseeds, which was 885 kg per hectare in 2004-05 increased to 968 kg per hectare in 2015-16.

The objectives of the study were ; (i) To study the mustard cultivation in important states of India, crop business opportunity and agro climatic zones segmentation, (ii) To map Must have traits and Good to have traits in mustard seeds based on agro climatic zones / state wise / cluster wise, (iii) To define segment-wise opportunity and ideal product requirement for future product development, (iv) To conduct competitors analysis with respect to 4Ps, (v) To study Rasi channel preparedness for mustard business, channel gap and strength.

The primary data were collected from 250 mustard growers, 200 distributor of seeds, and 10 company personnel. The secondary data were collected from every district revenue office and agricultural office in the study area. Furthermore, some trader were also contacted for discussion regarding the auctioning of mustard oilseed. The data were recorded on pretested semi-structured schedule and questionnaire. The field observations

of mustard crop were taken throughout the study to get more profound knowledge on biotic and abiotic stress associated with the crop.

The cultivation practices of the farmers varies from region to region as in Bihar mixed cropping, intercropping and mono-cropping were being practiced but in all other regions under study only mono-cropping was observed, also the spacing, seed rate and sowing period of the farmers were different for different region. In case of rainfed condition the seed rate was generally higher and spacing was lesser compared to irrigated areas. The method of sowing in Saran and Nalanda district of Bihar was completely broadcasting whereas in the parts of Gujarat and Aligarh district of Uttar Pradesh both broadcasting as well as seed drill sowing were observed. The organization have a big crop business opportunity in both hybrid and improved varieties segment as still there is untapped market for both the segments and also the seed replacement ratio in several parts of the country like Tonk, Sawaimadhopur, Sheopur, and parts of Gujarat was less than 50% indicating great potential for the mustard seed replacement and enhancing productivity of the farmers along with high crop business opportunity for the company.

In view of this study it is clear that, mapping of traits requirement into different location would give company a chance to introduce products customized to that particular cluster which would enhance not only the productivity also market value of mustard oilseed with the preferred grain texture into that region. The trait mapping was done for the biotic and abiotic stress prevailing into that area causing major damage to the crop, whereas agronomic and morphological traits were based upon the farmers' likeness. The major trait which is categorized as must have trait in all the selected districts except in Gujarat is Sclerotinia stem rot resistance (biotic stress) and frost tolerance (abiotic stress) for some parts, bottom branching (agronomical trait), medium height plant (agronomical trait), and medium duration (agronomical trait), of the crop which were the most preferred traits by the farmers.

The study gave insights to the company regarding the opportunities into each segment for mustard business with respect to the current market size, seed replacement ratio and also the potential of each district. The maximum opportunity with the present market size and seed replacement ratio was in Sri Ganganagar and Hanumangarh district

of Rajasthan where almost 100% seed replacement and largest market size (650MT and 450 MT approximately respectively) were observed.

This study also revealed that major market player in mustard seed business in hybrid segment were PHI, Bayer crop science and Advanta seeds whereas major market player in improved varieties segment were different in different region like in M.P, U.P and parts of Rajasthan, Krishna seeds had major market share, whereas in Bihar it was Nath biogene. The price of the mustard seed ranged from Rs 350 to Rs 600 per kg for hybrid seeds and PHI had premium leadership in case of market share and price. The PHI had very strong marketing channel network with more than one channel partner in every mustard market and have year round activities in the villages for the promotion. Thus it was leader in the promotional activities also followed by the Bayer crop science and Dhanya seeds. Rasi seeds had not much impact on mustard seed business due to lesser reach and network as well as very less promotional activities as compared to others a market players.

The study of Rasi channel revealed that company have a huge untouched mustard market and also the gap in existing market channel. Out of the total 25 district, the presence of channel partner was found to be only 64% and remaining markets were untapped by the company. It was also revealed that the existing channel partner were able to cover only 77% of the market of study area indicating a gap of 23% which need to be covered. Rasi Seeds had channel strength in cotton seed channel partners in different market where it had no mustard seed distributor. Cotton seed distributor in those markets can be utilized as mustard seed distributors as well. This strategy would expand market size of mustard product.

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LIST OF ABBREVIATIONS

A	Area
P	Production
Y	Yield
Kg	Kilogram
Mha	Million hectare
Mt	Million Ton
MT	Metric Ton
PHI	Pioneer Hybrid India ltd.
NLP	Net Landing Price
MRP	Maximum Retail Price
FP	Farmer's Price
Min	Minimum
Max	Maximum
Avg	Average
Temp	Temperature
Mm	Millimeter
Cm	Centimeter
SSR	Sclerotinia Stem Rot
R X R	Row X Row
SSPL	Super Seed Pvt. Ltd
TM	Territory Manager
PO	Project Officer
SD	Short Duration
MD	Medium Duration
FD	Full Duration
NA	Data Not Available
%	Per cent

I. INTRODUCTION

Rapeseed-Mustard is an important group of edible oilseed in India and ranks second after soybean. India is one of the largest producer of oilseeds in the world and this sub-sector occupies an important position in the agricultural economy. The production of oilseeds was increased from 24.35 million tonnes in 2004-05 to 25.30 million tonnes in 2015-16. The yield of oilseeds, was 885 kg per hectare in 2004-05 and it was 968 kg per hectare in 2015-16.

India is one of the largest producers of rapeseed and mustard in the world. European Union (EU) is expected to be the top producer followed by China and Canada in 2015-16. India may be the fourth largest producer. India's share in global production of mustard oil in 2015-16 may be around 9.0 percent. Mustard seed is the third biggest source of vegetable oil in the world after soybean oil and palm oil. It is the second largest source of protein meal in the world after soybean meal. Oil content in rapeseed & mustard varies from 33% to 46% and average oil recovery is around 32% to 38%. After oil extraction, the remaining part of the seed is used to produce rapeseed/ mustard meal, an important component of cattle and poultry feed. Being a winter crop, it requires a temperate climate to prosper (Arvind Kumar et al 2009).

Market mapping is used in market segmentation to help companies identify the target group(s) for their segmentation project. It also has a number of other important applications, such as tracking changes in the channels to market, presenting your own company's performance on these routes to market and illustrating where your sales and marketing resources are allocated, which can then be compared with how your key competitors allocate their resources (Mostofa Jaman, 2012).

In India there is a vast variability in the climatic and edaphic conditions in the mustard growing areas, the selection of appropriate cultivars is important as it helps in increasing the productivity. Introduction of customized varieties will be favorable with the

environment where effective growing season is different with respect to different agro climatic conditions (Kapila Shekhawat et al 2012).

1.1 PRESENT STATUS OF RAPESEED-MUSTARD CULTIVATION IN COUNTRY

1.1.1 Rapeseed-Mustard Cultivation in India

Rapeseed-mustard is the second most important edible oilseed crop in India after groundnut. Mustard oil is traditionally the most important oil for the Northern, Central and Eastern parts of the country. Rapeseed-mustard is the major Rabi oilseed crops of India. Major mustard producing states in country are Rajasthan, accounting more than 50 per cent of its production followed by Uttar Pradesh, Haryana, Madhya Pradesh and Gujarat.

Table 1.1.1: Area, Production and Yield of Oilseeds in Last Three Years

(A= Area in million hectare, P= Production in million tonnes & Y= Yield in Kg/ha)

Year	Kharif			Rabi			Total		
	A	P	Y	A	P	Y	A	P	Y
2013-14	19.65	22.61	1151	8.4	10.14	1207	28.05	32.75	1168
2014-15	18.21	19.22	1056	7.39	8.32	1130	25.73	27.51	1037
2015-16	18.85	16.59	880	7.29	8.71	1195	26.13	25.30	968

(Source: Annual Report 2016-17 DAC & FW)

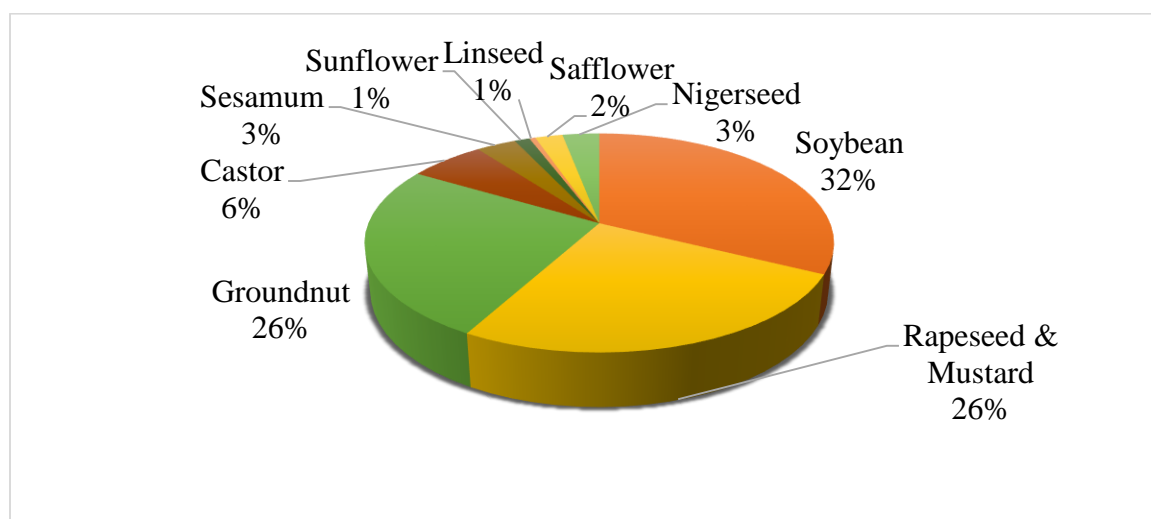
The area under oilseeds cultivation was decreased from 28.05 million ha in 2013-14 to 26.13 million ha in 2015-16. The production of oilseeds was decreased from 32.75 million tonnes in 2013-14 to 25.30 million tonnes in 2015-16. The yield of oilseeds, which was 1151 kg per hectare in 2013-14 decreased to 968 kg per hectare in 2015-16.

Table 1.1.2: Crop Wise Average Production of Nine Major Oilseeds from Year 2012-13 to 2016-17

(Production in million tonnes)						
S.No	Crop	2012-13	2013-14	2014-15	2015-16	2016-17
1	Soybean	14.67	11.86	10.37	8.59	14.22
2	Rapeseed & Mustard	8.03	7.88	6.28	6.82	NA
3	Groundnut	4.7	9.71	7.4	6.77	6.5
4	Castor	1.96	1.73	1.87	1.65	1.73
5	Sesamum	0.69	0.72	0.83	0.87	0.68
6	Sunflower	0.54	0.5	0.43	0.33	0.13
7	Linseed	0.15	0.14	0.16	0.13	NA
8	Safflower	0.11	0.11	0.9	0.6	NA
9	Nigerseed	0.1	0.1	0.8	0.8	0.1
Total Nine Oilseed		30.94	32.75	27.51	25.3	23.36

(Source: Annual Report 2016-17 DAC & FW)

The contribution of rapeseed-mustard to the total oilseed production of India is approximately 26% which is second largest edible oilseed in India and grown in an area of approximately 7 mha. (Fig 1.1.1)



(Source: Annual Report 2016-17 DAC & FW)

Figure 1.1.1: Contribution of Rapeseed-Mustard to Total Oilseed Production in 2015-16

Table 1.1.3: Area under Rapeseed-Mustard Cultivation in India

(A= Area in million hectare, P= Production in million tonnes & Y= Yield in Kg/ha)

Year	A	P	Y
2007-08	5.8	5.8	1001
2008-09	6.3	7.2	1143
2009-10	5.6	6.6	1183
2010-11	6.9	8.2	1185
2011-12	5.9	6.6	1121
2012-13	6.4	8	1262
2013-14	6.6	8.3	1250
2014-15	6.5	6.3	969
2015-16	6.5	6.8	1046

(Source: Annual Report 2016-17 DAC & FW)

Table 1.1.1 shows that acreage under Rapeseed-Mustard during the Year 2015-16 was 6.5 mha whereas it was 5.8 mha in 2007-08.

In India, rapeseed–mustard is grown in diverse agro-climatic conditions ranging from north-eastern/north-western hills to down south under irrigated/rainfed, timely/late sown and mixed cropping. Indian mustard accounts for about 75-80% of the 6.5 million hectare under these crops in the country during 2015-16. Rapeseed-mustard crops in India comprise traditionally grown indigenous species which are given in Table 1.1.4

Table 1.1.4: Cultivated Species of Rapeseed-Mustard in India

S.No.	Common name	Botanical name
1	Indian mustard	<i>Brassica juncea</i>
2	Yellow mustard	<i>Brassica rapa</i> var. <i>yellow sarson</i>
3	Brown sarson	<i>Brassica campestris</i>
4	Black mustard	<i>Brassica nigra</i>
5	Karan rai	<i>Brassica carinata</i>
6	Toria	<i>Brassica rapa</i> var. <i>toria</i>

7	Taramira	<i>Eruca sativa</i>
8	Gobhi sarson	<i>Brassica napus</i>

(Source: www.drmr.res.in)

1.2 INTRODUCTION TO COMPANY

1.2.1 History

Rasi Seeds (P) Ltd. was envisioned and initiated by Mr. Ramasami in 1973 at Attur, located in Salem District of Tamilnadu, India. Rasi hybrid Seeds has made rapid advances from seed production and supply ventures to a commendable position in Research and Development (R&D) and transformed as Rasi Seeds (P) Ltd. in 1986. Having more than 800 qualified workforce the company serve over 4 million Indian farmers.

Rasi Seeds has been recognized as the leader in cotton hybrids, besides hybrids in maize, pearl millet and vegetables. When the company launched its first research cotton hybrid, RCH 2 in 1992, the agricultural industry was overwhelmed by the tremendous yield of this hybrid. This has been achieved by the excellent guidance of Mr. R. Krishnamurthy, a well-known Cotton Breeder in India. RCH 2 cotton hybrid is one among the few proprietary research hybrids that has been notified by the Government of India. The company has excellent processing facilities and follows efficient seed production techniques considering seed quality and purity.

1.2.2 Fact File

- 44 Years' experience in Seed Business
- Leading Player in Hybrid Cotton Research
- Emerging Multi Crop Seeds Group
- Recognized as one of the TOP 10 Biotech seed companies in India for the year 2010

1.2.3 Company Profile

- **Company Name-** RASI SEEDS (P) LTD
- **Established-** 1973
- **Chairman-** Dr. M. Ramasami
- **Managing Director-** Mr. R. Krishnamurthy
- **Corporate Office-** Coimbatore
- **Total Employee –** More than 800

1.2.4 Product Profile

Table1.2.4.1: Product Profile Field Crops

Hybrid Corn	Hybrid & Research Paddy		Hybrid Bajra	Wheat	Mustard
3022	RHR 111	Poonam	1818	Thunder	Karuna
3033	RHR 333	Laxmi	1827	Spark	Anmol
3591	RRX 113	Poonam Gold			Bullet
4750		Pavitra			
4640					
4642					
4212					
4558					
4595					
SAMPPANN/4444					
4794 (W)					
Sx 38 (W)					

1.3 RATIONALE OF THE PROJECT

This project was carried out according to the requirement of Rasi Seeds (P) Ltd. The company is also being engaged in mustard seed business. Therefore, it wanted to know requirements of mustard growers in terms of must have and good to have traits and about major market players in mustard seed business. The data and findings of the study has to helpful to understand the practices farmers are following in mustard crop.

With above background the study entitled “**Mapping and Segmentation of the Mustard Growing Areas for Introduction of right products**” was planned with the following specific objective after consulting with company’s general manager and product manager (project guide).

1.4 OBJECTIVES

1. To study the mustard cultivation in important states of India, crop business opportunity and agro climatic zones segmentation
2. To map Must have traits and Good to have traits in mustard seeds based on agro climatic zones / state wise / cluster wise
3. To define segment wise opportunity and ideal product requirement for future product development
4. To conduct competitors analysis with respect to 4P’s
5. To study Rasi channel preparedness for mustard business, channel gap and strength

II. REVIEW OF LITERATURE

Lionneton E, et al (2004) Studied on “Genetic analysis of agronomic and quality traits in mustard (*Brassica juncea*)”. To develop an efficient mustard breeding programme, a better knowledge of the genetic control and relationships of the main selected characters is needed. The most important agronomic and quality traits of brown mustard could be bred independently and can be incorporated into one cultivar based on the requirements and suitability to location.

Arvind Kumar, et al (2009) Studied on “Rapeseed-Mustard cultivation in India” Rapeseed-Mustard crop offers immense scope for further yield enhancement as far as India is concerned. . The existing low level of productivity offers immense potential for advancements in crop improvement through application of research findings. Development of new methodological approaches and crop production and protection techniques which are eco regional in scope and simultaneously incorporating the constraints imposed by the natural resource availability of the region is the need of the hour. For India, the attainment of self-sufficiency in edible oils is possible if the production potential of our annual edible oilseed crops are harnessed through improved technologies and their timely transfer to the oilseed cultivators.

Hamid Reza Azimi et al (2012) Studied on “Morphological traits of Indian mustard (*Brasica juncea* L.) as influenced by sowing date and manure fertilizers” To investigate the effect of sowing date and manure fertilizers on morphological traits of Indian mustard (*Brasica juncea* L.) means comparison of interaction between sowing date and manure fertilizer treatment. Morphological traits were significantly affected by different sowing dates and manure fertilizers.

Kapila Shekhawat et al (2012) Studied on “Advances in Agronomic Management of Indian Mustard” Since, there is a vast variability in the climatic and edaphic conditions in the mustard growing areas of India, the selection of appropriate cultivars is important as it helps in increasing the productivity. Introduction of relatively short duration cultivar found favor with the environment where effective growing seasonal length is short. Improved

varieties of mustard stabilize oil and seed yield through insulation of cultivars against major biotic and abiotic stresses enhance oil (low erucic acid) and seed meal (low glucosinolate) quality. Vertical growth in mustard production can be brought by exploiting the available genetic resources with breeding and biotechnological tools which will break the yield barriers. Horizontal growth in rapeseed-mustard can be brought in those rapeseed-mustard growing areas/districts of the country, wherever, the yield is lower than the national average. Production technologies for different agro-ecological cropping systems, crop growing situations like intercropping, salinity, and rainfall.

Mostofa Jaman (2012) Studied on “Critical Analysis of Segmentation Strategy for Potential Product Launch - Mapping The Customers” First of all, segment must exist and not to be an object of the marketers’ imagination. Existing market must be measurable or identifiable in terms of size and purchasing power. It means that segment is distinguished and responds to the different marketing mix and other incentives in a changing way. Obviously, segment must be accessible or reachable in order to establish connection. On the other hand, in terms of business prospective segment must be substantial and stable for a significantly long period. Under this requirement is mentioned that tailored marketing program should be targeted to the significant amount of people with the same needs and characteristics. In addition to that, amount should be such a big that business should be profitable. And, final requirement is actionable criterion, which concludes company’s capability to deal with so many segments as it is possible from the company’s extent of resources. Due to the correct market segmentation, company can benefit from distribution point of view, carry out business in an effective and efficient way, increase sales/profit and market share. However, market segmentation becomes a dilemma for the company, because of different reasons, such as incorrect formulation of marketing strategy, incorrect understanding of the customers behavior regarding to the marketing mix, more theoretical rather than practical approach choosing wrong variables.

III. METHODOLOGY

The study entitled **“Mapping and Segmentation of the Mustard Growing Areas for Introduction of Right Products”** was carried out during the period of 15th January 2017 to 15th May 2017. The topic was given by RASI SEEDS (P) LTD, Coimbatore. This chapter deals with the method of investigation, research design and tools employed in the present study.

3.1 COVERAGE OF THE STUDY

3.1.1 Selection of the State/District/Taluka

The selection of the north-western states for the study were done on the basis of acreage under mustard crop cultivation with the help of time series data of last three year from 2011-12 to 2013-14. With the limitation of the time period for the survey six major mustard producing states were selected on the basis of area under cultivation of mustard and from each states major district under mustard cultivation were selected based on the acreage of mustard for the past three years. While selecting districts faster movement for data collection was considered by selecting nearby locations (Fig.3.2). After selection of district from each district two talukas were selected on the basis of areas under mustard crop, whereas in Bihar the data of acreage was not available therefore, from each district two talukas was selected after consultation of personnel of the company. From each selected talukas one village was selected on the basis of information collected from distributor about potential villages with high acreage under mustard cultivation. The details of the states, districts and talukas covered under study presented in Table 3.1.1.

3.1.2 Selection of the Mustard Growers

From each selected village total five mustard growers were selected which constitute total sample size of mustard growers was 250. Thus total 250 farmers were selected from villages of talukas of districts of six states.

3.1.3 Selection of the Distributors/Channel partners

The Rasi channel partners were selected based on the list of channel partners provided by the company personnel in the selected districts and other company's channel partner were also selected based on the referrals from Rasi channel partner. The sample size of channel partner was 200.

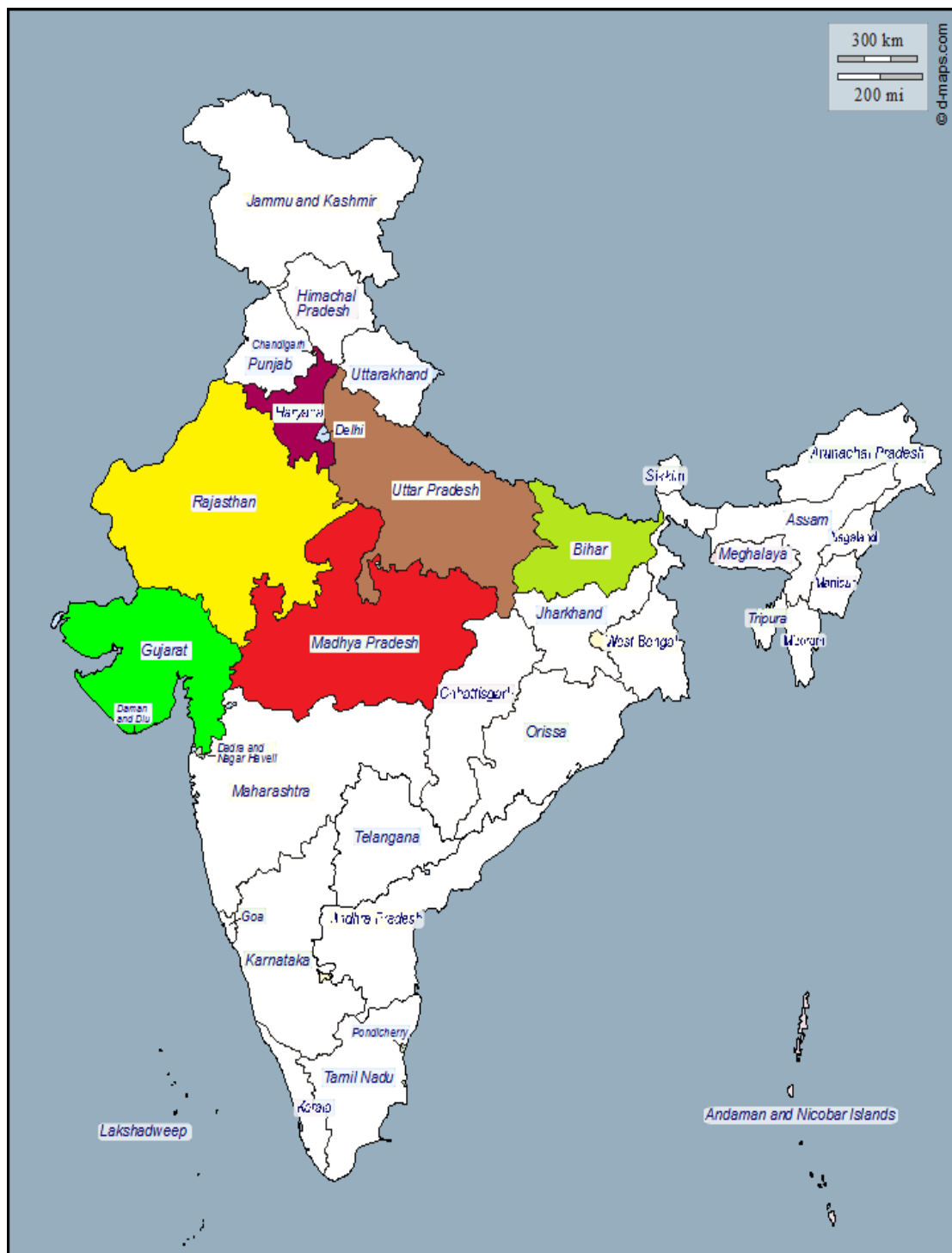


Figure 3.1 Map of the Selected Area of the Study

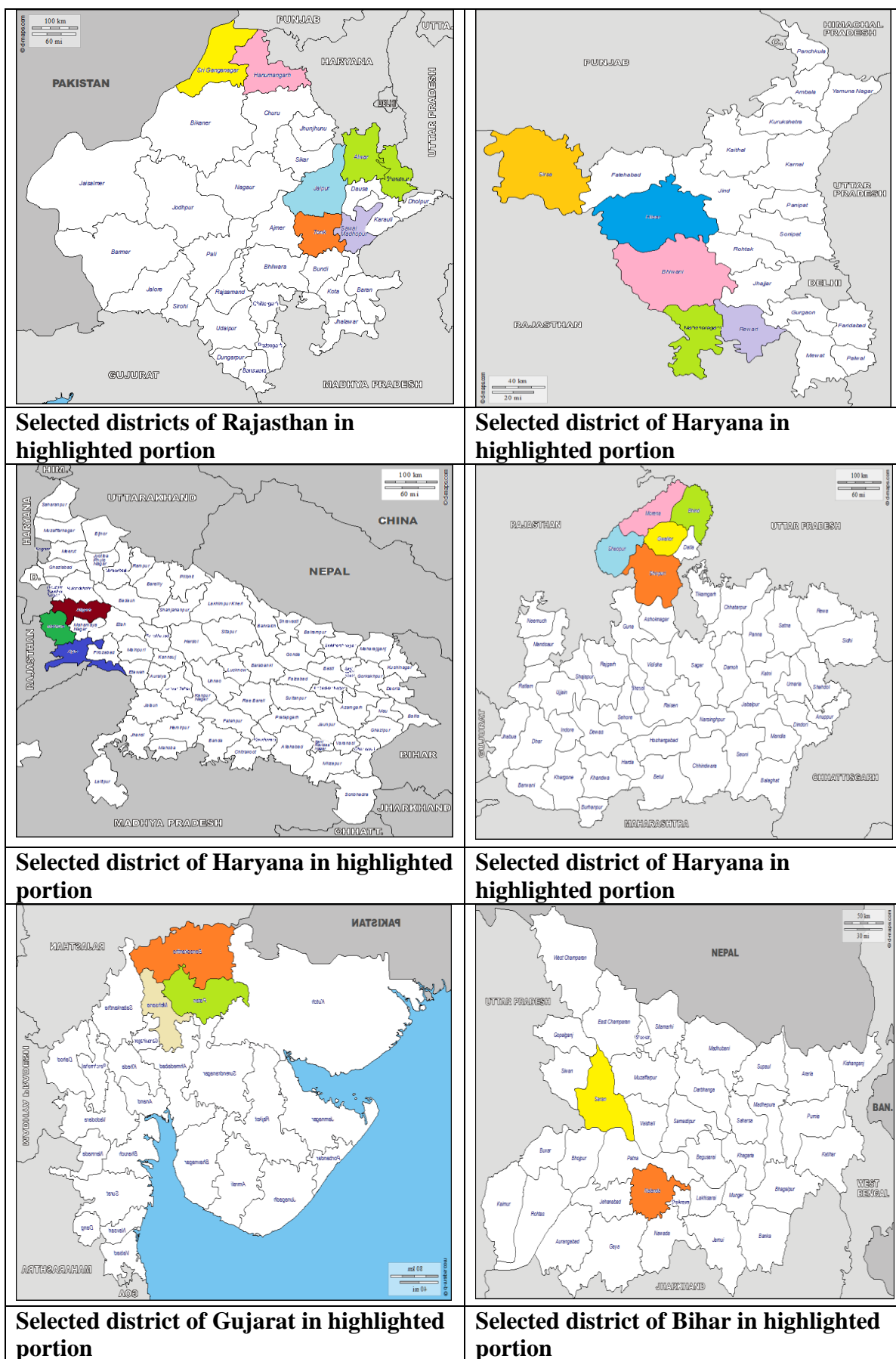


Fig.3.2: Map Showing Sampling Area (Districts selected for study)

Table 3.1.1 Coverage of the Study

States	District	Tehsil 1	Tehsil 2
Rajasthan	Tonk	Tonk	Uniyar
	Alwar	Behror	Mundawar
	Sri Ganganagar	Sri Ganganagar	Raisinghnagar
	Bharatpur	Deeg	Nagar
	Sawaimadhopur	Sawaimadhopur	Bonli
	Jaipur	Kotputli	Chomu
	Hanumangarh	Hanumangarh	Pilibanga
Madhya Pradesh	Bhind	Bhind	Mehgaon
	Morena	Morena	Jaura
	Gwalior	Gwalior	Dabra
	Sheopur	Sheopur	Vijaypur
	Shivpuri	Karera	Bairad
Haryana	Bhiwani	Dadri	Loharu
	Mahendergarh	Mahendergarh	Kaneena
	Rewari	Rewari	Kosali
	Hisar	Hisar	Adampur
	Sirsa	Sirsa	Dabwali
Bihar	Saran	Chhapra	Manjhi
	Nalanda	Parbalpur	Hilsa
Uttar Pradesh	Agra	Khairagarh	Fatehabad
	Mathura	Gowardhan	Mathura
	Aligarh	Atrauli	Khair
Gujarat	Banaskantha	Dhanera	Tharad
	Mahesana	Mahesana	Visnagar
	Patan	Patan	Chanasma

3.1.4 Selection of the Company Personnel

Rasi Seeds personnel responsible for company's seed business in the study area were selected for data collection of company's mustard seed business for year 2016-17. The sample size of company personnel was 10.

