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RESEARCH PAPER

District Wise Performance of Isabgol Cultivation in Rajasthan: In Context of Instability and Source of Output Growth

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ABSTRACT

The primary objective of this study to examine the growth rate, variability and contributing factors of output growth in acreage, production and yield of isabgol in leading districts Rajasthan as well as the state as a whole. This study was purely based on secondary time series data. The study period was considered from 2010-11 to 2023-24. The data was analysed using the exponential growth model, Cuddy-Della Valle instability index and decomposition analysis to fulfil the objectives of the study. The findings of study indicated that highest growth rates were found in the production (31.90%)and area (29.65%) of Bikaner district. The lowest growth rate was seen in production (12.98%) and area (11.21%) of Chittorgarh district. The upmost instability in production (73.22%) and area (64.93%) was found in Bikaner and Chittorgarh districts respectively. The major contributor to expand the output of isabgol in all selected districts was expanded in area under the crop. Varietal development could be major contributor to enhance the output and increase international demand.

HIGHLIGHTS

- Highest positive and significant growth rate was observed in production of isabgol in Bikaner district.
- Major source of output growth in isabgol was expanded area in selected study area.
- The maximum variability was found in isabgol production of Bikaner district.

Keywords: Exponential growth model, Cuddy-Della Valle, output growth, isabgol

Isabgol (*Plantago ovata Forsk.*) is a medicinal herb of *Plantaginaceae* family. It is mostly cultivated in *rabi* season under humid and dry climate. It is popular as '*Desert Indian Wheat*' in the country (Jose and Kumar, 2022). Since last decade, Isabgol is mostly demanded crop under medicinal plants not only in the country but also for export purpose. Seed coat of isabgol is known as husk which is having medicinal properties to cure various stomach disorders such as constipation, irritation of digestive tract, etc. Apart from medicinal value, it is also used as a basic stabilizer in preparing ice-cream, chocolates, candy, biscuit and other food products. Further, Isabgol gum uses in preparing dry toothpaste powder and genomic gels. India is kept a special identity in medicinal and aromatic plants and these are good source of income for a large group of people in rural areas. The practices of production, processing, distribution and trade of isabgol derive employment

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in rural as well as urban part of the country. India is major producer and export of isabgol in the world. It is an important foreign exchange earning crop of India. Therefore, the enhancing value is helped in improvement of living standard. Chouhan and Sarawgi, 2019 reported in their study that more than 55 percent cost of isabgol cultivation was fallen under Cost-A_1 component. In the mean time its competitive crops such as garlic and wheat were also reported similar pattern of cost of cultivation. The manpower is the major contributor under cost- A_1 for isabgol and its competitive crops. In case of profitability aspect, the maximum B-C ratio was recorded for isabgol production follower by its competitive crops whest and garlic. The extending area under isabgol crop is more profitable for enhancing living standard of farming community as compared to its competitive crops.

The existence of national and international sound market demand is providing to growers incentive prices for isabgol husk in order to boost production. However, its future production planning is hampered by crop production and income uncertainties. Growth patterns in the area, production, and yield of isabgol is also crucial for knowing chronological changes in a country or state overtime. Identifying trends in isabgol crop is a very informative work because it provides us with a chronological background of how its cultivation influences the living standard of farmers, either positively or negatively. The study has attempted to determine the peak or trough in the cultivation of isabgol crop in the previous years. Now, we all know that Indian farmers are not in a good economic condition, therefore, this information useful to policymakers in developing new measures to increase the area, production, and yield of this important crop in the state of Rajasthan. With the aforementioned facts keeping in mind, a study on the growth, instability and source of output growth in the area, production, and productivity of isabgol in Rajasthan was conducted.

MATERIALS AND METHODS

Rajasthan is leading province in area and production of Isabgol in the country. Simultaneously, arid and semi-arid climatic conditions of Rajasthan are found suitable for its production. The leading eight districts *viz.*, Barmer, Jalore, Jodhpur, Bikaner, Churu, Jaisalmer, Nagaur and Chitorgarh were selected for the present study along with Rajasthan as whole. During 2023-24, these districts are having national and international identity and contributing more than 92 percent isabgol production of the state. This study had focused on growth instability and contributing sources of growth in acreage, production and yield in isabgol in study area.

