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Relational Analysis of Foodgrains and its Seed Production in India: Current Scenario and Future Prospects

Rajeev Kumar Srivastava[1*] and Sudhanand Prasad Lal[2]
[1]Assistant Professor-cum-Scientist (Agronomy), Directorate of Seed and Farms,
Tirhut College of Agriculture Campus, Dholi, Muzaffarpur – 848 121 (Bihar), India.
Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur-848 125 (Bihar), India.
[2]Assistant Professor-cum-Scientist (Extension Education),
Department of Extension Education, PG College of Agriculture,
Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur-848 125(Bihar), India.

(Corresponding author: Rajeev Kumar Srivastava)*
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ABSTRACT: In the current study the status of foodgrains and its seed production in India was tried to be figured out. A positive trend in production of foodgrains during last 10 years was recorded from the period of 2010-11 to 2019-20. Various tools and techniques were used to analyze the secondary data *viz*., descriptive statistics, Compound Annual Growth Rates, Cuddy-Della Valle Instability Index and Correlational Analysis. Production and Irrigation was flabbily significant at 20% level and it implied that with better strategies; production can be achieved even without much irrigation coverage. The research concludes that Decadal Production growth rate of foodgrains was relatively high which is commendable at 1.95% CAGR. But, pulse productivity is 3.75 times less than the Rice-Wheat. The production crossed the landmark of >25 MT in 2017-18 but in 2020-21 also India is the net importer of Pulse. So, it's high time to 'act on pulses now'.

Keywords: Decadal analysis, Foodgrains, Green Revolution, Pulses Revolution, Seeds.

INTRODUCTION

India's economy is centered on agriculture and allied sectors, and 70% of its rural households depend on it (FAO, 2021). India's arable land (% of total land area) was reported to be 52.61% of the total geographical area in 2018 (World Bank, 2021). This indicates that India has a great deal of opportunity for utilizing agricultural resources for current and long-term food security. During the Green revolution, India initiated using several high-yielding varieties (HYVs) of cereals around 1965 (2nd five-year plan). It involved the inclusion of various techniques comprising seeds of HYVs, chemical fertilizers, pesticides, pump sets, combined harvesters, tractors, threshers *etc*. The food grain production growth was about 2.4% per annum before 1965, but it had been increasing at the rate of 3.5% after 1965 (Bowonder, 1979). According to the third advance estimates for 2020–21 published by the Directorate of Economics and Statistics (DES), the nation's total foodgrain production is projected to reach a new height with 305.44 million tones *i.e*. an increase of 7.94 million tones (MT) over the 297.50 MT during 2019–20. Additionally, foodgrain production in 2020–21 is greater by 26.66 MT than the average of the preceding 5 years (2015–16 to 2019–20) production. A total of 121.46 million tonnes of rice are expected to be produced overall in 2020–21, which is a record production. It exceeds the 112.44 million tonnes average production over the previous 5 years by 9.01 million tonnes.

The production of wheat is anticipated to reach a record 108.75 million tonnes in 2020–21. Compared to the production of 100.42 million tonnes (MT) on average, it is 8.32 million tonnes higher. Nutri/coarse cereal production is projected to be 49.66 MT, which is higher by 1.91 MT than the 47.75 million tonnes produced in 2019–20. Furthermore, it exceeds the average production by 5.68 million tonnes. The predicted 25.58 million tonnes of the total production of pulses in 2020–21 is an increase of 3.64 million tonnes from the average production during the preceding five years, which was 21.93 million tonnes (DES, 2021). As per the International Year of Millets (IYoM) 2023 portal, Millets should be marketed as "nutri cereals" rather than "coarse grains," and their advantages should be made known to the general public through a concerted, effective campaign. To promote millets for nutrition security, India proclaimed 2018 as the National Year for Millets. India has also taken the lead role in the celebrations of the International Year of Millets 2023. A subsidiary programme of the National Food Security Mission is NFSM-Nutri Cereals. There is a total of 25 nutri-cereals seedhub in India (IYoM, 2021). A total of ₹ 8760.81 crores have been sanctioned to the states and the other operational institutions as a central share between 2014–15 and 2019–20. Following the program's national adoption and coordinated efforts by the state governments and the Indian government; as a

result, the production of all foodgrains increased, rising by 17.71% from 252.02 MT in 2014–15 to 296.65 MT in 2019–20. Foodgrain productivity grew from 2028 kg/ha to 2325 kg/ha from 2014–15 to 2019–20, respectively (*i.e.* 14.64% raise). The production of pulses, which enhanced by almost 35% from 17.15 million tonnes (2014–15) to 23.15 million tonnes (2019–20), is specifically commendable (PIB, 2021).