3.2 SOURCE OF DATA

Primary as well as Secondary data were collected to meet the objective of the study.

3.2.1 Primary Data

Primary data was collected from Farmers, Channel partners, distributors, and company personnel. Mustard breeders from different agricultural universities were consulted for the expert views and information on locality based trait requirement of mustard crop.

3.2.2 Secondary Data

District wise secondary data of area under mustard cultivation was collected from Department of Agriculture Cooperation and Farmers' Welfare and taluka wise data were collected from District agriculture offices, Revenue offices.

3.3 SAMPLING DESIGN

3.3.1 Sampling Method

The sampling method is probability and nonprobability as selection of the farmers were done simple random sampling and selection of channel partners by purposive sampling whereas for other distributors, snowball sampling techniques were used.


3.3.2 Research Tool

Keeping in view the nature of the study and for obtaining correct and perfect information from the respondents, the information was collected through personal interview using the semi-structured schedules for mustard growers and channel partners and questionnaires for company personnel after pretesting the schedules and questionnaires.

3.4 METHOD OF ANALYSIS

Tabular, Graphical analysis and required statistical tools has used to analyse the data.

Some Snapshot of Survey

	
District Agriculture Office	Distributor Data Collection
	
Farmers Data Collection	Auctioning of Mustard Oilseed
	
Field Observation during Survey	

IV. RESULT AND DISCUSSION

4.1 MUSTARD CULTIVATION IN THE SELECTED AREA OF STUDY

4.1.1 Acreage under Rapeseed-Mustard Cultivation

Table 4.1.1.1 Area under Mustard Cultivation for Last five Years in Sample Districts

(Area in ha)

State	2011-12	2012-13	2013-14	2014-15	2015-16	Average
Tonk	299060	266482	281439	299065	250912	279392
Alwar	230660	245516	238293	230660	230658	235157
Ganganagar	193620	257010	215406	193620	238665	219664
Bharatpur	196515	231278	211103	196515	203222	207727
Sawaimadhopur	185007	181313	184269	185007	168057	180731
Hanumangarh	95638	105523	119119	114503	126170	112191
Jaipur	114503	121256	97208	95638	86739	103069
Rajasthan	2433773	2724956	2782539	2433773	2532330	2581474
Bhind	172917	182808	184782	147416	147870	167159
Morena	134093	141899	137860	115676	113516	128609
Gwalior	53799	47466	49682	54381	48418	50749
Sheopur	49455	47053	47985	42299	38253	45009
Shivpuri	40082	36504	33360	31584	28880	34082
Madhya Pradesh	662435	703261	702055	713000	716000	699350
Bhiwani	169808	162459	155221	142321	156313	157224
Mahendergarh	98299	96681	87874	88761	126193	99562
Rewari	64314	67309	66492	62763	63369	64849
Hisar	59725	61966	68570	66770	67584	64923
Sirsa	34864	43319	43128	41206	44559	41415
Haryana	535850	558290	536991	481938	580000	538614
Saran	3608	2912	2576	3608	3193	3179

Nalanda	2403	1834	2206	2403	2958	2361
Bihar	84445	86823	85246	84445	89657	86123
Agra	51991	52627	50718	37016	NA	48088
Mathura	44464	45346	42967	38933	NA	42928
Aligarh	17893	19693	19731	16185	NA	18376
Uttar Pradesh	603663	644631	646615	584287		619799
Banaskantha	112004	115300	122520	120950	129778	120110
Mahesana	24800	36200	21609	20977	22928	25303
Patan	25400	27900	29687	29262	27398	27929
Gujarat	207600	212800	282000	184000	190500	215380
All India	5900000	6400000	7214600	6517300	6453300	6728400

(Source: <http://aps.dac.gov.in>, District Revenue Offices)

Rapeseed- mustard as an important edible oilseed crop for the country which requires an intensive approach to increase not only the productivity but also need to increase area under cultivation to fulfill the demand of the country. Table 4.1.1.1 shows that maximum area under mustard cultivation was in Rajasthan followed by Madhya Pradesh, Uttar Pradesh, Haryana, Gujarat and Bihar. Largest area under mustard cultivation among selected districts was in Tonk district of Rajasthan.

4.1.2: District-wise Cultivated Area under Rabi Crops (2015-16)

Area under rabi crops for year 2015-16 in selected districts were presented in from Table 4.1.2.1 to Table 4.1.2.2 and from Fig 4.1.2.1 to Fig 4.1.2.22.

Table 4.1.2.1: Area under Rabi Crops-Tonk

Crop	Wheat	Barley	Gram	Mustard	Other	Total
Area (ha)	66500	5500	21550	186100	15250	294900

(Source: District Revenue Office, Tonk)

Table 4.1.2.1 shows that mustard was leading crop cultivated under 63% of the total area under rabi crops followed by wheat 23%, gram 7% barley 2% and remaining crops including vegetables constituted only 5% (fig. 4.1.2.1).

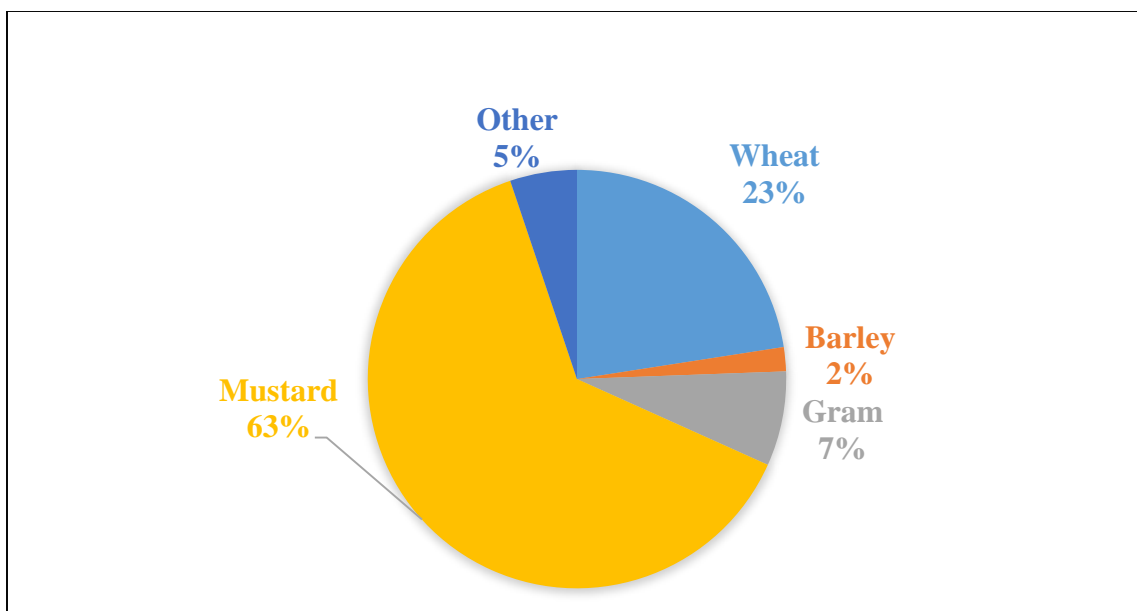


Fig. 4.1.2.1: Area under Rabi crops- Tonk

Table 4.1.2.2: Area under Rabi Crops-Alwar

Crop	Wheat	Mustard	Gram	Others	Total
Area (ha)	213011	234421	8472	13136	469040

(Source: District Revenue Office, Alwar)

Table 4.1.2.2 shows that mustard was leading crop cultivated under 50% of the total area under rabi crops followed by wheat 45%, gram 2% and remaining crops including vegetables constituted only 3% (fig. 4.1.2.2).

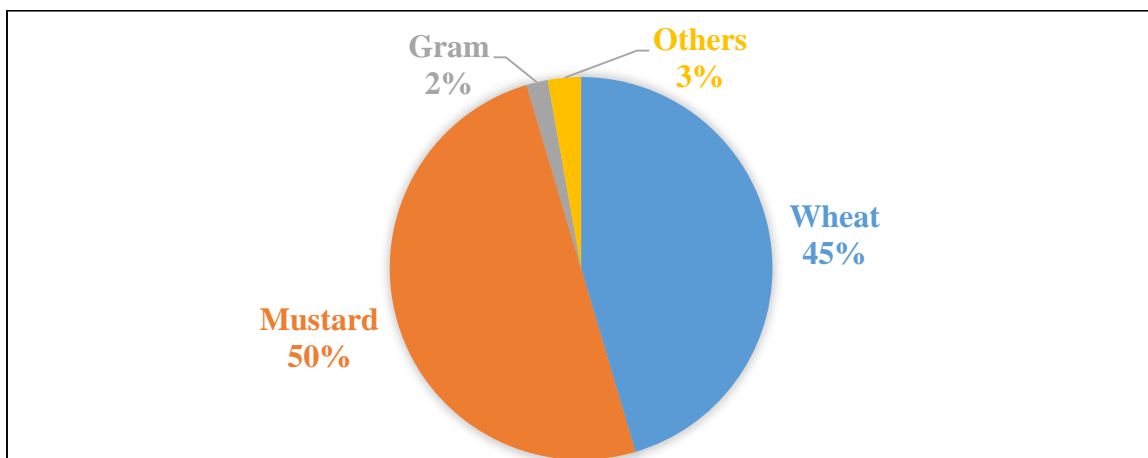


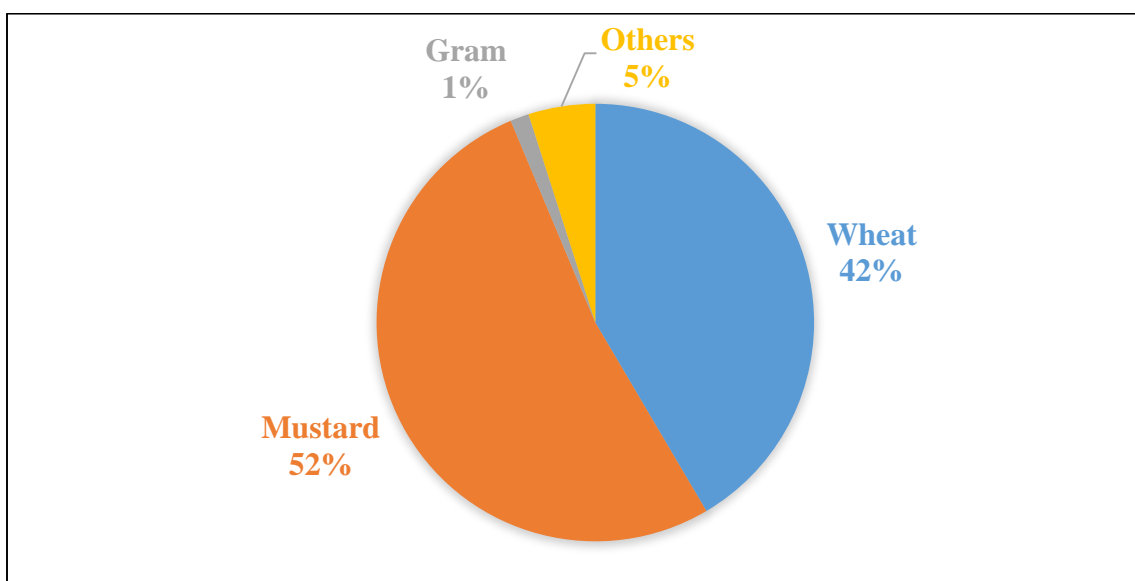
Fig. 4.1.2.2: Area under Rabi Crops-Alwar

Table 4.1.2.3: Area under Rabi Crops-Bharatpur

Crop	Wheat	Mustard	Gram	Others	Total
Area (ha)	156009	195968	5172	18562	375711

(Source: District Revenue Office, Bharatpur)

Table 4.1.2.3 shows that mustard was leading crop cultivated under 52% of the total area under rabi crops followed by wheat 42%, gram 1% and remaining crops including vegetables constituted only 5% (fig. 4.1.2.3).

**Fig. 4.1.2.3: Area under Rabi Crops-Bharatpur****Table 4.1.2.4: Area under Rabi Crops-Jaipur**

Crop	Wheat	Mustard	Barley	Gram	Vegetable	Others	Total
Area(ha)	150340	86739	55864	15169	17877	13107	339096

(Source: District Revenue Office, Jaipur)

Table 4.1.2.4 shows that after wheat (44% of total area under rabi crops) mustard was leading crop cultivated under 26% of the total area under rabi crops followed by barley 17%, vegetables 5%, gram 4% and remaining crops constituted only 4% (fig. 4.1.2.4).

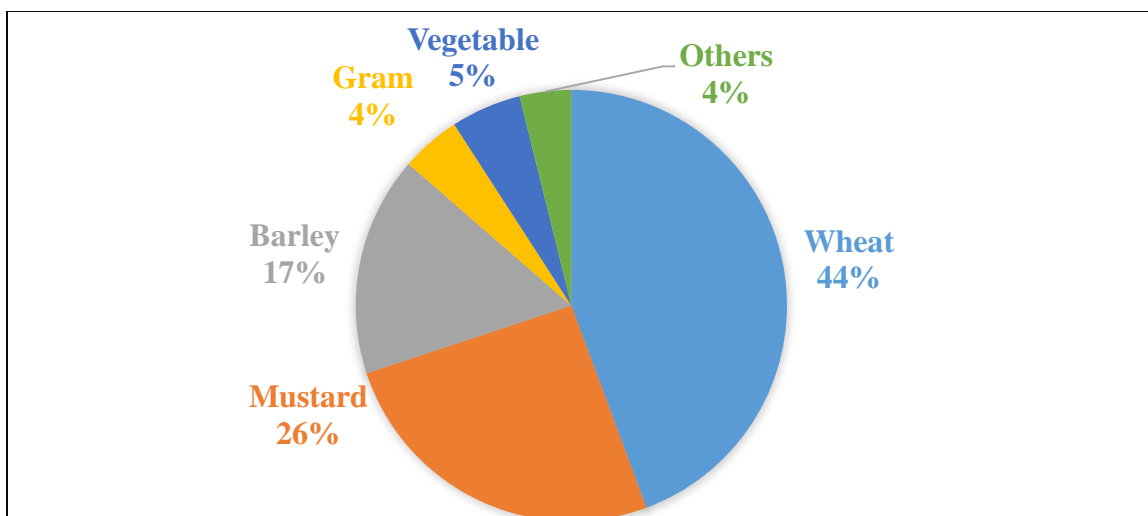


Fig. 4.1.2.4: Area under Rabi Crops-Jaipur

Table 4.1.2.5: Area under Rabi Crops-Sawaimadhopur

Crop	Wheat	Mustard	Gram	Others	Total
Area (ha)	69279	168057	12420	6873	256629

(Source: District Revenue Office, Sawaimadhopur)

Table 4.1.2.5 shows that mustard was leading crop cultivated under 65% of the total area under rabi crops followed by wheat 27%, gram 5% and remaining crops including vegetables constituted only 3% (fig. 4.1.2.5).

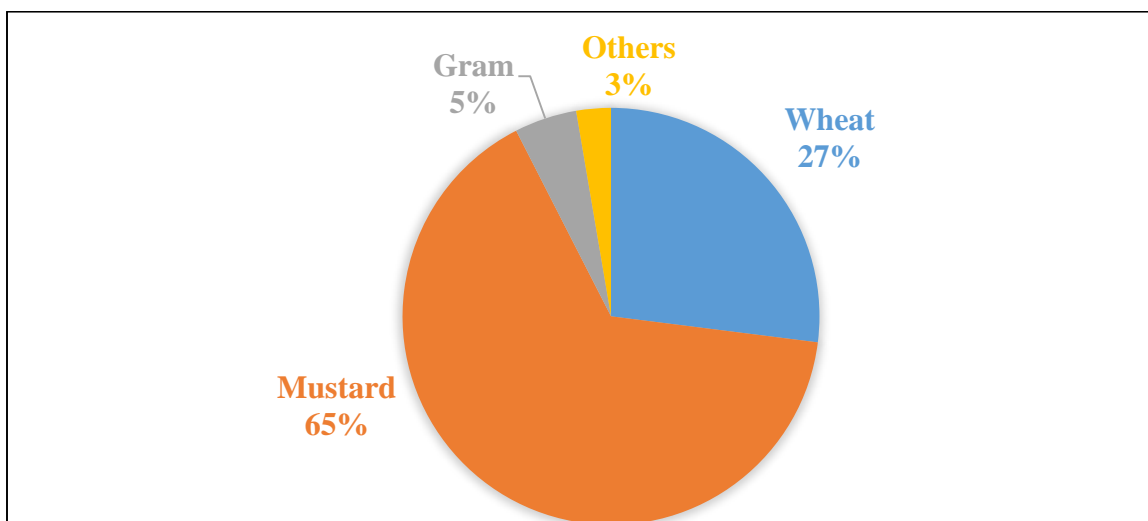


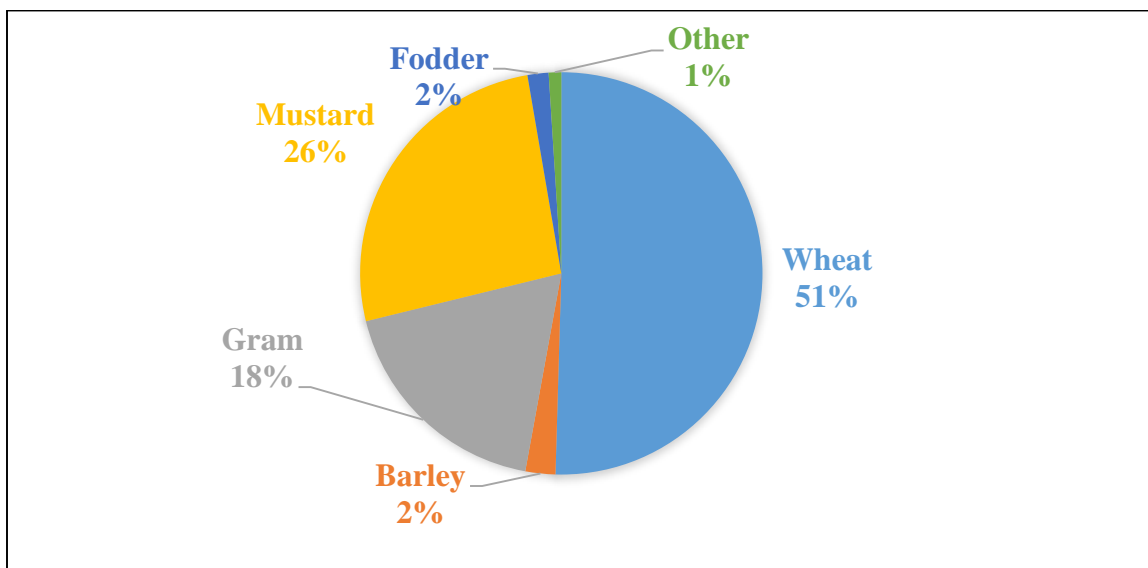
Fig. 4.1.2.5: Area under Rabi Crops-Sawaimadhopur

Table 4.1.2.6: Area under Rabi Crops-Hanumangarh

Crop	Wheat	Barley	Gram	Mustard	Fodder	Other	Total
Area(ha)	243714	11629	88405	126170	8170	4865	482953

(Source: District Revenue Office, Hanumangarh)

Table 4.1.2.6 shows that after wheat (51% of total area under rabi crops) mustard was leading crop cultivated under 26% of the total area under rabi crops followed by gram 18%, barley 2%, fodder 2% and remaining crops constituted only 1% (fig. 4.1.2.6).

**Fig. 4.1.2.6: Area under Rabi Crops-Hanumangarh****Table 4.1.2.7: Area under Rabi Crops-Sriganganagar**

Crop	Wheat	Barley	Gram	Mustard	Other	Total
Area (ha)	274584	36641	67746	239948	26598	645517

(Source: District Revenue Office, Sriganganagar)

Table 4.1.2.7 shows that after wheat (43% of total area under rabi crops) mustard was leading crop cultivated under 37% of the total area under rabi crops followed by gram 10%, barley 6% and remaining crops constituted only 4% (fig. 4.1.2.7).

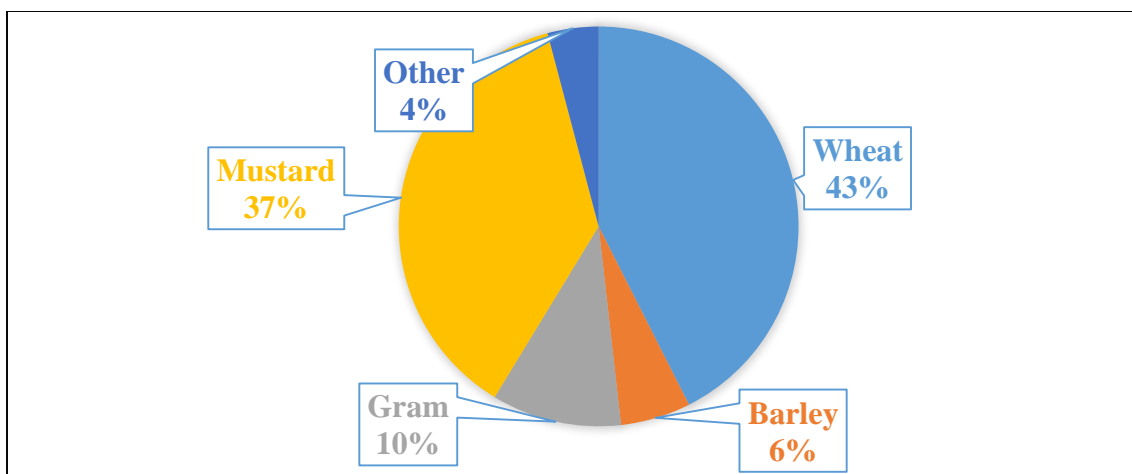


Fig. 4.1.2.7: Area under Rabi Crops-Sriganganagar

Table 4.1.2.8: Area under Rabi Crops-Bhind

Crop	Wheat	Mustard	Barley	Pea	Berseem and Lucerne	Other	Total
Area(ha)	124924	147850	5305	7183	2696	20572	309496

(Source: District Revenue Office, Bhind)

Table 4.1.2.8 shows that mustard was leading crop cultivated under 48% of the total area under rabi crops followed by wheat 40%, pea 2%, barley 2%, berseem and Lucerne 1% and remaining crops including vegetables constituted only 7% (fig. 4.1.2.8).