Sampling procedure: Purposive sampling procedure was used to collect secondary information on area, production and yield of isabgol in study area. Isabgol crop is mostly cultivated in Rajasthan, Gujarat and Madhya Pradesh states of India. Based on highest cultivated area, Rajasthan state is selected for the present study of isabgol. In the next stage of sampling, isabgol cultivating major eight districts namely, Barmer, Jalore, Jodhpur, Bikaner, Churu, Jaisalmer, Nagaur and Chitorgarh of Rajasthan state were selected for the analysis of pre-decided parameters. This study is depended solely on secondary time series data about area, production and yield of isabgol. The study period for the study is varied from 2010-11 to 2023-24. The required information about area, production and productivity of isabgol in selected district as well as Rajasthan state as a whole were collected from various published Government E-sources as Rajasthan Agricultural Statistics at a Glance and Directorate of Economics and Statistics, Government of Rajasthan.

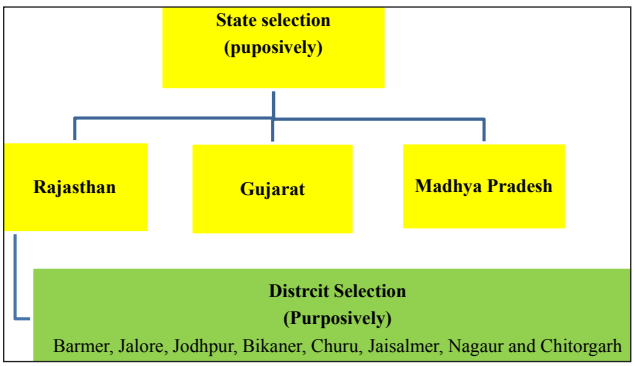

Chart-1: Sampling Procedure

Analytical framework: According to pre-determined objectives of the study, the collected data on different aspects *viz.*, area, production and yield of isabgol crop was compiled and analyzed logically.

Compound annual growth rate (CAGR): The compound annual growth rate in area, production and yield of the isabgol in major contributing

districts and the Rajasthan state as a whole were computed by exponential growth model.

$$Y_t = A(1 + r)^t \quad \ldots(1)$$

After taking log on both sides of equation (1),

$$lnY_t = ln\ A + t\ ln\ (1 + r) \quad \ldots(2)$$

Where,

Y_t is the dependent variable (area/production/ productivity) of isabgol crop for t^{th} period,

t is the independent variable as time period

r is the compound annual growth rate, and

ln is the natural logarithm.

Now putting;

$lnY_t = y$

$ln\ A = a$ and

$ln\ (1 + r) = b$

Therefore, the above equation becomes,

$$y = a + bt$$

Now, a and b parameters were estimated by using OLS method and the CAGR was computed as given below:

$$r = (Antilog\ of\ b - 1) \times 100$$

The most popular statistical tool Student 't' test was used to test the level of significance of growth rate in area, production and productivity of Isabgol.

When the P-value of beta coefficient (case sequence) is less than 0.01, then it is highly significant i.e. significance at 1 percent level.

Instability analysis: The instability in area, output and productivity of isabgol were calculated by using Cuddy-Della Valle instability index. The algebraic form of this index is given as follow:

$$I = CV \times \sqrt{(1 - Adj\ R^2)}$$

Where,

I is the instability index (%),

CV is the coefficient of variation (%), $CV = \frac{SD}{AM} \times 100$

SD is standard deviation and AM is Arithmetic mean

The range of CDVI is categorized into three sub-groups (Bairwa *et al.* 2020; Balai *et al.* 2021; Bairwa *et al.* 2021 and Balai *et al*. 2022) as given below:

Table 1: Range of instability index

Instability index category	Range (in %)
Low instability	Less than 15
Medium instability	15 to 30
High instability	More than 30

This index is superior then CV and index of dynamic instability, because simple CV over estimate the extent of variability in secular data series characterized by long term trend. This method removes this distortion in coefficient of variation. The instability was worked out in relative terms, which is commonly used as measure of instability in chronological data.

Decomposition analysis: Decomposition analysis was used to measure the relative contribution of area, yield and combined of both towards the total output change of isabgol. Earlier many researchers such as Basitine and Palanisami, 1994; Gupta and Saraswat 1997; Sijuand Kombairaju 2001; Kakali and Basu, 2006 and Bairwa *et al.* 2022 were applied this model to examine the growth performance of different crops. The general outline of decomposition model for isabgol production in Rajasthan state was depicted as below:

$$P_i = A_i\ Y_i \quad \ldots(3)$$

Where,

P_i = Production of i^{th} crop

A_i = Area of i^{th} crop

Y_i = Yield of i^{th} crop; here i = Isabgol

Then,

$$P_0 = A_0\ Y_0 \quad \ldots(4) \text{ and}$$

$$P_c = A_c\ Y_c \quad \ldots(5)$$

Where,

A_0, P_0 and Y_0 stand for area, production and yield of isabgol respectively in base year and

A_c, P_c and Y_c stand for area, production and yield respectively of same crop in current year.

