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# An Enquiry into Divergence of Regional Inequalities in Agricultural Developments of Western Odisha: A Statistical Analysis

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## Abstract

In the present study, an attempt has been made to determine regional inequalities in agricultural development among districts of Western Odisha at block levels. A sample of six districts of Western Odisha namely Nuapada, Jharsuguda, Boudh, Sundargarh, Sambalpur, and Baragarh out of ten districts of western Odisha was selected by the method of Simple random sampling. The "Statistical Abstract of various regions in Western Odisha: 2019-20", The Directorate of Economics and Statistics (DES) was the major source of data utilized for the purpose of the study. The method of Principal Component Analysis is employed and ten main components were extracted out of fifteen indicators which were tested as Normally distributed by Kolmogorov Smirnov tests. The three Quartiles Q 1, Q 2, and Q 3 of the Normal probability distributions have been used to divide fifty blocks into four homogeneous groups namely Meteoric, Progressive, Mediocre, and Laggard on the basis of their composite index scores. The above four mentioned groups are found to be significantly different with respect to Agricultural area in hectors, Yield rate in quintal/hectors and Production in quintals by one-way ANOVA test. A random sample of five blocks is selected from each group to compare the degree of inequality by computing the Gini concentration ratio (GCR)to take policy decisions at block levels.

**Keywords:** Principal Component Analysis, Kolmogorov Smirnov Test, Gini concentration ratio, Meteoric, Progressive, Mediocre and Laggard.

## Introduction

Odisha is a state consisting 30 districts which ranks ninth in terms of area and eleventh in terms of population. The economy is based mainly on agriculture. Nevertheless, the state seems to have a lot of regional inequality development issues. Not all regions in Odisha expect equal benefits due to various substantial economic, agricultural, and social constraints. Likewise, due to various their connections with farmers, NGOs were able to set up decisions that take advantage of better information systems and develop them by reintegrating formerly developed technologies. (Munda et al., 2022)

India's economy is agrarian and known for its diversity in agricultural development due to various of social and economic factors (Handa, 2014). The broad concept of agricultural development specifically focuses on the quality and improvement of the local agricultural system, including agricultural potential and trade. It also brings better agricultural resources, irrigation and irrigation system, high yielding varieties of quality crops, organic manure [NPK], pesticides, and pesticides, and irrigation and pesticides (Mohammad Ali, 1979). Growing agricultural production, agricultural area, irrigation, crop buildup, infrastructure, agricultural technology, human resource technology, etc. are all key developments of the agricultural sector's development. It is impacted by a variety of things, including (Krishna G.1992). Research on agricultural development is important.