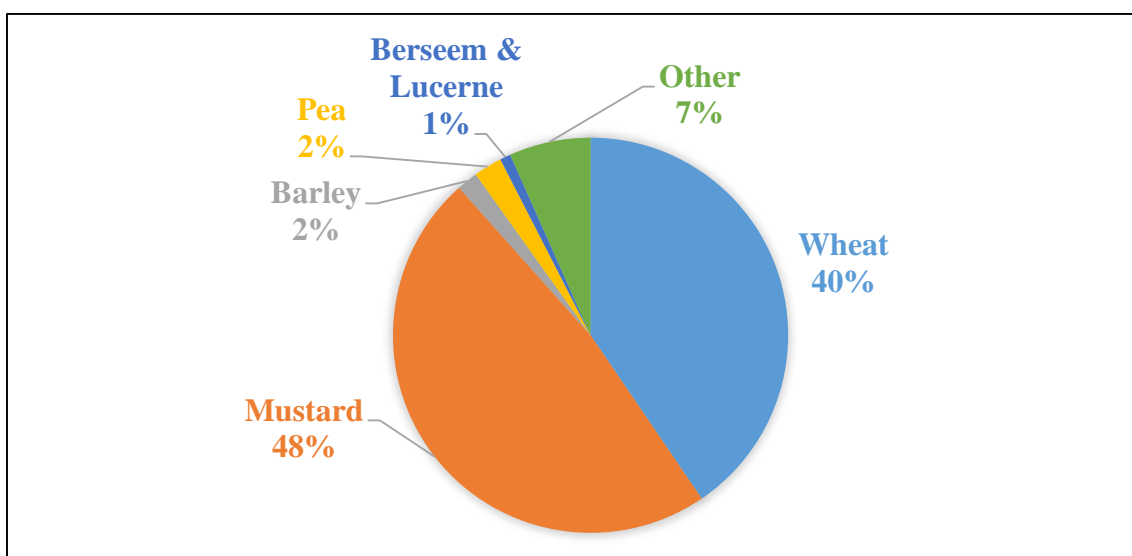


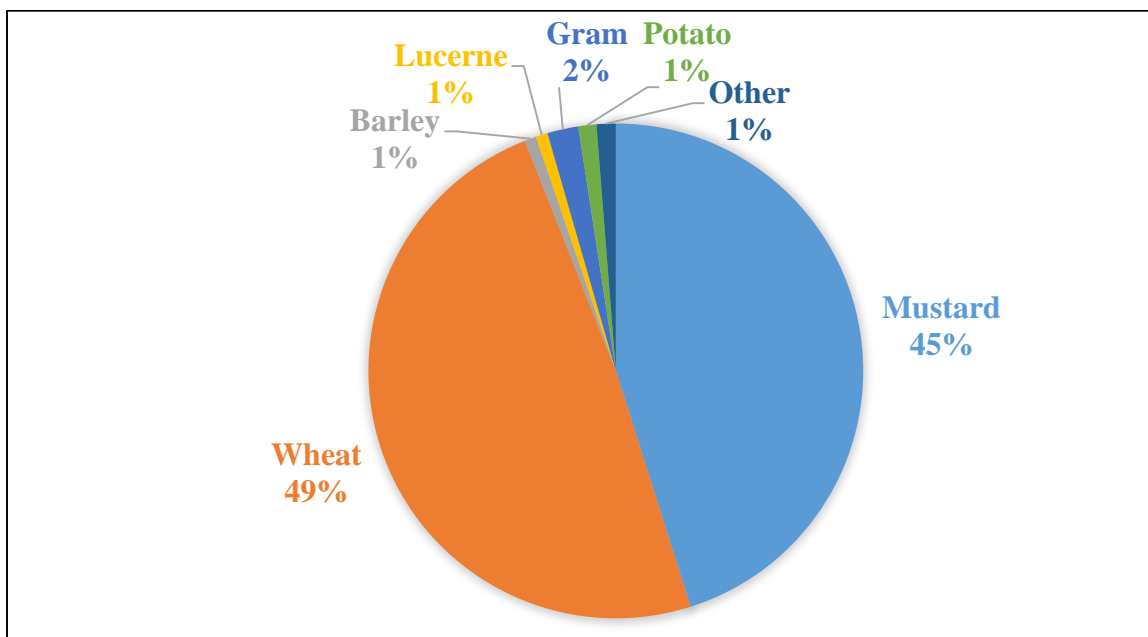
Fig. 4.1.2.8: Area under Rabi Crops-Bhind

Table 4.1.2.9: Area under Rabi Crops-Morena

Crop	Mustard	Wheat	Barley	Lucerne	Gram	Potato	Other	Total
Area (ha)	113897	123448	1908	1954	5128	2967	3169	252471

(Source: District Revenue Office, Morena)

Table 4.1.2.9 shows that after wheat (45% of total area under rabi crops) mustard was leading crop cultivated under 45% of the total area under rabi crops followed by gram 2%, potato 1%, Lucerne 1%, barley 1% and remaining crops including vegetables constituted only 1% (fig. 4.1.2.9).

**Fig. 4.1.2.9: Area under Rabi Crops-Morena****Table 4.1.2.10: Area under Rabi Crops-Gwalior**

Crop	Wheat	Barley	Lucerne	Gram	Mustard	Other	Total
Area (ha)	112998	796	2173	13306	48418	6317	184008

(Source: District Revenue Office, Gwalior)

Table 4.1.2.10 shows that after wheat (61% of total area under rabi crops) mustard was leading crop cultivated under 26% of the total area under rabi crops followed by gram 7%, lucerne 1%, barley 1% and remaining crops including vegetables constituted only 4% (fig. 4.1.2.10).

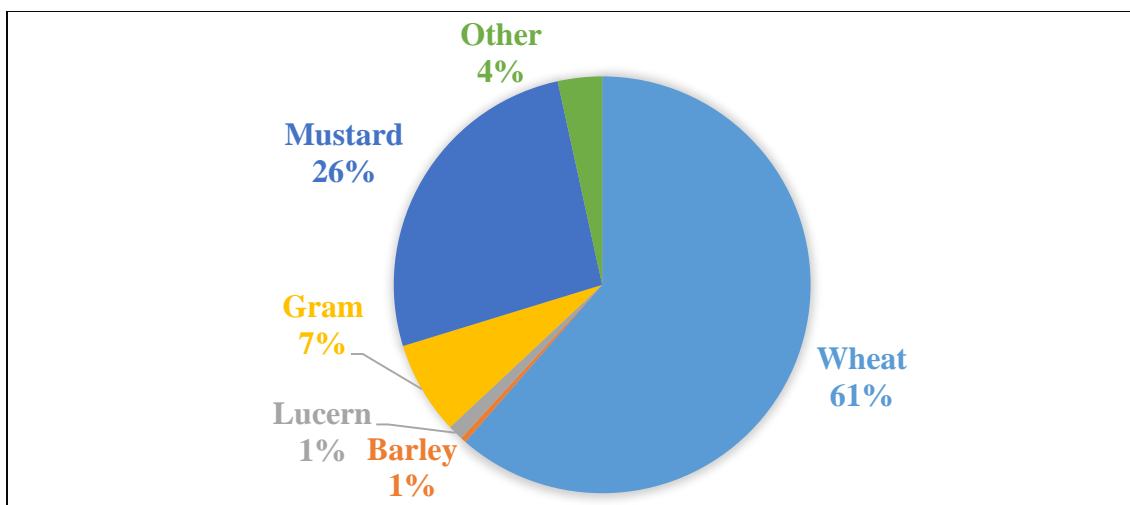


Fig. 4.1.2.10: Area under Rabi Crops-Gwalior

Table 4.1.2.11: Area under Rabi Crops-Sheopur

Crop	Wheat	Berseem	Gram	Mustard	Coriander	Other	Total
Area (ha)	84442	934	7310	38253	16412	1705	149056

(Source: District Revenue Office, Sheopur)

Table 4.1.2.11 shows that after wheat (57% of total area under rabi crops) mustard was leading crop cultivated under 26% of the total area under rabi crops followed by coriander 11%, gram 5%, barley less than 1% and remaining crops including vegetables constituted only 1% (fig. 4.1.2.11).

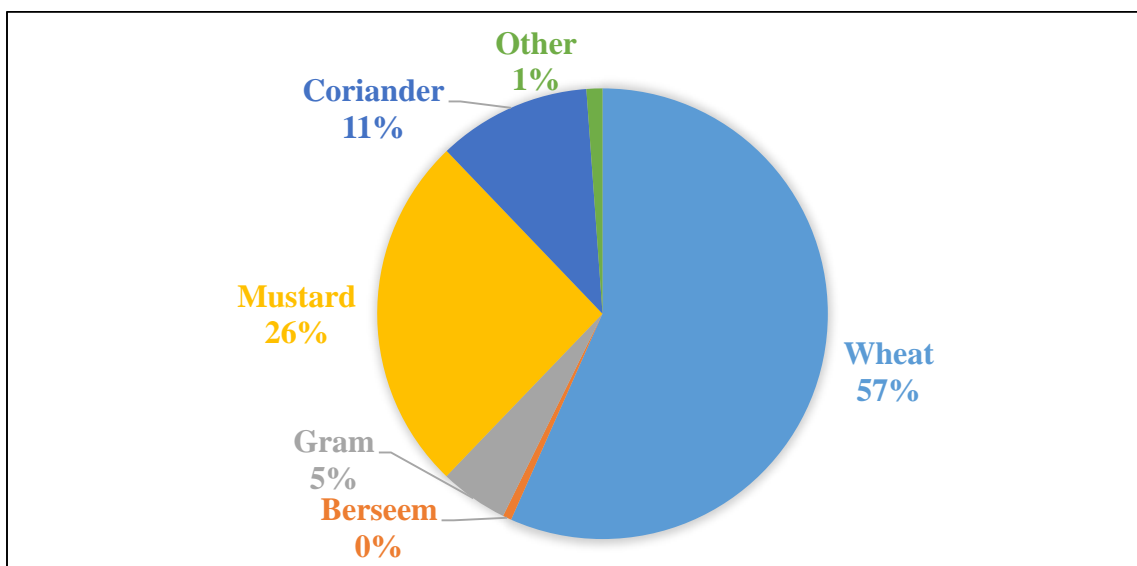


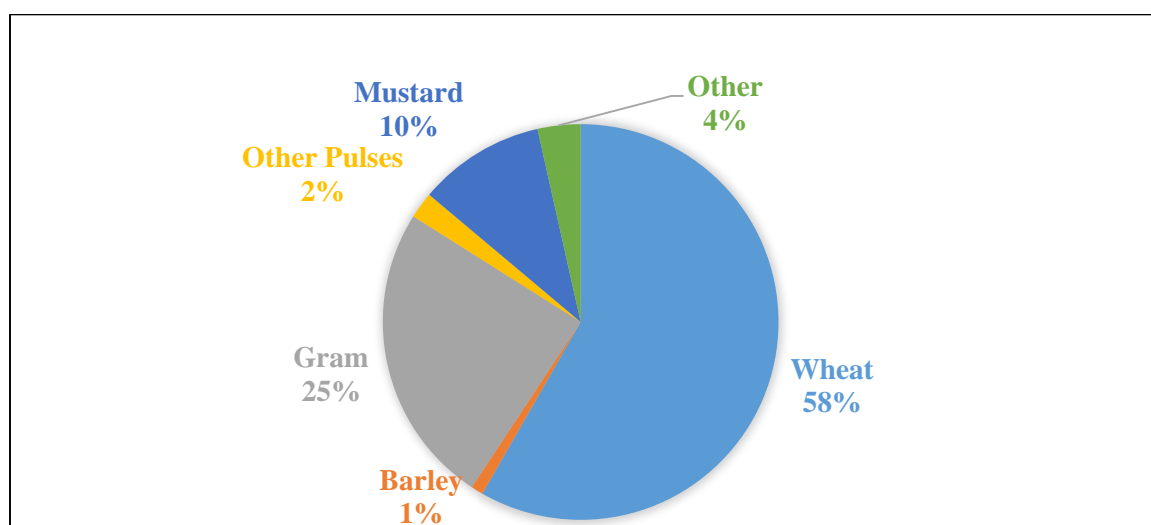
Fig. 4.1.2.11: Area under Rabi Crops-Sheopur

Table 4.1.2.12: Area under Rabi Crops-Shivpuri

Crop	Wheat	Barley	Gram	Other Pulses	Mustard	Other	Total
Area (ha)	162300	2765	68741	6022	28879	9765	278472

(Source: District Revenue Office, Shivpuri)

Table 4.1.2.12 shows that mustard was not primarily cultivated crop in the district as area under mustard cultivation was only 10% of total area under rabi season crops. Wheat with 58% of total acreage followed by gram 25% were major rabi season crops (fig. 4.1.2.12).

**Fig. 4.1.2.12: Area under Rabi Crops-Shivpuri****Table 4.1.2.13: Area under Rabi Crops-Rewari**

Crop	Wheat	Barley	Mustard	Vegetables	Other	Total
Area (ha)	50911	1445	63369	861	516	117102

(Source: District Revenue Office, Rewari)

Table 4.1.2.13 shows that mustard was leading crop cultivated under 54% of the total area under rabi crops followed by wheat 44%, barley 1%, vegetables 1% and remaining crops constituted less than 1% (fig. 4.1.2.13).

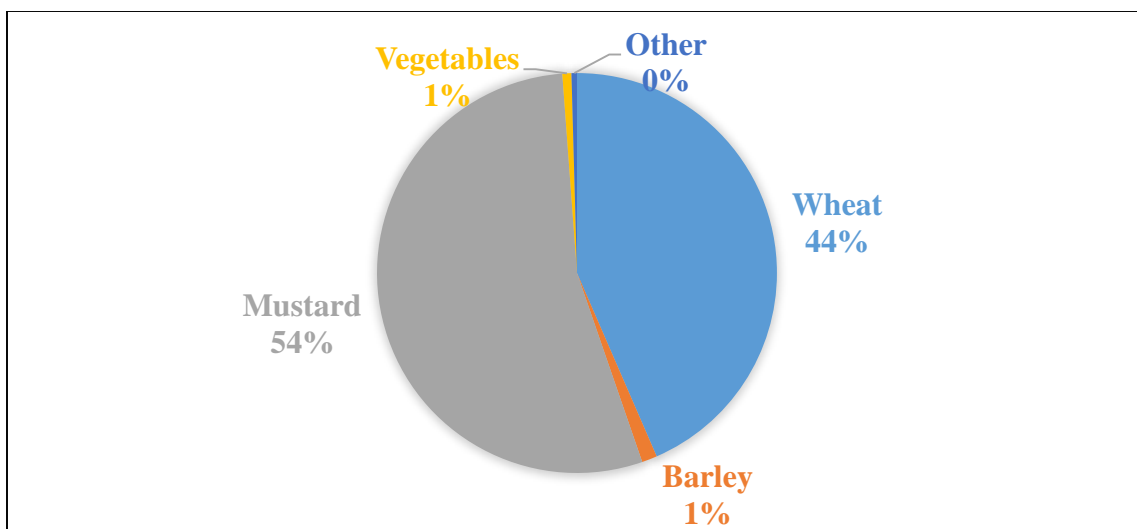


Fig 4.1.2.13: Area under Rabi Crops-Rewari

Table 4.1.2.14: Area under Rabi Crops-Mahendergarh

Crop	Wheat	Gram	Mustard	Fenugreek	Other	Total
Area (ha)	50606	1645	82326	802	1409	136783

(Source: District Revenue Office, Mahendergarh)

Table 4.1.2.14 shows that mustard was leading crop cultivated under 60% of the total area under rabi crops followed by wheat 37%, gram 1% fenugreek 1% and remaining crops including vegetables constituted only 1% (fig. 4.1.2.14).

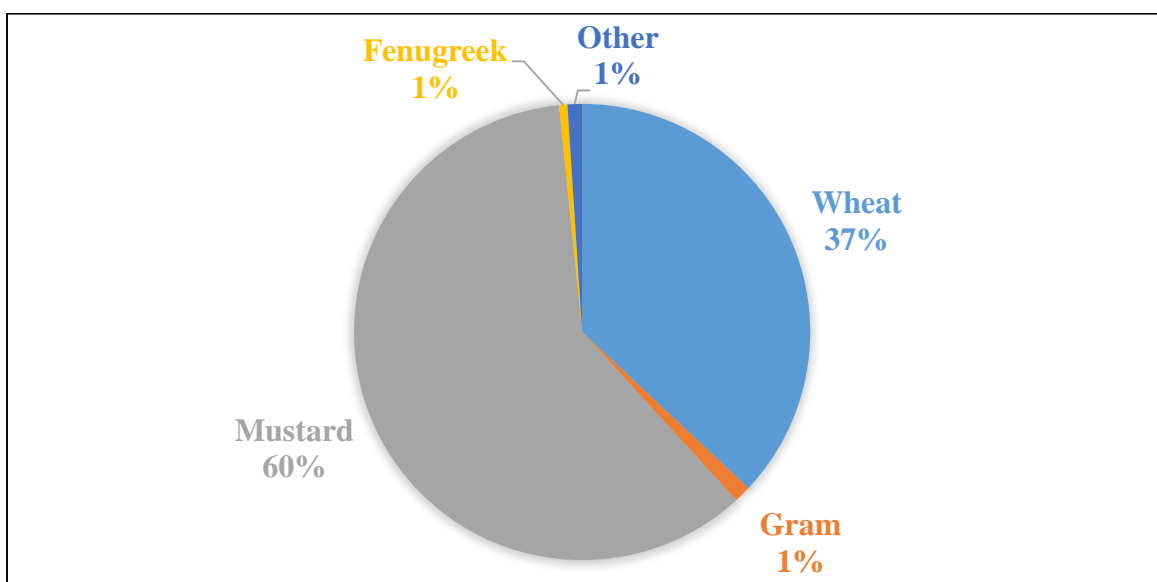


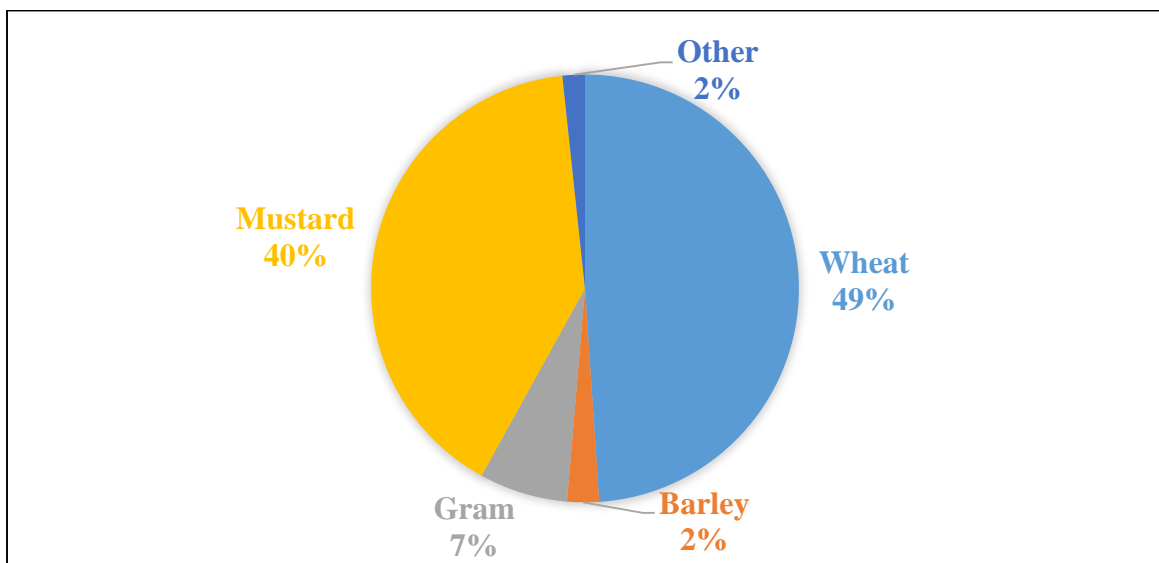
Fig. 4.1.2.14: Area under Rabi Crops-Mahendergarh

Table 4.1.2.15: Area under Rabi Crops-Bhiwani

Crop	Wheat	Barley	Gram	Mustard	Other
Area (ha)	189950	9332	25959	156313	6577

(Source: District Revenue Office, Bhiwani)

Table 4.1.2.15 shows that after wheat (49% of total area under rabi crops) mustard was leading crop cultivated under 40% of the total area under rabi crops followed by gram 7%, barley 2% and remaining crops including vegetables constituted only 2% (fig. 4.1.2.15).

**Fig. 4.1.2.15: Area under Rabi Crops-Bhiwani****Table 4.1.2.16: Area under Rabi Crops-Hisar**

Crop	Wheat	Barley	Mustard	Berseem	Gram	Other	Total
Area (ha)	225415	4274	67584	7301	12619	9451	326644

(Source: District Revenue Office, Hisar)

Table 4.1.2.16 shows that after wheat (69% of total area under rabi crops) mustard was main crop cultivated under 21% of the total area under rabi crops followed by gram 4%, berseem 2%, barley 1% and remaining crops including vegetables constituted only 3% (fig. 4.1.2.16).

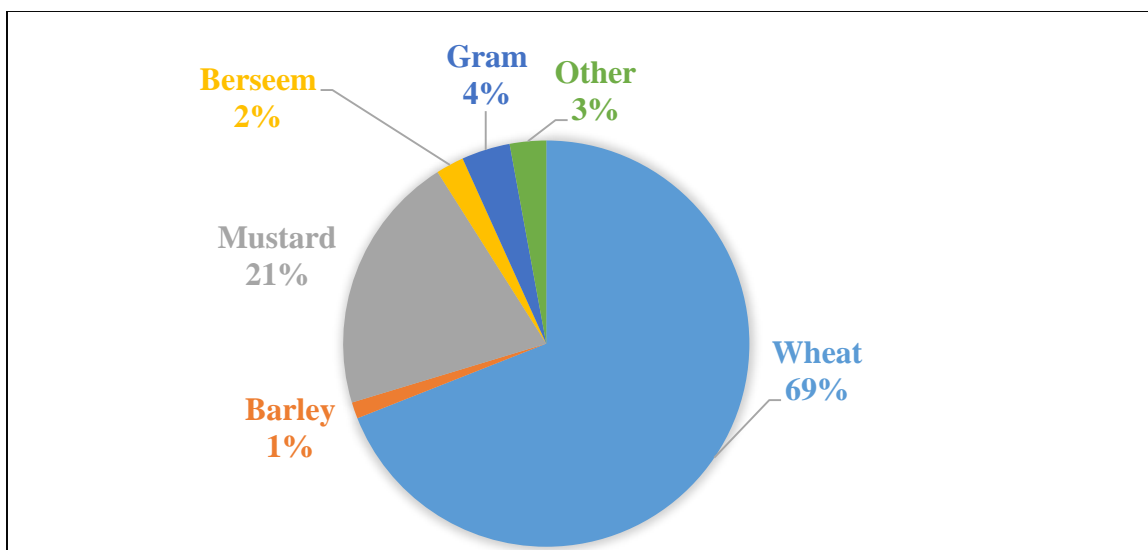


Fig. 4.1.2.16: Area under Rabi Crops-Hisar

Table 4.1.2.17: Area under Rabi Crops-Sirsa

Crop	Wheat	Barley	Mustard	Berseem	Gram	Other	Total
Area (ha)	301150	5000	44559	3975	4799	12598	372081

(Source: District Revenue Office, Sirsa)

Table 4.1.2.17 shows that mustard was not primarily cultivated crop in the district as area under mustard cultivation was only 12% of total area under rabi season crops. Wheat with 81% of total acreage was major rabi season crops (fig. 4.1.2.17).

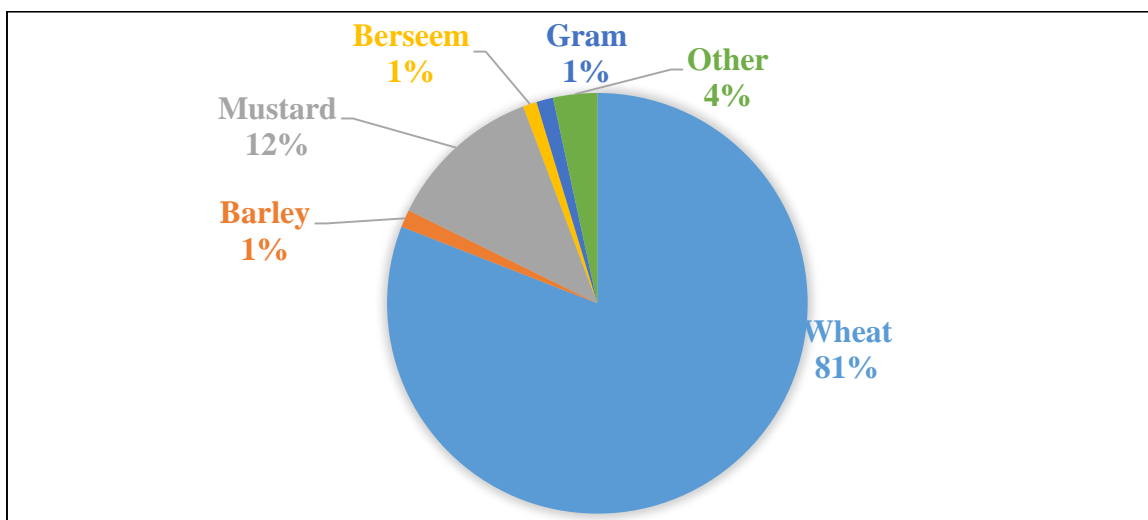


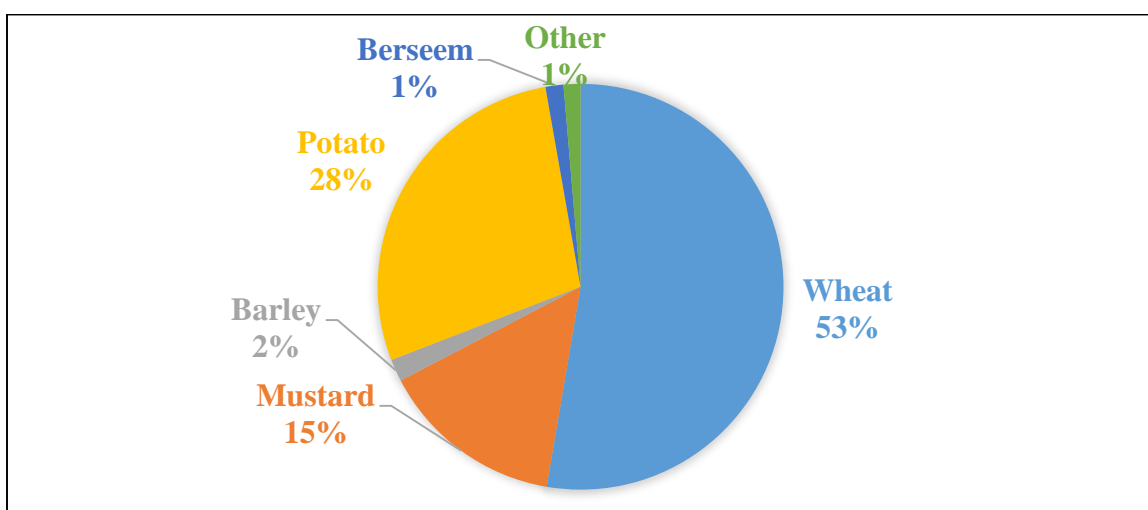
Fig. 4.1.2.17: Area under Rabi Crops-Sirsa

Table 4.1.2.18: Area under Rabi Crops-Agra

Crop	Wheat	Mustard	Barley	Potato	Berseem	Other	Total
Area (ha)	132915	37016	4479	70904	3597	3405	252316

(Source: District Revenue Office, Agra)

Table 4.1.2.18 shows that mustard was not primarily cultivated crop in the district as area under mustard cultivation was only 15% of total area under rabi season crops. Wheat with 53% of total acreage followed by potato 28% were major rabi season crops (fig. 4.1.2.18).

