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Exploring the Performance of Wheat Crop in India and China

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ABSTRACT

Background: Wheat is pre-eminent among the world's crops in regard to its importance as a staple food of mankind. India is the second largest producer of wheat in the world after China and contributes more than 12 per cent to the global wheat basket. The most important crop after rice in India is wheat and occupies approximately 27.80 million ha area. India has witnessed a significant increase in total food grain production of 233.88 million tons. On the other hand, India is also the second largest wheat consumer after China. Thus, wheat and its various products play an increasingly significant role in managing India's food security.

Methods: The data of wheat production, area harvested and yield for last six decades have been procured from FAO, Government of India. The change in production function of a crop has been estimated by using linear function and compound growth rate. Further, the Cuddy-Della Valle Index has also been calculated.

Result: The study showed an average increase in area, production and yield of wheat crop by 144.53 per cent, 896.54 per cent and 307.53 per cent in case of India, respectively whereas in China, the area was decreased by 7.81 per cent and the increase in production and yield by 279.97 per cent and 238.68 per cent, respectively. The wheat production in India and China has been increased by 0.000265 per cent and 0.000428 per cent, respectively due to yield effect and the change due to interaction between yield and area were 0.049576 per cent and -0.00855 per cent, respectively. Further, the results by linear regression model and compound growth rate model were, the production and yield of wheat in China showed highly significant growth rate of 1.033 per cent and 1.035 per cent giving an increase of 20.532 lakh tons per year and 0.881 quintal per hectare yield every year as compared to India but the area was found to be good fitted for India *i.e;* 1.014 per cent giving an annual increase of 2.949 lakh hectares. The instability was low in case of area, production and yield because of the slow growth rate. The findings of this study have far-reaching implications that will have a significant impact on the planning, execution and design of appropriate methodologies in order to achieve meaningful and fruitful results not only for wheat growers, but also for other sectors that essentially provide feedback to agencies involved in various demonstration programs.

Key words: Area harvested and yield, Compound growth rate, Linear regression model, Wheat production.

INTRODUCTION

Cereals play a pivotal role to satisfy the global food demand of growing population, particularly in developing nations where cereal-based production system is the only predominant source of nutrition and calorie intake (Nikos and Jelle, 2012). Wheat (*Triticum aestivum* L.) is one of the principal cereal crops grown worldwide and one of the important staples of nearly 2.5 billion of world population. Wheat is the major staple food crop, providing almost half of all calories in the region of North Africa and West and Central Asia. Being next to rice, wheat constitutes one of the key sources of protein in least developed countries and middle-income nations in terms of calories and dietary intake. The major source of increase in total production was mainly attributed to increase in productivity followed by slight increase in area. While increase in productivity was due to the use of high yielding varieties, fertilizer and adoption of other improved technologies of wheat cultivation. Similar results were obtained by Ramdas *et al.* (2019) in their study.

India, being blessed and enriched with a diverse agro ecological condition, ensuring food and nutrition security to a majority of the Indian population through production and steady supply particularly in the recent past, is the second largest producer of wheat worldwide. The total area under the crop is about 316.1 lakh hectares in the country in 2020-21. The production of wheat in the country has increased significantly from 109.97 lakh tons in 1960-61 to an all time record high of 1095.90 lakh tons in 2020-21. In 1961, Government of India appointed a commission to assess the feasibility of increasing the crop productivity under prevailing Indian ecological conditions. As result of various steps taken by Govt. of India, the wheat scenario in our country has completely changed. In the post-independence era, country used to import wheat for our needs but due to bumper increase in the production and productivity of wheat in the 'Green Revolution' period in late sixties, our country became self-dependent in wheat production. At present,

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country is producing much more excess wheat than the requirement and godowns are over-flooded with the crop.

As far as China is concerned, first largest producer of wheat worldwide. It feeds 20 per cent of the population of the world and consumes an average of approximately 5 million tons of food annually. Wheat is the main food for more than 65 per cent of the chinese population. Over the previous three decades, the farming of wheat accounted for about 27-29 per cent of the total grain production; nearly 41-45 per cent of the area being used for wheat production of the total national grain production. From 1960-61 to 2020-21, the wheat crop production was 142.94 lakh tons to 1369.52 lakh tons, the harvested area was 255.67 lakh hectares to 235.71 lakh hectares and the yield was 5.59 quintal per hectare to 58.10 quintal per hectare (FAO data).

MATERIALS AND METHODS

The secondary data of area, production and yield of wheat crop have been taken from year 1960-61 to 2020-21 which were utilized for this study. The data were collected from FAOSTAT (2021). Here, the production, yield and area are denoted by Q_n, Y_n and A_n for the current period and Q_0, Y_0 and A_0 for base period, the increase in production $Q = (Q_n - Q_0)$ in n years over base period is a function of change in area $A = (A_n - A_0)$ and yield $Y = (Y_n - Y_0)$. The change in production function of a crop as (Ganeshan, 2015; Nisha *et al*., 2019; Kaur and Grover, 2020; Mahajan *et al.,* 2023; Khan *et al.,* 2023).

$$Q = A_0Y + Y_0A + AY \quad ....(i)$$

Where,

A_0Y = Yield effect.