## Review of Literature

Numerous studies of regional variances at the state and federal levels have been conducted since the 1960s using a variety of instruments and approaches to draw conclusions. In his study from 1982, Rangarajan examined the connections between India's industrial and agricultural sectors. There were three different kinds of links discussed: demand, output, savings, and investment. In their book, Eicher & Staalz, 1998, took into account the most recent advancements in agriculture in various nations. There has been discussion of the agricultural and rural development lessons learnt in these nations since the 1950s. Chauhan & Chand. Since 1980–81, policy documents from the several states demonstrated regional variations in agriculture output and income per hectare. The project had seen the Shenggen, Gulati, and Thorat (2007) reviewed trends in government subsidies and investment spending on Indian agriculture and showed the impact of these expenditures on agricultural growth and poverty reduction in India. The authors proposed several reform options regarding re-prioritizing government spending and improving institutions and governance. The main findings of the book are that those initial subsidies on loans, fertilizers, and irrigation are crucial to getting small farmers to adopt new technologies because in the initial adoption of a new technology small farms are often the losers; Agricultural product prices are typically pushed down by a greater supply of products from large farms adopting the new knowledge. The EPW Report (2008) discussed the prevailing inequalities at the state, interstate and interstate levels and the challenges posed to the agricultural sector in terms of funding availability. State-by-state analyses revealed that a significant proportion of farmers want to leave the farming profession because it is no longer profitable. The differences between regions widened even more and despite the increase in the state revenue share of almost all underdeveloped regions between 1993-94/1995-96 averages and 2002-03/, the central and eastern regions' main credit shares either decreased or stopped. 2004-05 averages. In their research paper, Bhalla and Singh (2009) shed light on changes in crop yield and total agricultural output in Indian agriculture during the post-economic liberalization period (1990-93 to 2003-06) and compared it with the pre-reform period. 1980-83 to 1990-93). To support the study, the authors analysed detailed data for India's 281 districts and provided a region-by-region analysis of agricultural growth in India from the beginning of liberalization to the slowdown in agriculture and the growing farming era trouble. The results of the study show that in most of the states in India during the post-reform period there was a slowdown in overall agricultural production as well as the growth rate in crop yield. The authors used econometric techniques and statistical measures to analyse important issues. Pertaining to agriculture in India. In his article Reddy (2010) examined how regional diversity in A.P has increased since its inception and suggested policy interventions to reduce these disparities. The author used the Gini-Concentration Ratio (GCRs) to calculate the agricultural production of two rice and legume crops at the regional level and the large irrigation area (LIA). The results showed that the Gini Ratio increased LIA and the benefits of land development/irrigation increased significantly in several regions. The author argued that different parts of the state are not geographically different and therefore different policy interventions are needed accordingly. Bhalla and Singh (2010) conducted this study to analyse regional approaches to the levels and growth of agricultural production and productivity per agricultural activity in each region. The report used strategies such as frequency adder, Lorenz curve, and economic model to analyse the variability. In their paper, Birtha, Singh, and Kumar (2011) investigated the rapid economic growth in major Indian countries during the period of economic independence (1980/81-2004/05) and analysed the factors that contributed to economic growth in these provinces and placed them in a similar stability position. The results showed full variation in inflation rates in all provinces. The article states that investment in concrete infrastructure and human resources development alone is not enough; instead, investing in these sectors should go hand in hand with reducing agricultural employment pressures by promoting labour-intensive agricultural technology and improving labour market links with non-farm sectors to boost economic growth. Chand & Raju (2011) examined the instability and regional diversity of Indian agriculture in policy documents. The main reason for the persistent diversity of regional agricultural and farm incomes was the uneven effect of technological change and the formulation of certain government policies. In their article, Ramaesh and Kumari (2012) analyze regional and regional disparities in agricultural development in the Uttar Pradesh region using 13 guidelines for agricultural development with the help of a UNDP (United Nations Development Programme) based approach. The variance associated with changes in the various regional categories is calculated by the two-year consolidation index for the stages 1990-91 and 2008-09. The results of this article show that there are high and persistent differences in government between agricultural countries over the years (Andrabi and Khan 2013). The main purpose of this article was to look at the differences in the level of agricultural development at the county level. The authors used the 'Z-score' process, selected seven variables for agricultural development, and ranked the regions according to their level of development. Ordinary schools of CSS-Composite Standard Scores were combined to find inequalities in agricultural development in the Kashmir region. Kumar and Jain (2013) highlighted the growth trends and instability of Indian agriculture at the regional level. The paper calculated the crop production rate for different regions - very low, low, average, high, and very high. The newspaper suggested taking drastic stabilization measures, such as insurance, to mitigate the effects of instability. In addition, the newspaper emphasized the importance of modern technology and rational management of rainwater. In their article from 2013, Tripathy and Umakanta focused on the growth of regional diversity in various parts of Orissa state. The two years of 1980–1981 and 2000–01 were compared. The findings led to the classification of the various regions as most backward, progressive, regressive, and advanced. In this article, the growth rate of various development indicators was calculated using a log-line function. According to the document, in order to achieve the national government's goal of eliminating diversity, the State Treasury should be given the authority to conduct a multi-level assessment of the needs of various areas. In their article, Mukherji, Stuti, and Shah (2013) stressed the regional variations in the groundwater economy of the nation and suggested the necessity for efficient management measures. (2015) Gadekar Deepak Janardhan completed a Temporary. Imran Ali Baig& Md. Abdus Salam (20 19) blocks in the For the years 2017–2018, Aligarh district in Uttar Pradesh examined regional variations in agricultural development. Principal Component Investigation [PCA] was used to adjust and compile data from fifteen indicators for the research analysis. An essential component was used to produce the index in order to identify regional variations in Block Levels in the Aligarh district. In their study, Dr. Giri Sanjay Pralhad and Gadekar Deepak, Janardhan (2020) used 19 indicators to gauge the degree of progress in the learning domain. The four main groups of indicators are Census, Resources, Agriculture, and Employment. The level of development in the national field was evaluated using the Z scoring system. Regional differences in agricultural productivity have been studied by (Munda et al., 2022).In this study, an attempt has been made to examine the regional variability in agricultural development among fifty blocks in six regions of Western Odisha on the basis of their composite scores by dividing them into different levels of agricultural development such as Meteoric, Progressive, Mediocre, and Laggard so that one can focus on their relative developmental level.

## Data

The study's primary data source is cross-sectional information from the annual "Statistical Abstract of the several districts in Western Odisha" and "District Outlines" reports from the Odisha Government Department of Economy and Statistics (DES) for the years 2018 to 2019. However, the major component was used to develop the composite index, which will be used to discover wide variations in block levels across six districts. For the study, several following indicators are considered in this study. : **X1**–Consumption of fertilizer(KG),**X2-**Population density, **X3-**Crooping intensity,**X4-**Irrigation intensity,**X5-**Percentage of agricultural labour to total main worker,**X6-**Percentage of agricultural worker to total population,**X7-**Percentage of cultivator to the total main worker,**X8-**Percentage of literate population to total population,**X9-**Percentage of total main worker to total population,**X10**-Percentage of total irrigated area to net irrigated area,**X11-**Percentage of net irrigated area by creek,**X12-**Percentage of net irrigated area by tube well,**X13**-Percentage of net irrigated area bylift,**X14-**Percentage of net irrigated area bymajor,**X15-**Percentage of net irrigated area by minor.

