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Trend analysis of wheat yield in Bihar

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Abstract
In agriculture sector, among crops wheat is the important rabi crop of India, which is not only a staple food crop of India, however staple food crop for world. India's rank in wheat production is 2nd followed by china. In India wheat occupies an area of 30.23 million hectares having production 93.50 million tone and having productivity of wheat is 3093 kilogram per hectare. The present study was aimed to analyze the trends of wheat yield in Bihar with all three agro-climatic zones of Bihar purposively because cultivation of wheat in whole Bihar on large scale and also due to better profitable crop. A time series data on wheat yield were collected for 1964-65 to 2015-16 from Directorate of Economics and Evaluation Department, Govt. of Bihar, Patna. After study were done for trend analysis, it were found that the trend is likely to be increasing order of wheat yield (except few years). The overall trend in all three agro-climatic zones i.e. zone-I, zone-II, zone-III and also for whole Bihar seems to increasing and linear. A validity test were also done by using Kendall test, Spearmann test and Pearson test, it was found that all are highly significant.

Keywords: wheat, trend analysis, productivity, agro-climatic zones

Introduction
Wheat (*Triticum aestivum* L.) is an important cereal crop in the world under a varied range of climatic conditions. In India, Wheat is grown from 11°*N* to 30°*N* latitude and from sea level up to elevation of 3658m in the Himalayas. It is grown in a wide range of temperature and annual rainfall, from sandy loam soil to heavy black cotton clay soils (Chatterji, 1966) [1].
Wheat (Triticum spp.) is an ancient grain and also one of the leading cereal crops, ranking third, in the world (http://faostat.fao.org/). The Centre of origin of wheat is South-western Asia. It has been a food crop for mankind since the beginning of agriculture. Hybridization of diploid and tetraploid wheat occurred several thousand years ago resulting in the production of hexaploid wheat (common wheat: T. aestivum L.) (Fenillet *et. al.*). A wheat grain is divided into three main parts, the bran, endosperm, and germ. The bran, the outer layer, is composed of fibres (50%), antioxidants, B vitamins, and 50-80% of minerals are composed of iron, copper, zinc and magnesium (Sremkova *et. al.*). Wheat grain is comprised mainly of starch, proteins, and cell wall polysaccharides (Shewry *et. al.*).
Wheat is the excellent source of carbohydrates**,** energy and has no fat. It is also a good source of vitamins and minerals such as thiamine, niacin, iron, riboflavin, vitamin D, calcium, and fiber. It is also grown in the coastal sandy regions in some of the hilly tracts of north. The pace of wheat production has to be maintained accordingly due to fast increasing population of the country (Singh *et al.*, 2003) [10]. In India Wheat is cultivated under wide range of agro-climatic conditions. The cultivation practice adopted in different agro-climatic zones.
On worldwide the crop occupies both in area and production is 219.04 million hectares & 715.90 million tone respectively with 13.54% area and 13.06% production share by India. In India wheat occupies an area of 30.23 million hectares having production 93.50 million tone and having an average productivity of wheat is 3093 Kilograms per hectare (India Stat 2016-17). The ranks of India is second in production followed by china. It is cultivated in as many countries around the world including China, India, USA, European Union, Canada are the major wheat producing countries in the world.
Among major wheat producing states in India the contribution of Uttar Pradesh is highest in production. In Bihar production of the crop is 59.89 million tonnes and 21.06million hectares of area with an average yield of 2843 kilograms per hectare in 2016-17. Directorate of Economics & Evaluation Department, Govt. of Bihar. It is observed an impressive rate of growth in Bihar during few decades/years.

Objective of the study
The study was undertaken to analyze the trends of wheat yield in Bihar including different agro-climatic zones of Bihar.

Materials and Methods

An attempt will be made to study the non-linear growth pattern of wheat yield in Bihar with three agro-climatic zones. For this purpose the three agro-climatic zones comprising of the following districts have been considered.

Zone-1

Saran, Siwan, Gopalganj, East-Champaran, West-Champaran, Muzaffarpur, Sitamarhi, Shiwhar, Vaishali, Darbhanga, Madhubani, Samastipur and Begusarai.

Zone-2

Saharsa, supaul, Madhepura, Purnia, Kishanganj, Araria, Katihar & Khagaria.

Zone-3

Patna, Nalanda, Arwal, Bhojpur, Buxar, Bhabhua, Rohtas Gaya, Jahanabad, Nawada, Aurangabad, Munger, Sheikhpura, Lakhisarai, Jamui, Bhagalpur and Banka.