Y_0A = Area effect.

AY = Interaction between area and yield.

To analyze the time series data, the following function was fitted.

The linear function is:

$$Y_t = a + bt \quad ....(ii)$$

Where,

Y_t = Area/production/average yield of wheat crop in the year.

a = Constant.

b = Regression co-efficient.

t = Time variable in years (t= 1, 2, ..., 60).

Moreover, Compound growth rate (C.G.R) has been calculated as:

$$C.G.R.\ (\%) = (\text{Antilog } b - 1) \times 100 \quad ....(iii)$$

Instability (Cuddy-Della Valle index)

Instability in area, production and yield (Chand and Raju, 2009; Tewari *et al*., 2017; Jain, 2018; Jomon, 2020; Mahapatra *et al.,* 2024) can be estimated by using Cuddy-Della Valle instability index for the series following a time trend. The Cuddy-Della Valle Index (Cuddy and Della Valle, 1978) was computed as:

$$I = CV * \sqrt{1 - \text{Adj } R^2} \quad ....(iv)$$

Where,

I = Instability index (%).

CV = Coefficient of variation (%).

R^2 = Coefficient of determination from a time trend regression adjusted for its degrees of freedom.

The ranges of CDVI (Sihmar, 2014) are given as follows: Low instability = 0 to 15; Medium instability = 15 to 30; High instability = 30 and above.

RESULTS AND DISCUSSION

The summary statistics of area, production and yield of wheat crop for India and China have been presented in Table 1.

Here, variable production of wheat for India have maximum CV (54.09 per cent) followed yield (38.12 per cent) whereas the variable area has minimum CV (23.14 percent) which clearly indicates lot of variation among the independent variables, may be due to the presence of influential observations. In case of China, the variable yield has maximum value of CV (49.79 per cent) followed by production (46.19 per cent) and the variable area has minimum CV (9.86 per cent).

The graphical representation of area, production and yield of wheat crop for both countries are shown in Fig 1 and Fig 2. The production and yield of wheat in India and China showed an increasing trend but in case of area, India showed an increasing trend whereas, China's trend is declining. It is found that the production of China is more than India, may be because of using high quality seed, modern technologies, high yielding varieties *etc.*

The average per cent change in area, production and yield of wheat crop for India and China has been calculated by using base period as 1960-61 and current period as 2020-21 as shown in Table 2. The table revealed that in India, the area has increased by 144.52 per cent, production by 896.54 per cent and yield by 307.53 per cent whereas in China, the area have been decreased by 7.80

Table 1: Summary statistics of exogenous variables for the area, production and yield of wheat in India and China.

Country	Variable (Unit)	Mean	Std. deviation	CV
India	Area (lakh hectare)	234.78	54.35	23.14
	Production (lakh tons)	541.16	292.76	54.09
	Yield (quintal per hectare)	21.27	8.11	38.12
China	Area (lakh hectare)	264.14	26.05	9.86
	Production (lakh tons)	823.99	380.61	46.19
	Yield (quintal per hectare)	31.59	15.73	49.79

Table 2: Percentage change in average area, production and yield of wheat crop in India and China.

Area (lakh ha), Production (lakh tons), Yield (quintal/ha)

Year(t)	India			China		
	Area harvested	Production	Yield	Area harvested	Production	Yield
Base period (1960-61)	129.27	109.97	8.50	255.67	142.94	5.59
Current period (2020-21)	316.10	1095.90	34.66	235.71	1369.52	58.10
Change (%)	144.52	896.54	307.53	-7.80	858.09	939.18

per cent but the drastic change has been seen in production and yield by 858.09 per cent and 939.18 per cent.

The contribution of yield, area and their interaction to increase the production has been studied and shown in Table 3. The production of wheat in India has increased 0.00189 percent and in China, it was decreased by 0.00016 per cent, respectively due to area effect and 0.04957 per cent and -0.00855 per cent, respectively due to interaction between yield and area. The contribution of yield was found to be 0.00026 per cent and 0.00042 per cent, respectively. Therefore, yield and its interaction with area have played the key role in increasing the production of wheat in India.

