A DECOMPOSITION ANALYSIS OF GROWTH AND INSTABILITY OF LEGUMINOUS CROPS IN BIHAR

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Abstract:
Bihar has a very diverse agricultural diversity for producing crops. To maintain high agrarian production, the examination of growth and instability are the right tool for measuring the health of farming. Cost of production is core of economic analysis. It is subjected to maximize output by using given set of input and reducing expenditure on production without decrease in optimal level of output. As we know that agriculture is backbone of the modern civilization which fulfills the need of food security. But, most of the developing countries like India are facing the problem of decline of agriculture share in total output of the countries. The major concerning problem of Indian agriculture is high cost of production especially after the era of green revolution. High cost of production in agriculture leads decrease in profit share of the farmers. The use of input in production process is a continuous process which led beginning to end in production process. Same would be applied in the farm level of crop production, because optimum use of agricultural input must be produced optimum level of agricultural output. To examine growth and pattern of leguminous crops is taken at Bihar. A sound measurement of instability is being examined through three decomposition tools. Leguminous crops are selected for the time period 2000-2020 and data collected from the Comprehensive Cost of Cultivation Scheme published by the Ministry of Agriculture and Farmers' welfare. The study will indicate also categorized in higher instability and low stability that help to make better policy in crop production.
Keywords: Leguminous Crops, Instability, Interaction Effect, Time Effect, Bihar

1. Introduction

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Indian proverb Dal (Pulse)-Roti (Chapatti) is a well-known saying that refers to a subsistence lifestyle. Indians, who are primarily vegetarians, depend heavily on pulses in their daily diet. In India, the combination of daal (pulse) and roti (chapatti) or daal and bhat (rice) supplies all of the necessary amounts of the essential amino acids and aids in the eradication of protein-calorie malnutrition. Individuals with low incomes can easily purchase pulses because they are the least expensive type of dietary protein. The primary nutritional source of protein as well as other essential nutrients for human growth, including iron and fiber, is pulses. The pulses and other lupin-producing plants are exclusively picked for their dry seed. They are high in protein and nutrients, making them an excellent source of protein, especially in areas where meat and dairy are not physically or monetarily accessible. Pulses have a low fat content and a high concentration of soluble fibre, which can decrease cholesterol and aid in blood sugar regulation. It has been demonstrated that pulses can aid in the fight against obesity. Because of these characteristics, they are suggested by health organisations for the management of non-communicable diseases such as diabetes and heart problems. According to the World Health Organization, men should consume 80 grams of pulses daily. The Indian Council of Medical Research recommends 40 grams of pulses per male per day (ICMR). However, the actual availability ranges from 30 to 35 g pulses man^{-1} day^{-1}. Only people from lower socio-economic strata may access these, which is disheartening. Because of their immense potential to address issues with environmental, social, and economic sustainability, the Food and Agriculture Organization of the United Nations (FAO) recognised pulses as a group of crops in 2016. The year 2016 has been declared the International Year of Pulses (IYP).

The usage of pulses can lessen reliance on synthetic fertilisers, which are used to provide nitrogen to the soil artificially, helping to mitigate the effects of climate change. These fertilisers emit greenhouse gases when they are produced and used, and too much of them can harm the ecosystem. However, pulses naturally fix air nitrogen and, in certain cases, free phosphorus tied to the soil, which reduces the requirement for synthetic fertilisers. Pulses' ability to fix nitrogen also promotes soil fertility, which raises and prolongs the productivity of farms. Different pulse species fix 60 to 300 kg of nitrogen per hectare, and they don't require fertilisation other than a beginning dose of 10 to 20 kg of nitrogen (N) per hectare. This category of crops is at the forefront because to the enormous amount of N produced. There is a need to give incentives (subsidies for seed, etc.) for expanding the area under pulse production in light of these externalities (fertility enhancement and sustainability) in pulse production. Farmers may protect their fields from hazardous pests and illnesses while promoting soil biodiversity by intercropping and covering their fields with pulses. Pulses are a crucial crop for farmers since they may be used by them and their families for both sale and consumption. Farmers may maintain household food security and build economic stability by having the option to consume and sell the pulses they grow. Green-harvested crops, such as green peas and green beans, are not considered pulses; instead, they fall under the category of vegetable crops.