**Fig. 4.1.2.18: Area under Rabi Crops-Agra****Table 4.1.2.19: Area under Rabi Crops-Mathura**

Crop	Wheat	Barley	Mustard	Vegetable	Potato	Fodder	Total
Area (ha)	192820	4741	38933	19380	18762	4979	279615

(Source: District Revenue Office, Mathura)

Table 4.1.2.19 shows that wheat with 69% of total acreage under rabi crops followed by mustard 14%, potato 7% and vegetables 7% were major rabi season crops in the district (fig. 4.1.2.19).

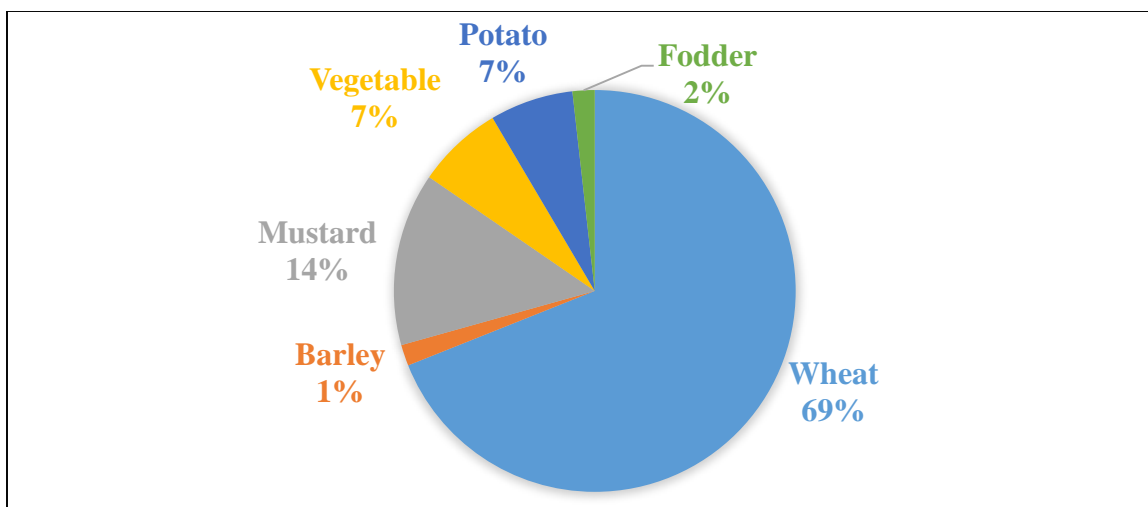


Fig. 4.1.2.19: Area under Rabi Crops-Mathura

Table 4.1.2.20: Area under Rabi Crops- Aligarh

Crop	Wheat	Potato	Mustard	Barley	Vegetable	Fodder	Other	Total
Area (ha)	220742	25991	16185	7535	27285	7229	1278	306245

(Source: District Revenue Office, Aligarh)

Table 4.1.2.20 shows that wheat was leading crop cultivated under 72% of the total area under rabi crops followed by potato 9%, vegetables 9%, mustard 5% and remaining crops including fodder constituted less than 3% (fig. 4.1.2.20).

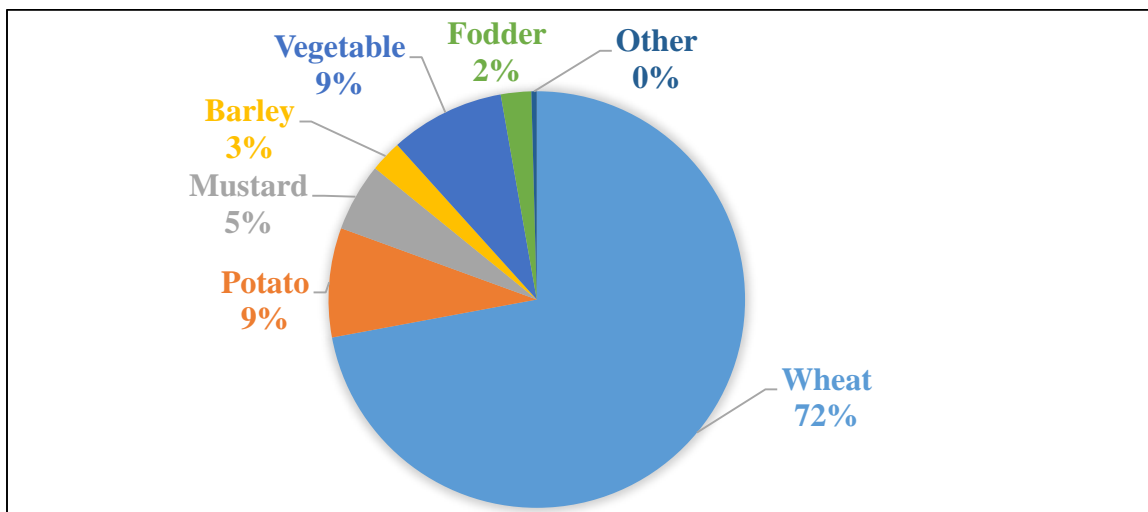


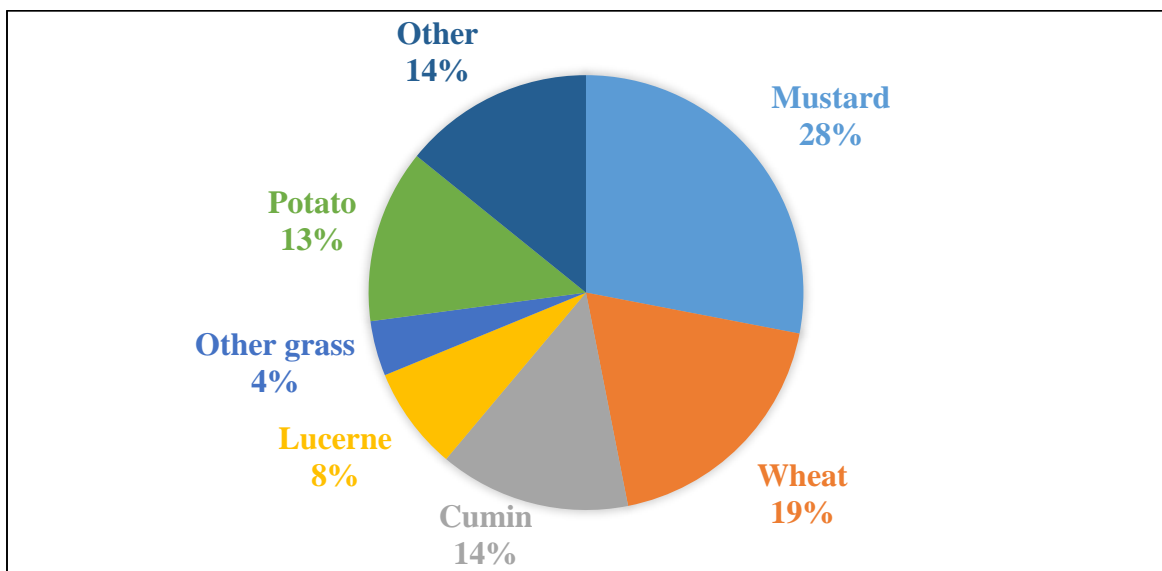
Fig. 4.1.2.20: Area under Rabi Crops-Aligarh

Table 4.1.2.21: Area under Rabi Crops- Banaskantha

Crop	Mustard	Wheat	Cumin	Lucerne	Other grass	Potato	Other	Total
Area (ha)	120950	81480	61390	33155	17677	55732	61263	431647

(Source: District Agriculture Office, Banaskantha)

Table 4.1.2.21 shows that mustard was leading crop cultivated under 28% of the total area under rabi crops followed by wheat 19%, cumin 14%, potato 13%, Lucerne 8% and remaining crops including vegetables constituted 14% (fig. 4.1.2.21).

**Fig. 4.1.2.21: Area under Rabi Crops- Banaskantha****Table 4.1.2.22: Area under Rabi Crops-Mahesana**

Crop	Wheat	Mustard	Tobacco	Spices	Potato	Vegetable	Other	Total
Area (ha)	63054	22928	13350	20855	7867	5231	3458	173655

(Source: District Agriculture Office, Mahesana)

Table 4.1.2.22 shows that wheat with 36% of total acreage under rabi crops followed by fodder crops 21%, mustard 13%, spices 12%, tobacco 8%, potato 5% and other crops constituted only 5% (fig. 4.1.2.22).

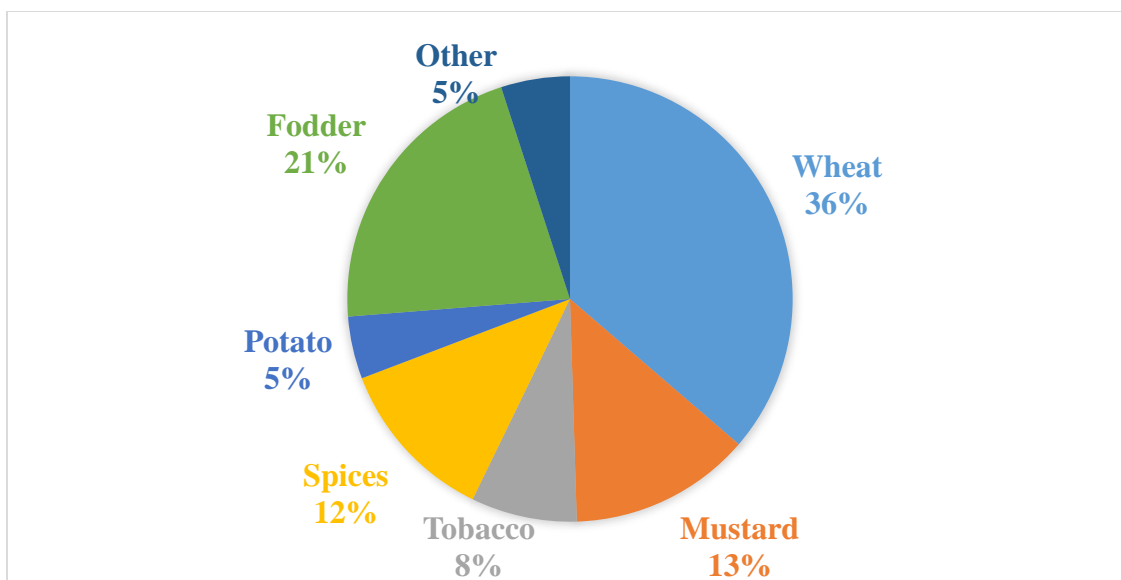


Fig. 4.1.2.22: Area under Rabi Crops-Mahesana

4.1.3 Agro-Climatic Zone Segmentation

The agro-climatic zone wise segmentation of the selected districts was been done to understand the requirements of the mustard traits based upon climatic conditions of that particular segment which would help to find right product for right customer. The climatic factors that plays important role in the mustard productivity are temperature, rainfall & humidity. Therefore considering this parameter selected districts were segmented.

Agro-climatic Zone wise monthly average, minimum, maximum temperature, rainfall and humidity for selected districts for year 2016 were presented from Table 4.1.3.1 to Table 4.1.3.15. Based on temperature, rainfall and humidity selected districts of each state with same or similar agro-climate were kept into one segment.

Table 4.1.3.1: Rajasthan Monthly Average, Minimum and Maximum Temperature

District	Temp (°C)	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Tonk	Avg	33	32	27	24	22	25	31
	Min	26	25	20	16	14	17	23
	Max	37	36	32	30	28	30	36
Jaipur	Avg	33	32	28	24	22	25	31
	Min	25	25	20	16	14	17	23

	Max	37	36	33	30	28	31	36
Ganganagar	Avg	38	34	27	23	20	23	29
	Min	30	25	18	15	12	13	19
	Max	43	40	34	30	26	30	34
Hanumangarh	Avg	37	34	27	23	20	23	29
	Min	30	25	19	16	13	14	20
	Max	42	39	33	29	26	30	34
Alwar	Avg	34	32	27	22	20	23	30
	Min	27	25	18	13	11	12	20
	Max	38	37	33	29	27	30	35
Bharatpur	Avg	34	33	27	21	20	24	31
	Min	28	26	19	14	12	15	22
	Max	38	38	33	28	26	31	36
Sawaimadhopur	Avg	32	32	27	23	22	25	31
	Min	26	24	19	15	14	17	23
	Max	36	36	33	30	28	31	36

(Source: www.worldweatheronline.com)

Table 4.1.3.2: Rajasthan Monthly Rainfall and Rain days

Districts	Rainfall	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Tonk	Rain(mm)	13.41	8.2	0	0	0.8	1.71	9.68
	Days	8	2	0	0	3	3	10
Jaipur	Rain(mm)	13.41	8.3	0	0	0.81	1.71	9.68
	Days	8	2	0	0	3	3	10
Ganganagar	Rain(mm)	2.4	0	0	0	1.41	1.8	25.92
	Days	2	0	0	0	1	2	12
Hanumangarh	Rain(mm)	6.49	0	0	0	0.8	2.59	21.12
	Days	3	0	0	0	1	2	5
Alwar	Rain(mm)	14.5	9.41	0	0	2.31	2.11	21.8
	Days	6	4	0	0	2	3	12

Bharatpur	Rain(mm)	9.92	0.2	0	0	0.3	0.4	10.39
	Days	7	1	0	0	2	1	7
Sawaimadhopur	Rain(mm)	38.12	17.77	0	0	2.1	2.2	13.1
	Days	11	6	0	0	3	2	10

(Source: www.worldweatheronline.com)

Table 4.1.3.3: Rajasthan Monthly Humidity (%)

Districts	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Tonk	54	34	22	34	38	26	22
Jaipur	54	34	22	34	38	26	22
Ganganagar	28	19	18	26	31	26	33
Hanumangarh	30	20	18	25	30	24	31
Alwar	48	29	23	41	47	36	29
Bharatpur	53	29	24	39	46	32	25
Sawaimadhopur	58	37	26	38	39	27	22

(Source: www.worldweatheronline.com)

With the available data on temperature, rainfall and humidity selected districts of Rajasthan were categorized into three segments based on similarity in agro-climatic factors. The details of segments with figure showing similarity in the minimum, maximum and average temperature, rainfall, rain days and humidity of each segment is given from fig. 4.1.3.1 to fig. 4.1.3.9.

Segment-1: Tonk and Jaipur

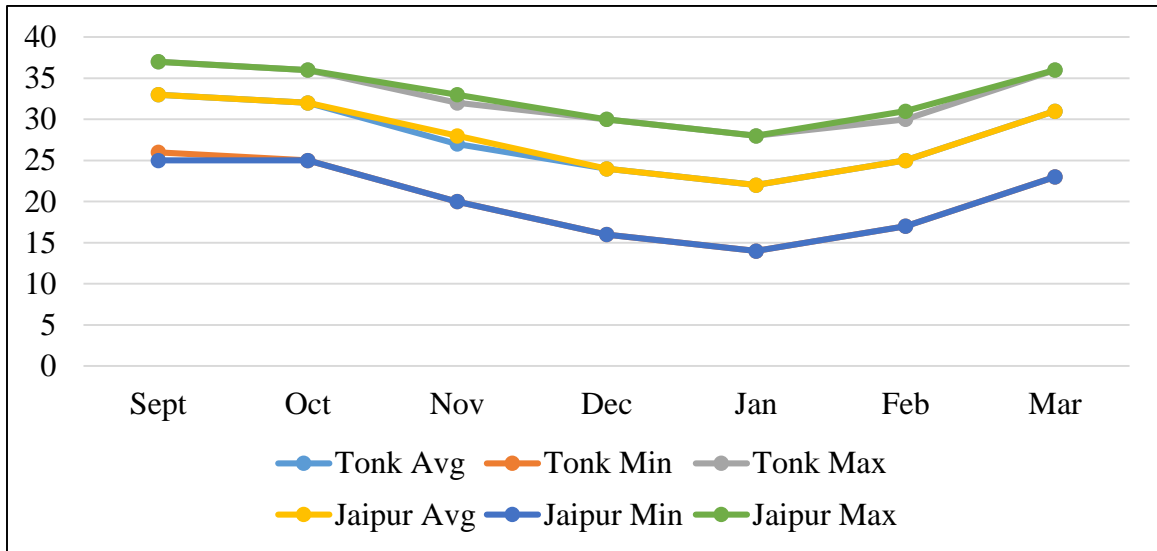


Fig 4.1.3.1: Min, Avg and Max Temperature of Segment-1 (Tonk and Jaipur)

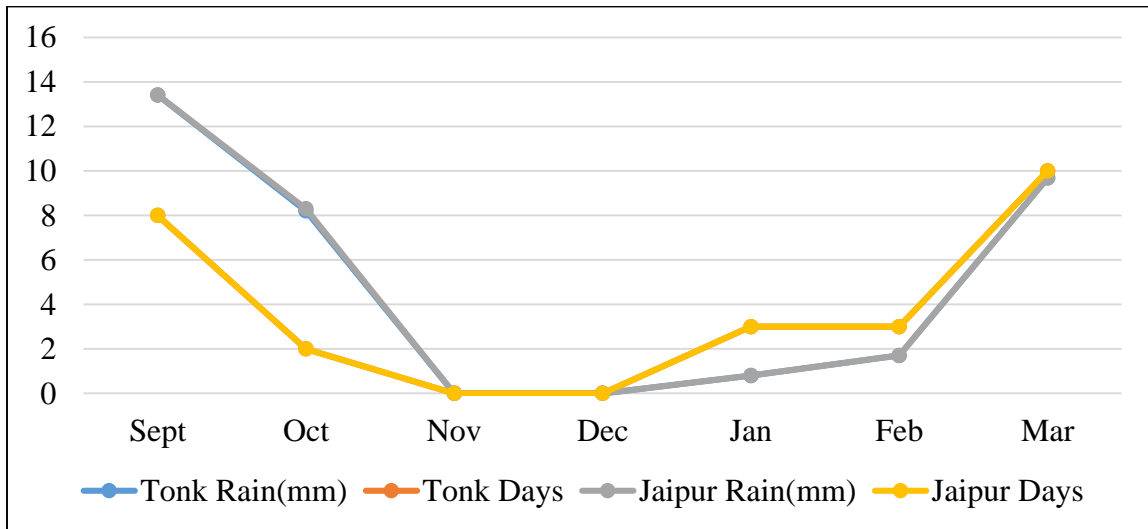


Fig 4.1.3.2 Rainfall and Rain days of Segment -1 (Tonk and Jaipur)

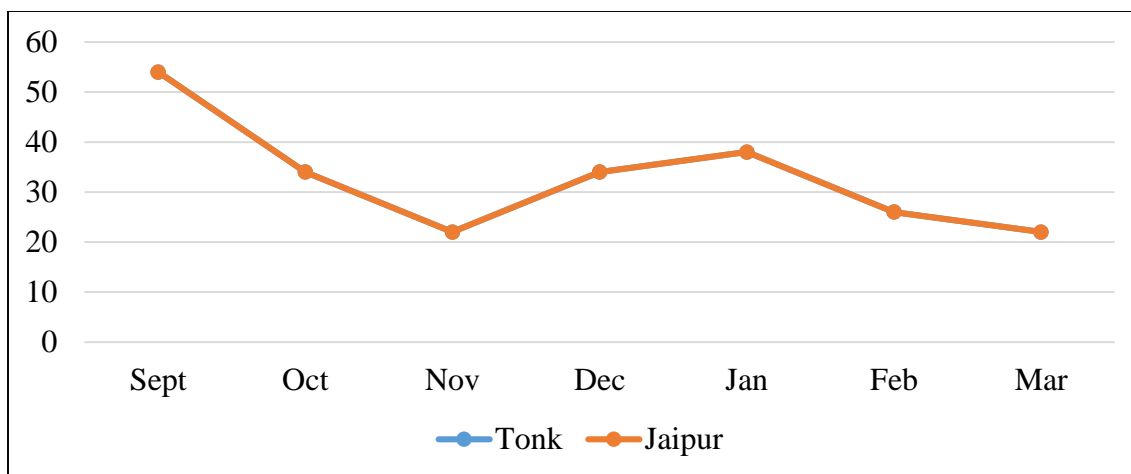


Fig 4.1.3.3 Humidity (%) of Segment-1 (Tonk and Jaipur)

Segment-2: Alwar, Bharatpur and Sawaimadhopur

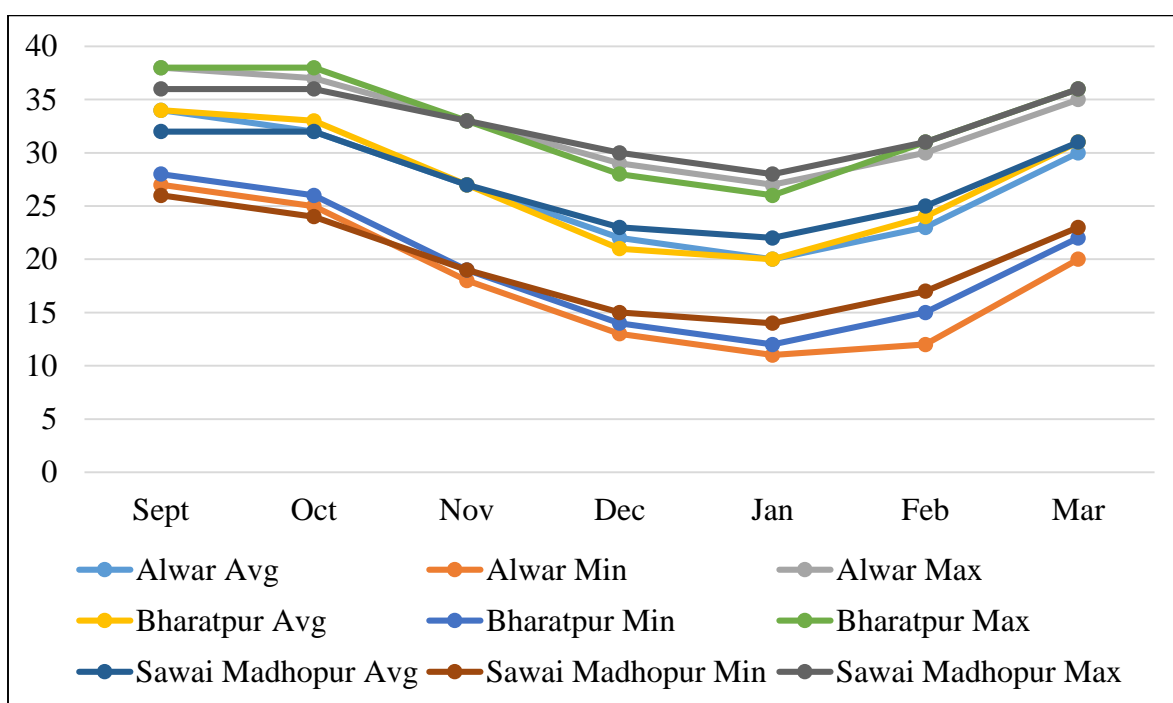


Fig 4.1.3.4: Min, Avg and Max Temperature of Segment-2 (Alwar, Bharatpur and Sawaimadhopur)

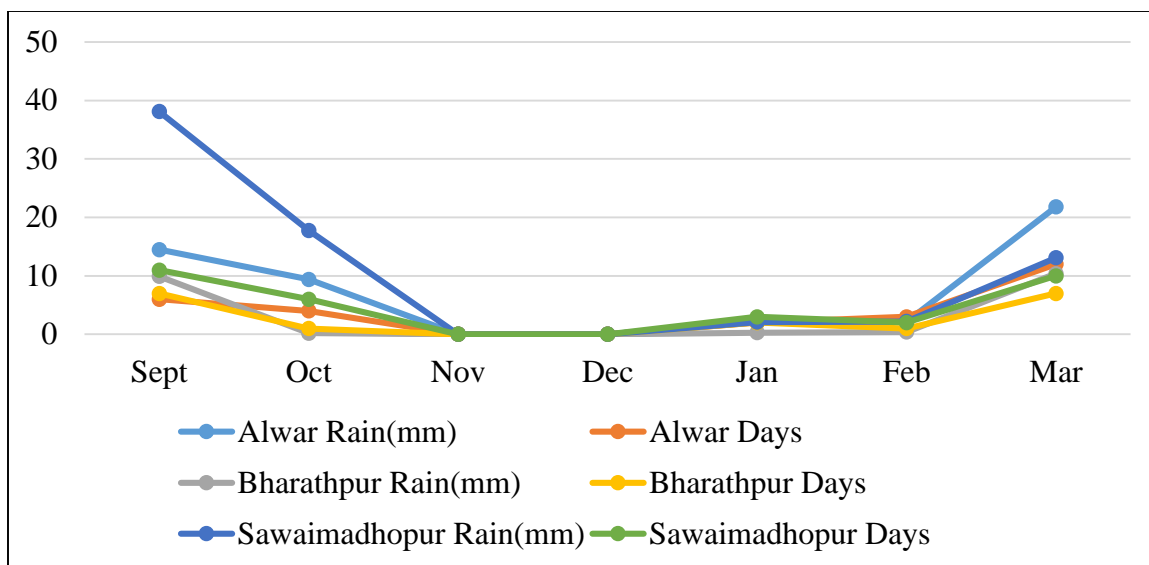


Fig 4.1.3.5 Rainfall and Rain days of Segment-2 (Alwar, Bharatpur and Sawaimadhopur)