The total geographical area of Bihar is 94163 sq. km. Under this study all districts of Bihar are categorized under their different agro-climatic zones & selected because of cultivation of wheat in whole Bihar on large scale and due to staple food and profitable crop. The study was based on secondary data on productivity of wheat yield in three agro-climatic zones of Bihar and also for whole Bihar. Time series wheat data were collected for the period from 1964-65 to 2015-16 from Directorate of Economics and Evaluation department Govt. of Bihar, Patna. The weather data were collected from Patna.

On the basis of wheat yield time series data analysis trend values were obtained. After analysis by graphical method, the trend of wheat yield were calculated at different points of trend line.

Result and Discussion

The time series data pertaining to yield of wheat in three agro-climatic zones and in whole Bihar collected from the directorate of economics and evaluation department, govt. of Bihar, Patna. Data were collected for the period of 1964-65 to 2015-16.

Zone I

After study the figure1 it is noticed that the trend value of yield in 1964 is 0.76 t/ ha which is gradually increases and goes upto 2.38 t/ha in 2014. Minimum actual yield in 1996 is 0.5 t/ha whereas maximum actual yield in 2011 is 3.37 t/ha. Overall trend is in increasing order and seems to be almost linear.

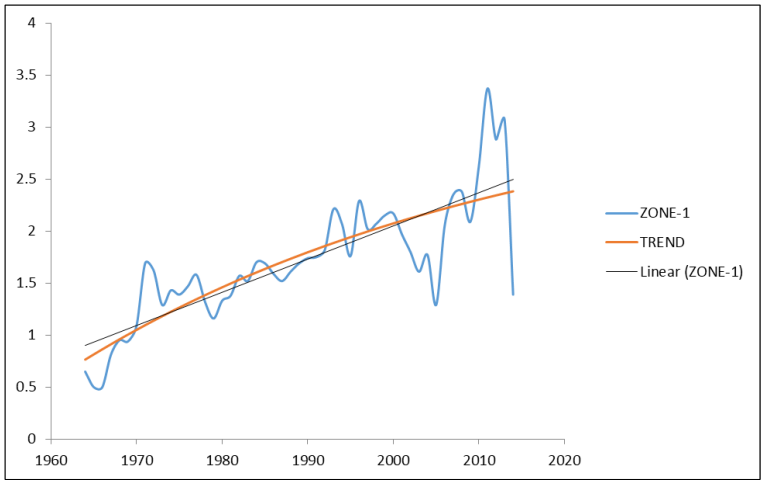

Fig 1: Graph of trend value under zone-I

Zone II

After study the figure 2 it is noticed that the trend value of yield in 1964 is 0.71 t/ ha which is gradually increases and goes upto 1.98 t/ha in 2014. Minimum actual yield in 1965 is 0.25 t/ha whereas maximum actual yield in 2013 is 2.78 t/ha. Trend is seems to be linear.

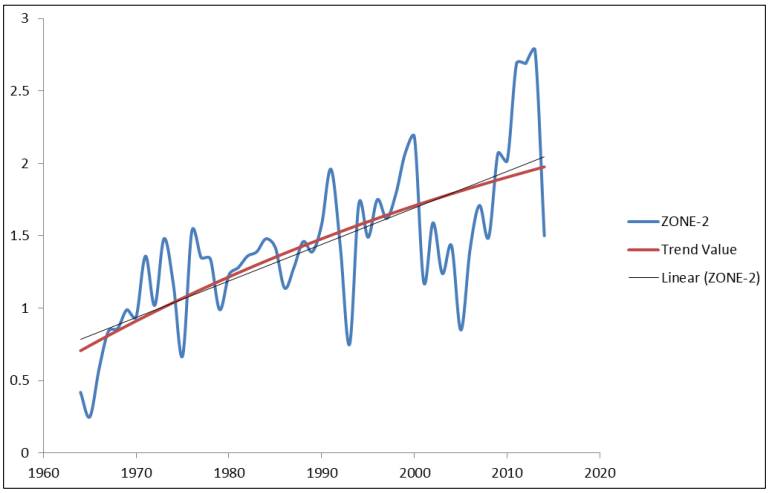

Fig 2: Graph of trend value under zone-II

Zone III

After study the figure 3 it is noticed that the minimum trend value of yield in 1964 is 0.51 t/ ha which is gradually increases and goes upto 2.29 t/ha in 2014. Minimum actual yield in 1965 is 0.14 t/ha whereas maximum actual yield in 2012 is 2.89 t/ha. Overall trend is linear.