The key ingredient for increasing agricultural productivity is the seed. Utilizing high-quality seeds can increase yield by 15 to 20 per cent (Seednet, 2021). As a result, increasing the replacement ratio of the high-quality seeds from hybrids or high-yielding varieties is crucial to improving agricultural output rates. Thus, the seed industry would need to expand considerably more quickly in order to fulfill the growing demand for the different hybrid seeds and also to switch out outdated types for new, high-yielding ones. The Indian Seed Programme plays an instrumental role in the agriculture of India and is well positioned for future expansion (NITI Aayog, 2018). According to DA&FW (2021), India's total breeder seed production was 92.7 thousand quintals in 2019-20, a decrease of 11.56 thousand quintals over the 104.26 thousand quintals realized during 2018–19. The production of breeder seed in 2019-20 is lesser by 6.62 thousand quintals than the average production during the preceding 5 years (2014–15 to 2018–19). But the production of foundation seed was 22.25 lakh quintals in 2019-20, which was 4.25 lakh quintals higher than the last year. Moreover, it exceeds the average production of the previous five years (2014–15 to 2018–19) by 4.18 lakh quintals. In 2019-20, the total amount of distribution of certified/quality seed was 383.72 lakh quintals, which was an increase of 63.31 lakh quintals over the last year. Even it was 58.08 lakh quintals greater than the preceding five years (2014–15 to 2018–19) average distribution. Therefore, among the breeder seeds, foundation seeds, and certified/quality seeds, the production of breeder seeds is in a decreasing trend. If we see the current status of the requirement and availability of different seeds. In that case it can be observed that the production of all the cereals, pulses, and oilseeds was in a bountiful position. The availability of seeds for the cereal crops was 257.07 lakh quintals, which was 33.08 lakh quintals higher than its total requirement of 223.99 lakh quintals in 2019-20. Similarly, the availability of the seeds for the production of pulse crops in 2019-20 was 4.23 lakh quintals higher than its requirement of 35.16 lakh quintals in the country. The requirement for oilseeds was 55.50 lakh quintals. For the oilseeds, the amount of seed availability exceeded the amount of seed requirement by 7.64 lakh quintals. In the last two years (2017-18 and 2018-19) also, the availability of seeds for all the cereal, pulses and oilseeds was greater than its actual requirement. If one look at the last eight years' trend (2012-13 to 2019-20) of the requirement and availability of quality/certified hybrid seeds of various food crops like paddy, maize, jowar, bajra *etc*., the seeds available are always higher than the seeds required (DA&FW, 2021). Therefore, it can be assumed that presently there is no scarcity of crop seeds in India. It could happen because different seed crop zones have developed with high specialization levels over time. Likewise, India's seed processing or conditioning industries have acquired the processes of quality upgrading and upkeep to maintain the high standards of physical condition as well as quality for post-harvest handling. Various geographical regions in the nation have flourished as the optimal storage places for seeds under circumambient conditions as a result of the varied agro-climates. There are more than 20000 seed dealers as well as distributors working in the seed marketing and distribution industry. The various seed corporations under the public sector will maintain to hold a central position in the production of seeds for cereal crops, pulse crops and oilseeds in the upcoming years as the private sector has not been optimistic about approaching the high volume and low margin crop seed production of paddy, wheat, other cereals, pulses and oilseeds (NITI Aayog, 2018). The Seed Replacement Rate (SRR) and productivity are directly proportional. There is a poor seed replacement rate in India as a result of the enormous demand-supply disparity. Only approximately 15% of the net total cropped area of India is currently sown each year with newly acquired and high-quality seeds. Farm-saved seeds are used for sowing a sizable 85 percent of the region. This percentage ranges from 7% for staple crops to a maximum of 70% for various vegetables and fruits, depending on the crop. Between 9 and 18 per cent applies to rice and wheat (Lal *et al*., 2019). Vegetables, fruits, flowers, and varied high value/ expensive seed crops can all get their hands on seeds, but the low value/large volume crops like rice and wheat don't get nearly enough of them (NITI Aayog, 2018; Srivastava, 2018). As per FAO observation, the production of India is cereal-centric, resource-intensive, and regionally biased even though Indian agriculture has attained grain self-sufficiency. Serious sustainability challenges have also been brought up by the resource-intensive methods used in Indian agriculture. Restructuring and reconsidering policy would be necessary given the country's increasing demand for its water supplies. Agriculture in India is also seriously threatened by desertification and land degradation (FAO, 2021). Considering these facts and figures in the backdrop, it was sensed that foodgrains production measurement is a key factor to ensure sustainability of livelihood security in a long term. In light of this, the current study was executed with the following three objectives: i) To execute the decadal analysis of food grain in India ii) To figure out the relationship of foodgrains production and irrigation percentage and iii) To perform Relational Analysis of foodgrains and its seed production in India.