The growth rates of area, production and yield of wheat in India and China have been presented in Table 4. Area of wheat in India has increased with highly significant growth rate, *i.e.*1.014 per cent giving an increase of 2.949 lakh hectare area every year. The production of wheat has shown a highly significant growth rate of 1.038 per cent giving an increase of 16.350 lakh tons per year. Yield of wheat has also increased with slight significant rate of 1.024 per cent *i.e.* an annual increase of 0.451 quintal per hectare. It depicts that production has increased more rapidly than area due to adoption of modern production technology at farmer's field. In case of China, area of wheat has decreased with slight significant growth rate of 0.998 per cent *i.e;* 0.438 lakh hectare showed a decline rate every year. The production of wheat has shown a highly significant growth rate of 1.033 per cent giving an increase

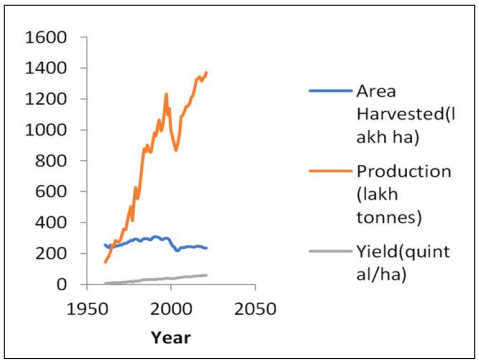


Fig 2: The trend of area, production and yield for wheat crop in China.

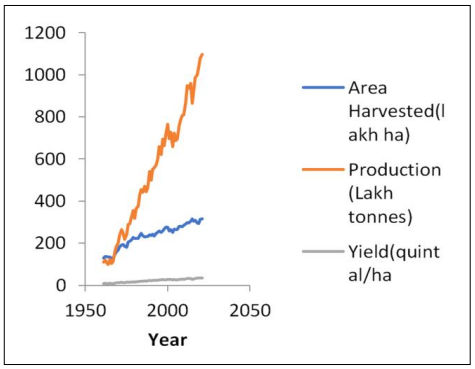


Fig 1: The trend of area, production and yield for wheat crop in India.

Table 3: Contribution of area, yield and their interaction to change the wheat production.

Variable(s)	Contribution (%)	
	India	China
Area	0.00189	-0.00016
Yield	0.00026	0.00042
Interaction between area and yield	0.04957	-0.00855

Table 4: Growth rates of area, production and yield of wheat crop.

Countries	Variables	Linear regression coefficient	R^2 (%)	Compound growth rate	R^2 (%)
India	Area harvested	2.949**	92.80	1.014**	86.60
	Production	16.350**	98.30	1.038**	91.50
	Yield	0.451**	97.30	1.024**	92.50
China	Area harvested	-0.438**	89.00	0.998**	97.00
	Production	20.532**	91.70	1.033**	83.30
	Yield	0.881**	98.80	1.035**	92.00

** =5% level of significance.

Table 5: Instability in wheat's area, production and yield for India and China.

Country	Variable	CV	Adj. R^2	Cuddy della valle instability (CDVI) index
China	Area harvested	9.86	0.74	5.02
	Production	46.19	0.91	13.85
	Yield	49.79	0.98	7.04
India	Area harvested	23.14	0.92	6.54
	Production	54.09	0.98	7.64
	Yield	38.12	0.97	6.60

of 20.532 lakh tons per year. Yield of wheat has also increased with highly significant rate of 1.035 per cent *i.e.*an annual increase of 0.881 quintal per hectare which is greater than India. It depicts that production has increased more rapidly than area and average yield in China. The instability of area, production and yield of wheat for India and China has been presented in Table 5. Both the countries showed low instability which indicated that the persistence of instability is low in case of area, production and yield as the growth is low.

CONCLUSION

Overall performance of the wheat crop in terms of growth in area, production and yield indicated a significant positive growth and low instability. The study identified that China with lesser cultivable land produces more the wheat crop than India. It has been concluded from the results that the average percentage change in area, production and yield in India is 144.52 per cent, 896.54 per cent and 307.53 per cent whereas, China showed negative change in area as 7.80 per cent but the positive change in production as 858.09 per cent and yield as 936.18 per cent. Area and production of wheat in India has increased with highly significant growth rate of 1.014 per cent and 1.038 per cent giving an increase of 2.94 lakh hectares per year area and 16.35 lakh tons per year production whereas for China, area showed a decline rate of 0.998 (0.438 lakh hectares per year), the production showed an increase with highly significant growth rate of 1.033 per cent (20.532 lakh tons per year). But the yield of wheat crop for both the countries showed almost similar trend *i.e;* increased with slight significant growth rate of 1.024 and 1.035 per cent with an annual increase of 0.451 quintal per hectare in India and 0.881 quintal per hectare in case of China. India ranked 1st in the area under cultivation and 2nd in terms of production, while at global level China ranked 1st in production and 3rd in the area under wheat cultivation. So, there is need to promote resource conservation technologies, awareness campaign among the farmers related to scientific package of practices, modern technologies, improved seed, integrated nutrients management *etc.* to reduce the gap between actual yield and potential yield of wheat in both the countries.

Conflict of interest

All authors declared that there is no conflict of interest.

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