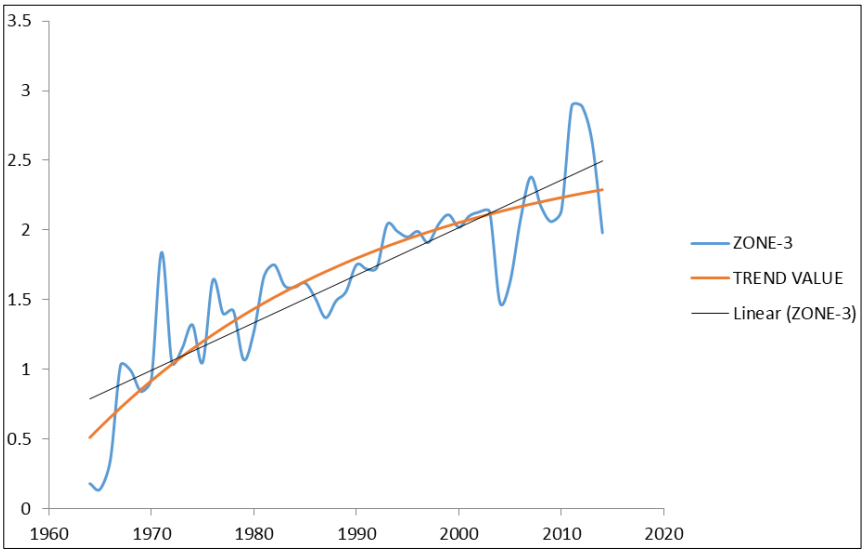

Fig 3: Graph of trend value under zone-III

Bihar

After study the figure 4 it is noticed that the trend value of yield in 1964 is 0.65 t/ ha which is gradually increases and goes upto 2.32 t/ha in 2014. Minimum actual yield in 1966 is 0.45 t/ha whereas maximum actual yield in 2011 is 3.05 t/ha. Overall trend is linear.

Also correlation between Yearvs. Trend value was tested by Kendall, Spearman& Pearson test. In these cases it has been found that highly significant.

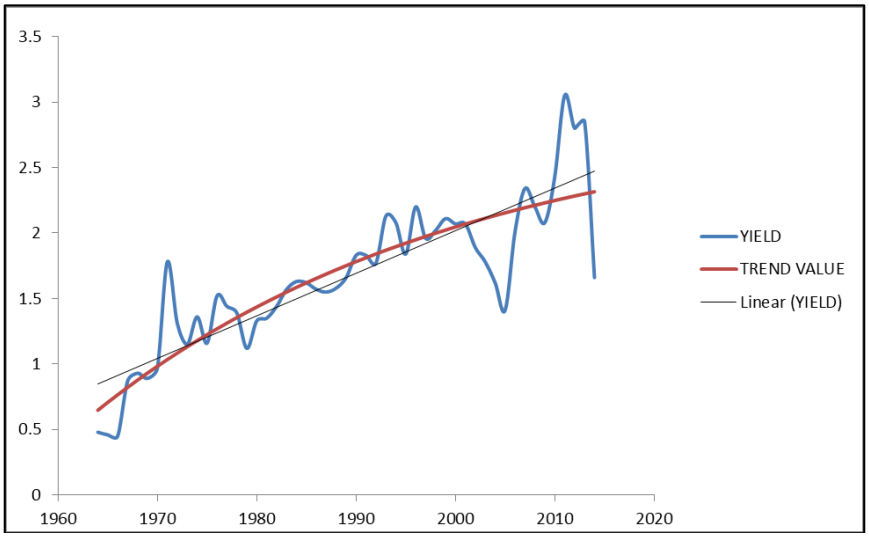

Fig 4: Graph of trend value of Bihar

Table 1: Correlation between Year vs. Trend value

Test	Correlation			
	Zone-I	Zone-II	Zone-III	Bihar
Kendall	0.0675	0.567	0.732	0.719
Spearmann	0.802	0.711	0.880	0.863
Pearson	0.806	0.713	0.856	0.857

Conclusion

The trend of wheat yield over a period of 1964-65 to 2015-16 seems likely to be linear in increasing order of yield (except some years). As an upward tendency seen in most of the trend data. It is clearly noted that trend in general, smooth and long term average tendency seen that different tendency of increasing, decreasing and stability are obtained in different section of time for data. However, the overall tendency seen that upward. After doing trend analysis by different test like Kendall, Spearman, Pearson are found to be highly significant table (4.15). The trend graph may be seen in Fig- 4.1 to 4.4. Residual v/s fitted value may be seen in fig. 4.5 to 4.8

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