MATERIALS AND METHODS

In this research secondary data was used to quantify Relational Analysis of foodgrains apropos seed production in India from the primary data collected by Department of Agriculture, Cooperation and Farmers'

Welfare, Government of India. Analysis of data that has already been acquired by others is referred to as secondary data analysis. Various tools and techniques were used to analyze the secondary data as mentioned below:

Compound Annual Growth Rates to compute Decadal growth of Foodgrain

CAGR was used to compute Decadal growth of Foodgrain Production in (Million Tonnes) in India. Log linear functions were used to determine CAGR since it is the apposite functional form as explained by Gujarati in 1988 (Gujarati, 2009; Joshi *et al*., 2021). The function was used to calculate CAGR in numerous more investigations. The formula to calculate CAGR is:

$$\boldsymbol{CAGR = \left(\frac{V_{initial}}{V_{final}}\right) 1/t - 1}$$

Where,

CAGR = Compound Annual Growth Rate

$V_{initial}$ = initial value

V_{final} = closing value

T = time in years.

Cuddy-Della Valle Instability Index to compute instability

Instability analysis in Decadal growth of Foodgrain Production in (Million Tonnes) in India was figured out through Cuddy Della Valle Index. Coefficient of Variation measures instability but it exaggerates the level of it in time-series data. The Cuddy Della Valle Index (Cuddy & Valle 1978) de-trends and pinpoints the exact direction of the instability (Nimbrayan *et al.*, 2019).

The equation is mentioned as follows

$$\text{CDVI} = \text{I} = \text{CV} * \sqrt{1 - \text{AdR}^2}$$

Cuddy-Della Valle-Instability index (%)

I = Instability Index (in %)

CV = Coefficient of variation (in %)

AdR^2 = Adjusted

R-Square = Coefficient of determination

Correlational Analysis between foodgrains production and irrigation percentage

Finding out whether two or more variables are connected is the rationale of correlational analysis (Marczyk *et al.,* 2005). Here, correlational analysis was used to compute relationship between top 12 major foodgrains producing states in 2019-2020 along with coverage under irrigation. The equation is mentioned as follows

$$r = \frac{\sum(x_i - \bar{x})\,(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \;\; \sum(y_i - \bar{y})^2}}$$

r = correlation coefficient

x_i = values of the x-variable in the present study

$\bar{x}$ = mean of the values of the x-variable

y_i = values of the y-variable in the present study

$\bar{y}$ = mean of the values of the y-variable.

RESULTS AND DISCUSSION

A. Growth Performance of foodgrain in India

The growth performance of production of foodgrain was calculated by using compound annual growth rate (CAGR) for the year 2010-11 to 2019-20. Decadal Production growth rate of foodgrains was relatively high which is commendable at 1.95% CAGR. The implementation of new technology for growing foodgrains *viz*., the use of high yielding cultivars, improved packages of practices, and improved infrastructure for farming, may be the plausible cause of this humongous growth. Fig. 1 denotes that over the course of 10 years *i.e.* from 2010-11 to 2019-20 the foodgrain production grew from 244.49 to 296.65 Million Tonnes thus having the praiseworthy compound annual growth rate (CAGR) of 1.95 %, when the country has almost reached the plateau of foodgrain production. It can also be deduced that the range of foodgrain production was from 244.49 MT in 2010-11 to 296.65 MT in 2019-20 (Fig. 1). The contributing factor to this humongous foodgrains production may be due to scaling up of indigenous science-led technologies, policy initiatives, extension machinery efforts and measures to ensure food and nutritional security across the country.