## The Aim of the Study

To use the Principal Component Analysis approach to divide fifty blocks of six randomly chosen districts in western Odisha into homogenous categories (Meteoric, Progressive, Mediocre, and Laggard) based on composite index score.

2. By estimating Gini coefficients between various groups for different blocks, secondary data based on agricultural area in hectors, yield rate in quintal/hectors, and production in quintals (Source: DES Odisha-2019-20) were used to determine the degree of inequality.

3. Identify the causes of inequality and recommend polices to confront issues.

## Methodology

The goal of principal component analysis (PCA) is to combine a number of independent, linear original variables that can account for the majority of the variation in the original dataset to describe the variance and covariance structure of a set of variables. The Principal Component refers to the linear combinations that are so obtained. The i$^{th}$ principal component is given by

$$P_i = a_{i1}Z_1 + a_{i2}Z_2 + a_{i3}Z_3 + \quad \dots\dots\dots\dots + a_{in}Z_n$$

Where, $a_{in}$are the weight of the input variable $Z_i$ in the linear composite of the factor k and $Z_i$ $=\frac{(x_i - \mu_i)}{\sigma_i}$, are standard normal variable $(i = 1, 2, \dots\dots n)$.

Where $Z_i$' s(i=1,2,.n) are the standardized scores with N(0,1).

ANOVA: In most of agricultural experiments, analysis of variance (ANOVA) is the widely used statistical methods for assessing the differences among the means of more than two treatments by considering single trail independently. The Anova test is performed by comparing two types of variation, the variation between the sample means, as well as the variation within each of the samples. The below mentioned formula represents one-way Anova test statistics: Alternatively,

$$F = MST/MSE.\ MST = SST/\ p\text{-}1.$$

Gini Coefficient: Gini co-efficient is a precise way of measuring the degree of inequality between two variables. It can be treated as a measure of concentration of areas between the Lorenz curve and the line of perfect equality and expressed as a proportion of the area enclosed by the tringle defined by

$$GCR=\sum_{i=1}^{N-1} \mid X_i Y_{i+1} - X_{i+1} Y_i \mid$$

Where $X_i$= Cumulative Proportion of first group of observations,
$Y_i$= Cumulative Proportion of second group observations.
Data Analysis and Findings: –

Five major components were generated from the data from the aforementioned fifteen indicators in nine blocks across six districts in western Odisha using SPSS-16.0 in Xlstat under MS-XP. It is used to compare the differences in agricultural development for the years 2018–2019 on a block–by–block basis at the various key component levels as well as at the overall development level. The first five main components were examined since they provided an explanation for the data's 97.229 percent variability. [Table-1]. The primary component number was chosen by the researcher using Kaiser's law. Only the items in Kaiser's instance that have Core Values larger than one that are deemed essential and should be kept in the analysis are described. The composite index, which is the arithmetic mean of all the principal components generated using the principal component's approach, is used by the researcher in this study. The Kolmogorov-Smirnov test was employed in the study to determine whether all extracted principal components were normal. [Table-2]. Using the quartiles of the normal distribution as a base, four degrees of agricultural development are used to categorise blocks. Since the mean and standard deviation of the composite index (CI) of and, respectively, are Q1=-0.6745x and Q3=+0.6745x, the first and third quartiles of the normal distribution, detailed block classifications are performed in accordance with the criteria stated in [Table-3].

However, a composite index was constructed using the major component in order to determine the regional variation in Block Levels in the six districts.

$$CI_j= \frac{1}{5}\sum_{i=1}^{n=10} P_i (j=1,2,3\ldots50);i=1,2,\ldots\ldots,5)$$

Here, $CI_j$is the composite index of blocks (j=1, 2…, 50) and $P_i$ (i=1, 2, 3…, 5) are the principal components.

***Hypothesis:***
$H_0 : \rho = 0$ i.e various indicators are independent in the population.
$H_1 : \rho \neq 0$ i.e various indicators are not independent in the population.

**Table-1:** *KMO and Bartlett's Test*

| | | |
|---|---|---|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | | .502 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 242.530 |
| | Df | 105 |
| | Sig. | .000 |

Table 1 shows the results of the study. The null hypothesis must be rejected since (Chi-Square value = 242.530) is significant at the 5% level (p=0.05). As an outcome, this can be assumed that different indicators are related in the population. Again, a Principal Component Analysis method is better appropriate for data reduction because the KMO value (0.502) is more than 0.5.

Five components are taken from the data after it has been analysed by XlStat, which accounts for 93.078 percent of the total variation in the data given in table 2.

**Table-2** *(Total Variance Explained)*

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|
| | **Total** | **% of Variance** | **Cumulative %** | **Total** | **% of Variance** | **Cumulative %** |
| 1 | 2.387 | 15.915 | 15.915 | 2.387 | 15.915 | 15.915 |
| 2 | 1.974 | 13.163 | 29.078 | 1.974 | 13.163 | 29.078 |
| 3 | 1.690 | 11.264 | 40.342 | 1.690 | 11.264 | 40.342 |
| 4 | 1.576 | 10.508 | 50.849 | 1.576 | 10.508 | 50.849 |
| 5 | 1.383 | 9.221 | 93.070 | 1.383 | 9.221 | 93.070 |

Extraction Method: Principal Component Analysis. a. 5 components extracted.