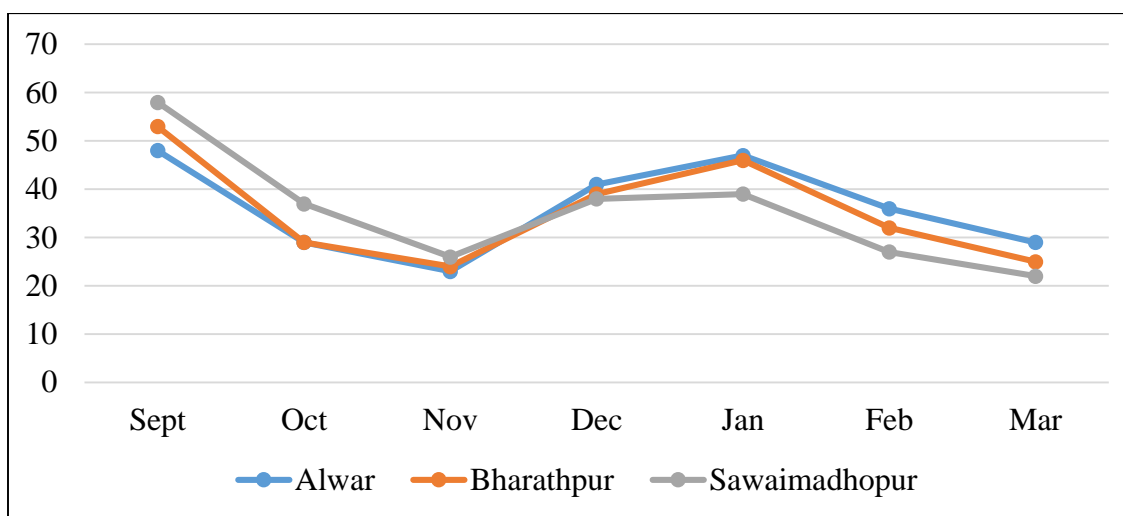


Fig 4.1.3.6 Humidity (%) of Segment-2 (Alwar, Bharatpur and Sawaimadhopur)

Segment-3: Hanumangarh and Sri Ganganagar

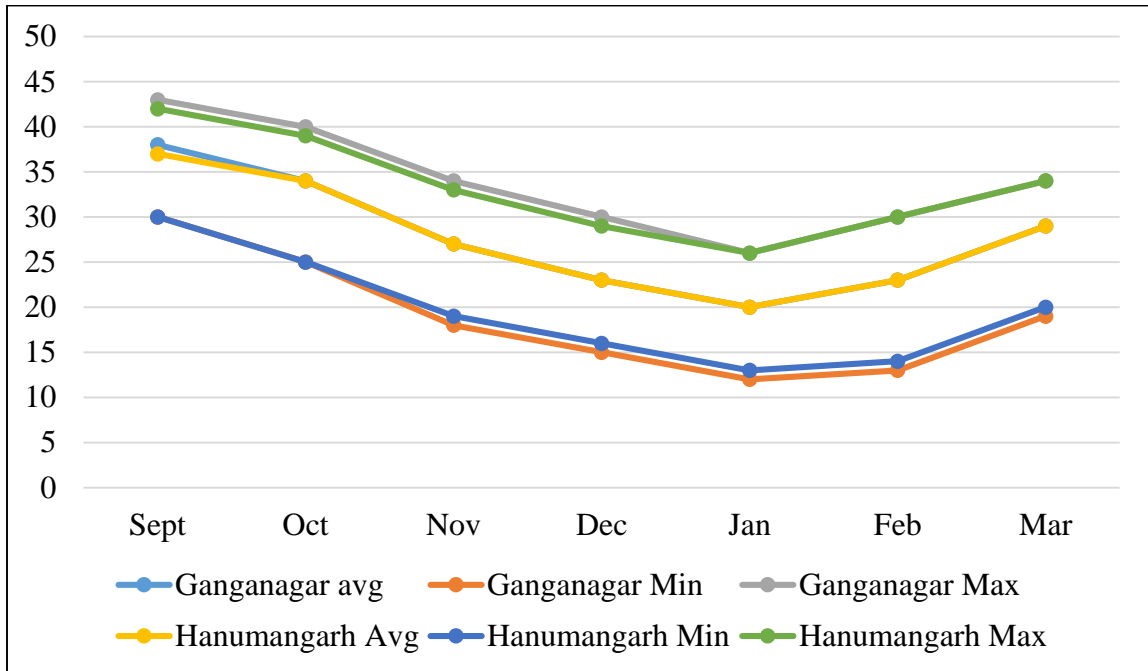


Fig 4.1.3.7: Min, Avg and Max Temperature of Segment-3 (Hanumangarh and Sri Ganganagar)

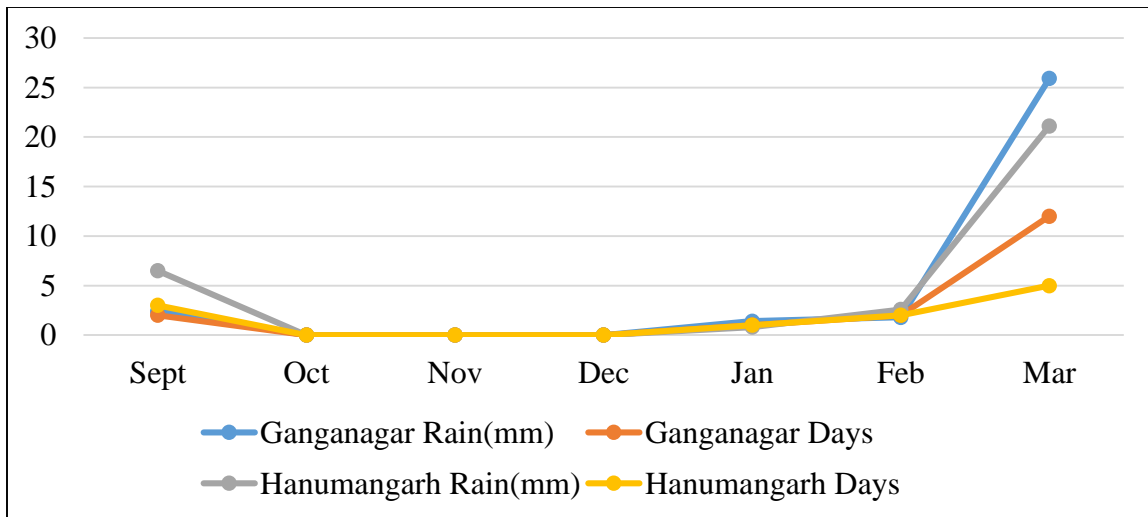


Fig 4.1.3.8: Rainfall and Rain days of Segment-3 (Hanumangarh and Sri Ganganagar)

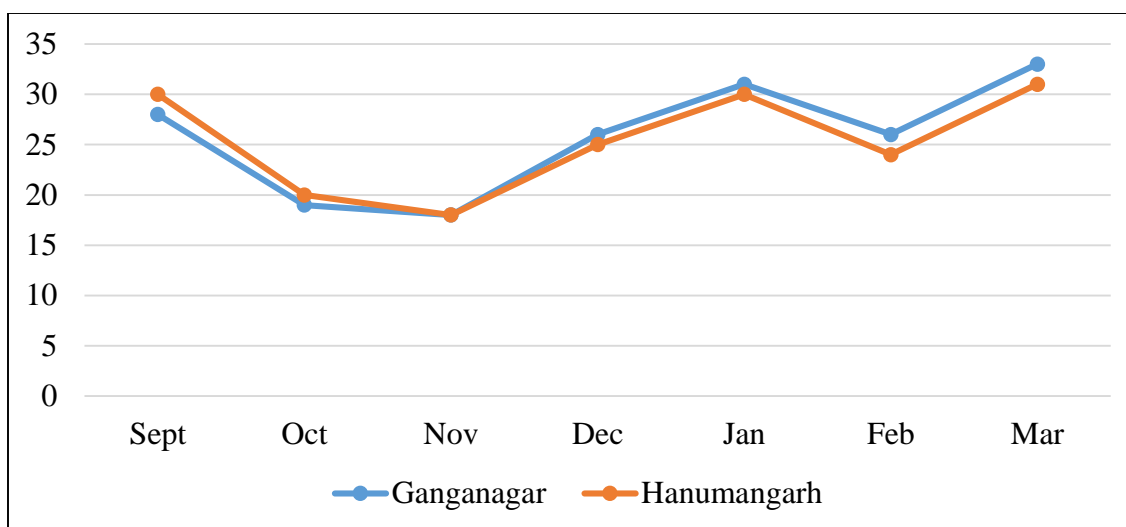


Fig 4.1.3.9 Humidity of Segment-3 (Hanumangarh and Sri Ganganagar)

Table 4.1.3.4: Madhya Pradesh Monthly Average, Minimum and Maximum Temperature

District	Temp (°C)	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Morena	Avg	33	32	26	21	21	24	31
	Min	27	24	18	14	13	15	22
	Max	36	36	32	27	27	31	37
Gwalior	Avg	33	32	26	21	21	24	31
	Min	27	24	18	14	13	15	22
	Max	36	36	32	27	27	31	37
Sheopur	Avg	32	31	27	23	22	26	24
	Min	26	23	18	15	15	17	32
	Max	36	36	33	30	28	32	37
Shivpuri	Avg	31	30	26	23	22	25	31
	Min	25	23	19	16	15	17	23
	Max	34	34	31	28	27	30	35
Bhind	Avg	33	32	27	22	21	25	32
	Min	27	25	20	15	14	16	23
	Max	37	37	33	28	27	31	37

(Source: www.worldweatheronline.com)

Table 4.1.3.5: Madhya Pradesh Monthly Rainfall and Rain days

District	Rainfall	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Morena	Rain(mm)	16.02	3.9	0	0	0.6	0.1	8.53
	Days	12	2	0	0	1	1	7
Gwalior	Rain(mm)	16.02	3.9	0	0	0.6	0.1	8.53
	Days	12	2	0	0	1	1	7
Sheopur	Rain(mm)	19.41	23.79	0	0	0.81	0	4.39
	Days	10	6	0	0	1	0	7
Shivpuri	Rain(mm)	64.57	65.42	0	0	2.38	0.3	9.1
	Days	19	7	0	0	1	1	9
Bhind	Rain(mm)	38.5	1.3	0	0	2.3	0.7	17.41
	Days	17	3	0	0	1	2	11

(Source: www.worldweatheronline.com)

Table 4.1.3.6: Madhya Pradesh Monthly Humidity (%)

District	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Morena	61	35	28	41	43	32	24
Gwalior	61	35	28	41	43	32	24
Sheopur	62	41	28	38	37	26	21
Shivpuri	66	42	28	37	38	28	23
Bhind	62	37	28	39	43	33	25

(Source: www.worldweatheronline.com)

With the available data on temperature, rainfall and humidity selected districts of Madhya Pradesh were categorized into two segments based on similarity in agro-climatic factors. The details of segments with figure showing similarity in the minimum, maximum and average temperature, rainfall, rain days and humidity of each segment is given from fig. 4.1.3.10 to fig. 4.1.3.15.

Segment-1: Morena, Bhind and Gwalior

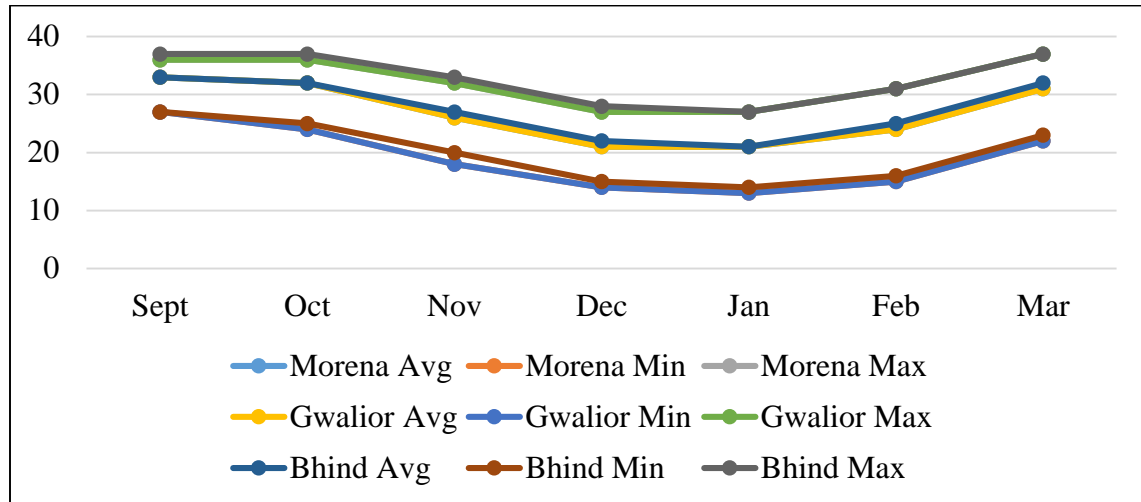


Fig 4.1.3.10: Min, Avg and Max Temperature of Segment-1 (Morena, Bhind and Gwalior)

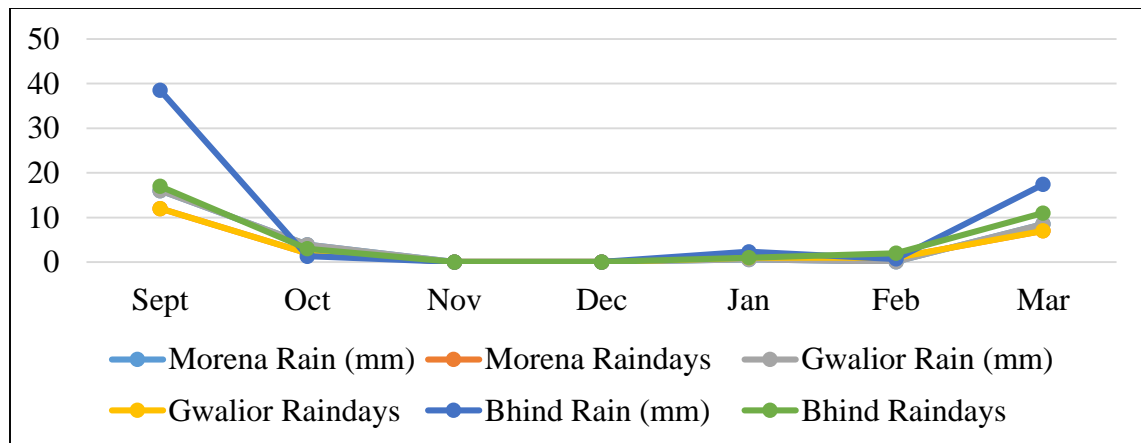


Fig 4.1.3.11: Rainfall and Rain days of Segment-1 (Morena, Bhind and Gwalior)

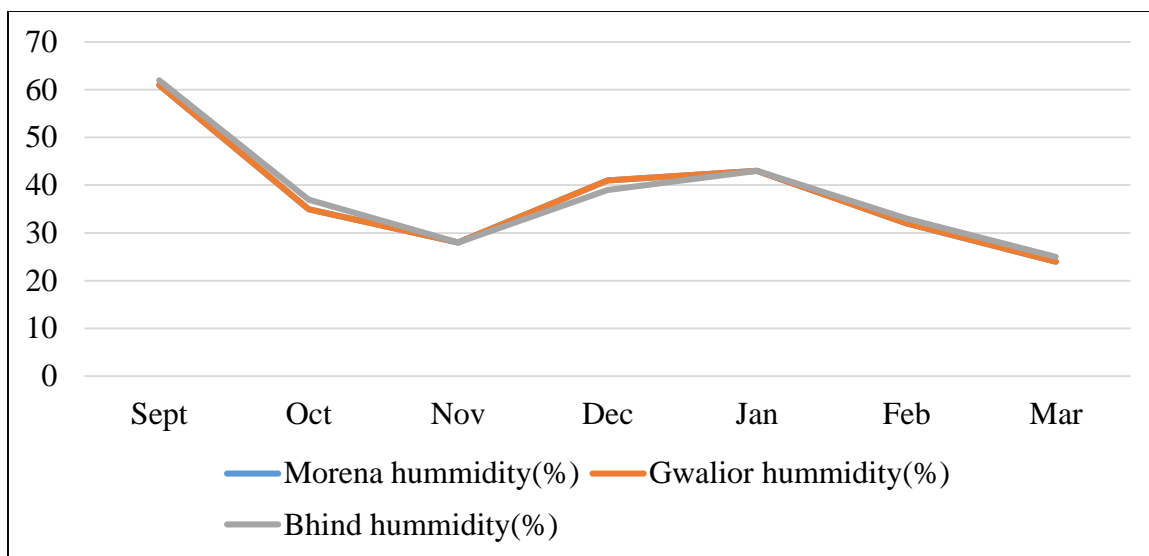


Fig 4.1.3.11: Humidity (%) of Segment-1 (Morena, Bhind and Gwalior)

Segment-2: Sheopur and Shivpuri

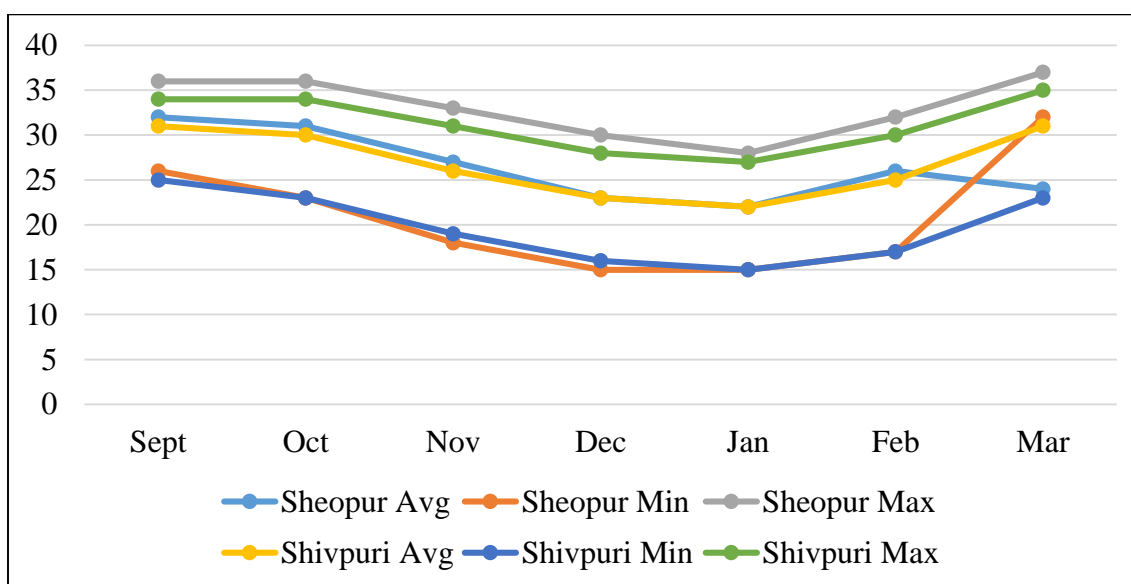


Fig 4.1.3.13: Min, Avg and Max Temperature of Segment-2 (Sheopur and Shivpuri)

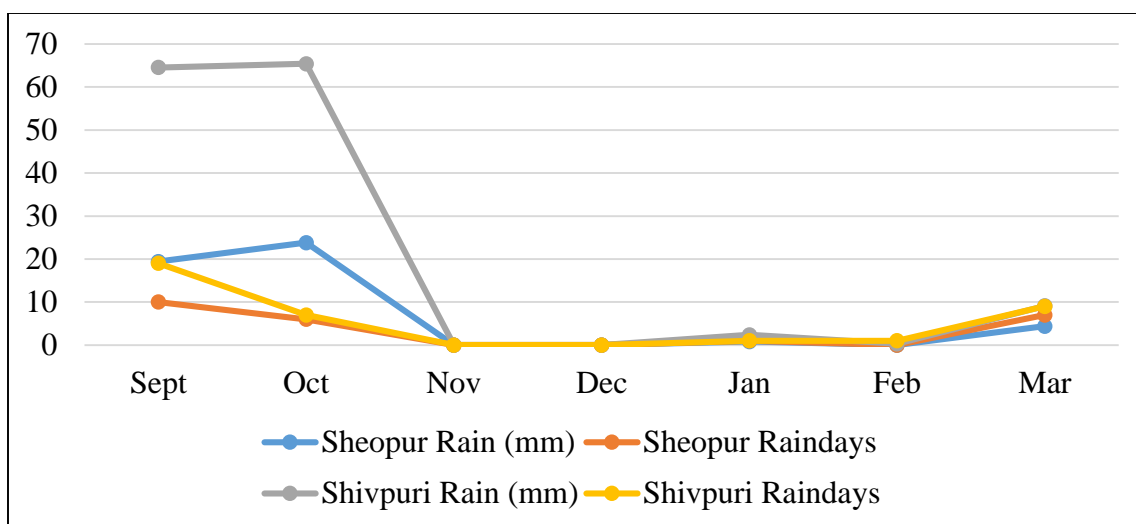


Fig 4.1.3.14: Rainfall and Rain days of Segment-2 (Sheopur and Shivpuri)

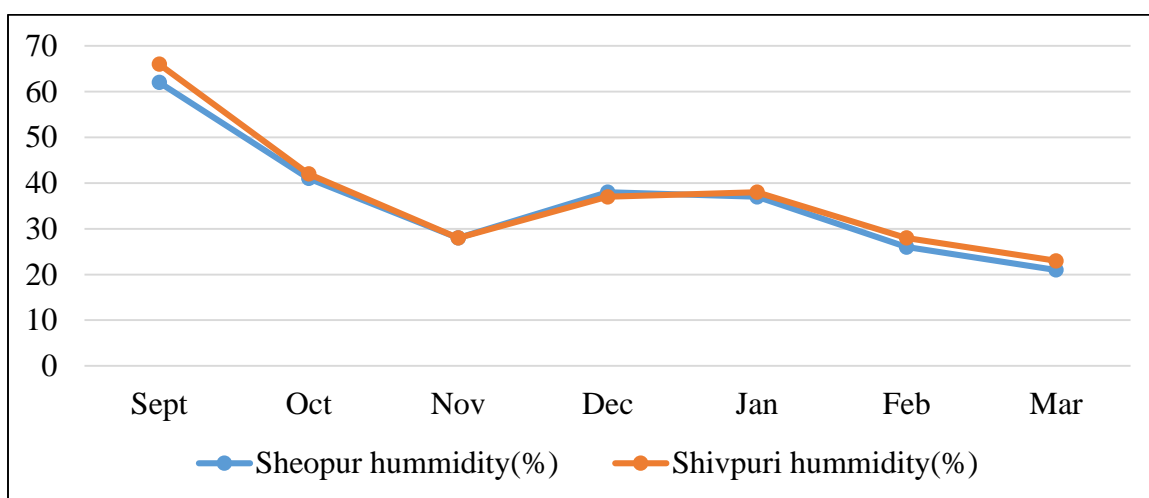


Fig 4.1.3.15: Humidity (%) of Segment-2 (Sheopur and Shivpuri)

Table 4.1.3.7: Haryana Monthly Average, Minimum and Maximum Temperature

District	Temp (°C)	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Bhiwani	Avg	36	33	27	22	20	23	29
	Min	29	26	20	16	12	14	21
	Max	40	38	33	28	26	29	34

Mahendergarh	Avg	34	33	27	22	19	23	29
	Min	28	26	19	15	12	13	20
	Max	38	37	32	28	25	29	34
Rewari	Avg	35	33	27	22	19	23	29
	Min	28	26	20	15	12	14	21
	Max	39	37	32	28	25	29	35
Hisar	Avg	36	34	27	23	20	23	29
	Min	30	26	20	16	13	15	21
	Max	40	38	33	29	26	29	34
Sirsa	Avg	37	33	26	22	19	23	29
	Min	29	24	18	14	12	13	19
	Max	41	39	33	28	25	29	34

(Source: www.worldweatheronline.com)

Table 4.1.3.8: Haryana Monthly Rainfall and Rain days

District	Rainfall	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Bhiwani	Rain(mm)	8.41	0	0	0	0.1	4.5	23.72
	Days	5	0	0	0	0	3	8
Mahendergarh	Rain(mm)	3.16	0.61	0	0	1.9	2.71	18.9
	Days	3	3	0	0	2	2	8
Rewari	Rain(mm)	8.42	0.31	0	0	1.5	1.7	10.62
	Days	3	1	0	0	2	2	10
Hisar	Rain(mm)	5.9	0.1	0	0	0.1	13.6	15.42
	Days	1	0	0	0	0	4	8
Sirsa	Rain(mm)	4.8	0.51	0	0.1	0.3	6.01	22.19
	Days	1	1	0	0	1	3	8

(Source: www.worldweatheronline.com)

Table 4.1.3.9: Haryana Monthly Humidity (%)

District	Sept	Oct	Nov	Dec	Jan	Feb
Bhiwani	38	22	18	30	39	32

Mahendergarh	42	26	20	33	44	34
Rewari	42	26	20	33	44	34
Hisar	35	21	17	27	34	28
Sirsa	32	21	17	26	32	27

(Source: www.worldweatheronline.com)

With the available data on temperature, rainfall and humidity selected districts of Haryana were categorized into two segments based on similarity in agro-climatic factors. The details of segments with figure showing similarity in the minimum, maximum and average temperature, rainfall, rain days and humidity of each segment is given from fig. 4.1.3.16 to fig. 4.1.3.21.

