# Growth and Instability in Area, Production and Productivity of Barley in Haryana vis-à-vis India

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*Authors' contributions*

*This work was carried out in collaboration among all authors. Author PKN designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors PKN, Sunita and JKB managed the analyses of the study. Authors Sunita, JKB and Heena managed the literature searches. All authors read and approved the final manuscript.*

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## ABSTRACT

The present study has made an attempt to examine the instability in the area, production and productivity of barley crop in India and Haryana during three phases i.e. pre-green revolution, green revolution and post green revolution period. The study is based on secondary data and used three analytical methods. The results showed that in case of area, the instability is more in the post-green revolution than pre-green revolution period as the focus of the green revolution was mainly on other crops like rice and wheat. In case of production, instability showed a decreasing trend from pre- to post-green revolution period due to the adoption of new technology and good quality seeds during the green revolution. A same decreasing trend was observed in yield instability also. In case of growth pattern, the area in Haryana and India both shows a negative growth trend in the pre-green revolution. In case of production, in Haryana, negative growth trends were observed in the green revolution period but in the post-green revolution, it was positive growth; while in India as a whole growth rate was negative. In case of yield, the growth rate was positive in both Haryana and India.

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## 1. INTRODUCTION

In India, there are many agricultural reforms such as land reforms, green revolution, declaration of minimum support price and new economic reforms which have directly affected the agricultural sector. Even these reforms are favourable in terms of production and productivity of all the crops but they have less favourable in terms of crop stability. Only a few crops such as rice and wheat are going towards stability but the coarse cereals and pulses are shown highest instability in area and production in the country. Coarse cereals had been traditionally the main components of the food basket of the poor people in India. However, it is now considered as one of the neglected crop sectors. Coarse cereals include cereals other than wheat and rice. A variety of coarse cereals are grown in India, but mostly as rain fed crop and in fragile agro-climatic regions. These crops include Jowar, Ragi, Bajra, maize, barley and other small millets.

Barley, *Hordeum vulgare*, is an edible annual grass in the family *Poaceae* has grown as a cereal grain crop. Barley is cultivated as a food cereal in the tropics and subtropics of India, Nepal, Tibet, Afghanistan, Russia, Ethiopia, North Africa and the Andean region of South America. The straw produced is used as an animal feed, bedding and to cover roofs of houses. In temperate regions, barley is used in malt production to brew beer and make other distilled alcoholic beverages, particularly whisky. But it is now considered as one of the neglected crops in India as its area is continuously being covered by other crops especially wheat.

The focus of the green revolution was on high yielding and high input utilization crops such as wheat and rice to meet the demand for food security resulted in policies favouring their cultivation. Further, these crops received research, extension and market support. Thus, on the supply side, there was a shift in the area under cultivation from coarse cereals to find cereals (rice & wheat). But still, they played important role in securing local level food security and very high nutritive value and can play important role in maintaining nutrition value in a country like India, where the problem of malnutrition is very high. More than 90% coarse cereals are produced in Rajasthan, Maharashtra, Karnataka, Uttar Pradesh, Madhya Pradesh, Gujarat, Andhra Pradesh, Haryana, Bihar and Tamil Nadu States.

The agriculture sector of Haryana has improved sharply after the adoption of new technology during mid-sixties (60-70). The new technology which Haryana had adopted, enhanced area, production and productivity of almost all the crops which ultimately helped India to achieve self-sufficiency in food grains production. The total food grains production in this state is following an increasing trend but there is a sharp decline in coarse cereals and pulses, due to the shift of area towards high yielding and assured crops, like rice and wheat. The reason for this tremendous performance in agriculture production is increasing the productivity of major crops during the green revolution period, which makes Haryana, a state as an important role player in the country's food security. The State is the second largest contributor to the central food grains pool. In 1966-67 total food grain production of sate was 2592 thousand tonnes, which witnessed a remarkable increase. In 1980-81 the total food grain production of the state was 6030 thousand tonnes which became 13294 thousand tonnes in 2000-01 and in 2010-11 it was 16568 thousand tonnes. Increase in the area was less as compared to the increase in the production of food grains.

Only in the starting years of eighty's area witnessed a considerable increase, after that it remain almost stagnant with marginal variations. So, this significant increase in food grain production was achieved by the increase in productivity. After the advent of the green revolution, the focus shifted towards wheat and rice. The area under coarse cereal either shifted to plain cereal or restricted in dry and less irrigated districts. Maize, Bajra, barley or Jowar are the major coarse cereals grown in Haryana. Barley a Rabi season coarse grain considered poor man crop, because of low input requirement. The crop needs less water and is more tolerant of salinity and alkali conditions than other winter cereals. It is, therefore, of great significance in areas where it is not possible to take a successful crop of wheat owing to unsuitable soil and insufficient irrigation.