The five principal components so extracted are tested for Normality using Kolmogrov-Smirnov Test and it is found that the test distribution is Normal.(Table-3).

**Table-3:** *One-Sample Kolmogorov-Smirnov Test*

| | | **F1** | **F2** | **F3** | **F4** | **F5** |
|---|---|---|---|---|---|---|
| **N** | | **50** | **50** | **50** | **50** | **50** |
| Normal Parameters[a,b] | Mean | .0000 | .0000 | .0000 | .0000 | .0000 |
| | Std. Deviation | 3.14327 | 2.15693 | 1.82272 | 1.48980 | 1.22313 |
| Most Extreme Differences | Absolute | .203 | .096 | .134 | .161 | .121 |
| | Positive | .203 | .096 | .134 | .161 | .121 |
| | Negative | -.108 | -.062 | -.108 | -.087 | -.065 |
| Test Statistic | | .203 | .096 | .134 | .161 | .121 |
| Asymp. Sig. (2-tailed) | | .000[c] | .200[c,d] | .024[c] | .002[c] | .066[c] |

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.
d. This is a lower bound of the true significance.

Table -4 represents the principal component values for different blocks calculated using the relation $P_i = a_{i1}Z_1 + a_{i2}Z_2 + a_{i3}Z_3 + \ \ldots + a_{in}Z_n$

Here, $Z_i$' s(i=1, 2. n) are the standardized scores with N (0,1). The Factor loadings and value of Z are presented in Appendix -1 and Appendix-2.

**Table 4** – *(Principal component value and Composite Index score for the blocks of Sambalpur district)*

| BLOCKS | $P_1$ | $P_2$ | $P_3$ | $P_4$ | $P_5$ | $CI_j$ |
|---|---|---|---|---|---|---|
| BODEN(NUAPADA) | 5.749593 | -1.1381 | 1.890861 | 0.726078 | -1.152332 | 2.43044 |
| KHARIAR(NUAPADA) | 6.431442 | -2.13809 | 0.109331 | 0.124608 | 1.9160816 | 2.577351 |
| KOMNA(NUAPADA) | 5.341082 | 0.911488 | 1.092317 | -0.25989 | -1.895178 | 2.075929 |
| NUAPADA(NUAPADA) | 3.574985 | 1.016864 | -0.09379 | -0.11905 | -1.797963 | 1.03242 |
| SINAPALI(NUAPADA) | 6.435334 | 0.320794 | 1.582857 | 1.506124 | -0.197868 | 3.858897 |
| JARSUGUDA(JHARSUGUDA) | 6.447797 | -1.04135 | 0.917939 | 0.36094 | -1.032051 | 2.261309 |
| KIRMIRA(JHARSUGUDA) | 6.024074 | -1.69172 | 0.290542 | -0.7873 | 1.7474501 | 2.233217 |
| KOLABIRA(JHARSUGUDA) | 5.111225 | 1.464363 | 0.434732 | -0.79274 | -1.102742 | 2.045935 |
| LAIKERA(JHARSUGUDA) | 4.039161 | 0.840707 | -0.83479 | -0.50173 | -1.503859 | 0.815797 |
| LAKHANPUR(JHARSUGUDA) | 6.320906 | 0.571831 | 0.9418 | 1.088976 | -0.47711 | 3.378561 |
| BOUDH(BOUDH) | -1.61101 | -1.20236 | -1.25437 | 1.186124 | -0.35519 | -1.29472 |
| HARBHANGA(BOUDH) | -0.89407 | -3.20087 | -2.05941 | -0.54694 | 0.7568471 | -2.37778 |
| KANTAMAL(BOUDH) | -0.92794 | -0.31806 | -1.18863 | 0.267054 | -0.186775 | -0.94174 |
| BAILSANKRA(SUNDARGARH) | -1.61101 | -1.20236 | -1.25437 | 1.186124 | -0.35519 | -1.29472 |
| BISRA(SUNDARGARH) | -0.89407 | -3.20087 | -2.05941 | -0.54694 | 0.7568471 | -2.37778 |
| BONAIGARH(SUNDARGARH) | -1.89808 | -1.81281 | 0.107317 | 0.274119 | -0.76904 | -1.6394 |
| GURUNDIA(SUNDARGARH) | -1.10492 | -2.51518 | -1.93584 | -1.16999 | 0.3676636 | -2.54331 |
| HEMAGIRI(SUNDARGARH) | 0.609833 | -0.06974 | 1.275841 | -1.82066 | -1.346967 | -0.54068 |
| KOIDA(SUNDARGARH) | -3.46853 | 0.557081 | -0.34149 | 0.219648 | -0.374439 | -1.36309 |
| KUANARMUNDA(SUNDARGARH) | -4.28966 | -0.27448 | 0.245414 | -1.23009 | -0.918944 | -2.5871 |
| KUTRA(SUNDARGARH) | -2.65025 | -2.21178 | -2.25294 | 0.219664 | -0.901448 | -3.1187 |
| LAHUNIPARA(SUNDARGARH) | -2.51433 | -0.79042 | 0.788335 | -0.83404 | -0.54449 | -1.55798 |
| LATHIKANTA(SUNDARGARH) | -1.60947 | -2.124 | -1.4849 | -0.22036 | 0.1210655 | -2.12707 |