Segment-1: Bhiwani, Rewari and Mahendergarh

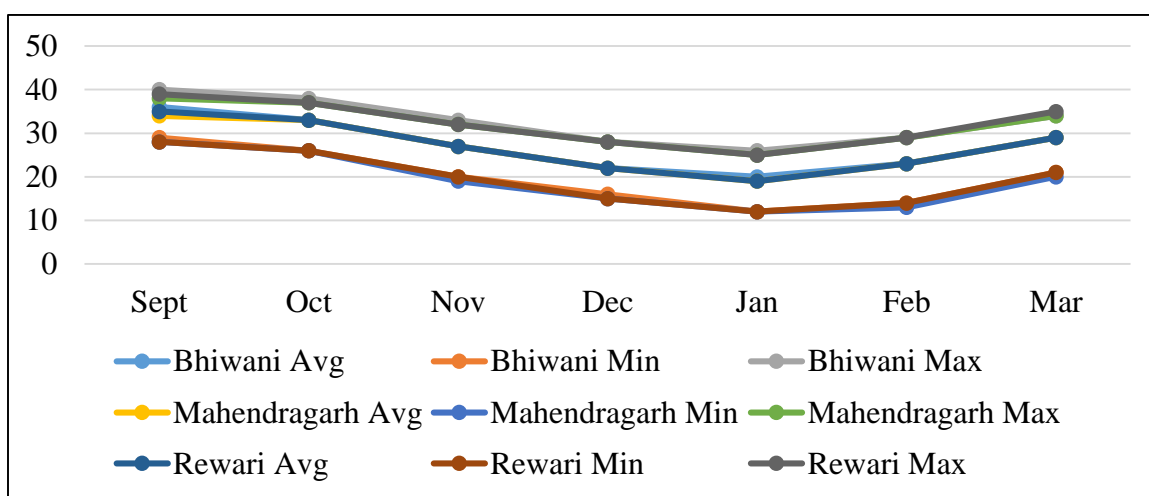


Fig 4.1.3.16: Min, Avg and Max Temperature of Segment-1 (Bhiwani, Rewari and Mahendergarh)

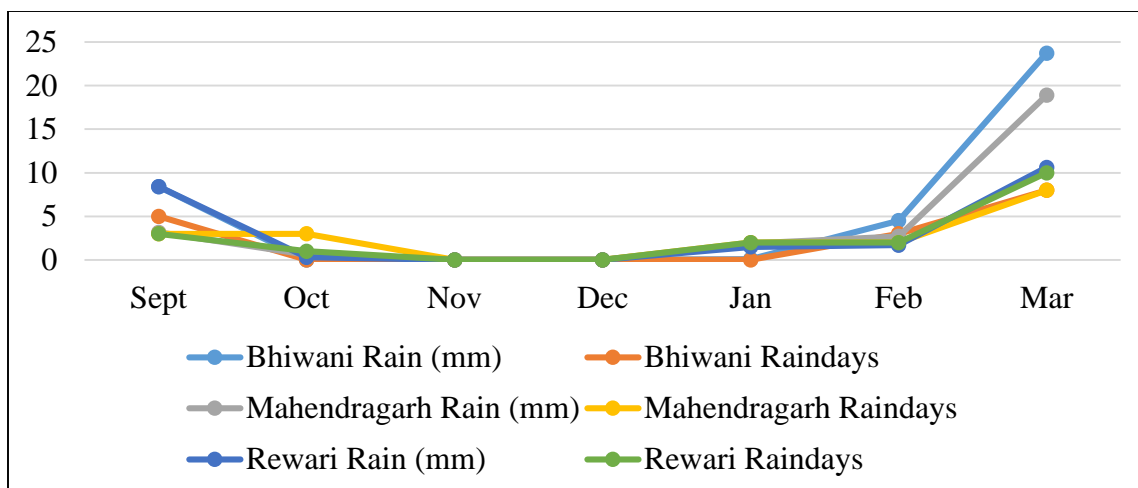


Fig 4.1.3.17: Rainfall and Rain days of Segment-1 (Bhiwani, Rewari and Mahendergarh)

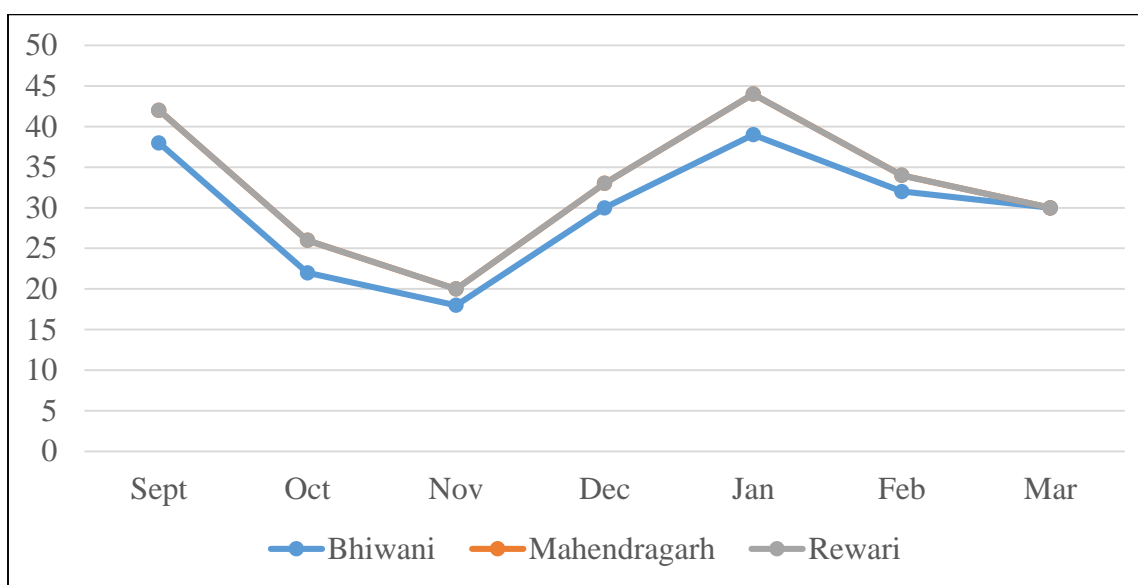


Fig 4.1.3.18: Humidity (%) of Segment-1 (Bhiwani, Rewari and Mahendergarh)

Segment-2: Hisar and Sirsa

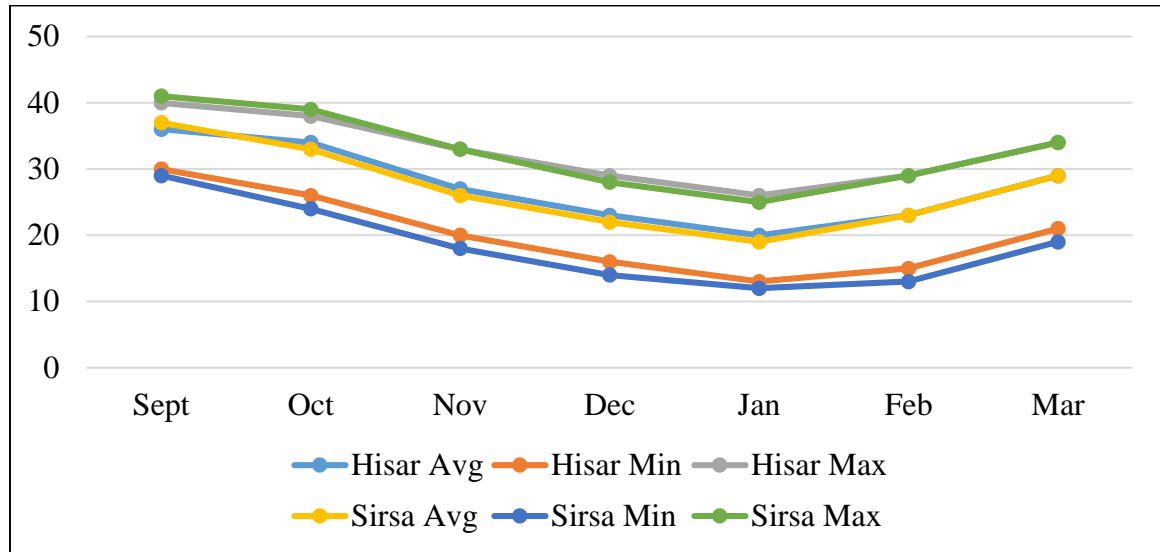


Fig 4.1.3.19: Min, Avg and Max Temperature of Segment-2 (Hisar and Sirsa)

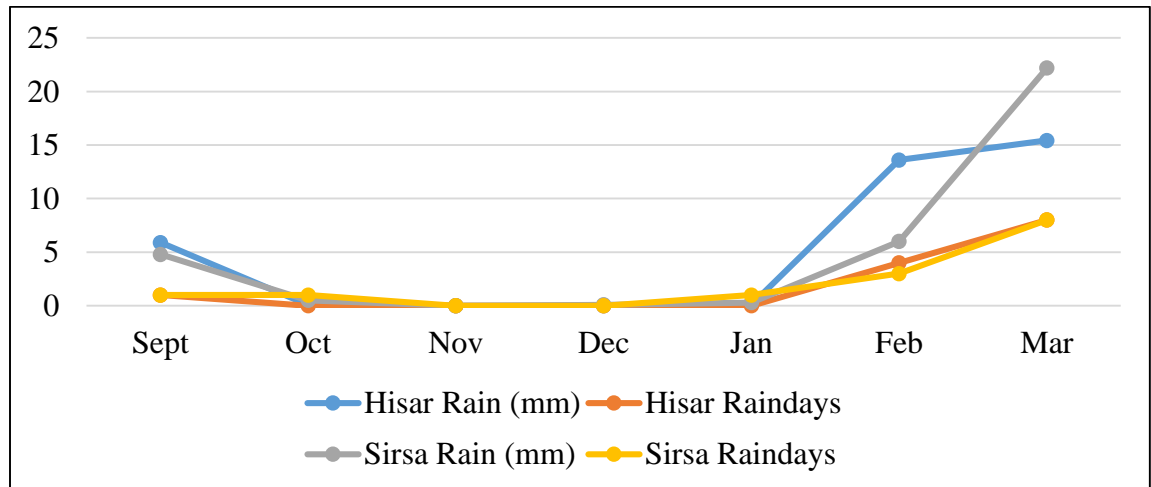


Fig 4.1.3.20: Rainfall and Rain days of Segment-2 (Hisar and Sirsa)

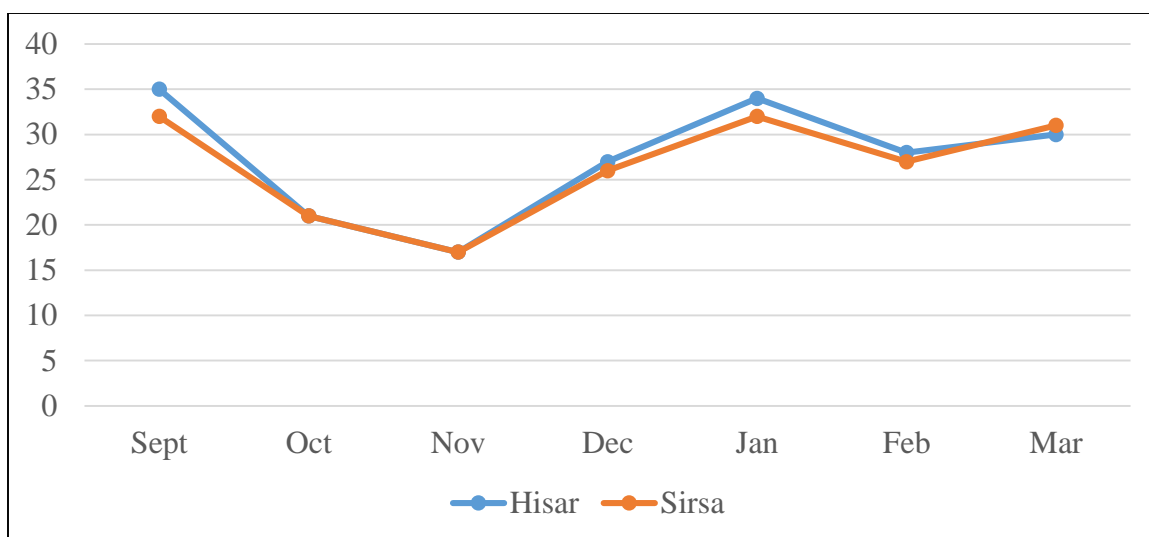


Fig 4.1.3.21: Humidity (%) of Segment-2 (Hisar and Sirsa)

Table 4.1.3.10: Uttar Pradesh Monthly Average, Minimum and Maximum Temperature

District	Temp (°C)	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Agra	Avg	34	35	28	23	22	25	32
	Min	28	26	21	16	14	16	23
	Max	37	38	33	29	27	31	37
Mathura	Avg	34	33	27	22	20	24	31
	Min	28	26	20	15	13	15	22
	Max	38	38	33	28	27	31	36
Aligarh	Avg	34	32	26	21	20	23	30
	Min	27	24	19	15	12	14	20
	Max	37	37	32	27	26	30	35

(Source: www.worldweatheronline.com)

Table 4.1.3.11 Uttar Pradesh Monthly Rainfall and Rain days

District	Rainfall	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Agra	Rain(mm)	30.18	0.4	0	0	0	0.4	14.2
	Days	15	1	0	0	0	2	7
Mathura	Rain(mm)	19.78	0.2	0	0	0.9	0.3	11.71

	Days	11	1	0	0	1	2	9
Aligarh	Rain(mm)	18.61	0.31	0	0	0.4	0.59	27.19
	Days	11	1	0	0	1	3	8

(Source: www.worldweatheronline.com)

Table 4.1.3.12 Uttar Pradesh Monthly Humidity (%)

District	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Agra	59	32	25	36	42	33	26
Mathura	53	29	23	37	45	33	26
Aligarh	56	30	24	34	42	34	28

(Source: www.worldweatheronline.com)

With the available data on temperature, rainfall and humidity selected districts of Uttar Pradesh were categorized into only one segments based on similarity in agro-climatic factors. The details of segments with figure showing similarity in the minimum, maximum and average temperature, rainfall, rain days and humidity of each segment is given from fig. 4.1.3.22 to fig. 4.1.3.24.

Segment-1: Agra, Mathura and Aligarh

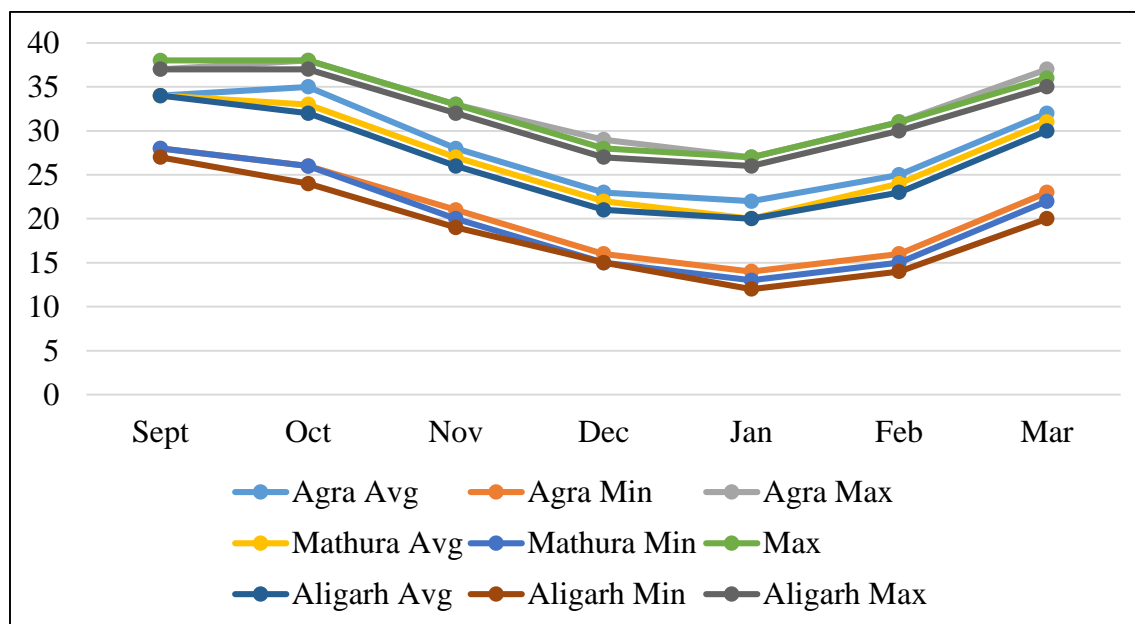


Fig 4.1.3.22: Min, Avg and Max Temperature of Segment-1 (Agra, Mathura and Aligarh)

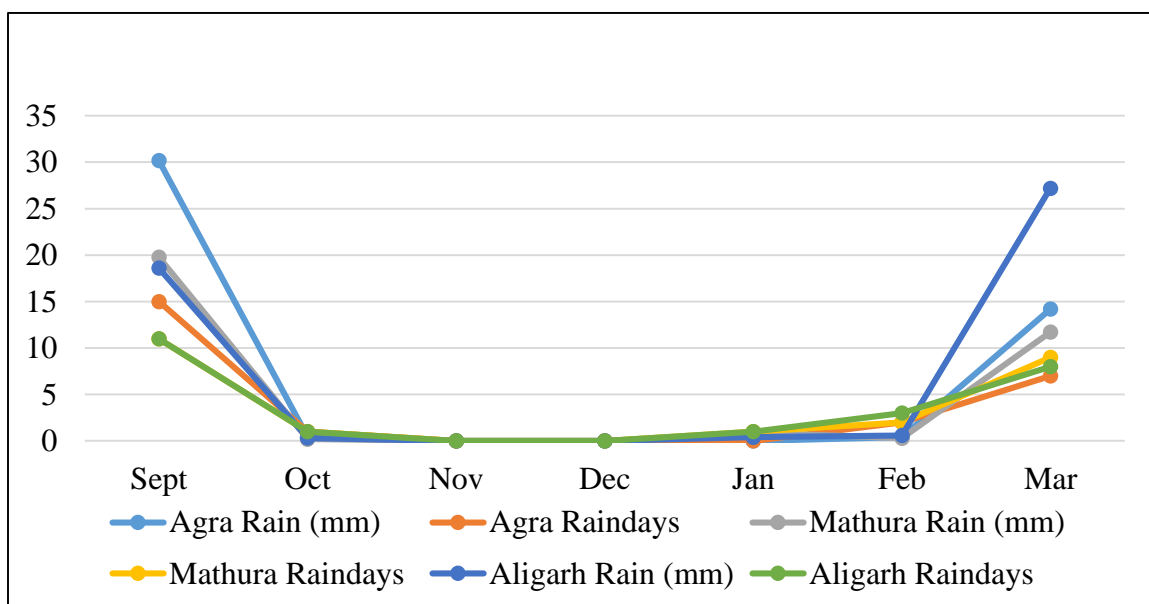


Fig 4.1.3.23: Rainfall and Rain days Segment-1 (Agra, Mathura and Aligarh)

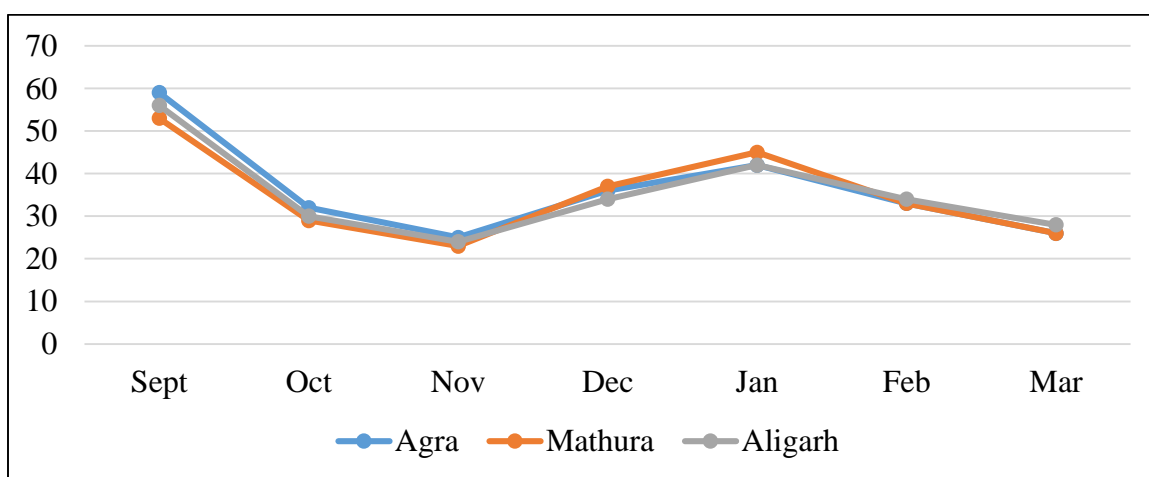


Fig 4.1.3.24: Humidity (%) of Segment-1 (Agra, Mathura and Aligarh)

Table 4.1.3.13: Gujarat Monthly Average, Minimum and Maximum Temperature

District	Temp (°C)	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Banaskantha	Avg	31	32	30	27	25	28	32
	Min	25	26	22	19	17	19	24

	Max	35	36	35	33	31	34	37
Mahesana	Avg	32	32	30	27	26	29	33
	Min	26	26	22	19	18	20	25
	Max	36	37	37	34	33	36	39
Patan	Avg	32	33	31	28	26	29	33
	Min	26	27	23	20	18	20	25
	Max	36	37	37	34	32	35	39

(Source: www.worldweatheronline.com)

Table 4.1.3.14 Gujarat Monthly Rainfall and Rain days

District	Rainfall	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Banaskantha	Rain(mm)	9.27	59.16	0	0	0.1	0.7	0
	Days	15	7	0	0	0	1	0
Patan	Rain(mm)	6.24	41.58	0	0	0	0.3	0.3
	Days	12	7	0	0	0	2	0
Mahesana	Rain(mm)	11.64	33.79	0	0	0	0	0.7
	Days	17	7	0	0	0	0	1

(Source: www.worldweatheronline.com)

Table 4.1.3.15 Gujarat Monthly Humidity (%)

District	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Banaskantha	62	47	25	29	33	22	25
Patan	61	46	26	31	34	22	25
Mahesana	64	49	28	33	34	22	24

(Source: www.worldweatheronline.com)

With the available data on temperature, rainfall and humidity selected districts of Gujarat were kept into only one segments based on similarity in agro-climatic factors. The details of segments with figure showing similarity in the minimum, maximum and average temperature, rainfall, rain days and humidity of each segment is given from fig. 4.1.3.25 to fig. 4.1.3.27.

