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Assessment of spatial distance of the west central table land and mid central table land zones of Odisha with respect to yield

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Abstract
Agriculture is the largest employer in our country, besides being an important contributor to the country's GDP. Rice is grown as a principal cereal crop in our state Odisha and here it is regarded as the staple food. To feed the exponentially growing population of our state the quantity of rice production is to be enhanced. But it has been seen that the rice area is retarding day by day due to industrialization, urbanization, construction of roads etc. The production and yield are also fluctuating over the years. In this endeavor, it has been tried to give a picture of rice on area, production and productivity of seven districts of west central table land and mid central table land of the state season wise. Besides, the similarity with respect to yield of rice has been studied among these seven districts along with their growth rates. Further, some univariate models have been fitted to rice area, production and yield of these districts season wise to forecast their near future values. This study will immensely help the policymakers for policy formulation and implementation to enhance the food security and sustainability of the people of Odisha.

Keywords: spatial distance, respect, Odisha, largest employer

Introduction
Agriculture sector contributes to the state's economy of about 26.4% of Net State Domestic Product in 2004-05. The state's income as well as larger percentage of people depend on this sector for food, fodder, fuel, fiber, shelter etc. In the year 2007-08, the area under rice cultivation was 4452 thousand hectare with a production of 7655 thousand metric tons and yield of 1720 kg/ha. During 2008-09, the area under its cultivation became 4455 thousand hectare with a total production of 6916 thousand metric tons and yield of 1553 kg/ha. (Agricultural Statistics report of Odisha, 2007-08 & 2008-09 respectively).
Despite these, the production and yield of rice is not satisfactory due to various factors like land degradation, rainfall, price of rice, diverse agro-ecological situation, insect attack, pest and disease attack etc.
Rice is cultivated all over the state in the districts like Sambalpur, Bargarh, Bolangir, Cuttack, Balasore, Mayurbhanj, Ganjam and Puri.
The state of Odisha lies in the sub-tropical belt in the eastern region of India between 17.52° and 22.45° North latitude and 81.45° and 7.5° East longitude. It covers an area of about 15571 thousand hectares which is about 4.74% of total area of our country. The state is bounded by states of Jharkhand, West Bengal, Chhattisgarh and Andhra Pradesh in north, north-east, north-west and south-west respectively. The Bay of Bengal has a long coast of 480 km to the east of the state. The state has 30 administrative districts and 314 developmental blocks.
The physical features of the state together with its micro topography influences the nature and extent of agriculture and land use in the state. The land can be classified into 3 categories, i.e. Low Land (25.65%), Medium Land (33.6%) and Upland (40.8%) with various types of soils. The state is divided into 10 agro climatic zones with varied characters. They are:

- North Western Plateau
- North Central Plateau
- North Eastern Coastal Plateau
- East and South Eastern Coastal Plateau
- North Eastern Ghat
- Eastern Ghat High Land
- South Eastern Ghat
- Western Undulating Zone
- West Central Table Land
- Mid Central Table Land

Presently there is a global competition in rice production. The land availability is diminishing day by day and there is inherent need for increasing the production of rice. The rice area, production and yield are fluctuating due to various forces. With a view to achieve the substantial rise in the production and yield of rice, it is imperative to study the behavior of rice production (together with the factors of it) in the past for forecasting the future values. For obtaining the future values, selection of good models on rice area, production and yield and its factors are important under the prevailing decline of land area. Most of the variables of today, what we observe are equally and sequentially spaced with respect to time and space are called time series variables. Univariate modeling is quite appropriate and simple to forecast the future values of a time series variable. This type of model essentially requires a stationary time series variable. A time series variable is said to be stationary if its mean, variance and auto-correlation function are constant over time. But in practice the time series variables are found to be non-stationary. Non-stationary variables can be transformed suitably to make stationary and the models based on it can predict the near future values precisely. Forecasting of area, production and yield of rice is very useful for the planning of future requirements of the state and of the country and hence it is necessary to model the rice area, production and yield to forecast for the future by using time series best fitted functional form.