## 2. MATERIALS AND METHODS

Data on important variables like area, production and yield of barley were compiled for the period

1956-57 to 2016-17 from Department of agriculture and farmers welfare, Haryana and Ministry of agriculture & farmers welfare, Government of India, New Delhi. In order to capture the impact of green revolution on the stability of agriculture, the entire selected period was divided into three phases and termed them as pre-green revolution phase, the period of the green revolution and post green revolution phase with wider dissemination of technology. pre-green revolution is taken from 1956-57 to 1964-65. The next period is taken from 1967-68 to 1987-88, which we referred to as the green revolution phase. Post green revolution period is taken from 1988-89 to 2016-17.

Instability analysis in the area, production and yield of barley was studied using three methods of instability such as:

**Method 1: Coefficient of Variation**

Coefficient of Variation (C.V) is the simplest measure of instability, its over-estimates the level of instability in time series data which are characterized by long-term trends.

$$\text{Coefficient of Variation(CV)} = \frac{\text{standard deviation}}{\text{mean}} \times 100$$

**Method 2: Cuddy-Della Valle index**

The Cuddy Della Valle Index de-trends the annual price and shows the exact direction of the instability [1]. Hence, it is a better measure to capture instability in the agricultural area, production and yield. A low value of this index indicates low instability in prices and vice-versa. The Cuddy-Della Valle index corrects the CV as:

$$\text{Cuddy} - \text{Della Valle Instability Index (\%)} = \text{CV} \sqrt{(1 - \bar{R}^2)}$$

Where,

CV = coefficient of Variation (%)
$\bar{R}^2$ = adjusted coefficient of determination

**Method 3:** Ray (1983b) developed a very simple measure of instability given by the standard deviation in annual growth rates [2]. The method satisfies properties like instability based on detrended data and comparability. That's the third measure to find the instability in barley's area, production and productivity.

$$\text{Instability index (II)} = \text{Std}\left[\ln\left(\frac{Y_{t+1}}{Y_t}\right)\right]$$

Where,

std = Standard deviation
ln = Natural logarithm
$Y_{t+1}$ = Area / production / yield for the current year
$Y_t$ = Area/production/ yield in the previous year

This index measures deviations from the underlying trend. Moreover, it is unit free and robust index. In this method, if the series of any given variable fluctuates more than ratio $Y_{t+1}/Y_t$ also fluctuates more, that increases standard deviation. On the other hand, if there are no deviations from the trend than ratio $Y_{t+1}/Y_t$ is constant and thus standard deviation is zero.

To measure the growth of the area, production and yield of barley, compound growth rates were evaluated by fitting to the time-series data in exponential function of the following form:

$$Y = ab^t \tag{1}$$

Where,

Y = Index number of area, production, productivity as the dependent variable
t = Time variable (year) as independent variable
a = Intercept
b = Regression coefficient

Equation (1) can be expressed in logarithmic form as follows:

$$\log y = \log a + t \log b \tag{2}$$
$$\log y = A + B t \tag{3}$$

Where,

A = log a
B = log b

The compound growth rate "r" was computed as:

$$r = (\text{Antilog of b - 1}) \times 100 \tag{4}$$

## 3. RESULTS AND DISCUSSION

### 3.1 Instability in Haryana

Estimates of instability through all methods in area, production and yield of barley is presented in Table 1. According to the coefficient of variation method, instability in the area of barley in Haryana in the green revolution period is more than the other two periods. Post green revolution period's instability is more than pre-green

revolution period comparatively. In the case of production, instability is in decreasing order through first to the third period. Yield instability in barley was higher in the first period then it decreases in the second period but in third period instability is again rising but not higher than the first period.

In Cuddy-Della valle instability index in the area of barley in Haryana, the instability is higher in the second period as compared to both first and second periods. In case of instability in production, it shows declining through pre-green revolution to post green revolution period. Similarly, in yield instability index also showed declining trend during throughout period.

In the third method, inter-year variation in the area of barley in Haryana increased in green revolution period as compared to the pre-green revolution period and in the post green revolution period though it declined. Instability in the production of barley in Haryana shows an increase in the second period as compared to the first period and in the third period, it further declined as compared to the second period. In case of instability in yield of barley in Haryana first and the second period are the same but in the third period it was declined. Instability in yield in Rajasthan was higher after the green revolution period [3].