| | | | | | | |
|---|---|---|---|---|---|---|
| LEPHRIPADA(SUNDARGARH) | -0.54766 | -2.36184 | -2.20839 | 0.213247 | -0.27382 | -2.07138 |
| NUAGAON(SUNDARGARH) | 0.205133 | -1.65837 | -0.52725 | 0.376772 | -0.035495 | -0.65568 |
| RAJGANPUR(SUNDARGARH) | -0.31976 | -1.80072 | -0.42321 | -0.60415 | -0.838143 | -1.59439 |
| SUBDEGA(SUNDARGARH) | -0.93743 | 0.450433 | -1.25134 | 0.779943 | 0.1437621 | -0.32585 |
| SUNDARGARH(SUNDARGARH) | -2.22177 | 0.924951 | -1.14101 | 0.754 | -0.302456 | -0.79452 |
| TANGARPALI(SUNDARGARH) | -1.29549 | -0.64468 | -1.83949 | 0.451475 | -1.23934 | -1.82701 |
| BAMRA(SAMBALPUR) | -2.14077 | 3.853833 | 0.117894 | 1.210305 | 1.0356756 | 1.630777 |
| DHANKUDA(SAMBALPUR) | -3.28041 | -5.30923 | 4.68361 | -0.7672 | 0.7858475 | -1511.55 |
| JAMINKIRA(SAMBALPUR) | -1.62141 | 2.692609 | 0.356396 | -0.95107 | -0.339378 | 0.054857 |
| JUJUMURA(SAMBALPUR) | -1.90417 | 2.240105 | 0.7072 | -0.09223 | -0.599164 | 0.140693 |
| KUCHINDA(SAMBALPUR) | -3.77166 | 5.570706 | 0.091209 | 2.744959 | -0.207228 | 1.771193 |
| MANESWAR(SAMBALPUR) | -5.95667 | 0.14472 | 8.797553 | 0.435607 | -1.061099 | 0.944046 |
| NAKTIDEAUL(SAMBALPUR) | -0.02158 | 3.895269 | -0.5084 | -1.97991 | 0.6133853 | 0.799504 |
| RAIRAHKOL(SAMBALPUR) | -0.87994 | 4.699939 | -1.10678 | -0.96074 | 0.3388978 | 0.83655 |
| RENGALI(SAMBALPUR) | 0.31302 | 2.922955 | -1.20199 | -2.14663 | 2.1776648 | 0.826008 |
| AMBABHONA(BARGARH) | -2.95143 | -1.01909 | -0.66873 | -1.01882 | -1.534905 | -2.87719 |
| ATTABIRA(BARGARH) | -3.41785 | -0.63404 | 0.273678 | 0.080267 | -0.10496 | 1.521161 |
| BARGARH(BARGARH) | -0.42827 | -1.68755 | 1.480519 | 0.071351 | 0.5992368 | 0.841167 |
| BARPALI(BARGARH) | -0.41376 | -0.78442 | -0.00961 | 7.629434 | 2.3977541 | 3.527761 |
| BHATLI(BARGARH) | 0.556418 | 1.843627 | -0.91825 | 0.445338 | -0.646975 | 0.512062 |
| BHEDEN(BARGARH) | -0.21512 | 1.131077 | 1.009024 | -1.91053 | 2.5497059 | 1.025663 |
| BIJEPUR(BARGARH) | 1.248663 | 1.36536 | 0.609585 | -0.0144 | 1.2670117 | 1.790489 |
| GAISILET(BARGARH) | -0.09139 | 2.73478 | -0.58421 | 0.823781 | 0.280643 | 1.265438 |
| JHARBANDH(BARGARH) | -2.13739 | -1.09422 | -2.02987 | 0.318483 | -1.397314 | -2.53612 |
| PADAMPUR(BARGARH) | -0.39759 | 1.383783 | 0.547007 | -0.84225 | 0.4538038 | 0.457903 |
| PAIKMAL (BARGARH) | -0.02018 | -0.84614 | 1.3478 | -1.49088 | 3.9836987 | 1.189716 |
| SOHELLA(BARGARH) | 0.036274 | 1.235201 | -0.52026 | -1.88586 | 1.1988305 | 0.025671 |

