

# Agricultural Productivity and Development: A Case Study of Daspur-II and Nayagram Blocks of Paschim Medinipur District of West Bengal

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**Abstract:** This paper attempts to find out agricultural productivity and development in Daspur-II and Nayagram blocks of Paschim Medinipur district. It also examines whether agricultural productivity is determined by the levels of agricultural development. The levels of agricultural productivity have been assessed by using both the cropland occupancy and yield of principal crops. The spatial pattern of agricultural development has been determined with the help of sixteen indicators. Panchayat wise levels of agricultural development have been calculated using Principal Component Analysis (PCA). The study concludes that Palaspai panchayat of Daspur-II block ranked top in both levels of agricultural development (5.30) and agricultural productivity (257.41). In case of Nayagram block, among twelve panchayets Nayagram performed best in both levels of agricultural development (5.72) and agricultural productivity (127.43). The correlation between agricultural development and agricultural productivity of Daspur-II and Nayagram block has been calculated through Pearson Co-relation Co-efficient and a high positive correlation was found to exist between them (0.915 and 0.857 respectively).

**Key words:** Productivity, Development, Cropland, Principal component analysis, Correlation.

## 1. INTRODUCTION:

Agricultural development in true sense denotes not only a positive change in agrarian structure but also in the quality of the agricultural system of a region in terms of productivity, diversification, mechanization and commercialization. It denotes improving production, ensuring enough food for present and future generations and generating sufficient income for farmers through increasing agricultural productivity by the introduction of modern agricultural inputs, mechanization, marketing and socio-economic development. Agricultural development can be measured through five key indicators namely, physical, social, agricultural inputs, infrastructure and performance. Physical indicators include land configuration, nature and types of soil, climate, water availability and groundwater potential etc (Osawa, *et. al*, 2016). Social indicators (Togarsi, *et. al*, 2016 and Adekunle, *et. al*, 2016) comprise of population density, labour intensity, percentage of literacy, percentage of female literacy, persons per household, percentage of agri-labour and farmer's perception (Tewari, 1992, Gbetibouo, 2009, Darko, 2014, Saqib, *et. al*, 2016 and Tesfahunegn, *et. al*, 2016). Indicators of agricultural inputs are percentage of irrigated land, number of tractors per Net Cropped Area (NCA), number of harvesters per NCA, number of oil-engines per NCA, number of electric-pump set per NCA, fertilizer consumption rate and pesticide consumption rate etc. (Aphiphan, 1992; Barakade and Sule, 2014; and Meraner, *et. al*, 2015). Infrastructural indicators are metalled road density, electrified mouzas to the total mouzas, number of agricultural banks, number of seed stores and number of the cold stores, government policies and so on (Satish, 2007; Rahman, 2009 and Hussain, 2015). The indicators of performance are crop yield, agricultural productivity and agricultural efficiency etc. (Sidhu and Bhular, 2005).

## 2. LITERATURE REVIEW:

Agricultural productivity has drawn the attention of many scholars, especially with respect to its measurement. Thompson (1926) measured the productivity of British and Danish farming with the help of gross output crops and livestock. Kendall (1939) calculated the productivity by four coefficients: productivity coefficient, ranking coefficient, money value coefficient and starch value coefficient. Hirsch (1943) used 'Crop Yield Index' to measure productivity. Stamp (1958) measured the productivity by calories intake of a person. Shafi (1960) applied ranking coefficient techniques to measure the productivity. Enyadi (1964) has determined the agricultural productivity of Hungary using productivity co-efficient. Sarma (1965) has considered productivity in relation to land, labour and capital and all the agricultural output converted into calories for better analysis. Bhatia (1967) has adopted yield index for productivity analysis. Pal (1975) suggested that agricultural productivity can be achieved by HYV seeds, chemical fertilizers, scientific water management and other practices. Sinha (1968) has applied standard deviation techniques to determine the agricultural efficiency. Bhalla (1978) has measured labour productivity in terms of prices. Agricultural development is one of the key strategies of overall development of a region. Mellor (1967) proposed that Indian agricultural development depends on socio-economic infrastructure. Other eminent scholars like Mitra, 1967; Nath,

1969; Mohammad, 1979 and Srivastava, 1983 have worked on the spatio-temporal variations in agricultural development.