## 3.2 Instability in India

In India, instability through the first method in the area was higher in the green revolution period as compared to pre and post green revolution periods. In the case of production instability in the second period was higher as compared to both the first and third period. But instability in yield its shows increasing through pre-green revolution period to post green revolution period.

Instability through cuddy-della valle instability index, area instability is less in the first period and showed an increase in the second period but in the third period, it's latterly less from the second period. In production instability index is higher in the green revolution period followed by post green revolution and pre-green revolution, respectively. Similarly, in yield instability is higher in the second period followed by the third and first period, respectively. The higher instability in the area, production and productivity in cotton [4].

In the case of the third method of instability in India, instability in the area was higher in the green revolution period as compared to both pre and post green revolution period. In production case of India, instability was higher in the pre-green revolution period. Similar trends were also studied [5]. In the case of yield instability in India, instability was higher in the second period as compared to the first period but instability in the third period was lower from both the first and second period.

## 3.3 The Pattern of Growth Trends in Haryana vis-à-vis India

To estimate the growth performance of the area, production and yield of barley in the Haryana vis-à-vis India during the three periods, pre-green revolution phase (1956-1965), green revolution period (1968-1988) and post green revolution phase (1989-2017) time series data were analysed and presented in Table 3. In Haryana, area during pre-green revolution period compound annual growth rate (CAGR) was positive but in the second period i.e. green revolution period CAGR was negative and third-period CAGR was negative but less than the second period. In the case of production in Haryana, during first-period growth was positive but in second-period growth rate was negative but again in third-period growth was positive. After green revolution period positive growth in production was found in barley [6]. Negative growth rate report in production in Himachal Pradesh [7]. In yield of Haryana, the growth rate in all period was positive but in the second period, it was less than the first period. In the third period, the growth rate of yield in Haryana was again rising. Growth trends of area, production and productivity of barley in Haryana is shown in Fig. 1.