Now $Y_c - Y_0 = \Delta Y_c$

$$A_c - A_0 = \Delta A_c$$

$$P_c - P_0 = \Delta P_c \quad \ldots(6)$$

Now substituting the terms indicated in equation 6 into equation 5

$$P_c = (A_0 + \Delta A_c)\,(Y_0 + \Delta Y_c)$$

$$\Delta P_c = (P_c - P_0) = \{(A_0 + \Delta A_c)\,(Y_0 + \Delta Y_c)\} - A_0\,Y_0$$

$$\Delta P_c = (A_0\,\Delta Y_c) + (Y_0\,\Delta A_c) + (\Delta A_c\,\Delta Y_c) \quad \ldots(7)$$

Yield Effect *Area Effect* *Interaction Effect*

RESULTS AND DISCUSSION

During 2023-24, India has produced 205.79 thousand tonnes isabgol from 491.41 cultivated areas of 491.41 thousand hectares. Rajasthan state is leading in coverage of area under isabgol and its output in the country.

At state level, isabgol showed annual growth-rates in area, production and productivity to the tune of 415.23%, 14.66% and 6.59% respectively (Table 2). In the district wise area growth rates,the upmost annual growth rate was depicted in Bikaner (29.65%) followed by Churu (13.59%) and Barmer (8.84%) per annum. In case of production, the Bikaner (31.90%) district recorded the highest growth rate of isabgol followed by Churu (15.48%) and Jaisalmer (11.80%) per annum. Jaisalmer recorded highest growth rate in productivity accounting for 3.89% annually followed by Bikaner (1.72%) and Churu (1.65%) per annum. The growth rate in productivity of isabgol was non-significant. The lowest growth rate in area, production and productivity were recorded in Chittorgarh district at (11.21%), (12.98%) and (-2.0%) respectively per annum.

Table 2: Compound Annual Growth Rates in Area, Production and Productivity of Isabgol in Major Districts of Rajasthan (in Per cent)

District	Area		Production		Productivity	
	CAGR	R^2	CAGR	R^2	CAGR	R^2
Barmer	8.84*	0.833	7.42*	0.483	-1.32NS	0.036
Bikaner	29.65*	0.905	31.90*	0.635	1.72 NS	0.009
Chittorgarh	-11.21**	0.309	-12.98**	0.313	-2.00 NS	0.068
Churu	13.59*	0.663	15.48*	0.572	1.65 NS	0.032
Jaisalmer	7.61*	0.706	11.80*	0.732	3.89 NS	0.237
Jalore	1.58NS	0.036	1.54NS	0.031	-0.04 NS	0.000
Jodhpur	4.99**	0.389	6.01NS	0.240	0.97 NS	0.018
Nagaur	5.15*	0.480	6.23*	0.595	1.02 NS	0.022
Total Raj.	7.56*	0.749	14.66*	0.433	6.59 NS	0.169

Source: *Author's own computation from compiled time series data.*

**Significant at 1 percent level of significance, **significant at 5 per cent level of significance and NSNon-significant*

The increase in the growth rate of isabgol in Area and production were associated with augmenting demand in national as well as international markets. Similar results were reported by Kumawat and Meena (2005) for major seed spices in Rajasthan and Acharya *et al.* (2012) for major crops of the Karnataka state.

Instability analysis

The results of instability measures were presented for isabgol in table 3.