Despite being crucial to human life, pulses are frequently referred to be "orphan crops." Crops referred to be orphans are ones that are not a part of the main, widely traded crops that are commonly regarded as staples, like rice, wheat, or maize. The most popular and consumed types of pulses are dried beans, lentils, and peas. For a variety of reasons, pulses are crucial crops. The most widely farmed pulse crops in India include the chickpea, also known as bengalgram (Cicer arietinum), pigeonpea, arhar (Cajanus cajan), greengram, also known as mungbean (Vigna radiata), blackgram, sometimes known as urdbean (Vigna mungo), lentil, also known as masur (Lens culinaris), fieldpea, also known as matar (Phaseolus vulgaris).

2. Significance of Study

Pulses are consistently in more demand domestically than they are produced. With 36% of worldwide acreage and 26% of global production, India leads the globe in both area and production of pulses. Pulses are produced on 28.1 million hectares of land in India with production 21.9 million metric tonnes. Chickpea is the most important pulse among all pulses, ranking first in terms of production, area, and productivity on a national scale. The adaptability of a crop variety to the agro-climatic conditions determines its yield. In comparison to the global average of 909 kg/hectare, the average yield of all pulses in India is approximately 780 kg/hectare. Approximately 63% of the overall production comes from Rabi pulses. With a market share of over 44% of the total production, gram is the most important pulse, followed by tur/arhar at 15% to 20% and urad/black pea and moong at roughly 8% to 10% apiece. Top producing States for pulses are Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, and Karnataka (GOI, 2021).

3. Production Status of Pulses in Bihar

A total of 93.60 lakh hectares are considered to represent the geographical area of Bihar, of which only 56.03 lakh hectares are net cultivated and 79.46 lakh hectares are grossly cultivated. Approximately 33.51 lakh net hectares and 43.86 lakh gross hectares are irrigated using various methods. Rice, wheat, corn, and legumes are the main food crops. Bihar contributes roughly 3.82 percent of the state's gross cropped area and 5.58 percent of production, making it one of India's most important states for pulse production and consumption. Bihar ranks 12th in terms of pulses output, contributing 0.48 million tonnes to the national pulse pool, but it accounts for only 7.39 percent of total food grain area, with productivity ranging from 819 kg/ha in 2000-01 to 884 kg/ha in 2020-21. Over the last three and a half decades, there has been a steady decline in pulses area, production, and productivity, accounting for approximately 480.76 thousand hectares, 424.89 thousand tonnes, and 884 kg ha^{-1} in 2020-21, compared to corresponding figures of 717.2 thousand hectares, 620.7 thousand tonnes, and 865 kg ha-1 in 2000-01. The poor performance of pulses production in the state and at the national level led to an increase in the deficit and the depletion of foreign exchange reserves as a result of skyrocketing import costs, unpredictable price increases, and lower net profits than competing crops **(Joshi & Saxena, 2002, Srivastava, Sivaramane & Mathur, 2010)**. India's output of pulses grew at a rate of just 1% per year from 1970 to 2013 compared to the country's 2% annual population growth. This slow growth in production led to a widening imbalance between supply and demand, which in turn led to higher pricing and lower per capita consumption. Due to the comparatively poor productivity of pulses together with policy preferences and support for cereals, notably for wheat and rice, pulse production has remained undesirable to Indian farmers (Ahlawat et. al, 2016). The productivity of pulses in Bihar was poor and unstable, creating a vicious cycle. Due to the lower per-hectare returns, which resulted in inconsistent and low yields, farmers preferred to grow pulses on marginal land without employing any production inputs. Farmers liked to grow pulses on lush, irrigated plots of land **(Singh, Shahi, & Singh, 2016)**. Due to a number of factors, including poor management, the farmers' economic situation, a lack of resources, notably knowledge about new farming technology, and huge yield gaps between potential and farmer's output. The irrigation system, the caliber of the seeds, the age, and the level of education of the state's farmers were shown to be the main factors affecting the yield differential (Kumari, Singh and Ahmad, 2020).

4. Research Methodology

- **Data Collection:** Leguminous crops are selected for the time period 2000-2020 and data collected from the Comprehensive Cost of Cultivation Scheme published by the Ministry of Agriculture and Farmers' welfare and various open data sources of Bihar government. The period 2000-2020 was chosen because Bihar was divided into Jharkhand, where much of the cultivated land has gone.
- **Growth Rate Analysis: An exponential function of the following form was fitted to estimate the compound growth rates of area, production, and yield of pulses for all of different zones in Bihar throughout the indicated periods.**

$$Y=ab^t$$

Log Y = Log A + t. Log b
Where, Y = Area/Production/Yield
A = Constant
b = (1+ r)
r = Compound Growth Rate
t = Time variable in years (1,2,3….n)
In order to calculate the compound growth rate, the link between
CGR ={Exp(b) – 1} × 100.
The significance of the regression coefficient was tested using the Student's 't' test