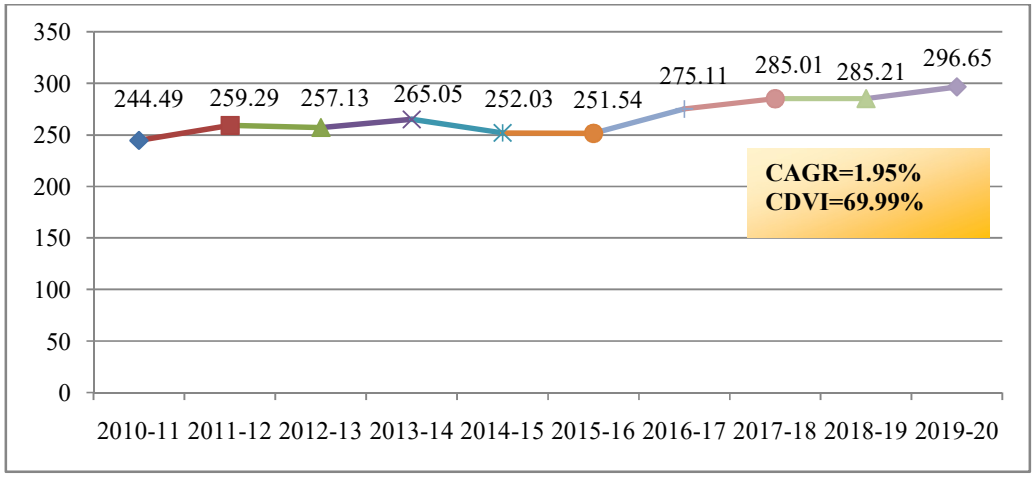

Fig. 1. Decadal growth of Foodgrain Production in (Million Tonnes) in India.

B. Instability index in production of foodgrain in India

The Instability index in production of foodgrain was computed by using Cuddy- Della Valle index. The result indicated that the instability index of production was high *i.e*. 69.99%. The ranges of CDVI are Low instability = between 0 and 15; Medium instability= >15 to 30 and High instability => 30 (Tambe *et al*., 2021). High instability was due to the fact that production increased from 244.49 to 296.65= 52.16 MT over a period of 10 years.

Major Foodgrains Producing States and corresponding Irrigation Coverage

After studying the production relationship it was tried to figure out which state is contributing the most to food basket of India. From Table 2 it is evident that top 3 major food grain producing states are Uttar Pradesh (55.03 MT) trailed by Madhya Pradesh (33.03 MT) and Punjab (30.02 MT). Top 11th and 12th foodgrain producing states were from South India *i.e*. Tamil Nadu (11.04 MT) and Telangana (11.02 MT) thus contributing 296.65 MT into the nation. Further it was tried to figure out the relationship between Production and Irrigation and it was revealed that there was a weak significant relationship between Production and Irrigation at 20% level and it was found to be non-significant at classical 1%, 5% and 10% level. The statistical finding is also supported by figures presented in Table 2. In top 5 foodgrains producing states *viz*., Madhya Pradesh and West Bengal has irrigation coverage of less than 60% and in Rajasthan it is <1/3rd.

Probability Output estimation of Top 12 major Foodgrains Producing States

Probability Output is denoted through Normal Probability Plot for Production vs Sample Percentile. From Fig. 2 it is evident that only 3 states *viz*., Uttar Pradesh, Madhya Pradesh and Punjab has sample Percentile >30 units.

Table 1: Variability of Index for Foodgrain Production over years

Variable	CV	AdR^2	CDVI	Inference
Foodgrain Production	303.456	71.43	**69.99**	High instability

Table 2: Relationship between Top 12 major Foodgrains Producing States in 2019-2020 along with Coverage under Irrigation.

Sr. No.	States	Production (MT)	Irrigation %	r-value
1	Uttar Pradesh	55.03	80.9	Pearson Correlation =.417 (p=.178) Significant at 20% level
2	Madhya Pradesh	33.03	59.4	
3	Punjab	30.02	99.1	
4	Rajasthan	23.18	33	
5	West Bengal	18.26	54.1	
6	Haryana	17.86	93.1	
7	Bihar	14.39	70.6	
8	Maharashtra	14.01	18.7	
9	Karnataka	12.58	22.4	
10	Andhra Pradesh	12.5	58.7	
11	Tamil Nadu	11.04	53.7	
12	Telangana	11.02	61.5	
13	Others	43.73		
	Total	296.65		