Table 3: Instability in Area, Production and Productivity of Isabgol in major districts of Rajasthan

District	Cuddy-Della Valle instability index (in %)		
	Area	Production	Productivity
Barmer	14.51	30.21	25.90
Bikaner	33.12	73.22	34.29
Chittorgarh	64.93	59.95	30.24
Churu	51.32	68.43	30.71
Jaisalmer	20.48	32.53	25.29
Jalore	34.10	37.88	17.88
Jodhpur	28.62	39.77	27.07
Nagaur	21.86	20.17	22.39
Total Raj.	**18.43**	**173.02**	**142.87**

Source: *Author's own computation from compiled time series data.*

It could be conclude from the table 3 that highest instability was recorded in isabgol production (73.22%) at Bikaner district followed by Churu district. In case of cultivated area of isabgol, the upmost instability was depicted at Chittorgarh (64.93%) followed by Churu district. In the mean time, the lowest variability in area and production of isabgol was found at Barmer (14.51%) and Nagaur (20.17%) districts respectively. In case of productivity, the instability was laying between 17.88 to 34.29 percent in selected districts of the Rajasthan. The higher instability in production of isabgol was a good indication of expanding production in Rajasthan.

Decomposition analysis

In the major districts of Rajasthan, the relative share of area, yield and their interaction effect to growth in output of isabgol was depicted in table 4.

Table 4: Sources of output growth in Isabgol production in major districts of Rajasthan

District	Yield Effect (in %)	Area Effect (in %)	Interaction Effect (in %)
Barmer	-12.44	124.69	-12.25
Bikaner	13.03	71.50	15.47
Chittorgarh	9226.62	6728.37	-15855.00
Churu	15.51	74.23	10.25
Jaisalmer	56.00	65.12	-21.12
Jalore	-342.66	-33.77	476.43
Jodhpur	-108.00	246.33	-38.33
Nagaur	90.87	159.90	-150.77
Total Raj.	**69.73**	**6.60**	**23.67**

Source: *Author's own computation from compiled time series data.*

It was revealed from the table 4 that during study period, the augmentation in production of isabgol in Chittorgarh and entire Rajasthan was predominantly contributed by growth in productivity. In the Chittorgarh district, yield effect was quite high to the extent of 9226.62 per cent. However, stronger yield effect was counter balanced by negative extent of interaction (-15855%). In the same way, area effect also had positive contribution on output growth. In the mean time, the isabgol production in Barmer, Bikaner, Churu, Jaisalmer, Jodhpur and Nagaur districts was mainly augmented due to expanded in area under the crop. The relative contribution of area in the Barmer, Bikaner, Churu, Jaisalmer, Jodhpur and Nagaur districts was recorded at 124.69, 71.50, 74.23, 65.12, 246.33 and 159.90 per cent, respectively. At the same time, the production of isabgol in Jalore district was mainly increased due to interaction effect (476.43%) of area and yield.

Since gift of nature (land) is scared, therefore productivity of isabgol should be mounted up by adoption of good package of practices and hybrid seeds. Bairwa *et al.* (2022) reported in their study that growth in output of coriander during 1991-92 to 2019-20 was predominantly due to productivity growth. Thus, it can be concluded from the above analysis that during the entire study period, the growth in output of isabgol was solely contributed by yield effect in the most of the districts.

CONCLUSIONS AND POLICY IMPLICATIONS

It could be concluded from the results that during entire study period, highest positive growth rate in area and production was recorded in Bikaner district of Rajasthan. In the mean time, Rajasthan state as a whole also reported positive growth rate in area, production and productibity of isabgol. The negative the growth rates in productivity in Barmer, Jalore and Chittorgarh districts were negative and non-significant. The highest extent of instability in production was found in Chittoragh district. In case of production and productivity, highest variability was recorded for Churu district. In case of entire Rajasthan, the variability in area, production and productivity of isabgol were recorded at18.43, 173.02 and 142.87 percent respectively. During entire study period, the expansion of the area under isabgol was a major contributor to augment the isabgol production in Barmer, Bikaner, Chitorgarh Churu, Jaisalmer, Jodhpur and Nagaur districts of Rajasthan. Apart from this, yield effect was second largest contributor to enhance production. In case of Rajasthan state as a whole, yield effect was major source of output growth followed by interaction effect. Based on findings, researchers should give more emphasis on strengthen package of practices and varietal assistance as per changing agro climate conditions with the help of National Research Centre for Medicinal and Aromatic Plants, Anand, Gujarat, SAUs, and the Rajasthan Agriculture Department. Just like spice crops, the state government should establish an Agri-Export

Zone for this crop in Rajasthan so that farmers can access better market price in international market.

GENERATIVE AI DECLARATION

The author(s) confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript, and no images were manipulated using AI. The authors developed and verified all scientific content, data analysis, interpretation of results, and conclusions. The authors take full responsibility for the accuracy, integrity, and originality of the work presented, and no AI tool was listed as an author.

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