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STUDY OF INSTABILITY IN PRODUCTION OF MAJOR FIELD CROPS OF KARNATAKA: DISTRICTWISE ANALYSIS USING NONPARAMETRIC TESTS

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ABSTRACT

In India Agriculture is one of the most prominent sectors contributing 28 per cent for its Gross National Product and the livelihood of more than two thirds of the population. As the economy grows, the scope of agricultural economy also expands horizontally and vertically. The overall performance of Indian Agriculture in the last five decades has been remarkable. However, the progress shown in the production of different crops and regions has been neither consistent nor symmetrical. The new farm technology has brought in regional disparities. The present study, gives information about to assess the sources and extent of instability of major field crops in Karnataka. The Secondary data of on production of rice on ragi of 15 districts on rice, 10 districts on wheat of and 11 districts at state (Karnataka) levels from 1994 to 2013 include data of groundnut has been collected from the Directorate of Economics and Statistics, Government of Karnataka, Bengaluru. Mann-Whitney, Friedman's Two Way and Other Non Parametric methods were used in present study. It was observed that, greater instability in rice, ragi, wheat and groundnut production during period II was more as compared to period I by Mann-Whitney test and other Non Parametric method respectively. By Friedman's Two Way Analysis, the variability in district to district yields and production were of same order in district to district during both periods I and period II where as the variability was present among crop to crop during both period I and period II.

KEYWORDS :Crop yields and production, Mann-Whitney Test, Friedman's Two Way Analysis and Other

Non Parametric method.

INTRODUCTION:

In India Agriculture is one of the most prominent sectors contributing 28 per cent for its Gross National Product and the livelihood of more than two thirds of the population. As the economy grows, the scope of agricultural economy also expands horizontally and vertically. By and large, agriculture makes three kinds of contribution to the economic growth of a nation viz., the factor contribution, the production contribution and the market contribution. Agriculture and allied sectors like forestry, logging and fishing accounted for 16.6% percent of the Gross Domestic Product (GDP) in 2013 and employed 60% of the country's population. About 43% of India's geographical area is cultivated. Since independent the share of agriculture in the GDP has declined in comparison to the growth of the industrial and services sectors. However, agriculture still provides the bulk of wage goods required by the non-agricultural sector as well as numerous raw materials for industry. Moreover, the direct share of agricultural and allied sectors in total exports is around 18 percent. When the indirect share of agricultural products in total exports, such as cotton textiles and jute goods is taken into account, the percentage is much higher. It accounts for 8.56% of India's exports.

The overall performance of Indian Agriculture in the last five decades has been remarkable. However, the progress shown in the production of different crops and regions has been neither consistent nor symmetrical. The new farm technology has brought in regional disparities. For instance, the regions like the Punjab plains have witnessed a tremendous upsurge in crop production, while the other regions especially the dry tracts do not bear any comparison. Structurally too, the impact of the Green Revolution has not been uniform. Rice, wheat and a few other annual crops registered a spectacular production performance, while in the case of coarse grains, pulses and oilseeds such a phenomenon was not forthcoming.

Agricultural production in India has increased at an impressive rate during the last two decades. A larger part of this increase has been attributing to adoption of new seed fertilizer based technology. It is frequently debated that the new technology had destabilizing effect on production and therefore, the production instability increased in India during the above period. This increasing instability leads to wide fluctuations in prices which in turn may lead to inefficiency in production and adverse income distribution. Hence, increased production instability is a matter of great concern to policy makers. Measurement of instability and identification of its sources are, therefore, the most important areas of study for sustaining and promoting agricultural production. The present study is an effort in this direction.

Instability in time data may be defined as the extent of fluctuations present in the observations. Instability between two or more time series data may be compared on this basis. Several authors in the past have tried to study the instability by dividing the whole period into two halves and made comparative study of variability in the two periods.