Materials and Methods

Secondary data of rice area, production and yield of the districts coming under West Central table land and Mid Central table land zones of Odisha were collected from different sources in accordance with the objectives delineated in the problem under study. The annual data (season wise) pertaining to area (‘000ha), production (‘000MTs), and productivity (kg/ha.) on rice of the seven districts (Angul, Bargarh, Bolangir, Deogarh, Dhenkanal, Sambalpur and Sonepur) of Odisha for 10 years (2000-01 to 2009-10) were collected from the Agriculture Statistics of Odisha, Directorate of Agriculture and Food Production and Bureau of Economics and Statistics, Govt. of Odisha, Bhubaneswar.

The multivariate analysis of cluster analysis was performed by means of dendrogram and K-clustering to sort the seven districts whose average yield was very much nearer or similar. The significance of sorting or clustering the districts were analyzed by the techniques of analysis of variance (Bhuyan, K.C.2005) [1]. The results of cluster analysis based on average rice yield in Autumn, Winter, Summer, total and all the seasons were presented from Table. 1 to Table. 4 and as Appendix II. The clustering into groups were confirmed from the respective dendrograms and F-ratios. The F-ratio from the ANOVA discriminates the districts as well as among the seasons.

From Autumn season rice yield cluster table (Table 1) it was seen that Sambalpur formed the first cluster with average rice yield of 1040.60 kg/ha. The next cluster was formed by Sonepur with average rice yield of 937.30 kg/ha. The third cluster was formed by Bargarh and Dhenkanal with average yield of 898.55 kg/ha. Last group included Angul, Bolangir and Deogarh with having lowest average rice yield of 843.83 kg/ha. It established the formation of districts into four clusters. The percentage variability in the cluster was 1.42 to 1.73 percent.

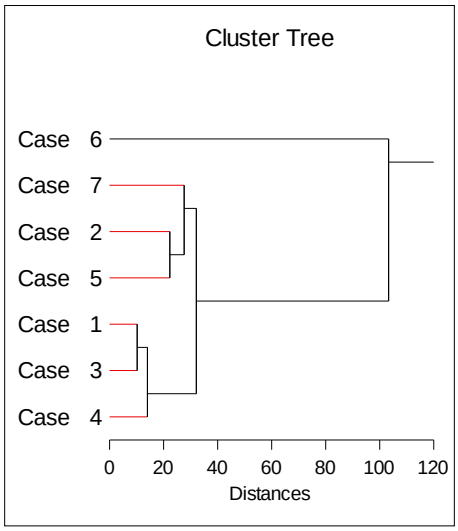

Fig 1: Dendrogram of clustering districts based on autumn season yield of rice (kg/ha)

Table 1: Clustering of districts based on Autumn season yield of rice (kg/ha)

Clusters	Districts	Minimum	Maximum	Mean	S.d	Cv (%)
1	Sambalpur	1040.60	1040.60	1040.60	-----	-----
2	Sonepur	937.30	937.30	937.30	-----	-----
3	Bargarh Dhenkanal	887.40	909.70	898.55	15.77	1.73
4	Angul bolangir Deogarh	831.10	855.30	843.83	12.15	1.42

Winter season rice yield formed the first cluster of highest yield (1767.93 kg /ha) consisting of Bargarh, Sambalpur and Sonepur districts (Table 2). The second cluster consisting of Dhenkanal gave the average yield of 1325.27 kg/ha. The third group was formed by Bolangir (1463.00 kg/ha) and the districts of Angul and Deogarh formed the fourth group (1219.85 kg/ha) revealed the lowest rice yield. The percentage variation in the rice yield within the cluster was highly consistent (1.34 to 1.63 per cent).

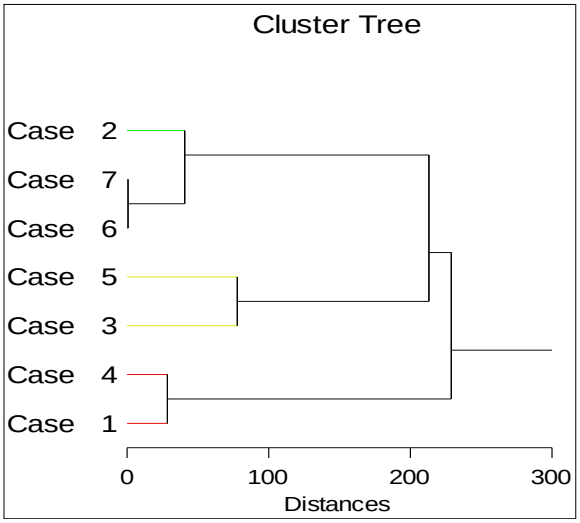

Fig 2: Dendrogram of clustering districts based on winter season yield of rice (kg/ha)