In India, the growth rate in all periods of the area was negative. During the green revolution period, the growth rate was lowest in all periods. In case of production in India, again growth rate was negative in all periods. In this case also during the green revolution period growth rate was lowest in all period but in the post-green revolution, the growth rate was increasing but still negative. Negative production growth trends in India and many states [8]. The growth rate of yield in all periods was positive but higher in the green revolution period. Growth trends of area, production and productivity of barley in India is shown in Fig. 2.
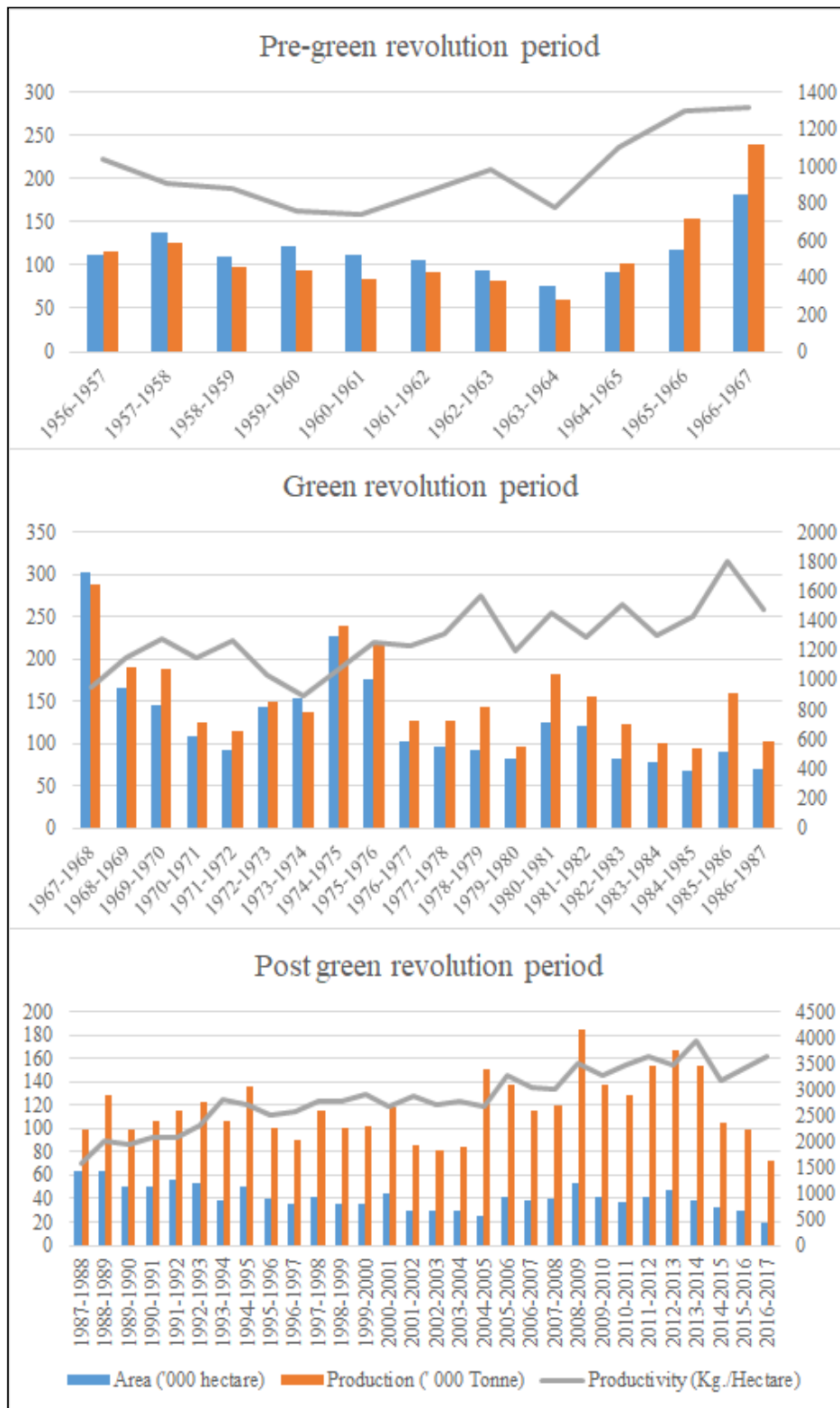
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**Fig 1. Growth trends of barley in area, production and productivity in all periods in Haryana**
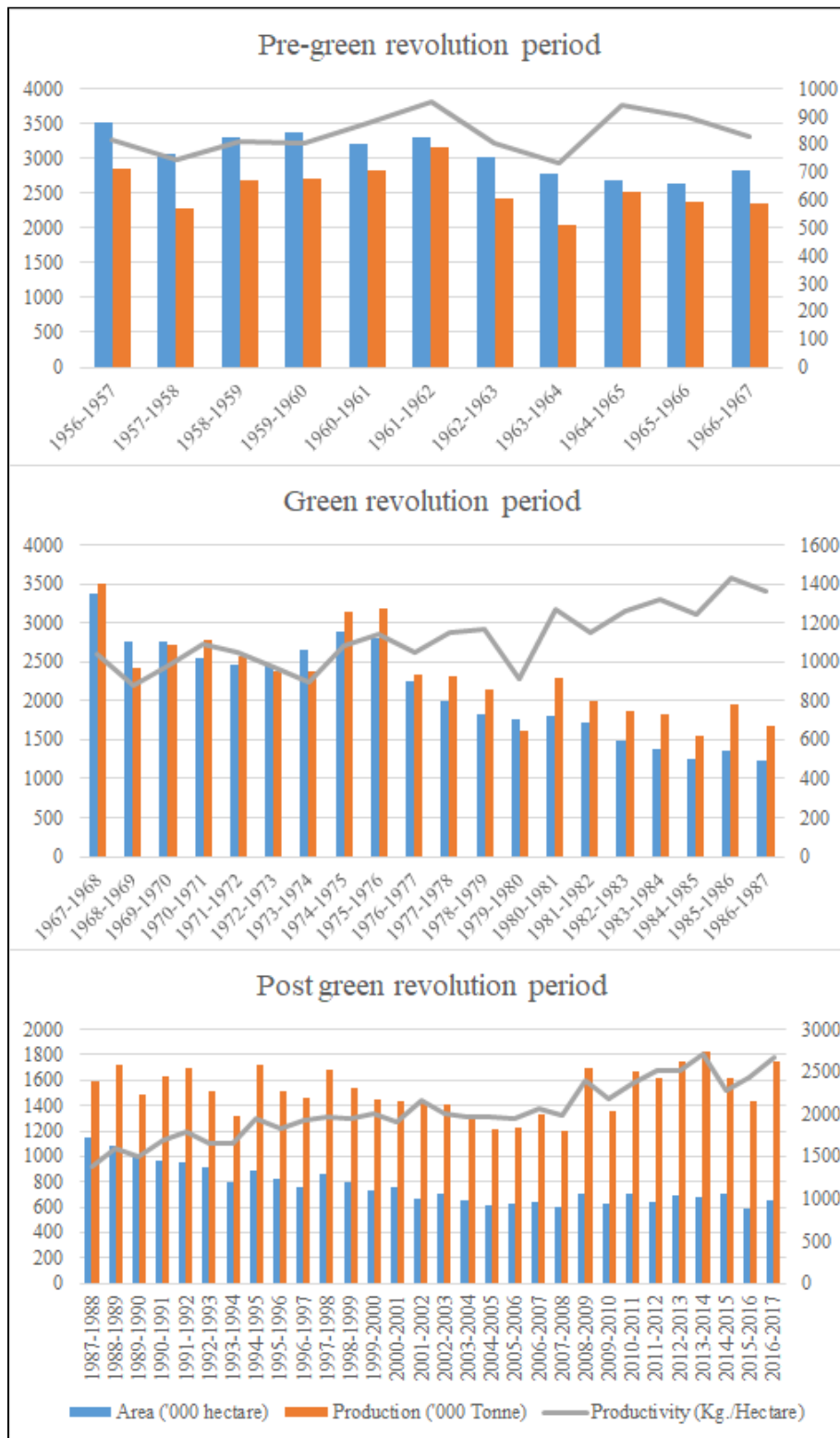
**Fig 2. Growth trends of barley in area, production and productivity in all periods in India**

