Research Article

NON-PARAMETRIC TREND ANALYSIS OF AREA, PRODUCTION AND PRODUCTIVITY OF JOWAR IN INDIA

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Abstract: In the current study 20 year's time series data of area, production and productivity of sorghum used for the trend analysis using non parametric test, data collected from the ICAR-IASRI databook 2018. The average area under sorghum cultivation during study period was found to be 8.07 (Million Ha) with standard deviation of 1.70 with a production of 6.75 (Million ton). Mann Kendall test reveals that total area and production was found to decreasing trend and statistically significant.

Keywords: *Mann-Kendall Test, Co-efficient of Variation*

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Introduction

Sorghum (*Sorghum vulgare* Pers.), widely known as jowar, is by far the most important food and feed crop in dryland agriculture. The estimated area under it is between 10 and 12 million hectares and annual production is between 4 and 6 million tonnes. Sorghum emerged in India and Africa. It is said that its origin is Abyssinia and that it has been brought from there to the USA and European nations. Jowar is distributed primarily in the peninsular and central regions of India. Maharashtra, Karnataka, Andhra Pradesh, Madhya Pradesh, Gujarat, Rajasthan, Uttar Pradesh (Bundelkhand region) and Tamil Nadu are the major jowar-growing states. In small areas, other states cultivate sorghum mainly for animal feed. The sorghum grain is mainly included as human food in a variety of forms, such as roti. Sorghums are also malted, popped and a number of local preparations are made. Green and dried feed is the most important food for cattle feed in the nation. The use of grain sorghum as feed for cattle, poultry ration and other industrial uses is currently not very important, although there is considerable scope.

Climate and soil

Sorghum plants are hardy and can withstand extreme temperatures and droughts, but are cultivated in the arid regions of U.P., Rajasthan and the tropical regions of Bengal and Bihar. It can be efficiently grown under ambient temperatures ranging from 15ºC to 40ºC and annual rainfall from 400 to 1000 mm. Sorghum is cultivated on a number of soil types, but the most suitable soil is the clay loam soil rich in humus. Medium acidity to medium salinity below pH 5.5 to 8.0 may be tolerated. A healthy sorghum cultivable soil must have adequate drainage facilities, although it can tolerate more water logging than maize.

Material and Methods

In the current study, area production and productivity of jowar in India, collected from the official website of ICAR-IASRI which is in public domain. For statistical study data collected from 1997 to 2016 is used for the analysis with an objective of knowing the trend in datasets.

Mann-Kendall test: To analyse temporal variation *i.e.* variation of rainfall across different period in 16 rain gauge stations of the district can be analysed by trend.

Mann-Kendall test a non-parametric statistical procedure is used in analysing trends in data over time. Mann-Kendall Statistic measures the trend in the data. Positive values indicate an increase in constituent concentrations over time, whereas negative values indicate a decrease in constituent concentrations over time. The intensity of the trend is directly proportionate to the magnitude of the Mann-Kendall statistic (*i.e.* the large magnitude indicates a strong trend).

$$sign(X_j - X_k) = \begin{bmatrix} 1 & if\ x_j - x_k > 0 \\ 0 & if\ x_j - x_k = 0 \\ -1 & if\ x_j - x_k < 0 \end{bmatrix}$$

Mann-Kendall Statistic (S) is described as the total of the number of positive differences minus the number of negative differences defined below.

$$S = \sum_{k=1}^{n-1} \sum_{j=k+1}^{n} sign(x_j - x_k)$$

Where j = 1,2,3,..., n-1 and k = j+1, j+2, j+3, ...n.
Where x_j and x_k are the annual values in years j and k, j > k, respectively
For large Sample s
Case 1 (no ties): for large sample (about n>8) S is normally distributed with

$$E(s) = 0 \quad VAR\,(S) = \frac{n(n-1)(2n+5)}{18}$$

Case 2 (tied observations) in case of ties the variance of S is

$$VAR\,(S) = \frac{1}{18}\left[n(n-1)(2n+5) - \sum_{p=1}^{g} t_p(t_p - 1)(2t_p + 5) \right]$$

Where, n is the number of data points
g is the number of tied group
t_p is the number of data points in the pth group

$$Z = \begin{cases} S > 0 & \dfrac{(s-1)}{\sqrt{VAR(s)}} \\ S = 0 & s = 0 \\ S < 0 & \dfrac{(s+1)}{\sqrt{VAR(s)}} \end{cases}$$

Table-1 *Mann Kendall statistics values*

Measures	Mann Kendall test statistics		
	Area	Production	Productivity
Z - test	-5.16	-4.12	1.98
S	-174	-128	62
Var(S)	950	948	948
p - value	1.99E-08	3.71E-05	0.047
n (count)	20	20	20