### **3. STUDY AREA:**

Located in the southern part of West Bengal, Paschim Medinipur has been carved from the erstwhile Medinipur district, the then largest district of India and came into existence in the present form on the 1<sup>st</sup> January 2002. Paschim Medinipur district is the southernmost district of the Burdwan Division, is situated between 21<sup>o</sup>36' 35" and 22<sup>o</sup>57' 10" North latitudes and between 86<sup>o</sup>33' 50" and 88<sup>o</sup>12' 40" East longitudes. Its boundary lies in Bankura and Purulia districts in the north, Mayurbhanj and Balasore districts of Odisha in the south, Hugli and Purba Medinipur districts in the east and Singbhum district of Jharkhand and part of Odisha in the west. The total geographical area of Paschim Medinipur district is 9345.00 sq. km. and has twenty nine blocks. Among twenty nine blocks Daspur-II and Nayagram secure top and bottom rank respectively with respect to human development (DHDR, 2011). This is the rationale for choosing these blocks for a study on agricultural productivity and development, which are in turn, dependent upon so many factors.

### **4. OBJECTIVES:**

The present study aims at the following objectives:

- i) To analyze levels of agricultural development and agricultural productivity in Daspur-II and Nayagram blocks.
- ii) To understand the correlation between levels of agricultural development and agricultural productivity in these two blocks.

### **5. MATERIALS AND METHODS:**

The present study is based on secondary data. Data on social indicators were obtained from District Census Handbook of Paschim Medinipur (2011). Data on agricultural inputs and infrastructure were obtained from the Office of Assistant Director of Agriculture of the concerned blocks. Panchayat-wise levels of agricultural development have been calculated using Principal Component Analysis (PCA) from following agro-inputs, agro-infrastructure and social indicators:

#### **5.1. Agricultural inputs:**

- Number of Power Tillers per 10 hectares NCA
- Number of Threshers per 10 hectares NCA
- Number of Sprayers per 10 hectares NCA
- Number of Pumps set per 10 hectares NCA
- Fertilizer consumption per 10 hectares NCA
- Pesticide consumption per 10 hectares NCA

#### **5.2. Agricultural infrastructure:**

- Percentage of irrigated land to total NCA
- Number of Seed Stores per 10 hectares NCA
- Metalled road density per sq.km.
- Number of Agricultural Banks per 10 hectares NCA
- Number of markets per sq.km
- Annual agri-market transaction in rupees.

#### **5.3. Social indicators:**

- Percentage of Literates
- Percentage of Cultivators to 10 hectares NCA
- Percentage of Agricultural Labourers to 10 hectares NCA
- Number of Marginal Farmers to 10 hectares NCA

Then composite indices have been calculated based on eigen values (King, 1968). Categories of agricultural development zones have been delineated with the application of Cluster Analysis (CA) technique based on composite indices values (Hotelling, 1933). To measure the levels of agricultural development among panchayets of selected blocks of Paschim Medinipur district following selected indicators have been taken into consideration for PCA.

Levels of agricultural productivity have been assessed by both the cropland occupancy and yield of principal crops. In this regard the formula of Agricultural Productivity considers both the cropland occupancy and productivity of crop, for ascertaining the level of agricultural performance as proposed by Jasbir Singh, et. al., 1990. The indices of inter-panchayat inequalities in agricultural performance can be calculated for each unit based on the following formula:

(i) Location Quotient (LQs)

$$LQ = \frac{Y_{ae} X \frac{P_{ae}}{P_{ar}}}{Y_{ar} \frac{P_{ae}}{P_{ar}}} + \frac{Y_{ae} X \frac{P_{ae}}{P_{ar}}}{Y_{ar} \frac{P_{ae}}{P_{ar}}} + \frac{Y_{ae} X \frac{P_{ae}}{P_{ar}}}{Y_{ar} \frac{P_{ae}}{P_{ar}}} + \dots \dots \dots N$$

Where,

Y=crop-yield of crop ‘a’ in kilograms per hectare

P=cropland occupancy of crop ‘a’ in percentage of gross cropped area

a, b, c=subscripts denotes crops considered

e, r= subscripts denotes enumeration unit and entire region respectively

N= Number of crops holdings more than 5 per cent of the total cropped area

(ii) Weighted Composite level of Agricultural performance ( $W_{ci}$ )

$$W_{ci} = \frac{\sum LQs}{N} \times 100$$

Where,

$\sum LQs$ = Summation of location quotient

N= Number of crops holdings more than 5 per cent of the total cropped area

Higher the value, higher the level of agricultural productivity.