**Table- 4** *(Factor Loadings)*

| Indicators(X) | Component | | | | |
|---|---|---|---|---|---|
| | **F1** | **F2** | **F3** | **F4** | **F5** |
| Consumption of fertilizer (Kg) | -0.063 | -0.466 | -0.238 | -0.215 | -0.203 |
| Population desnity | 0.207 | -0.255 | 0.375 | -0.050 | 0.648 |
| Cropping intensity | 0.544 | -0.554 | 0.095 | 0.229 | -0.428 |
| Irrigation intensity | -0.468 | -0.411 | -0.419 | 0.023 | -0.114 |
| Percentage of Agriculture labour to total main worker | -0.123 | 0.357 | 0.423 | -0.357 | -0.055 |
| Percentage of Agricultural Worker to total Population | -0.463 | -0.350 | -0.414 | 0.097 | -0.175 |
| Percentage of Cultivator to the total main worker | 0.053 | -0.058 | 0.006 | 0.747 | 0.267 |
| Percentage of Literate population to total population | 0.858 | -0.107 | 0.235 | 0.039 | -0.242 |
| Percentage of total main worker to total population | -0.835 | -0.183 | -0.043 | -0.052 | 0.181 |
| Percentage of total irrigated area to net irrigated area | -0.637 | -0.234 | 0.579 | -0.122 | -0.100 |
| Percentage of net irrigated area by CREEK well to total irrigation area | -0.109 | -0.326 | 0.431 | 0.604 | 0.074 |
| Percentage of net irrigated area by TUBEWELL to total irrigation area | -0.153 | 0.558 | -0.142 | 0.435 | -0.377 |
| Percentage of net irrigated area by LIFT to total irrigation area | -0.288 | 0.370 | 0.520 | -0.007 | -0.409 |
| Percentage of net irrigated area by MAJOR to total irrigation area | -0.353 | -0.544 | 0.472 | 0.003 | -0.212 |
| Percentage of net irrigated area by Minor to total irrigation area | -0.517 | 0.442 | 0.015 | 0.345 | 0.033 |

**Table:5** (*Criteria for Block classification in terms of Agricultural Development)*

| **Above[$\overline{CI}$+0.6745σ]** | **Meteoric** |
|---|---|
| $\overline{CI}$to[$\overline{CI}$+0.6745σ] | Progressive |
| [$\overline{CI}$-0.6745σto$\overline{CI}$ ] | Mediocre |
| Below [$\overline{CI}$-0.6745σ] | Laggard |

Where $\overline{CI}$ = Mean composite index score= $\frac{1}{k}\sum_{j=1}^{k} CI_j = 0$ and σ = Standard deviation of composite index score =$\frac{1}{k}\sum_{j}^{k}\left(CI_j - \overline{CI}\right)^2$=0.62653k=1,2,3…….5

The block classifications are based on the mean value of the combined index ($\overline{CI}$) presented in Table-6 listed in all fifteen indicators.

**Table :6** (*Block classification in terms Composite index Scores)*

| Composite Index Score | Blocks | | Class |
|---|---|---|---|
| [Above 0.62653] | BODEN(NUAPADA), | 2.43044 | Meteoric |
| | KHARIAR(NUAPADA), | 2.57735 | |
| | KOMNA(NUAPADA), | 2.07592 | |
| | NUAPADA(NUAPADA), | 1.03242 | |
| | SINAPALI(NUAPADA), | 3.85889 | |
| | JARSUGUDA(JHARSUGUDA) | 2.26130 | |
| | KIRMIRA(JHARSUGUDA), | 2.23321 | |
| | KOLABIRA(JHARSUGUDA), | 2.04593 | |
| | LAIKERA(JHARSUGUDA), | 0.81579 | |
| | LAKHANPUR(JHARSUGUDA) | 3.37856 | |
| | BAMRA(SAMBALPUR), | 1.63077 | |
| | KUCHINDA(SAMBALPUR), | 1.77119 | |
| | MANESWAR(SAMBALPUR), | 0.94404 | |
| | NAKTIDEAUL(SAMBALPUR), | 0.79950 | |
| | RAIRAHKOL(SAMBALPUR), | 0.83655 | |
| | RENGALI(SAMBALPUR), | 0.82600 | |
| | BARGARH(BARGARH), | 0.84116 | |
| | BARPALI(BARGARH), | 3.52776 | |
| | BHEDEN(BARGARH), | 1.02566 | |
| | BIJEPUR(BARGARH), | 1.79048 | |
| | GAISILET(BARGARH), | 1.26543 | |
| | ATTABIRA(BARGARH), | 1.52116 | |
| | PAIKMAL (BARGARH), | 1.18971 | |
| [0.0 to 0.62653] | JAMINKIRA(SAMBALPUR) | 0.05485 | Progressive |
| | JUJUMURA(SAMBALPUR) | 0.14069 | |
| | BHATLI(BARGARH) | 0.51206 | |
| | PADAMPUR(BARGARH) | 0.45790 | |
| | SOHELLA(BARGARH) | 0.02567 | |
| [ -0.62653to 0] | KANTAMAL(BOUDH) | -0.9417 | Mediocre |
| | HEMAGIRI(SUNDARGARH) | -0.5406 | |
| | NUAGAON(SUNDARGARH) | -0.6556 | |
| | SUBDEGA(SUNDARGARH) | -0.3258 | |
| | SUNDARGARH(SUNDARGARH) | -0.7945 | |
| [Below -0.62653] | BOUDH(BOUDH) | -1.2947 | Laggard |
| | HARBHANGA(BOUDH) | -2.3777 | |
| | BAILSANKRA(SUNDARGARH) | -1.2947 | |
| | BISRA(SUNDARGARH) | -2.3777 | |
| | BONAIGARH(SUNDARGARH) | -1.6394 | |
| | GURUNDIA(SUNDARGARH) | -2.5433 | |
| | KOIDA(SUNDARGARH) | -1.3630 | |
| | KUANARMUNDA(SUNDARGARH) | -2.5871 | |
| | KUTRA(SUNDARGARH) | -3.1187 | |
| | LAHUNIPARA(SUNDARGARH) | -1.5579 | |
| | LATHIKANTA(SUNDARGARH) | -2.1270 | |
| | LEPHRIPADA(SUNDARGARH) | -2.0713 | |
| | RAJGANPUR(SUNDARGARH) | -1.5943 | |
| | TANGARPALI(SUNDARGARH) | -1.8270 | |