In the wake of increasing population pressures and mounting food shortage, the agricultural production has undergone a radical change in most of the developing countries during the last two and a half decades. The new agricultural technology has introduced greater variability in crop output along with the upward shift in productivity and production. Year to year fluctuations in crop output generate instability which has far reaching economic implications particularly in under developed and developing countries. The problem of instability in agriculture has engaged the attention of scientists and planners in the recent past, and has led to the development of various statistical techniques for measurement of instability in crop output. The researcher discussed some aspects of non parametric methodologies relating to statistical measures of instability in crop output.

MATERIAL AND METHODS

Description of study area

The study pertains to Karnataka state including 26 districts of the state viz., Bidar, Gulbarga, Bijapur, Raichur, Bagalokot, Belgaum, Dharwad, Koppal, Gadag, Bellary, Uttara Kannada, Davanagere, Haveri, Shimoga, Chitradurga, Udupi, Chikmagalur, Tumkur, Dakshina Kannada, Hassan, Kolar, Kodagu, Bengaluru, Manday, Mysore and Chamarajnagar. Karnataka is the eighth largest state in India with a population of 52.8 million. Karnataka is bounded by Maharashtra and Goa on north, Andhra Pradesh on east, Arabian Sea on west and Tamil Nadu and Kerala on South.

Source of Data

The Secondary data on production of rice of 15 districts on ragi of 10 districts on wheat of 11 districts at state (Karnataka) levels during 1994 to 2013 for the research study has been collected from the Directorate of Economics and Statistics, Government of Karnataka, Bengaluru.

Analytical tools and techniques applied

To assess the sources and extent of instability of major field crops in Karnataka, the tool such Mann-Whitney Test, Friedman's Two Way Analysis and other Non Parametric methods were used in present study.

Test of variability in crop output between two periods (Mann- Whitney Test)

The significance of the difference in C.V. values of two periods based on various regions for each crop may be tested by Mann-Whitney Test. This test can also be used for studying the inter-regional or inter-crop variability.

For testing the null hypothesis

$$H0: C.V. (P_1) = C.V. (P_2)$$

against alternative hypothesis, H1: $C.V. (P_1) \neq C.V. (P_2)$

The values of CV's for two periods for a particular crop were combined for different districts and arranged in ascending order and ranked from 1 to 2 *n* where *n* is the number of districts. Then obtain the sum of ranks (R_1) for period I and (R_2) for period II. Test statistic for testing the null hypothesis is given as,

$$T = R_1 - \frac{n(n+1)}{2}$$

where T = Mann-Whitney statistic
n = Number of districts
R_1 = Sum of ranks for first period

If the computed value is more than or equal to critical value, then reject the null hypothesis which says that there is difference in the CV of period first and second. In this case, in order to find out whether $C.V. (P_1) >$ or $< C.V. (P_2)$, one-tailed test may be applied.

Test of variability between districts and crops (Friedman's Two Way Analysis or Slippage Test)

Variability based on crop outputs has been studied for period I and II separately by testing the null hypothesis (Ho), i.e. different districts belonging to populations corresponding to distribution functions that are identical with each other, against the alternative hypothesis (H1), i.e. some of the distribution functions differ at least with respect to their location parameter. The shifting of the position of the districts, if any on the basis of variability (C.V.) can also be studied between two periods with the help of this test.

Following steps are involved in the application of slippage test [Rai, (1987)]:

1) Arrange the CV's of all crops for each districts in ascending order in both the periods separately,
2) Districts are allotted ranks from 1 to *K*, where *K* = number of districts under study (here *K*=26) for each order statistic, i.e. 1st order, 2nd order, 3rd order and so on depending upon the number of crops, say n (here n = 3, hence up to 3rd order only) separately for period I and II,
3) Obtain the total ranks over different order statistic for each districts in two periods separately, and
4) Compute the test statistic to test Ho against H1,

$$M = \frac{12}{nK(K+1)} \sum_{j=i}^{k} R_j^{\ 2} - 3n(K+1)$$

Where, K = No. of districts, here K = 26

n = No. of crops, here n = 3

R_j = The sum of ranks of the j^{th} district and M is distributed as Chi- Square variate with (K-1) d.f.