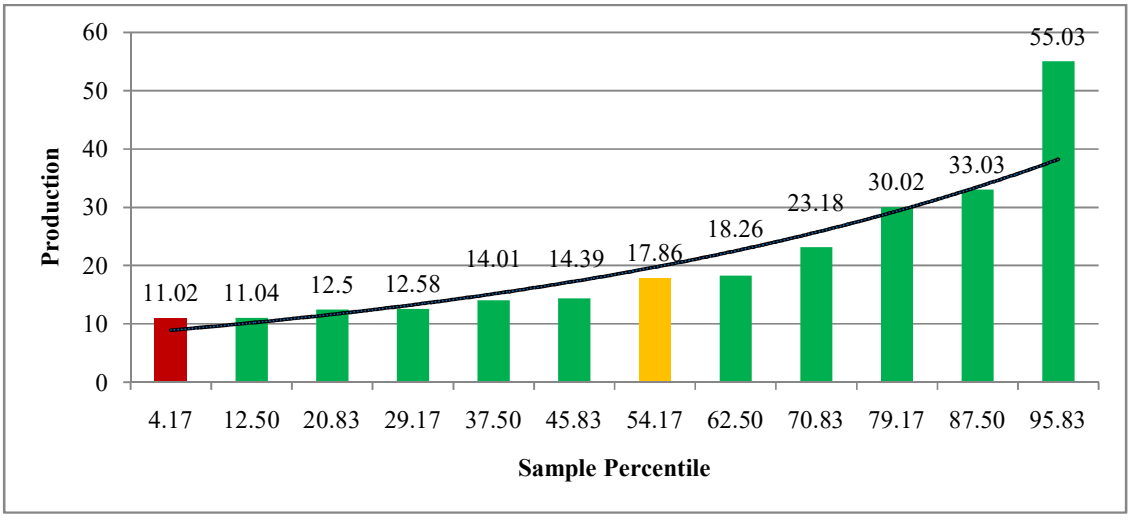

Fig. 2. Probability Output denoted through Normal Probability Plot (Production vs Sample Percentile).

Crop-wise Requirement and Availability of Certified/Quality Seeds

If we see the current status of the requirement and availability of different seeds. In that case it can be observed that the production of certified seeds of all the cereals was in a bountiful position. The availability of seeds for the cereal crops was 257.07 lakh quintals, which was 33.08 lakh quintals higher than its total requirement of 223.99 lakh quintals in 2019-20. Similarly, the availability of the seeds for the production of pulse crops in 2019-20 was 4.23 lakh quintals higher than its requirement of 35.16 lakh quintals in the country.

Table 3: Crop-wise Requirement and Availability of Certified/Quality Seeds in Lakh Quintals (2019-20).

Foodgrains	Requirement	Public	Private	Total Av.
Wheat	121.69	44.89	94.67	139.55
Paddy	82.4	52.21	40.07	92.28
Ragi	0.28	0.38	0.12	0.49
Barley	1.98	0.99	2.04	3.04
Maize	12.71	0.93	14.14	15.07
Bajra	2.51	0.29	2.45	2.74
Jowar	2.28	0.61	2.12	2.73
Other Cereals	0.13	0.08	0.07	0.16

Av=Availability

CONCLUSION

The research concludes that Decadal Production growth rate of foodgrains was relatively high which is commendable at 1.95% CAGR. But, as the yield ratio of Cereal to Pulse is 3.75 and from this it can be inferred that Pulse productivity is 3.75 times less than the Rice-Wheat. The production crossed the landmark of >25 MT in 2017-18 but in 2020-21 also India is the net importer of Pulse. So, it's high time to 'act on pulses now' as pulse and cereals diets combination is best and cost effective diet in whole world. Innovative, multifaceted strategies, collaborations, and technologies for increasing productivity and expanding the production area are required to meet the predicted 33 MT of pulse demand by 2024. In furtherance, collective action, convergence, and capacity building with an integrated extension approach may help to realize the desired yield of pulse. Finally, only the integrated application of chemical fertilizers and organic manures can restore the soil's fertility and boost rice, wheat and other cereals crop output in both quantity and quality.

FUTURE PROSPECTS BY REORIENTING FOOD BASKET OF INDIA

In 2019-20, if one compares All India Crop-wise Yield of Rice-Wheat (27.05+34.21=61.26/2=30.63 q/ha) to Pulses (8.17q/ha); the yield ratio of Cereals to Pulse is 3.75; from this it can be inferred that Pulse productivity is 3.75 times less than the Rice-Wheat. In 2017–18, India has witnessed a silent 'Pulses Revolution' by producing 25.42 MT of pulses (DA&FW, 2021). For the first time in the history of pulse, the production crossed the landmark of >25 MT and so far this is an exceptional achievement as production decreased in 2018-19 to 22.08 MT. Fact of the matter is in 2020-21 also India is the net importer of Pulse as imports are estimated to be around 1 MT (Kaundinya, 2020). So, it's high time to 'act on pulses now' as pulse and cereals diets combination is best and low cost diet in whole world (Narang, 2019). Rice fallow area is estimated to be 57.92 lakh hectare during 2016-17 (DAC & FW, 2018) and it can be fruitfully be used for the pulse production. Innovative, multifaceted strategies, collaborations, and technologies for increasing productivity and expanding the production area are required to meet the predicted 33 MT of pulse demand by 2024 (Wani *et al.*, 2021).

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Conflict of Interest. None.

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