- **Estimation of Magnitude of Instability:**

The instability index is a simple analytical technique for identifying variance or instability in any time series of data. Time series data were used to quantify instability, and the Cuddy-Della Valle method was applied to determine instability. This strategy modifies the coefficient of variance when data are dispersed around a trend line, whether it is positive or negative. Below is the Cuddy-Della Valle Index.

$$\mathrm{CDVI} = \mathrm{CV}\sqrt{1-\mathrm{R}^2}$$

Where CV is the coefficient of variation, which is calculated as the ratio of the sample standard deviation to its mean, and R^2 is the corrected coefficient of determination of the log linear trend function that fits the time series. When test findings are not statistically

significant or $R^2 > 0$ is used to evaluate instability index (the value of R^2 is located between 0 and 1; in the above log-log function, R^2 cannot be negative).

- **Decomposition Analysis:**

The decomposition analysis model, originally created by Minhas and Vaidhyanathan(1965) and revised by Sharma and Subramanyam (1984), was utilised by numerous researchers (Kalamkar,2003) to study the growth performance of crops on state. The approach states that A_0, P_0, and Y_0, respectively, are area, production, and productivity in the base year and A_n, P_n, and Y_n are values of the respective variable in the n^{th} year item.

$$P_0 = A_0 \times Y_0, \qquad P_n = A_n \times Y_n \text{……………………………..(1)}$$

$$\Delta P = P_n - P_0, \quad \Delta A = A_n - A_0, \quad \Delta Y = Y_n - Y_0 \text{………………………(2)}$$

From the equation 1 and 2, we get,

$$P = \frac{A_0 \Delta Y}{\Delta P} \times 100 + \frac{Y_0 \Delta A}{\Delta P} \times 100 + \frac{\Delta A \Delta Y}{\Delta P} \times 100 \text{……………......(3)}$$

Production= Yield Effect +Area Effect+ Interaction effect

The three components of the overall change in production are thus the yield effect, the area effect, and the interaction effect caused by the change in yield and area.

5. **Results and Discussion**

Despite the emphasis on increasing pulse acreage to ensure nutritional security, total pulse acreage has gradually declined. As a result of unfavorable climatic change over the last few decades, there has been little rainfall. The decrease in pulse crop area could be attributed to the frequency of disease-pest attacks on the crop. Given the state's and the country's growing populations, it was thought that assessing changes in the area, production, and productivity of the main pulse crops would be useful for future management and policymakers to ensure nutritional security. The acreage, production, and productivity of pulse crops cultivated in Bihar have seen significant change throughout time. Green gram, red gram, lentil, and other pulse crops were grown on less land over the time period mentioned (2010 over 2000 and 2019 over 2010). The only production that was seen was a rise in the yield of lentil crops. The primary pulse crop planted in Bihar is lentil, which is also farmed there on a higher scale than other pulse crops. It's quite possible that it's the cause of this crop's production rising positively.

- **Growth of Different Pulses in Bihar**

To investigate a variable's propensity to rise, fall, or remain constant over time, growth rates were calculated. Additionally, it showed how much the variable under examination was changing per unit of time. In all periods, it was discovered that the compound annual growth rate in the red gram area of Bihar was negative and substantial. Red gram production's CAGR was found to be negative and significant for the state as a whole, at (-) 1.7 percent annually for the entire period. According to statistical analysis, the production of gram for the state as a whole was shown to be positive and considerable (1.49 percent annually). The state's gram area CAGRs for the time period under consideration were discovered to be positive. For the majority of the periods in the state, CAGRs for production and productivity were negative. During the time period under inquiry for the state, gram production and area were unstable. Bihar's most significant pulse crop is lentil, which is still mostly grown in disadvantaged regions. Although there was a large rise in the lentil cultivating area from 2000 to 2010, there was no discernible change in the production of lentil; on the other hand, productivity was marginally dropping for lentil. Both the cultivating area and output of lentils decreased significantly between 2010 and 20; by 68 percent and 5 percent, respectively. Another important staple crop is green gram; from 2000 to 2010, its productivity and production both showed statistically significant declines. From 2011 to 2020, a similar trend was seen in the green gram cultivation area, which also showed statistical significance. For leguminous crops, we observe a decline in the yield of pulses, the area under cultivation, and productivity. According to these findings, the government ought to offer farmers incentives to encourage the adoption of efficient technology for enhancing pulse production in Bihar.