| | |
|---|---|
| DHANKUDA(SAMBALPUR) | -1511.5 |
| AMBABHONA(BARGARH) | -2.8771 |
| JHARBANDH(BARGARH) | -2.5361 |

An ANOVA test is conducted utilising the data on Agricultural area in hectors, Yield rate in quintal/hectors and Production in quintals (Source : DES Odisha 2019-20) by one way ANOVA test and the result is presented in Table-No. 7 as follows :

**Table No.-7** *Anova*

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| AREA IN HECTOR | Between Groups | 36044303.341 | 3 | 12014767.780 | 2.135 | .109 |
| | Within Groups | 258909626.659 | 46 | 5628470.145 | | |
| | Total | 294953930.000 | 49 | | | |
| YIELD RATE IN QTL/HECT | Between Groups | 380.591 | 3 | 126.864 | 5.031 | .004 |
| | Within Groups | 1159.899 | 46 | 25.215 | | |
| | Total | 1540.491 | 49 | | | |
| PRODUCTION IN QTL | Between Groups | 36257868762.076 | 3 | 12085956254.025 | 2.862 | .047 |
| | Within Groups | 194261621139.944 | 46 | 4223078720.434 | | |
| | Total | 230519489902.020 | 49 | | | |

From the above result it is quite evident there is significant difference between the groups (Meteoric, Progressive, Mediocre and Laggard) with respect to the Yield rate in quintal/hectors ($p<0.05$) and Production in quintals($p<0.05$) and no significant difference is observed between the groups with respect to Area in hector ($p>0.05$).

The degree of inequality in Agricultural area in hectors, Yield rate in quintal/hectors and Production in quintals are computed and presented in Table-8(a)-8(c) as below:

**Table-8** *(a)*

| | AREA IN HECTOR | | | |
|---|---|---|---|---|
| | **METEROIC** | **PROGRASSIVE** | **MEDIOCRE** | **LAGGARD** |
| METEROIC | | 0.291305 | 0.286088 | 0.47201 |
| PROGRASSIVE | | | 0.279368 | 0.2887 |
| MEDIOCRE | | | | 0.342915 |

Maximum degree of inequality is found between Meteoric and Laggard (47.2%) followed by Mediocre and Laggard (34.3%) as compared to Meteoric-Progressive (29.1%), Meteoric-Mediocre (27.9%) and progressive laggard (28.8%).

**Table-8 (b)**

| | YIELD RATE IN Hect./Qtnl. | | | |
|---|---|---|---|---|
| | **METEROIC** | **PROGRASSIVE** | **MEDIOCRE** | **LAGGARD** |
| METEROIC | | 0.159702 | 0.107847 | 0.131738 |
| PROGRASSIVE | | | 0.249204 | 0.249375 |
| MEDIOCRE | | | | 0.064288 |

Maximum degree of inequality is found between Progressive-Laggard (24.93%) followed Progressive-Mediocre (24.93%), Meteoric-Progressive(15.9%), Meteoric and Laggard (13.1%), Meteoric-Mediocre(10.7%) and Mediocre-Laggard(6.4%)

**Table-8 (c)**

| | PRODUCTION IN QUINTAL | | |
|---|---|---|---|
| **METEROIC** | **PROGRASSIVE** | **MEDIOCRE** | **LAGGARD** |
| METEROIC | 0.706476 | 0.18969 | 0.46765 |
| PROGRASSIVE | | 0.663548 | 0.462562 |
| MEDIOCRE | | | 0.397943 |

Maximum degree of inequality is found between Meteoric-Progressive (70.6%) followed by Progressive-Mediocre (66.3%), Meteoric-Laggard (46.7%), Progressive-Laggard (46.2%), Mediocre-Laggard (39.7%) and followed, Meteoric-Mediocre (18.9%).

## Conclusion

The combination of pandemic impact and natural calamities has prevented this sector from rebounding like the rest of the economy following the two-year downturn. As a result, the immediate task is to provide short-term assistance to the majority of its citizens who rely on agriculture while also taking measures to address structural issues that may be holding the sector back. The government has implemented a number of schemes to assist the sector, the most notable of which are KALIA (Krushak Assistance for Livelihood and Income Augmentation) and BALARAM (Boomihina Agriculturist Loan and Resources Augmentation Model).