Other Non Parametric Method for study of variability

We may test the null hypothesis,

Ho : Var(X) = Var (Y)

against the alternative hypothesis, H1 : Var(X) > Var (Y)

Var(X) < Var (Y)

Where, X's and Y's are the values of variates in the first and second periods respectively. In the ordered combined sample, assign rank 1 to the smallest value, rank 2 to the largest value, rank 3 to the second largest value, rank 4 to the second smallest value, rank 5 to the third smallest value, and so on, alternatively assigning ranks to the end values two at a time (after the first) and proceeding toward the middle. If Ho is false, the values of X or Y will tend to be in the tails of the combined sample and will thereby be assigned the smaller ranks. The ultimate result is that the test statistic T = s –n (n + 1)/2 will tend to be small where, s = sum of ranks of X values and n is the number of observations on X. T is distributed like Mann-Whitney test statistic of location parameter. The test consists of rejecting Ho if T is too small as defined by the Table given by Mann-Whitney (1947).

The usual parametric *F* test is known to be quite sensitive to the departures from normality [Siegel and Tukey, (1960)]. This suggests using non-parametric tests when the population may be non-normal [Rai and Sarup (1988)]. Non-parametric tests are generally less powerful and they rapidly lose power in the presence of unlike location parameters, a factor by which F-test is unaffected. In case of unequal location parameters, the test needs modifications. If the population means of X and Y differ by a known amount, the logical step is to subtracts that amount from the variate having higher mean and then test the null hypothesis. If the difference in location is unknown then use the sample means. If *E(Y) - E(X) = K*, then adjust the data by subtracting K from each of Y observations before testing the null hypothesis. An interesting safety feature of the test is that it's assigned rank estimator is never less than 0.864 as compared to *F*-test. These results assume that the distribution function of the two populations differ only in dispersion parameter. T is distributed like Mann-Whitney test statistic of location parameter.

RESULTS AND DISCUSSION

In order to test the specified objective of the present investigation, the data was subjected to statistical analysis. The results of the analysis are presented under the following headings:

Measures of Instability Using Non Parametric Tests

Instability in time series data may be defined as the extent of fluctuations present in the observations. Instability between two or more time series data may be compared on this basis. Several authors in the past have tried to study instability by dividing the whole period into two halves and made comparative study of variability in the two periods. The procedures followed by them along with the modifications as discussed below.

Coefficient of Variation (C.V.) as Measure of Variability:

Data on crop outputs may exhibit some trend. Generally, suitable trend lines are fitted separately for the first period and second period, and coefficients of variation of the residuals around trend line are obtained for the two periods. Here, autocorrelation may present some problems as it reduces variability over time. Therefore, the data should be first examined for the presence of auto-correlation before taking up the analysis. The coefficient of variation for different crops are calculated on the de-trended data for the two periods and compared on their face values of two periods.

Here the researcher discussed the techniques to test the difference in C.V. values which is a close approximation of the average year to year percentage variation adjusted for trend of different crops over different districts.

Test of Variability in Crop Output Between two Periods (Mann-Whitney Test):

The procedure is explained with the help of data on rice, ragi and wheat productions at state (Karnataka) levels during 1994 to 2013.

Coefficient of variation (C.V.) of crop output around the trend line was computed for each important crop for both the periods, i.e. 1994 to 2003 and 2004 to 2013.

All the 26 districts of Karnataka are included for the analysis. The results are presented in Table 1 for selected cereal crops of Karnataka state.

(a) Rice

Number of important rice growing districts included in the analysis $n = 15$.
Sum of ranks for period I = 260
Sum of ranks for period II = 205

$$T = 260 - \frac{15 \times 16}{2} = 140$$

Here, the computed value is greater than the tabulated value (56) at 0.02 probability level, hence equivalence of C.V.'s (Ho) is rejected. Again, it is observed that sum of Ranks for period I is more than period II, implying that greater instability in rice production during period I compared to period II at probability level 0.01.