Table 2: Clustering of districts based on winter season yield of rice (kg/ha)

Clusters	Districts	Minimum	Maximum	Mean	S.d	Cv (%)
1	Bargarh Sambalpur Sonepur	1753.90	1795.30	1767.93	23.70	1.34
2	Dhenkanal	1540.80	1540.80	1540.80	-----	-----
3	Bolangir	1463.00	1463.00	1463.00	-----	-----
4	Angul Deogarh	1205.60	1234.10	1219.85	20.15	1.63

3Clustering of districts in Summer season revealed that in first to fourth cluster there were one district like Bargarh(3065.10kg/ha) in first cluster, Sambalpur(2784.30 kg/ha) in second cluster, Sonepur(2464.50 kg/ha) in third cluster and Dhenkanal(2025.30 kg/ha) in fourth cluster. Angul and Bolangir were grouped in fifth cluster (1775.25 kg/ha). The last cluster was formed by Deogarh with average rice yield of 1576.20 kg/ha.

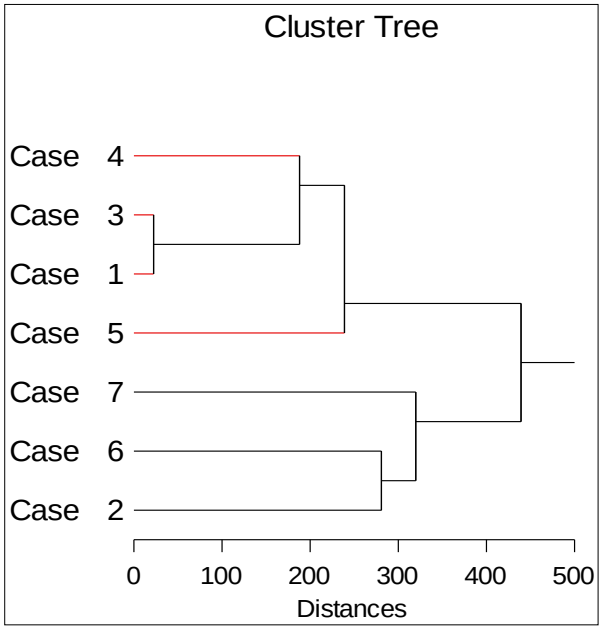

Fig 3: Dendrogram of clustering districts based on summer season yield of rice (kg/ha)

Table 3: Clustering of districts based on summer season yield of rice (kg/ha)

Clusters	Districts	Minimum	Maximum	Mean	S.d	Cv (%)
1	Bargarh	3065.10	3065.10	3065.10	-----	-----
2	Sambalpur	2784.30	2784.30	2784.30	-----	-----
3	Sonepur	2464.50	2464.50	2464.50	-----	-----
4	Dhenkanal	2025.30	2025.30	2025.30	-----	-----
5	Angul Bolangir	1764.10	1786.40	1775.25	15.74	0.88
6	Deogarh	1576.20	1576.20	1576.20	-----	-----

On the basis of oveall average yield of rice, there were five clusters with Bargarh and Sambalpur (1891.48 kg/ha) in first cluster, Sonepur (1718.80 kg/ha) in second cluster, Dhenkanal (1484.50 kg/ha) and Bolangir (1357.40 kg/ha) in fourth cluster were placed. Angul and Deogarh formed the fifth and the last cluster (1248.11 kg/ha). The percentage variability in rice yield was from 2.34 to 3.78 percent.