Krushak Assistance for Livelihood and Income Augmentation (KALIA) was launched in 2018 to accelerate agricultural prosperity and reduce poverty in the province by providing farmer support for smallholder farmers both in the Kharif and Rabbi period to support landless agricultural families through non-agricultural activities on a farm such as goats, sheep, poultry farming, mushroom farming, beekeeping, and fishing activities. The National Government's initiative has been recognised and commended in a number of forums across the country.

The Government of Odisha has launched the new BALARAM (Boomihina Agriculturist Loan and Resources Augmentation Model) programme by 2020 to provide institutional loan sharing between the majority of smallholder and subsistence farmers who lease land and those who have no other access to institutional credit. The goal is to simplify lakh JLGs that serve 5 lakh sharecroppers. This is a model government programme for wealthy farmers with the goal of improving farmers' quality of life and farm families' income.

Inequalities in agricultural development in the various blocks can be eliminated by the active role of NGOs in raising awareness of the Government's various programs and strategies to assist farmers. NGOs also developed a new distribution system, based on farmer-to-farmer interactions, climate groups, or individuals. NGOs are involved in creating awareness, improving livelihoods, conservation, sustainable production, skills development, and digital marketing.

The structural problems are well known and are not limited to Odisha or even India. While several schemes are in operation with varying degrees of success, improved post-harvest crop management (storage, marketing, etc.) facilities may provide income stability in the agriculture sector. Livestock rearing is a valuable supplement to crop farming and, in some cases, a viable alternative. Because of the risk of occasional animal/bird epidemics, it is critical to ensure a properly functioning veterinary system and an insurance mechanism to contain the fallout of such epidemics. Odisha's fishing industry is thriving, with both inland and coastal bodies of water providing ample opportunities. Ensuring a mechanism to overcome challenges such as working capital and financing would be beneficial.

Rural development is a multifaceted process of improving the quality of life in rural areas that is dependent on physical and social infrastructure. Given Odisha's low urbanisation, it is a top priority for the government, and its efforts in this area have yielded results such as full rural electrification, significant improvements in sanitation, improved rural road connectivity, and so on. These efforts, along with measures to increase rural income, must be maintained. The goal must be to ensure that no migration out of Odisha's rural areas is compelled by economic factors. Rural local governments must continue to be State Government partners in the formulation and implementation of development initiatives, and they must provide valuable feedback.

Natural disasters such as hurricanes, droughts, floods, and insect invasions are commonplace in Odisha. Almost every year or so, one or more parts of the State are affected by natural disasters of various kinds, and agricultural production is severely affected. Despite the many risks, timely interventions and the introduction of government risks reduction programs such as PMFBY (Pradhan Mantri Fasal Bima Yojana) and other investment programs and subsidy schemes can reorganize the plight of farmers and enable the State to become self-sufficient. Grains of food. Agricultural debt is an important part of the growth and environment driven by agricultural technologies, such as irrigation, farm implements and machinery, quality seeds, etc.

Crop borrowing is a very important requirement for a farmer to grow and maintain his production capacity in a technologically driven environment. A plant loan is a temporary loan given to farmers by banks and cooperative organizations can be used to buy improved seeds, fertilizers and so on. And new technologies to improve productivity and revenue. The low availability of crop loans, with very low interest rates, is aimed at giving farmers easy operating costs.

In recent years a number of post-harvest buildings have been built and various post-harvest activities have begun in Odisha. Most of the buildings are harvested after harvesting mandis, cold storage of many controlled goods, cashew milling industries, small delivery units, packing houses, inexpensive onion buildings, e-NAM candies, etc.

To establish an insect control system and to strengthen the pest control and control system, the pest monitoring program was initiated by the Government in 2010-11 with the involvement of the National Research Centre for Integrated Pest Management (NCIPM), in New Delhi. , Central Integrated Pest Management Centre (CIPMC), Bhubaneswar & OUAT, Bhubaneswar assists in pest management and timely adoption of control measures. (Government of Odisha, 2021)

An analysis of the classification of blocks according to the level of agricultural development is shown in Table 5. The result clearly indicates that remedial measures are required during the formulation of appropriate policy and planners to develop those factors that contribute to low agricultural development. We have analysed in the table above [Table 6], the low level of agricultural development due to the low level of technology and rural infrastructure in the agricultural sector in those blocks. Districts such as all nine blocks with a low level of agricultural development require special policy attention and are designed to improve farmers' awareness of technological advances and the use of fertilizers, etc. Government should increase the budget and public investment in agricultural investment and review its mandate.

Government should focus on major agricultural problems such as irrigation, high-quality seeds, and agricultural inputs such as HYVS seeds, Fertilizers, and pesticides by providing large amounts of support to farmers who play a key role in reducing the cost of grain production. However, farmers compensate for the budget and expenditure on other aspects of the agricultural sector, and farmers are encouraged to cultivate more and secure investment in order to attract more investment across the agricultural sector. The government should take appropriate steps to reduce regional diversity in agricultural development in the right way by prioritizing each key indicator at the level of prevention in the Sambalpur region.

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