Table-2 *Descriptive Statistics*

Measures	Descriptive Statistics of Jowar		
	Area	Production	Productivity
Minimum	5.14	4.24	697
Maximum	10.8	8.68	1021
Mean	8.07	6.75	847.75
Variance	2.9	1.46	8874.83
SD	1.7	1.21	94.21
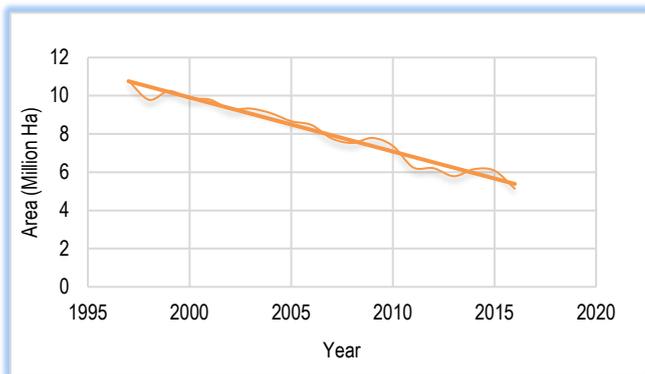
Fig-1 Time series plot of total area under Jowar cultivation
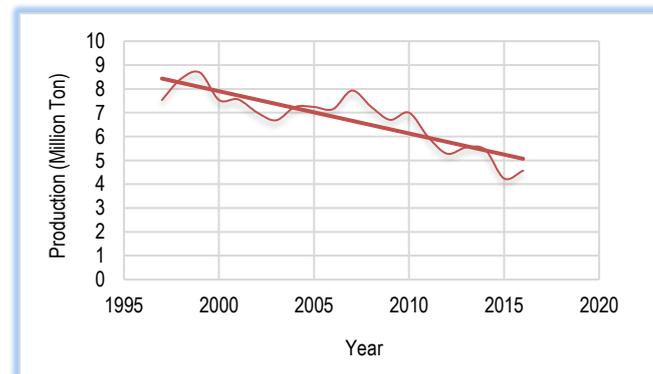
Fig-2 Time series plot of total Production of Jowar India
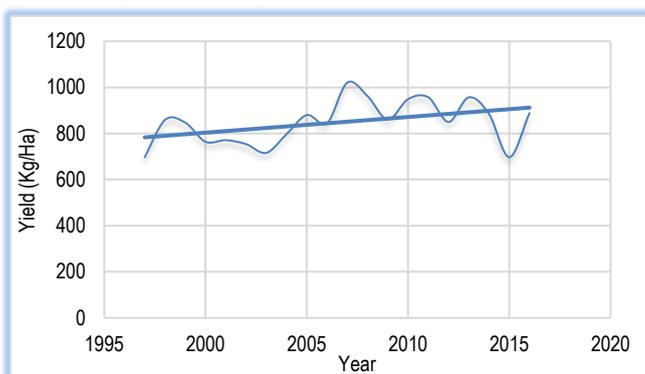
Fig-3 Time series plot of Productivity of Jowar India

If Z is negative and p < 0.05-trend is said to be decreasing. If Z is positive and p < 0.05-trend is said to be increasing. If computed probability p > 0.05, then there is no trend. To analyse spatial variation *i.e.* variation of rainfall across space for different raingauge stations, coefficient of variation for different periods is used and this is defined as the ratio of standard deviation to the mean. It is expressed in percentage.

Conclusion

The descriptive statistics of time series data (1997-2016) of jowar's area, production and productivity found to be with a minimum value for area is 5.14 (Million Ha) during the year 2016 and maximum area is 10.8 (Million Ha) during the year 1997. Over a period of time total area under jowar cultivation found to decreasing which is graphically presented in the [Fig-1]. The average area under the jowar cultivation during the study period is 8.07 (Million Ha). The average production of jowar during the study period is 6.75 (Million ton) with a productivity of 847.75 Kg/Ha. Due to continuous decrease in cultivable area under jowar results in decrease of production which is visualized in the [Fig-2] and [Fig-3]. From the [Table-1] Mann kendall test reveals that for area and production of jowar in India found to be decreasing and is statistically significant. In case of productivity of trend id found to be increasing trend which may be due to use of improved and is statistically significant.

Application of research: The time series analysis helps in forecasting the market price in future for farmers in order to take better decision to augment the profitability.
Research Category: Time series analysis

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Study area / Sample Collection: Department of Agricultural Statistics, University of Agriculture Science, Bengaluru, 560065, India and ICAR-IASRI databook 2018

Cultivar / Variety / Breed name: Sorghum (*Sorghum vulgare* Pers.)

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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