Segment-1: Banaskantha, Mahesana and Patan

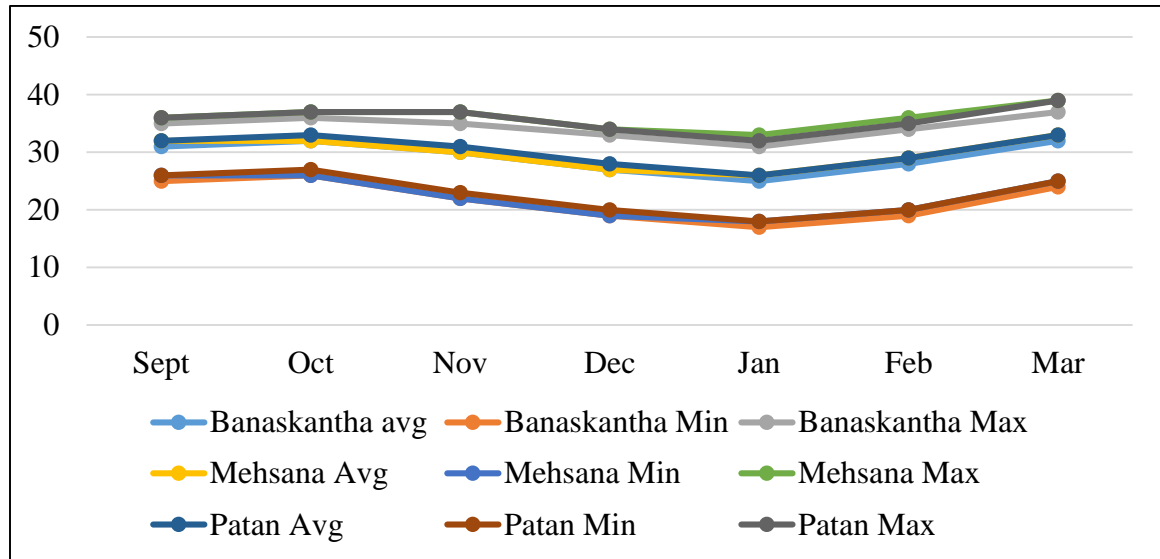


Fig 4.1.3.25: Min, Avg and Max Temperature of Segment-1 (Banaskantha, Mahesana and Patan)

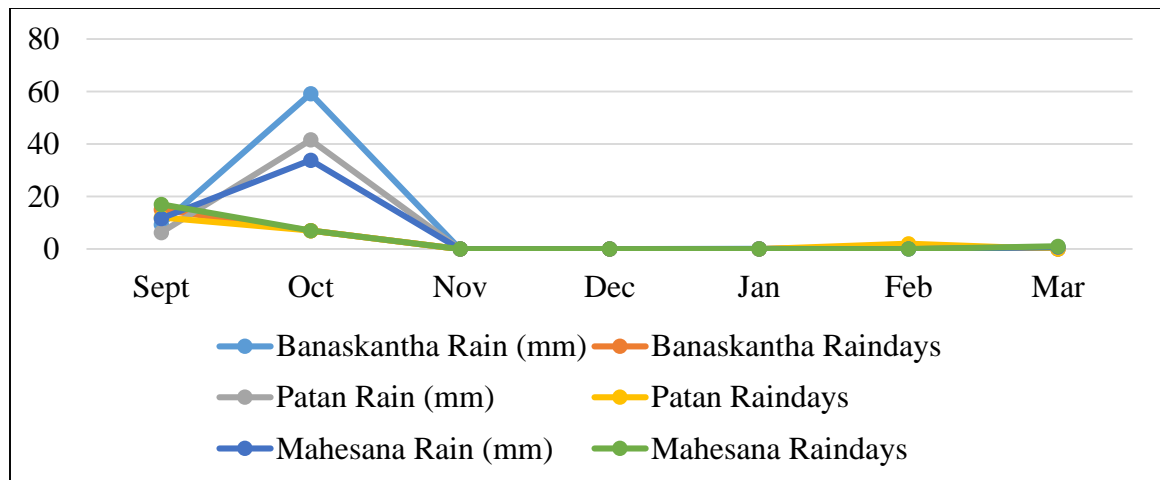


Fig 4.1.3.26: Rainfall and Rain days of Segment-1 (Banaskantha, Mahesana and Patan)

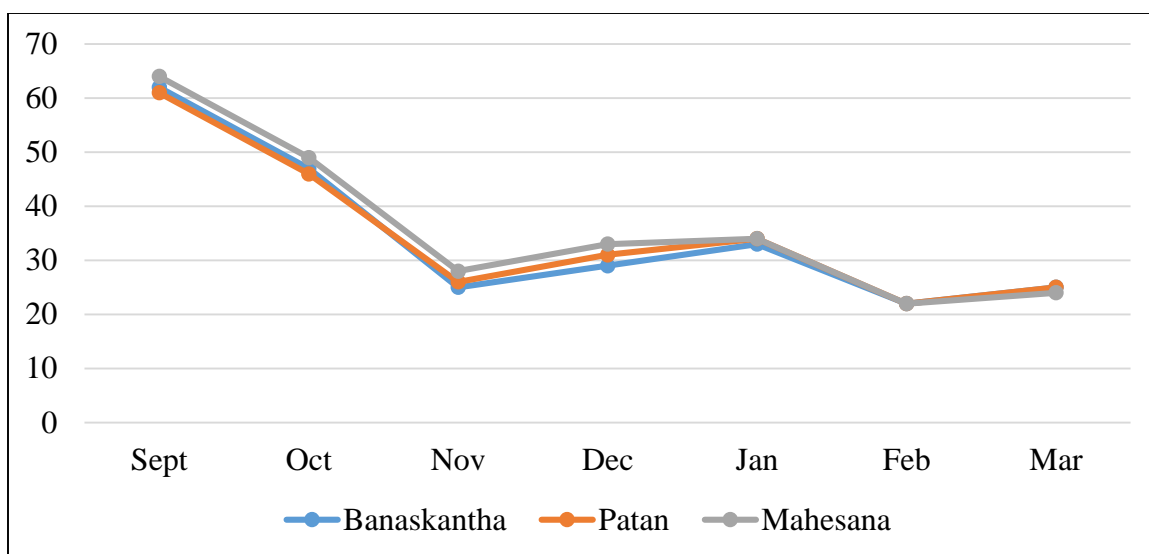


Fig 4.1.3.27: Humidity (%) of Segment-1 (Banaskantha, Mahesana and Patan)

4.1.4 Optimum Period of Sowing of Rapeseed-Mustard in Different Districts

Table 4.1.4.1 Sowing period of Rapeseed-mustard in different selected districts

Study Area	Sowing Period
Rajasthan	
Tonk	Mid Sept- Mid Oct
Alwar	Mid Sept-Mid Oct
Ganganagar	Mid Oct- Early Nov
Bharatpur	Mid Sept-Mid Oct
Sawaimadhopur	Mid Sept- Early Oct
Jaipur	Mid Sept-Mid Oct
Hanumangarh	Mid Oct- Early Nov
Madhya Pradesh	
Bhind	Early Oct- Early Nov
Morena	Early Oct- Early Nov
Gwalior	Early Oct- Early Nov
Sheopur	Late Sept- Mid Oct

Shivpuri	Late Sept- Mid Oct
Haryana	
Bhiwani	Late Oct – Mid Nov
Mahendergarh	Mid Oct- Late Oct
Rewari	Mid Oct- Late Oct
Hisar	Mid Oct- Early Nov
Sirsa	Mid Oct- Early Nov
Bihar	
Saran	2nd-3rd week Oct (Mono-cropping) Late Nov- late Dec (Mixed Cropping/Intercropping)
Nalanda	2nd-3rd week Oct (Mono-cropping) Late Nov- late Dec (Mixed Cropping/Intercropping)
Uttar Pradesh	
Agra	Early Oct- 3rd Week Oct
Mathura	Last week Aug- Early Sept (SD) 2nd- 3rd week Oct (FD)
Aligarh	Last week Aug- Early Sept (SD) 2nd- 3rd week Oct (FD)
Gujarat	
Banaskantha	Early Oct- Late Oct
Mahesana	Early Oct- Mid Oct
Patan	Early Oct- Mid Oct

Rajasthan: Maximum sowing of mustard seed was done by farmers during mid-September to mid- October. The sowing in rainfed area was early and starts from mid-September after first rainfall. Sowing in irrigated condition was done by farmers during mid-October. In Sri Ganganagar and Hanumangarh Sowing were done up to early November, whereas as late sowing extended up to mid-November.

Madhya Pradesh: Sowing of mustard in Madhya Pradesh was from late September to early November. In Morena, Bhind and Gwalior districts sowing of mustard was done from early October till early November, whereas in Sheopur and Shivpuri districts the farmers growing mustard mainly under rainfed condition so that sowing was done from early September till mid-October.

Haryana: Sowing of mustard in Bhiwani district was done by the farmers from late October till mid-November. In Sirsa and Hisar sowing were done till early November.

Bihar: Sowing of mustard in Saran and Nalanda district of Bihar varied according to the cropping system growers were following. In mono-cropping system farmers were sowing the mustard within the month of October. In inter-cropping and mixed-cropping system mustard was grown with wheat and barley crop and sowing was done with the sowing of wheat and barley in the month of Nov-Dec.

Uttar Pradesh: Sowing of mustard in Aligarh and Mathura districts of Uttar Pradesh was started from August month. Farmers in these two district were taking mustard as short duration crop after which they are taking wheat crop in rabi season. The full duration winter crop were also grown by farmers in this region and sowing was done in the month of October.

Gujarat: Sowing was done between early-October till mid-October in Mahesana and Patan district, whereas in Banaskantha it was done up to Late October.

4.1.5 Seed Rate, Method of Sowing and Spacing in selected district

Maintenance of optimum plant population is essential for getting good harvests. The seed rate depending on type of seed and spacing followed varies from 2.6-6.6 kg/ha. Seed rate and spacing practices followed in selected district under study are presented in Table 4.1.4

Table 4.1.5.1 Seed Rate, Method of Sowing and Spacing followed in the study area

Study Area	Optimum Seed Rate		Method of Sowing	Spacing(cm)
Rajasthan	Hybrid	Improved Varieties		(R X R)
Tonk	4.4	6.6	Seed drill	25-32.5

Alwar	3.1	4.4	Seed drill	25-32.5
Ganganagar	2.6	4.4	Seed drill	32.5-45
Bharatpur	3.5	4.4	Seed drill	25-32.5
Sawaimadhopur	4.4	6.6	Seed drill	25-32.5
Hanumangarh	2.6	4.4	Seed drill	32.5-45
Jaipur	3.1	4.4	Seed drill	25-32.5
Madhya Pradesh				
Bhind	3.5	4.4	Seed drill	30-37.5
Morena	3.5	4.4	Seed drill	30-37.5
Gwalior	3.5	4.4	Seed drill	30-37.5
Sheopur	4.4	6.6	Broadcasting/Seed drill	25-32.5
Shivpuri	4.4	6.6	Broadcasting/Seed drill	25-32.5
Haryana				
Bhiwani	3.5	4.4	Seed drill	30.5-37.5
Mahendergarh	3.5	4.4	Seed drill	32.5-37.5
Rewari	3.5	4.4	Seed drill	32.5-37.5
Hisar	2.6	4.4	Seed drill	32.5-45
Sirsa	2.6	4.4	Seed drill	32.5-45
Bihar				
Chhapra	3.4	6.8	Broadcasting	-
Nalanda	3.4	6.8	Broadcasting	-
Uttar Pradesh				
Agra	3.5	6.6	Seed drill	25-37.5
Mathura	3.1	6.6	Seed drill	25-37.5
Aligarh	4.4	6.6	Broadcasting/Seed drill	25-37.5
Gujarat				

Banaskantha	3.5	4.4	Broadcasting/Seed drill	25-37.5
Mahesana	4.4	6.6	Broadcasting/Seed drill	22.5-30
Patan	4.4	6.6	Broadcasting/Seed drill	22.5-30

Table 4.1.5.1 shows that seed rate for mustard crop was different from region to region and type of seeds used by the farmers. The seed rate for hybrid was lesser than seed rate for improved varieties of mustard. Lowest seed rate was in Sri Ganganagar and Hanumangarh district for hybrid and improved varieties, whereas highest seed rate for improved varieties was in Saran and Nalanda district of Bihar.

Method of sowing: Method of sowing in most of the study area was with the seed drill, whereas in some region broadcasting was also done by farmers like in Bihar, parts of Gujarat and Aligarh district of Uttar Pradesh. (Fig 4.1.5.1)

Spacing: The highest spacing in mustard was followed in Sri Ganganagar and Hanumangarh district of Rajasthan and Sirsa and Hisar district of Haryana. Lowest spacing was followed in broadcasted field. (Fig 4.1.5.1)



Broadcasting method of sowing



Seed Drill Sowing

Fig 4.1.5.1 Spacing followed in broadcasted and Seed drill sown field

4.1.6 Cropping Systems and Cropping Patterns

Table 4.1.6.1 Cropping System and Cropping Sequence followed in each District with Mustard Crop

Study Area	Cropping System	Cropping Sequence		
		Kharif	Rabi	Summer
Rajasthan				
Tonk	Mono-cropping	Bajra/Urd/Moong/Jowar	Mustard	Fallow
Alwar	Mono-cropping	Bajra/Cotton/Jowar/Guar	Mustard	Fallow
Ganganagar	Mono-cropping	Guar/Cotton	Mustard	Cotton
Bharatpur	Mono-cropping	Bajra/Guar/Jowar	Mustard	Fallow
Sawaimadhopur	Mono-cropping	Bajra/Urd/Til/Soybean	Mustard	Fallow
Jaipur	Mono-cropping	Bajra/Moong/Jowar/Guar	Mustard	Fallow
Hanumangarh	Mono-cropping	Guar/Cotton	Mustard	Cotton
Madhya Pradesh				
Bhind	Mono-cropping	Bajra/Til	Mustard	Fallow
Morena	Mono-cropping	Bajra	Mustard	Fallow
Gwalior	Mono-cropping	Til/Bajra/Soybean	Mustard	Fallow/Fodder
Sheopur	Mono-cropping	Soybean/Til/Bajra	Mustard	Fallow/Fodder

Shivpuri	Mono-cropping	Groundnut	Mustard	Fallow/Fodder
Haryana				
Bhiwani	Mono-cropping	Bajra/Cotton/Guar	Mustard	Fallow/Cotton
Mahendergarh	Mono-cropping	Bajra	Mustard	Fallow/Cotton
Rewari	Mono-cropping	Bajra	Mustard	Fallow/Cotton
Hisar	Mono-cropping	Bajra/Guar/Cotton	Mustard	Cotton
Sirsa	Mono-cropping	Cotton/Guar	Mustard	Cotton
Bihar				
Saran	Mono-cropping	Maize/Moong/ Rice	Mustard	Vegetable/ Maize
	Mixed cropping/Inter cropping	Maize/Moong/ Rice	Mustard+ Wheat/ Barley	Vegetable/ Maize
Nalanda	Mono-cropping	Maize/Rice	Mustard	Vegetable/ Maize
	Mixed cropping/Inter cropping	Maize/Rice	Mustard+ Wheat/ Barley	Vegetable/ Maize
Uttar Pradesh				
Agra	Mono-cropping	Bajra	Mustard	Vegetable
Mathura	Mono-cropping	Bajra/Fodder	Mustard	Vegetable

Aligarh	Mono-cropping	Bajra	Mustard	Vegetable
Gujarat				
Banaskantha	Mono-cropping	Bajra/Cluster bean/Castor	Mustard	Fallow
Mahesana	Mono-cropping	Bajra/Cotton /Cluster bean	Mustard	Fallow
Patan	Mono-cropping	Jowar/Castor/Cotton	Mustard	Fallow

Table 4.1.6.1 shows that in Saran and Nalanda district of Bihar mustard was grown as an inter-crop, mixed-crop and mono-crop, remaining all districts only as mono-crop. The cropping pattern was different in different states. Maximum followed cropping pattern was Bajra-mustard-cotton/fallow.



Intercropping in Saran (Bihar)



Monocropping

Fig 4.1.6.1 Cropping System

4.1.7 Crop Business Opportunity

Crop business opportunity for mustard business lies with the high acreage under cultivation of mustard in the country. With a large area under cultivation of mustard company can grab a share in the mustard seed business with the introduction of right products into right markets.

Table 4.1.7.1 District-wise Crop Business Opportunity for the Company

District	Average Acreage (Ha)	Potential (MT)	
		Hybrid	Research
Tonk	279392	1222	1834
Alwar	235157	720	1029
Ganganagar	219664	577	961
Bharatpur	207727	727	909
Sawaimadhopur	180731	791	1186
Hanumangarh	112191	295	491
Jaipur	103069	316	451
Rajasthan	2581474	11294	16941
Bhind	167159	585	731
Morena	128609	450	563
Gwalior	50749	178	222
Sheopur	45009	197	295
Shivpuri	34082	149	224
Madhya Pradesh	699350	3060	4589
Bhiwani	157224	550	688
Mahendergarh	99562	348	436
Rewari	64849	227	284
Hisar	64923	170	284
Sirsa	41415	109	181
Haryana	538614	1885	2356
Saran	3179	11	22

Nalanda	2361	8	16
Bihar	86123	377	754
Agra	48088	168	316
Mathura	42928	131	282
Aligarh	18376	80	121
Uttar Pradesh	619799	2712	4067
Banaskantha	120110	420	525
Mahesana	25303	111	166
Patan	27929	122	183
Gujarat	215380	942	1413

Table 4.1.7.1 shows that market potential of different districts which is crop business opportunity for the company in that district. The study found that crop business opportunity with respect to the area under cultivation is maximum in the state of Rajasthan followed by the Haryana, Madhya Pradesh, Uttar Pradesh, Gujarat and Bihar respectively. Largest market potential was in Tonk district followed by the Alwar and Sawaimadhopur of Rajasthan respectively.

4.2 CLUSTER WISE MUST HAVE TRAITS AND GOOD TO HAVE TRAITS IN MUSTARD SEEDS

Trait: trait is character/feature of an organism generally used in breeding. It is responsible for phenotypic expression of the organism.

Must have trait: Traits which are necessary in a plant to perform under certain climatic conditions suitable to locality and gives best yield when present in particular crop. These are traits which are most preferred by the farmers of particular region according to their agronomic practices and other requirements.

Good to have trait: these are the traits which gives an additional performance when combined with the necessary traits but will not perform better if must have traits are absent

in the crop. These are the traits which are liked by the farmers but is not in seriously required.

Biotic stress: Stress that occurs as a result of damage done to plants by other living organisms, such as bacteria, viruses, fungi, parasites, beneficial and harmful insects, weeds, and cultivated or native plants.

Abiotic stress: The negative impact of non-living factors on the living organisms in a specific environment.

Morphological trait:

Agronomic trait: Traits which gives physical appearance to the crop/plant or parts. This is responsible for the form and structure of the organism.

Based on above parameters the selected districts under study were grouped into different cluster. District with same type of trait requirements under must have and good to have traits category were grouped into one cluster. The cluster with identified must have and good to have traits are given below;

Cluster 1: Bharatpur-Sawaimadhopur-Alwar-Sheopur-Shivpuri

Particular	Must have traits	Good to have traits
Biotic stress	SSR Resistant	Painted bug resistant
	Orobanche resistant	Termite resistant
		Aphid resistant
		Stag head resistant
Abiotic	Frost tolerant	
	Heat tolerant at Seedling germination	
Agronomic	Earliness, Medium duration	Brownish black bold grain
	Drought tolerant	
	Bottom branching	
	Open siliqua type	
	Dwarf, Medium height	

Cluster 2: Jaipur-Tonk

Particular	Must have traits	Good to have traits
Biotic stress	SSR Resistant	Painted bug resistant
	Orobanche resistant	Aphid resistant
		Stag head resistant
Abiotic	Frost tolerant	Heat tolerant at seedling germination
Agronomic traits	Medium duration	Brownish black bold grain
	Bottom branching	Medium height
	Open siliqua type	

Cluster 3: Bhind –Morena- Gwalior

Particular	Must have traits	Good to have traits
Biotic stress	SSR resistant	Painted bug resistant
	Orobanche resistant	Aphid resistant
Abiotic	Frost tolerant	Stag head resistant
Agronomic traits	Non Shattering	Medium duration
	Medium height	Brownish bold shiny grains
	Bottom Branching	
	Close siliqua type	

Cluster 4: Hanumangarh- Sri Ganganagar- Hisar- Sirsa

Particular	Must have traits	Good to have traits
Biotic stress	SSR resistant	Alternaria Resistant
	Stag head resistant	Painted bug resistant
		Bihar hairy caterpillar resistant
		Aphid resistant
Abiotic	Frost tolerant	

Agronomic traits	Full duration	Medium-bold shiny grains
	Bottom Branching	Medium height
	Open siliqua type	

Cluster 5: Bhiwani- Mahendergarh- Rewari

Particular	Must have traits	Good to have traits
Biotic stress	SSR resistant	Painted bug resistant
	Orobanche resistant	Aphid resistant
		Stag head resistant
Abiotic	Frost tolerant	Salinity tolerant
Agronomic traits	Bottom Branching	Medium duration
	Open siliqua type	Bold shiny grains
	Medium height	

Cluster 6: Mahesana- Patan- Banaskantha

Particular	Must have traits	Good to have traits
Biotic stress	Orobanche resistant	Mustard saw fly
	Powdery mildew resistant	Aphid resistant
	White rust resistant	
Abiotic	Heat tolerant at seedling & Terminal stage	Lodging resistant
Agronomic traits	Earliness (115-120 Days)	
	Dwarf Variety	
	Bottom Branching	Black bold shiny grains
	Open siliqua type	

Cluster 7: Mathura-Aligarh-Agra

Particular	Must have traits	Good to have traits
Biotic stress	SSR Resistant	Aphid resistant
	Stag head resistant	Alternaria Resistant
		Painted bug resistant
Abiotic		Frost tolerant
Agronomic traits	Medium duration	Black bold shiny grains
	Bottom Branching	Medium height
	Open Siliqua type	
Autumn sowing		
Agronomic traits	Short duration	
	Dwarf variety	

Cluster 8: Saran-Chhapra

Particular	Must have traits	Good to have traits
Biotic stress	SSR Resistant	Aphid resistant
	White rust resistant	DBM resistant
	Alternaria Resistant	Bihar hairy caterpillar resistant
Abiotic	Heat tolerant at Seedling	
Agronomic traits	Non shattering	Black bold shiny grains
	Mid early duration	Medium height
	Bottom Branching	
	Open Siliqua type	

4.3 SEGMENT WISE OPPORTUNITY AND IDEAL PRODUCT REQUIREMENT FOR FUTURE PRODUCT DEVELOPMENT

4.3.1 Segment Wise Opportunity

The business opportunity for mustard seed business was calculated based on the last season's market size. The approximate market size was calculated based on sell of different types of hybrid and improved varieties sold by the distributor of different companies. The market was segmented into hybrid seed and research seed segment.

Table 4.3.1.1 District-Wise Business Opportunity in Hybrid and Research Seed Segment

District	Acreage (Ha) 2015-16	Market Size		
		Total(MT)	Hybrid(MT)	Research(MT)
Tonk	250912	185	105	80
Alwar	230658	270	145	125
Ganganagar	238665	650	230	420
Bharatpur	203222	250	145	105
Sawaimadhopur	168057	180	85	95
Hanumangarh	126170	450	165	285
Jaipur	86739	200	95	105
Rajasthan	2532330			
Bhind	147870	70	26	44
Morena	113516	110	45	65
Gwalior	48418	40	11	29
Sheopur	38253	30	8	22
Shivpuri	28880	25	6	19
Madhya Pradesh	716000			
Bhiwani	156313	320	158	162
Mahendergarh	126193	240	158	82

Rewari	63369	220	128	92
Hisar	67584	140	75	65
Sirsa	44559	80	41	39
Haryana	580000			
Saran	3193	150	50	100
Nalanda	2958	20	4	16
Bihar	89657			
Agra	37016	135	70	65
Mathura	38933	105	45	60
Aligarh	16185	120	42	78
Uttar Pradesh	584287			
Banaskantha	129778	170	100	70
Mahesana	22928	40	13	27
Patan	27398	48	17	31
Gujarat	190500			

Table 4.3.1.1 shows that maximum opportunity with the present market size and seed replacement ratio was in Sri Ganganagar and Hanumangarh district of Rajasthan where almost 100% seed replacement and largest market size (650MT and 450 MT approximately respectively) were observed.

4.3.2 Ideal Product Requirement

Ideal product for company is mustard seed which can perform better in every agro climatic zone and would be perform better in every geographical location of the studied districts.

Parameter	Traits composition
Biotic Stress	SSR Resistant
	Orobanche Resistant
	Stag Head Resistant
	Alternaria Resistant

	Aphid Resistant
Abiotic	Frost Tolerant
	Heat Tolerant
Agronomic Traits	Medium Duration
	Medium height
	Bottom Branching
	Open Siliqua
Rainfed Condition	Drought Tolerant

4.4 COMPETITORS ANALYSIS WITH RESPECT TO 4P's

4.4.1 Product

Table 4.4.1.1 Product Type, Variety and Pack Size of the Existing Market Players

Major Competitor	Hybrid	Research	Pack Size (kg)
PHI	45S35		1
	45S42		
	45S46		
Bayer Crop Science	5222		1
Advanta Seeds	Coral 432	Amruta	0.8
	Coral 444		0.8
	Coral 401		1
J.K Seeds	8532	Samriddhi Gold	1
	8536		
	8031		
	8008		
Shri Ram	1666	Rani	1
Shaktivardhak	SVJ314	Parasmani-1	1
	SVJ64	Parasmani-2	
		Parasmani-8	

Nirmal	NIMH-10	Nirmal Bold	1
	NIMH-23	Ganga	
	NIMH-31		
Mahyco	Shraddha	Mahyco Bold Plus	1
Dhanya		555	1
		666	
		999	
Krishna		KM-22, KM-22+	1
		Lafar kranti, Alankar	
		Chhutki, Chhapka,	
Nuziweedu		Jumbo	1
Srirambioseed		Sonalika	1
Avni Seeds		Anvni-9	1
		Avni-15	1
Super Seed		Super Jugni	1
		Super Jhilmil	1
Hytech		749	1
Kavery		K121	1
		Ak-47	1
Bharat Seeds		Kamdhenu	1
		Kamdhenu 2	1
Ankur		Suhani	1
Ajeet		Ajeet 201	1
Nath		Nath Sona Super	1
		Nath Sona -212	1
Mahindra		Swarndhara	1
		Krishna	1
Sona Genetics		Sona Sunahri	1
		Fortune	1

Table 4.4.1.1 shows that only 5 companies had hybrid seeds of mustard and remaining all had only research or improved varieties of the mustard seeds. The major market players with very good hybrid were PHI, Bayer, Advanta, whereas the Krishna seeds have maximum product in the category of research seeds. The pack size for all companies mustard seed was 1kg with exception of Advanta seeds had pack size of 0.8 kg.

4.4.2 Product Features and Quality

Table 4.4.2.1 Product Features and Quality of Different Products in Market

Product name	Maturity (Days)	Height (cm)	Grain Size	Quality
Karuna	25-130	180-190	Bold	Higher oil percentage
45S35	115-120	140-160	Bold	Early Maturing hybrid/Bottom branching/Open siliqua
45S42	125-130	160-180	Bold	White rust tolerance//Bottom branching/Open siliqua
45S46	125-135	160-180	Bold	Frost tolerant//Bottom branching/Open siliqua
5222	125-130	160-180	Bold	Early & late sowing
5444	135-140	190-210	Bold	Frost tolerant
5450	130-135	180-190	Bold	White rust tolerance
5411	115-120	140-160	Bold	Suitable for early sowing
5121	135-140	180-200	Bold	White rust tolerance
Coral432	135-140	180-200	Medium	Alternaria tolerant
Coral444	135-140	180-190	Medium	White rust tolerance
Coral401	135-140	180-200	Medium	Higher oil percentage
Amruta	125-130	160-180	Bold	Early & late sowing
Parasmani-1+	140-150	190-220	Bold	White rust tolerance
Parasmani-2	130-135	180-200	Bold	White rust tolerance
Parasmani-3	130-135	190-210	Bold	White rust tolerance

Parasmani-8	135-140	180-210	Bold	Higher oil percentage
Nath Sona Super	125-130	160-180	Bold	White rust & Aphid tolerant
Nath Sona -212	125-130	160-180	Bold	White rust & Aphid tolerant

4.4.3 Price

Table 4.4.3.1 Comparative Analysis of Price between Existing Market Players

Company	Variety	Pack	MRP	Invoice	NLP	FP
Rasi Seeds	Karuna	1	325	205	144	300
PHI	45S35	1	550	500	430	450-500
	45S42	1	550	500	430	450-500
	45S46	1	650	600	520	600-650
Bayer	5222	1	570	450	370	500
	5444	1	500	350	280	400
	5450	1	500	350	280	400
Advanta	Coral432	0.8	600	432	370	450
	Coral444	0.8	600	432	370	450
	Amruta	1	350	290	230	280
Dhanya	999	1	400	268	170	220
	666	1	400	268	170	220
	555	1	400	268	170	220
Mahyco	Mahyco Bold Plus	1	285	175.5	110	225
	Shraddha	1	450	330	250	330
Shriram Fert.	Rani	1	350	250	160	200
	1666	1	540	450	400	470
J.K Seeds	8532	1	550	410	290	450
	8536	1	550	410	290	450
	8031	1	550	410	290	450
	8008	1	550	410	290	450
	Samriddhi Gold	1	240	175	140	200

Ankur	Suhani	1	220	165	145	200
Ajeet	Ajeet 201	1	350	270	189	230
Nath	Nath Sona Super	1	350	260	160	220
	Nath Sona -212	1	350	260	160	220
Krishna	KM-22, KM-90	1	360	280	220	250
	Radha	1	300	200	165	200
	Lafar Kranti	1	160	120	90	150
Nuziweeddu	Jumbo	1	280	200	160	220
Sriram Bioseed	Sonalika	1	360	240	170	250
Super Seed	Super Jugni	1	350	260	160	250
	Super Jhilmil	1	350	260	160	250
Kavery	K121	1	370	300	260	320
	AK-47	1	370	300	260	320
Bharat Seeds	Kamdhenu	1	300	220	90	150
	Kamdhenu 2	1	300	200	100	160
Nirmal	NIMH-10	1	550	420	385	450
	Ganga	1	320	260	195	250
Shaktivardhak	Parasmani-1	1	290	210	140	280
	Parasmani-2	1	290	140	140	280
	Parasmani-8	1	290	140	140	280
Mahindra	Swarndhara	1	320	200	188	250
	Krishna	1	360	270	230	300
Sona Genetics	Sona Sunahri	1	400	360	300	350
	Fortune	1	400	360	300	350

Table 4.4.3 shows that maximum price of the hybrid mustard seed farmers paid was for seeds of PHI followed by the Bayer crop science, Advanta Seeds and J.K Seeds. The PHI seeds were sold for more than 500 Rs per kg. The price of Rasi Seeds product was equal to 300 Rs per kg which was much lesser than the several major market players.