The correlation between agricultural development and agricultural productivity has been calculated using Pearson Co-relation Co-efficient.

## 6. RESULTS AND DISCUSSION:

### Case Study 1: Daspur-II block

**Agricultural Development:** This section portrays a detailed scenario of the status of agricultural development in the block as a whole and also across the panchayats of the Daspur-II block. Based on eigen value four principal components were selected which together explain 77.51 percent of the variance and these are pesticide consumption, number of power tiller, number of sprayers per and number of pump-sets per (10 hectares NCA). The first principal component of agricultural indices of fourteen panchayats is presented in (Table No-1). It is observed that there exist an inter-panchayat disparity in the levels of agricultural development which may be categorized into Panchayats with agricultural development, Medium agricultural development and Low agricultural development. Palashpai (5.295) is the top ranking block in terms of agricultural development and Ranichak (- 4.218) is the bottom ranking block. Based on Levels of agricultural development fourteen panchayats have been arranged into following three categories:

Sl. No.	Panchayats	Agricultural Development (PCA-1)	Agricultural Productivity Weighted Composite Index(WCI)
1	Benai	-1.246	122.22
2	Kheput	0.6524	153.69
3	Nischintapur	1.8594	205.43
4	Palashpai	5.2951	257.41
5	Jot Ghanashyam	-0.018	200.29
6	Goura	0.6583	215.42
7	Khukur Daha	3.2815	244.81
8	Dudkumrah	1.468	217.58
9	Guchhati	-0.206	174.87
10	Chaipat	0.9961	204.69
11	Sahachak	-0.952	191.31
12	Kamalpur	-3.756	114.16
13	Ranichak	-4.218	116.2
14	Khanjapur	-3.814	118.07

Source: Computed by authors.

**(a) High agricultural development:** This category consists of the panchayats like Khukurdaha, Palashpai and Nischintapur. In this category along with key principal components like pump-sets, sprayers, power tillers and pesticides, social indicators like literacy rate and the number of marginal farmers have raised the levels of agricultural development of Daspur-II block.

**(b) Moderate agricultural development:** Kheput, Goura, Dudkumrah and Chanipat panchayets appear in medium category which perform better in terms of consumption of pesticides in comparison to the blocks in high agricultural development and thus raise levels of agricultural development. In case of agricultural implements panchayets of this group have consistently performed high to moderate.

**(c) Low agricultural development:** Low agricultural development is found in seven panchayets like Jot Ghanashyam and Ranichak panchayets, located in north-western, northern and north-eastern part of the Daspur-II block. Ranichak ranked the lowest in levels of agricultural development because of very low performance in number of agricultural implements and pesticide consumption. Poor availability of agricultural implements, inadequate opportunities to have fertilizer and pesticide consumption per 10 NCA among farmers together contributes to lower levels of agricultural development of panchayats in this category.

**Agricultural Productivity:** On the basis of Weighted Composite Index (Jasbir Singh, *et. al*, 1990) score of fourteen panchayets of Daspur-II block can be conveniently divided into three categories:

**(a) High agricultural productivity:** Seven panchayets, located in the southern part of Daspur-II block fall in this category. These are Palashpai (257.41) followed by Khukurdaha (244.81), Dudkumrah (217.58), Goura (215.42), Nischintapur (205.43), Chanipat (204.69) and Jot Ghanashyam (200.29). In these blocks, more than 50 percent NCA is covered with better irrigation facilities, high agricultural mechanization and heavy consumption of fertilizers and pesticides. Palashpai ranked highest in terms of pesticides consumed (12.59 kg/ 10 NCA). Paddy is the major crop which is highly concentrated here and produced in large quantities.

**(b) Moderate Agricultural Productivity:** Sahachack, Guchhati and Kheput panchayet show moderate levels of agricultural productivity, their scores being 153.69, 174.87 and 191.31 respectively. Located in eastern and western part of the block, these are contiguous to the agriculturally high productivity region. In these panchayets moderate use of agricultural inputs like fertilizers, pesticides and implements together contribute to medium agricultural productivity. Periodic impact of floods causes massive crop loss as well degradation of cropland which ultimately reduces the agricultural productivity of the panchayets.