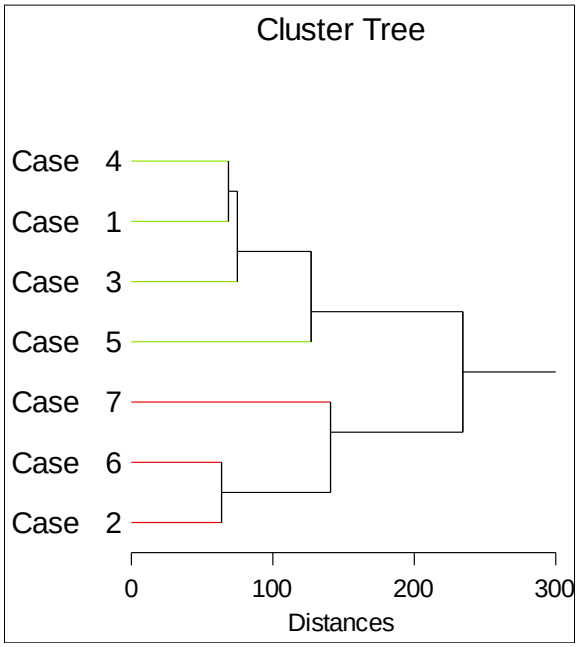

Fig 4: Dendrogram of clustering districts based on average yield of rice (kg/ha)

Table 4: Clustering of districts baseon average yield of rice (kg/ha)

Clusters	Districts	Minimum	Maximum	Mean	S.D	Cv (%)
1	Bargarh Sambalpur	1859.60	1923.37	1891.48	45.09	2.34
2	Sonepur	1718.80	1718.80	1718.80	-----	-----
3	Dhenkanal	1484.50	1484.50	1484.50	-----	-----
4	Bolangir	1357.40	1357.40	1357.40	-----	-----
5	Angul Deogarh	1213.80	1282.43	1248.11	48.52	3.78

On the basis of clustering the seven districts into four clusters based on average rice yield in all the seasons (autumn, winter and summer) the first cluster was formed by Bargarh and Sambalpur with average rice yield of 975.15 to 2924.70 kg/ha. Second cluster was formed by only Sonepur (937.30 to 2464.50 kg/ha). Bolangir and Dhenkanal formed the third cluster (866.25 to 1894.70 kg/ha). The fourth cluster included Angul and Deogarh with average rice yield of 843.20 to 1681.30 kg/ha.

Fig 5: Dendrogram of clustering districts based on all seasons (autumn, winter and summer) yield of rice (kg/ha)

Table 5: Clustering of districts based on all season(autumn, winter and summer) yield of rice (kg/ha)

Clusters	Districts	Seasons	Minimum	Maximum	Mean	S.D	Cv(%)
1	Bargarh Sambalpur	Autumn	909.70	1040.60	975.15	92.56	8.89
		Winter	1753.90	1795.30	1774.60	29.27	1,63
		Summer	2784.30	3065.10	2924.70	198.56	6.47
2	Sonepur	Autumn	937.30	937.30	937.30	-----	------
		Winter	1754.60	1754.60	1754.60	------	------
		Summer	2464.50	2464.50	2464.50	-----	-----
3	Bolangir Dhenkanal	Autumn	845.10	887.40	866.25	29.91	3.37
		Winter	1463.00	1540.80	1501.90	55.01	3.57
		Summer	1764.10	2025.30	1894.70	184.70	9.11
4	Angul Deogarh	Autumn	831.10	855.30	843.20	17.11	2.00
		Winter	1205.60	1234.10	1219.85	20.15	1.63
		Summer	1576.20	1786.40	1681.30	148.63	8.32

From the analysis of variance and testing in forming clusters on average rice yield was established by applying cluster analysis. Bargarh district showed the maximum average rice yield in all the seasons followed by Sambalpur.

Conclusion

Based on the results and discussion, it was found that the scenario on rice area, production and yield of the districts in the three seasons as well as on the total was not blooming. The area under rice cultivation was decreasing day by day due to industrialization, urbanizations, construction of roads, change of cropping pattern, scarcity of rainfall, drought, flood etc. The rice area as well as production was found to be decreasing in its absolute value as well as in the growth rate. The yield of rice was also found to be stagnant. Based on the rice yield the districts were grouped into four clusters in Autumn and Winter seasons and into six groups in Summer season. But they were not having similar yields even in the nearby districts. All the seven districts covered and their seasons didn't follow any particular model. Under these scenario and findings there is need of more emphasis on cultivation of rice in these districts to boost production as well as yield in the prevailing and diminishing availability of land under rice cultivation. More and more area should be covered under rice cultivation. Sufficient inputs should be provided to the farmers and they are to be encouraged to go for rice cultivation. Awareness is needed for them not to go for non-food crops and cash crops cultivation. Government subsidies, fertilizers, good quality planting materials are to be made available easily along with pesticides, insecticides etc. to boost their production. Which will let our state's and country's economy to grow.

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