4.4.4 Place

Table 4.4.4.1 Number of Channel Partners of Some Major Market Players and Rasi Seeds

State							
Rajasthan	Rasi	PHI	Bayer	Advanta	Nath	Bioseed	SSPL
Tonk	1	8	3	3	2	2	2
Alwar	5	18	11	15	13	5	2
Ganganagar	0	24	15	8	9	6	8
Bharatpur	7	9	7	15	5	4	4
Sawaimadhopur	1	6	4	6	2	3	3
Hanumangarh	14	16	12	10	4	3	6
Jaipur	1	18	10	9	4	4	6
Madhya Pradesh	Rasi	PHI	Bayer	SSPL	Nath	Dhanya	Mahyco
Bhind	1	4	1	2	1	2	1
Morena	3	8	4	2	3	4	3
Gwalior	0	6	5	1	1	4	5
Sheopur	1	3	2	0	0	3	2
Shivpuri	0	3	2	1	1	3	3
Haryana	Rasi	PHI	Bayer	Advanta	Nath	Dhanya	Mahyco
Bhiwani	2	7	10	6	4	7	3
Mahendergarh	2	12	8	11	3	9	3
Rewari	3	13	5	7	1	4	4
Hisar	7	10	12	6	5	10	8
Sirsa	0	9	5	10	3	9	6
Bihar	Rasi	PHI	Bayer	Advanta	Nath	Dhanya	Mahyco
Saran	3	18	4	1	4	6	8
Nalanda	1	12	8	2	5	3	6
Uttar Pradesh	Rasi	PHI	Bayer	Advanta	Nath	Dhanya	Mahyco
Agra	1	15	9	3	2	8	10

Mathura	0	8	6	1	2	6	2
Aligarh	4	5	4	3	1	7	1
Gujarat	Rasi	PHI	Bayer	Kanha	Nath	Dhanya	Mahyco
Banaskantha	0	8	5	2	1	8	4
Mahesana	0	2	1	1	1	2	1
Patan	0	2	1	1	1	1	1

Table 4.4.4.1 shows that no of distributors in all the districts were maximum for PHI Followed by Bayer crop science and Dhanya Seeds respectively, whereas Rasi Seeds had gap in several market, with no distributors in 9 districts and less distributors compared to other market leaders in existing markets.

Table 4.4.4.2 Competitors Market Size in Mustard Seed Business and Rasi Seeds Market Share

District	Market size (MT)	PHI (MT)	Bayer (MT)	Advanta (MT)	Rasi (MT)	Rasi Share (%)
Tonk	185	90	4	6	0.15	0.08
Alwar	270	127	15	13	1.392	0.52
Ganganagar	650	196	30	24	0	0.00
Bharatpur	250	120	17	15	0.864	0.35
Sawaimadhopur	180	65	7	13	0	0.00
Hanumangarh	450	125	18	22	0	0.00
Jaipur	200	75	12	8	5.4	2.70
Rajasthan						
Bhind	70	23	2.5	6	0.431	0.62
Morena	110	38	5	6	0.174	0.16
Gwalior	40	8	2	2	0	0.00
Sheopur	30	4	1	0.5	0	0.00
Shivpuri	25	4	1	0.5	0	0.00
Madhya Pradesh						

Bhiwani	320	121	10	22	0.76	0.24
Mahendergarh	240	117	12	25	1.25	0.52
Rewari	220	95	8	22	0.9	0.41
Hisar	140	52	9	12	2.8	2.00
Sirsa	80	35	5	5.5	0	0.00
Haryana						
Saran	150	32	8	2	3	2.00
Nalanda	20	4	1	1	0	0.00
Bihar						
Agra	135	52	18	6	0	0.00
Mathura	105	35	10	4	0	0.00
Aligarh	120	35	7	1	0.3	0.25
Uttar Pradesh						
Banaskantha	170	92	8	3	0	0.00
Mahesana	40	10	3	1	0	0.00
Patan	48	13	4	1	0	0.00
Gujarat						

Table 4.4.4.2 shows that market share of Rasi Seeds compared to the other major market players was negligible. Maximum market share was of the PHI almost 50% in all the mustard markets, whereas share of Rasi Seeds was 2.7% in Jaipur followed by 2% in Hisar and for remaining all the markets less than 1%. Rasi Seeds had no share in 9 major mustard market.

4.4.5 Promotion

4.4.5.1 Comparison of Advertisements done by different Company

Table 4.4.5.1 Respondents selection for company doing maximum advertisements

Name of the Company	No of respondents for maximum advertisement
PHI	146
Bayer	28
Dhanya	17
Advanta	6
Rasi Seeds	0
Krishna Seeds	3
J.K Seeds	0

Table 4.4.5.1 shows that PHI was the leader in the advertisement of its product said by 73% of the respondent followed by Bayer crop science with 14%, Dhanya Seeds 8%, Advanta Seeds 3% and Krishna Seeds 2% only. Rasi Seeds was not selected by any respondents for high promotional activities.

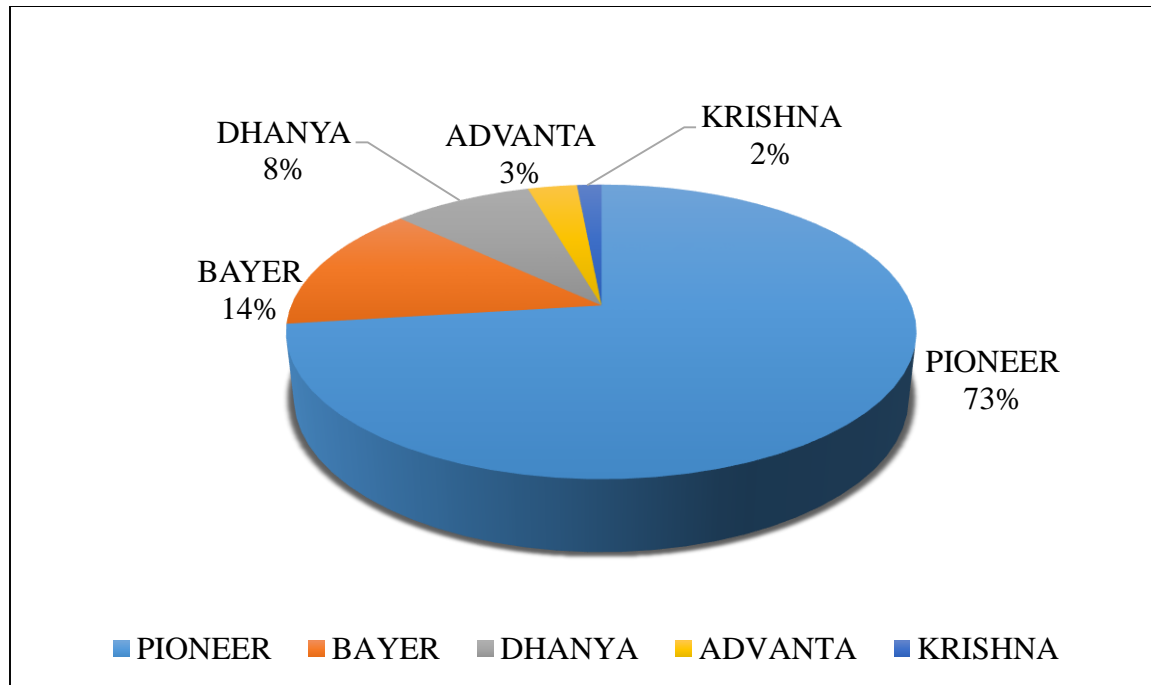


Figure 4.4.5.1 Maximum advertising Company

4.5 RASI CHANNEL PREPAREDNESS FOR MUSTARD BUSINESS, CHANNEL GAP AND STRENGTH

4.5.1 Rasi Channel Preparedness Gap and Strength

Table 4.5.1.1 No. of Rasi Distributor, POs & TM in Each District

District	No. of distributor	No. of PO	Presence of TM
Tonk	1	1	Yes
Alwar	5	4	Yes
Ganganagar	0	0	No
Bharatpur	7	3	Yes
Sawaimadhopur	2	0	Yes
Hanumangarh	0	0	No
Jaipur	7	3	Yes
Rajasthan			
Bhind	1	1	Yes
Morena	3	1	Yes
Gwalior	0	0	No
Sheopur	1	0	Yes
Shivpuri	0	0	No
Madhya Pradesh			
Bhiwani	2	2	Yes
Mahendergarh	2	2	Yes
Rewari	3	3	Yes
Hisar	7	1	Yes
Sirsa	0	0	No
Haryana			
Saran	3	1	Yes
Nalanda	1	1	Yes
Bihar			
Agra	1	1	No

Mathura	0	0	0
Aligarh	4	3	Yes
Uttar Pradesh			
Banaskantha	0	0	No
Mahesana	0	0	No
Patan	0	0	No

Table 4.5.1.1 shows that company had only 64% markets with prepared channel partners for mustard business of the total 25 district, the company had 36% markets with no prepared for mustard seed business. (Fig 4.5.1.1)

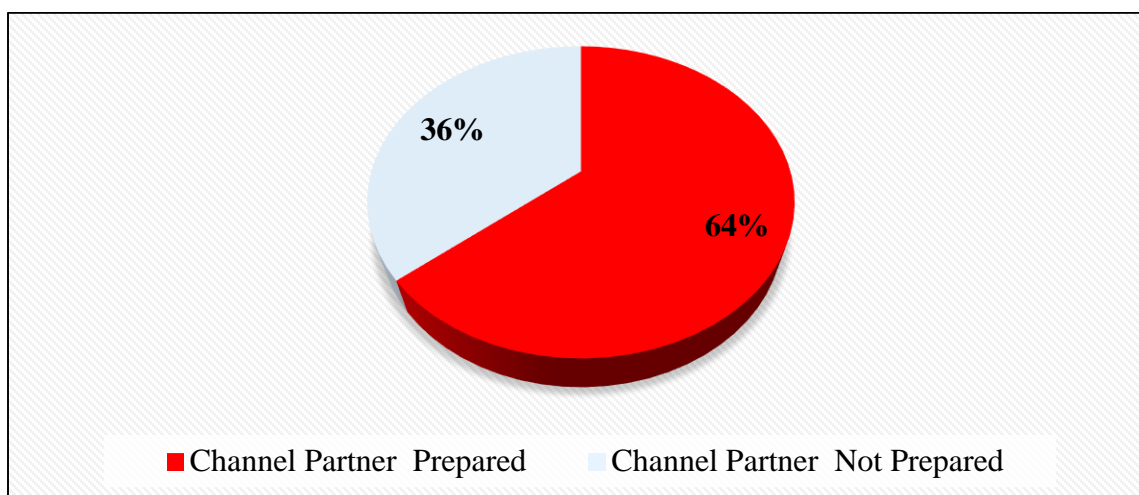


Figure 4.5.1.1 Rasi Channel Preparedness

4.5.2 Channel Gap

Table 4.5.2.1 No. of Rasi Distributor Present and Required

District	No. of distributor present	No. of distributor to be added
Tonk	1	2
Alwar	5	1
Bharatpur	7	0
Sawaimadhopur	2	1

Jaipur	7	0
Bhind	1	1
Morena	3	0
Sheopur	1	1
Bhiwani	2	1
Mahendergarh	2	1
Rewari	3	3
Hisar	7	0
Saran	3	1
Nalanda	1	1
Agra	1	2
Aligarh	4	0
Total	50	15

Table 4.5.2.1 shows that the existing channel partner were able to cover only 77% of the market of study area indicating a gap of 23% which need to be covered. (Fig 4.5.2.1)

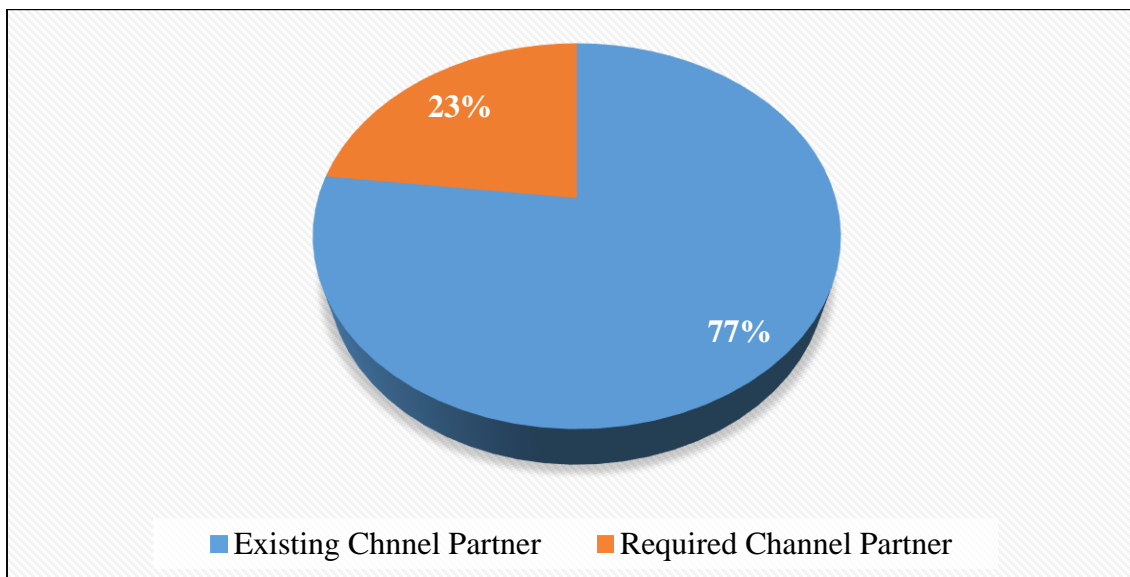


Figure 4.5.2.1 Rasi Channel Gap

4.5.3 Rasi Channel Strength

Table 4.5.3.1 Vacant Market and Presence of Rasi Seeds Cotton Business Channel Partner

Vacant Market without Channel Partner	Presence of Rasi Cotton Distributor
Ganganagar	Present
Hanumangarh	Present
Gwalior	Not Present
Shivpuri	Not Present
Sirsa	Present
Mathura	Not Present
Banaskantha	Present
Patan	Present
Mahesana	Present

Table 4.5.3.1 shows that Rasi Seeds had channel strength in cotton seed channel partner in different markets where it had no mustard seed distributor. Company had cotton seeds distributor 67 % market which can be utilized as mustard seed distributors as well. This strategy would expand market coverage of mustard product (Fig 4.5.3.1).

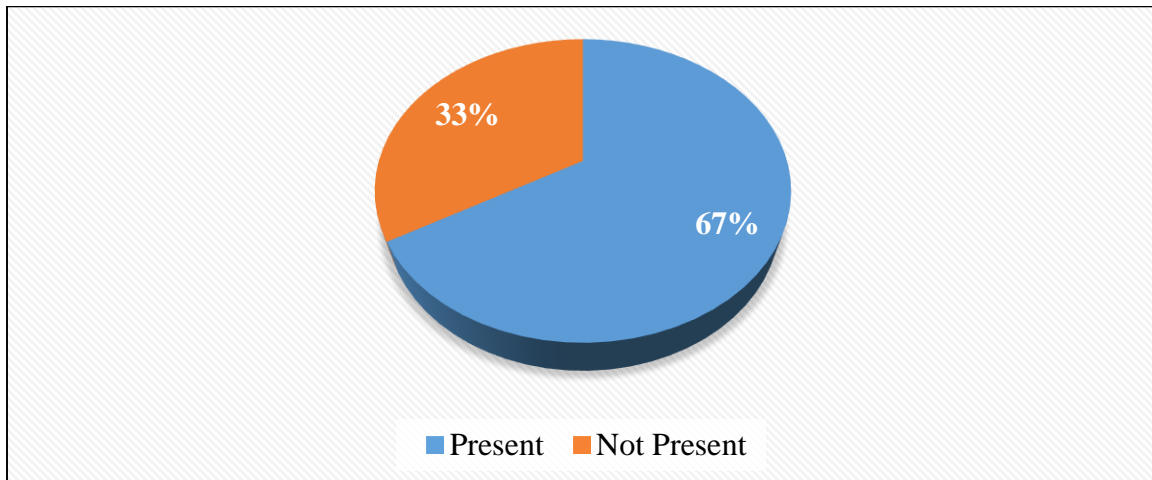


Figure 4.5.3 Channel Strength

V. SUMMARY AND CONCLUSION

Rapeseed-Mustard is an important group of edible oilseed in India and ranks second after soybean. India is one of the largest producer of oilseeds in the world and this sub-sector occupies an important position in the agricultural economy. The production of oilseeds was increased from 24.35 million tonnes in 2004-05 to 25.30 million tonnes in 2015-16. The yield of oilseeds, was 885 kg per hectare in 2004-05 and it was 968 kg per hectare in 2015-16.

This project was carried out for Rasi Seeds (P) Ltd which is also being engaged in mustard seed business. The study was conducted with the following specific objective (i) To study the mustard cultivation in important states of India, crop business opportunity and agro climatic zones segmentation, (ii) To map Must have traits and Good to have traits in mustard seeds based on agro climatic zones / state wise / cluster wise, (iii) To define segment-wise opportunity and ideal product requirement for future product development, (iv) To conduct competitors analysis with respect to 4Ps, (v) To study Rasi channel preparedness for mustard business, channel gap and strength.

The primary data were recorded on pretested semi-structured schedule and questionnaire from 250 mustard growers, 200 distributor of seeds and 10 company personnel. The secondary data were collected from every district revenue office and agricultural office in the study area. The field observations of mustard crop were taken throughout the study.

5.1 Major Findings of the Study

The cultivation practices of the farmers varies from region to region as in Bihar mixed cropping and mono-cropping both were being practiced but in all other region under study only mono-cropping was being practiced. The spacing, seed rate and sowing period of the farmers were different in rainfed and irrigated condition. The seed rate in rainfed condition was generally higher and spacing was lesser compared to irrigated areas. The method of sowing in Saran and Nalanda district of Bihar was completely broadcasting whereas in the parts of Gujarat and Aligarh district of Uttar Pradesh both broadcasting as well as seed drill sowing were observed. The organization have a big crop business opportunity in both hybrid and improved varieties segment as

still there is untapped market for both the segments. Seed replacement ratio in several parts of the country like Tonk, Sheopur, Shivpuri, and parts of Gujarat is less than 50% having great potential for the mustard seed replacement and enhancing productivity of the farmers.

The major trait categorized as must have trait in all the selected districts except in Gujarat is Sclerotinia stem rot resistance (biotic stress) and frost tolerance (abiotic stress) for some parts, bottom branching (agronomical trait), medium height plant (agronomical trait), and medium duration (agronomical trait), of the crop which were the most preferred traits by the farmers.

The maximum opportunity with the present market size and seed replacement ratio was in Sri Ganganagar and Hanumangarh district of Rajasthan where almost 100% seed replacement and largest market size (650MT and 450 MT approximately respectively) were observed.

Only 5 companies had hybrid seeds of mustard and remaining all had only research or improved varieties of the mustard seeds. The major market players with very good hybrid were PHI, Bayer, Advanta, whereas the Krishna seeds had maximum product in the category of improved varieties seeds. The pack size for all companies of mustard seed was 1kg with exception of Advanta seeds which had pack size of 0.8kg. Maximum price of the hybrid of mustard seed paid by was for seeds of PHI followed by the Bayer crop science, Advanta Seeds and J.K Seeds. The PHI seeds were sold at more than Rs 500 per kg. The price of Rasi Seeds mustard product was about Rs 300 per kg which was much lesser than the several major market players. Number of distributors in all the districts were found to be maximum for PHI followed by Bayer crop science and Dhanya Seeds. Whereas in case of Rasi Seeds a gap was found in several markets with no distributors in 9 districts and less distributors compared to other market leaders in existing markets. Market share of Rasi Seeds compared to the other major market players was negligible. Maximum market share was of the PHI which was almost 50% in all the mustard markets, whereas share of Rasi was 2.7% in Jaipur followed by 2% in Hisar and for remaining all the markets less than 1%. Rasi Seeds had no share in 9 major mustard market. PHI was the leader in the advertisement of its products, said by

73% of the respondent followed by Bayer crop science with 14%, Dhanya Seeds 8%, Advanta Seeds 3% and Krishna Seeds 2% only.

In case of Rasi Seeds, out of the total 25 district, the presence of channel partner was found to be only 64% and remaining markets were untapped. It was also revealed that the existing channel partner were able to cover only 77% of the market of study area indicating a gap of 23% which need to be covered. Rasi Seeds had channel strength in cotton seed channel partner in different markets but it had no mustard seed distributor in those markets. The company had 67 % cotton seeds distributor in study area which can be utilized as mustard seed distributors as well. This strategy would expand market coverage of mustard product.

5.2 Suggestions

1. Organizations need to increase the number of channel partners as the present number of channel partners are not sufficient to cover all the potential mustard market.
2. Organizations need to introduce new product in hybrid seed segment as the farmers are preferring hybrids seeds over improved varieties.
3. Organization should introduce different products suitable to local agro-climatic conditions and with must have traits for each cluster.
4. The company should enter into new potential markets with existing products where company has no presence.
5. The organization need to increase the staff for existing market of company and also need to employ personnel into new markets.
6. Company should increase its promotional activity and conduct village level meeting of farmers and retailers intensively.
7. Company has good market network for cotton seed and this network should be utilized for mustard seed business.
8. Company should target big potential villages initially to carry out promotional activities, product and yield demonstration.
9. Company should provide post sale services to farmers in order to benefit them maximum from their produce.

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SCHEDULE FOR RAPESEED & MUSTARD GROWERS

Basic profile			
Name -		Age -	
Village-		Tehsil -	
District -		State -	
Contact No. -			
Operational land holding details			
Operational land holding	Area	Irrigated	Rainfed
Under mustard crop			
Under other crop			
Total			
Cropping pattern details			
Season	Crop	Irrigated	Rainfed
Kharif			
Rabi			
Summer			
Growing mustard as			
1. Mono crop		2. Mixed crop	3. Intercrop
4. Trap crop			
Cropping sequence for mustard crop field			
1.			
2.			
3.			
What type of seeds you use			
1. Traditional saved seeds		2. Improved varieties/Hybrid	3. Both
Quantity of seeds purchased in previous/present season			
Month of sowing			
Month of harvesting			
Method of sowing			
1. Broadcast & furrow		2. Line sowing	3. Ridge & furrow
		4. Broad bed	
Variety/Hybrid of mustard grown in last two years			
1.			
2.			
Reasons for cultivating same variety()/ Reasons of switching over to new variety()			
1. Yield specific		2. Duration of the crop	3. Pest & Disease resistance
4. Suitability to soil conditions		5. Suitable for intercropping/mixed cropping	

6. Temperature specific drought 9. Any other reason	7. Resistant to water logging	8. Resistant to drought
Duration of the mustard crop you are growing at present		
1. Early maturity	2. Medium maturity	3. Late maturity
Biotic stress		
Name of disease	Growth stage	
1. Downy mildew		
2. Powdery mildew		
3. White Rust		
4. Leaf spot		
5. Any other disease		
Name of pest	Growth stage	
1. Mustard aphid		
2. Mustard saw fly		
3. Diamond back moth		
4. Painted bug		
5. Any other pest		
Abiotic stress		
Water requirement of crop is fulfilled by		
1. Rainfall only	2. Irrigation only	3. Both
Do you experience any drought problem for your mustard crop		
a. Yes	b. No	
If , yes then growth stages in which you experienced drought		
Do you experience any water logging conditions for your mustard crop		
a. Yes	b. No	
If , yes then growth stages in which temperature was not favourable		
Whether you experience any temperature variation unfavourable during growth of mustard		
a. Yes	b. No	
If , yes then growth stages in which temperature was not favourable		
Yield of mustard crop		
	Yield	Reason for change in yield(varietal/stress)
Present year		
Last year		

Rank your preferred traits of an improved variety of mustard

1. High yielding
2. Duration of the crop
3. Pest & Disease resistance
4. Suitability to soil conditions
5. Suitable for intercropping/mixed cropping
6. Temperature specific
7. Resistant to water logging
8. Resistant to drought

SCHEDULE FOR RAPESEED & MUSTARDSEED DISTRIBUTOR

[illegible]

Trait contributing for maximum demand					
1. Yield specific		2. Duration of the crop		3. Pest & Disease resistance	
4. Suitability to soil conditions		5. Suitable for intercropping/mixed cropping			
6. Temperature specific		7. Resistant to water logging		8. Resistant to drought	
9. Any other reason					
Which pack size of seed is having maximum demand					
Name the company which is involved maximum in promotional activity					
Do you sell Rasi seeds products?					
a. Yes			b. No		

Variety/ Hybrid	Company	Share	Pack size	MRP	Invoice	NLP	FP	Quantity sold

Questionnaire to be filled by Company Personnel

Name:						
Territory Under Coverage: (District)						
Particular						
MRP						
Invoice to Distributor						
Net Rate to Distributor						
Invoice to Dealer/Retailer						
Net Rate to Dealer/Retailer						
Quantiy Sold						
No of Rasi Distributor						
No of Rasi Retailer/Dealer						
No of Staff In Territory (PO)						
Market Name						
Market Potential						
Market Leader						
Rasi Share						
No of Distributor of						
Company	Market1	Market 2	Market3	Market4	Market 5	Total