(b) Ragi

Number of districts studied = 10
Sum of ranks (R1) of period I = 102
Sum of ranks (R2) of period II = 108

$$T = 102 - \frac{10 \times 11}{2} = 47$$

The calculated value is observed to be greater than the tabulated value (19) at 0.02 probability level; hence the null hypothesis (Ho) of equivalence of CV's is rejected. Again it is observed that the sum of ranks in period II is greater than period I implying that variability in ragi production during period II is more as compared to period I.

(c) Wheat

Here number of districts included in the analysis n = 11
Sum of ranks (R1) of period I = 109
Sum of ranks (R2) of period II = 144

$$T = 109 - \frac{11 \times 12}{2} = 43$$

Here again the tabulated value (25) is less than the computed values at 0.02 probability level, hence the null hypothesis of equivalence of C.V.'S is rejected.

Again it is observed that the sum of Ranks in period II is more than period I implying thereby that the instability in period II is greater as compared to period I.

Table 1: Mann- Whitney Statistic (U) value to test variability in different crops output between two periods, period I (1994 to 2003) and period II (2004 to 2013)

Crops	No. of Districts	Sum of Ranks		Mann-Whitney U	Remarks
		Period I	Period II		
Rice	15	260	205	140.00**	p=0.01
Ragi	10	102	108	47.00*	p=0.02
Wheet	11	109	144	43.00*	p=0.02

Test of Variability between Districts and Crops (Friedman's Two Way Analysis or Slippage Test)

The variability between districts and crops with respect to yield and production are presented in table 2 which is summarized below.

Test of variability between districts (yield)

The calculated value of Friedman test statistic χ^2, (14.80) for period I and for period II (20.22) in different districts of Karnataka which are non-significant, implying acceptance of null-hypothesis, i.e. the variability in district to district yields are of same order during both periods I and period II.

Test of variability between crops (yield)

The value of Friedman test statistic χ^2, (22.23) for period I and for period II (15.16) in different cereal crops of Karnataka, which are statistically significant, implying the rejection of null-hypothesis i.e. the variability is present among crop to crop during both period I and period II.

Test of variability between districts (production)

The value of Friedman test statistic χ^2, (12.43) for period I and for period II (17.21) in different districts of Karnataka, where the value is not significant.

Table 2: Variability between districts and crops with respect to yield and production

Particulars	Period I		Period II	
		Level of Significance (p)		Level of Significance (p)
Variability between districts (yield)	14.8	0.74	20.22	0.38
Variability between crops (yield)	22.23	0.00	15.16	0
Variability between districts (production)	12.43	0.82	17.21	0.43
Variability between crops (production)	26.46	0.00	26.12	0

Other Non Parametric method for study of Variability

This procedure is explained on the data of groundnut in Karnataka through 1990-91 to 2012-2013. The whole period has been divided into two parts: Period I pertain to 1990-1991 to 2000-01, and the Period II refer to 2002-2003 to 2012-2013. It is observed that the mean of groundnut production during period II (say, Y series) is higher by 220 thousand tonnes as compared to the mean of Period-I (say, X series). Hence the production figures for period II are adjusted by subtracting this amount from each observation of Y series. The data of both the series is then combined and arranged in the ascending order and assigned ranks as explained in the chapter materials and methods.

Now the sum of the ranks of X series is observed to be 272 and the value of computed T comes out to be 136. This value is observed to be greater than the tabulated value at 5% level of significance implying thereby that Period I and Period II have different variability.

CONCLUSION

The present study has demonstrated that, greater instability in rice, ragi, wheat and groundnut production during period II was more as compared to period I by Mann-Whitney test and other Non Parametric method respectively. By Friedman's Two Way Analysis, the variability in district to district yields and production were of same order during both periods I and period II where as the variability was present among crop to crop during both period I and period II.

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