Table No. 1

(Percent)

Compound annual growth rate of area, production, and productivity of different leguminous crops in Bihar

Time Period Area		Production	Productivity
Red Gram			
2000-10	-1.34**	-1.7*	0.24***
2011-20	-2.9	-2.1	1.9
Gram			
2000-10	-2.28	1.49*	-0.11
2011-20	-0.89	2.92	1.89**
Lentil			
2000-10	34.9	3.89	-10.89
2011-20	-68.6**	-78.09	-5.26*
Green Gram			
2000-10	-16.1	-34.67**	-12.34*
2011-20	-23.89*	11.34	3.56

***, ** and *** Significant at 1, 5, and 10 percent level.**

- **Instability of different Pulses in Bihar**

The state's 2000-10 periods for the red gram area, production, and productivity had stability indices of approximately 15, 20, and 6, respectively, as shown in Table 2. The findings showed that Period-II had increased crop variability in terms of area, yield, and productivity. It may be the result of the growers' emphasis on the rice-wheat cropping system at a time when the use of contemporary inputs, such as high yielding seeds, was encouraged during and after the referencing time periods. It was impossible for farmers to find pulse crops to be more profitable because Kharif crops of pulses takes more than six month for producing final output. For the 2011-20 periods, the area's greatest instability index was predicted to be 23.09. A change in farmers' crop preferences had an impact on the area under gram, according to a period-by-period analysis. According to yield statistics, there had been a little gain, but production had dramatically decreased as a result of a rapid reduction in the region, as shown by the instability indicators. Compared to other pulse crops grown in the state, the instability indices for the area, production, and productivity of green gram for the 2000-10 periods in the state were 14.54, 7.28, and 12.38, respectively and 20.56, 8.9, and 19.51. Green gram in the state is generally grown in the summer season, and required more irrigation. Consequently, compared to other crops, less state land was used for farming. However, lentil achieved excellent results in terms of instability for the periods 2000–10, 4.34, 12.76, and 8.29 for area, production, and productivity, and 6.23, 1.42, and 6.21 for the periods 2011–20.

Table No. 2

(Percent)

Instability indices of area, production, and productivity of different leguminous crops in Bihar

Time Period	Area	Production	Productivity
Red Gram			
2000-10	15.89	20.76	6.28
2011-20	23.09	18.21	12.67
Gram			
2000-10	14.67	18.45	28.89
2011-20	9.82	14.65	21.78
Lentil			
2000-10	4.34	12.76	8.29
2011-20	6.23	1.42	6.21
Green Gram			
2000-10	14.54	7.28	12.38
2011-20	20.56	8.9	19.51

Sources: Authors' own calculation based on Data

- **Analysis of the decomposition of leguminous crops in Bihar**

Decomposition analysis was performed to determine the importance of area, production, and productivity in pulse production, as well as the interaction effect. According to the breakdown analysis of the main pulse crops provided in Table 3, the yield effects of a red gram were rather weak in the state. Interaction effects also showed mixed results. According to the results of a gram data decomposition analysis, the area effect was found to be negative for both time periods -239.89, and -170.73 for the state as a whole. The remainder of the periods in the state area saw positive as well as negative effects on gram production. According to the findings, the yield effect was also found to be negative for the state as a whole for gram in the period 2000-10. The yield effects in the lentil crop in the state were discovered to be comparatively higher and positive for the both periods in the state. According to the results of a decomposition analysis of green gram during both Periods, the state experienced positive area effects and production effect. The area and interaction effects showed varying trends across all time periods.

Table No. 3

(Percent)

Decomposition of production growth of different pulses crop in Bihar			
Time Period	**Area Effect**	**Yield Effect**	**Interaction Effect**
Red Gram			
2000-10	-170.82	-132.05	37.93
2011-20	-106.09	269	-99.09
Gram			
2000-10	-239.089	167.29	-89.2
2011-20	-170.73	-89.17	62.39
Lentil			
2000-10	130.872	92.92	-72.556
2011-20	231.92	-140.37	115.87
Green Gram			
2000-10	272.89	362.92	-220.37
2011-20	-150.37	218.9	-201.78

Sources: Authors' own calculation based on Data

6. Conclusion

The percentage change in area and production for pulse crops decreased during both reference periods. Only lentil production was found to be favored. With the exception of lentil, all pulse crop growth rates were negative, according to the findings. Despite this, all of the pulse crops under investigation experienced positive productivity growth during the investigation period. In comparison to other pulse crops grown in the state over the entire period, stability indices for the area, production, and productivity of green gram in the state were found to be relatively low. Decomposition analysis revealed that the area had the greatest influence on gram production, and productivity had no bearing on the state. The ground beneath the lentil was mostly still. The study emphasized the importance of expanding the area under pulse crops and increasing pulse production through technological intervention to meet the growing demand.

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