**(c) Low Agricultural Productivity:** Benai, Kamalpur, Ranichak, Khanjapur panchayets lying in the north-eastern part of the block, performed low in levels of productivity. Lower levels of agricultural mechanization in terms of power tillers, pump sets, threshers and sprayers and low consumption of fertilizers and pesticides proved to be a hindrance to agricultural development of panchayets. Ranichak performed consistently low in all the indicators of agricultural development and ranked lowest. Annual floods and water logged conditions in Silai river during rainy season causes huge crop losses and transition to mono-cropping pattern with low productivity.

**Correlation between agricultural development and agricultural productivity in Daspur-II block:** Correlation between agricultural development and productivity was very high positive (Product Moment of Pearson) ( $r=0.915$ ) and Spearman's Rank Correlation Co-efficient ( $r=0.934$ ). It suggests that levels of agricultural development are highly positively correlated with productivity in Khukurdaha, Palashpai, Nischintapur, Goura, Dudkumrah and Chanipat panchayets (Figure No.-1). In case of Jot Ghanashyam and Guchhati panchayets, the situation is different in the sense that although levels of agricultural development are negative, the increased productivity could be due to other natural inherent and other favourable factors like fertile soil, irrigation facilities etc. Kheput, Sahachack, Guchhati, Benai, Kamalpur, Khanjapur and Ranichak performed consistently low in all the indicators of agricultural implements but better development of agricultural infrastructure like number of agri-markets, road density, agricultural banks and annual market transaction help to maintain agricultural productivity irrespective of flood and water logging conditions. Flood may cause crop failure in one season but the developed agricultural infrastructure revives the overall productivity in the next.

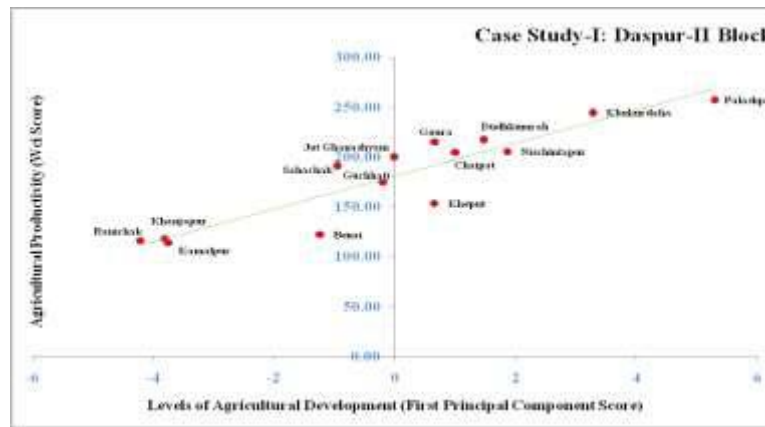


Figure No.-1 Correlation between agricultural development and agricultural productivity

**CASE STUDY-2: Nayagram block**  
**Agricultural Development:**

Here too, panchayat-wise levels of agricultural development are reflected in composite score of PCA-1. Based on eigen value, five principal components i. e. fertilizer consumption per 10 hectares NCA, number of agricultural banks per 10 hectares NCA, number of pumps sets per 10 hectares NCA, number of power tillers per 10 hectares NCA and percentage of irrigated land have been selected which together explain 86.47 percent of the variance. The first principal component of agricultural indices of eleven panchayets is presented in Table No-2. It is obvious from the table that there exist wide inter-panchayat disparities in the levels of agricultural development. The top ranking Panchayat in respect of agricultural development is Nayagram (5.72) and the bottom ranking is Chandabila panchayat (- 3.24). The eleven panchayets of the block may be conveniently arranged into three categories and these are:

**(a) High agricultural development:** Consistent higher values of five principal components together contributed to high levels of agricultural development in Nayagram panchayat, the top ranking panchayat. It consumed 3.23 metric tons of fertilizers per 10 hectares NCA. In addition to this, mechanization level in terms of power tillers, pump sets, threshers and sprayers per 10 hectares of NCA and availability of other agricultural infrastructure are also facilitates better agricultural development.

**(b) Moderate agricultural development:** Jamirpal, Patina and Malam panchayets belong to the medium level of agricultural development. Better performance in terms of mechanization and consumption of fertilizers contributed to medium levels of agricultural development. In case of agricultural implements too, panchayets of this group have consistently performed high to moderate.