**Table 1. Instability in area, production and yield of barley in different periods in Haryana level (%)**

|  | Area | | | Production | | | Yield | | |
|---|---|---|---|---|---|---|---|---|---|
|  | 1956-1965 | 1968-1988 | 1989-2017 | 1956-1965 | 1968-1988 | 1989-2017 | 1956-1965 | 1968-1988 | 1989-2017 |
| 1st method | 24.32 | 46.57 | 25.78 | 43.16 | 33.62 | 22.64 | 20.67 | 17.07 | 19.97 |
| 2nd method | 25.48 | 35.50 | 20.85 | 41.29 | 29.16 | 22.26 | 17.75 | 12.02 | 7.91 |
| 3rd method | 22.42 | 31.99 | 20.81 | 30.16 | 34.04 | 22.60 | 17.57 | 17.80 | 9.73 |

**Table 2. Instability in area, production and yield of barley in different periods at India level (%)**

|  | Area | | | Production | | | Yield | | |
|---|---|---|---|---|---|---|---|---|---|
|  | 1956-1965 | 1968-1988 | 1989-2017 | 1956-1965 | 1968-1988 | 1989-2017 | 1956-1965 | 1968-1988 | 1989-2017 |
| 1st method | 9.87 | 29.72 | 19.33 | 12.26 | 23.01 | 11.76 | 8.57 | 14.01 | 16.64 |
| 2nd method | 5.59 | 10.92 | 10.50 | 11.67 | 15.76 | 11.97 | 8.40 | 8.18 | 6.92 |
| 3rd method | 7.12 | 10.06 | 9.05 | 16.09 | 20.81 | 13.33 | 12.22 | 13.99 | 8.25 |

**Table 3. Growth in area, production, and yield of barley in different periods at Haryana and India level (%)**

|  | Area | | | Production | | | Yield | | |
|---|---|---|---|---|---|---|---|---|---|
|  | 1956-1965 | 1968-1988 | 1989-2017 | 1956-1965 | 1968-1988 | 1989-2017 | 1956-1965 | 1968-1988 | 1989-2017 |
| Haryana | 0.15 | -4.85 | -1.76 | 3.41 | -2.83 | 0.52 | 3.31 | 2.12 | 2.23 |
| India | -2.50 | -4.85 | -1.76 | -1.59 | -3.06 | -0.02 | 0.93 | 1.89 | 1.77 |

## 4. CONCLUSION

In this study, three methods were used to find instability in barley's area, production and yield. In all methods, cuddy della valle instability index was found a better measure to capture instability in the agricultural area, production and yield. Economic performance of barley in Haryana vis-à-vis India showed both positive and negative trends in the growth of the area, production and productivity. The area in Haryana and India both showed negative trends in growth in the pre-green revolution. In production, growth trends in Haryana showed negative in green revolution phase but in the post-green revolution, showed positive growth; while in the case of India as a whole, growth rates were negative. In the case of yield, growth rate was positive in both Haryana and India.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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