**(c) Low agricultural development:** Out of twelve panchayets, eight fall in this category among which Chandabila ranked lowest in levels of agricultural development because of very low performance in the number of agricultural implements and fertilizer consumption. Lower proportional availability of agricultural implements, inadequate opportunities to have fertilizer and pesticide consumption per 10 NCA among farmers together contribute to lower levels of agricultural development of panchayets in this category.

Table No.-2: Calculation table for PCA-Score and Agricultural Productivity			
Sl. No.	Panchayat	Agricultural Development (PCA-1)	Agricultural Productivity Weighted Composite Index(WCI)
1	Patina	1.2544	111.11
2	Barakhakri	-0.141	91.85
3	Chandabila	-3.242	51.71
4	Baranguri	-1.952	57.14
5	Kharikamathani	-0.812	62.71
6	Malam	0.7216	103.79
7	Nayagram	5.7232	127.43
8	Chandrarekha	-0.31	57.35
9	Beligeria	-0.658	93.96
10	Berajal	-1.601	72.08
11	Jamirpal	1.9571	121
12	Arrah	-0.941	64.54

Source: Computed by authors

**Agricultural Productivity:** On the basis of crop yield and cropland occupancy (Jasbir Singh, *et. al.* 1990), a weighted Composite Index Score of fourteen panchayets of Daspur-II block was worked out to arrive at agricultural productivity. The panchayets can be conveniently divided into three categories as follows:

**(a) High Agricultural Productivity:** Nayagram, Patina, Malam and Jamirpal blocks of Nayagram block belong to high agricultural productivity category. Highest levels of agricultural productivity were found in Nayagram (127.43) followed by Jamirpal (121.00), Patina (111.11) and Malam (103.79). Fertile alluvial soil, along with improved levels of agricultural mechanization in terms of power tillers, pump sets, threshers and sprayers leads to high productivity. In addition, consumption of fertilizers and pesticides is also very high in these panchayats. Paddy is the major crop and most of the cultivated land is double or multi cropped. Social factors like the number of agricultural laborers also play a significant role in raising agricultural productivity.

**(b) Moderate Agricultural Productivity:** Only Beligeria and Barakhakri panchayats located in western part of the block, show moderate levels of agricultural development with productivity scores of 93.96, and 91.85 respectively. A moderate use of agricultural inputs like fertilizers, pesticides and implements together contributes medium agricultural productivity. The double cropped area is confined only to the banks of the river Murli. Levels of agricultural mechanization and agricultural infrastructure are also moderate in this zone.

**(c) Low Agricultural Productivity:** Arrah, Berajal, Kharikamathani, Baranguri, Chandabila and Chandrarekha panchayets lying mainly in northern and central parts of the block performed low in terms of agricultural productivity. Maximum areas of these panchayets practice mono-cropping due to adverse physiography, unreliable rainfall, infertile and coarse soils, and inadequate irrigation facilities. Along with these primitive farming practices, the backward attitudes of farmer also generate very low levels of productivity. These panchayets fall under drought-prone region which often witness crop failure and lack of irrigation facilities turn the situation agriculturally more vulnerable. Financial crisis due to lower number of agricultural banks is the main inertia for the agricultural development of these panchayets. Lower levels of agricultural mechanization in terms of power tillers, pump sets, threshers, sprayers and low consumption of fertilizers and pesticides cumulatively hindered the agricultural development of panchayets. In spite of these factors, so many other factors are also responsible for lower development in agriculture and there is lack of facility for seed quality control, lack of awareness regarding seed treatment facilities and lack of adequate storage facility for grains.

**Correlation between agricultural development and agricultural productivity in Nayagram block:** Correlation between agricultural development and agricultural productivity is highly positive in Nayagram block according to Pearson's Product Movement ( $r=0.857$ ) and Spearman's Rank Correlation Co-efficient ( $r=0.88$ ). This indicates that agricultural development is also responsible for higher productivity (Figure No.-2). But there are exceptions like in case of Arrah, Berajal, Kharikamathani, Baranguri, Chandabila and Chandrarekha panchayats, the levels of agricultural development are negatively co-related with productivity. A rugged topography, scarcity of rainwater, extended forest area and infertile soils are the key hurdles for agricultural development. These panchayets fall under drought prone region which often causes crop failure. In spite of these hindrances introduction of agricultural implements and agricultural infrastructure facilities has helped to maintain agricultural productivity.

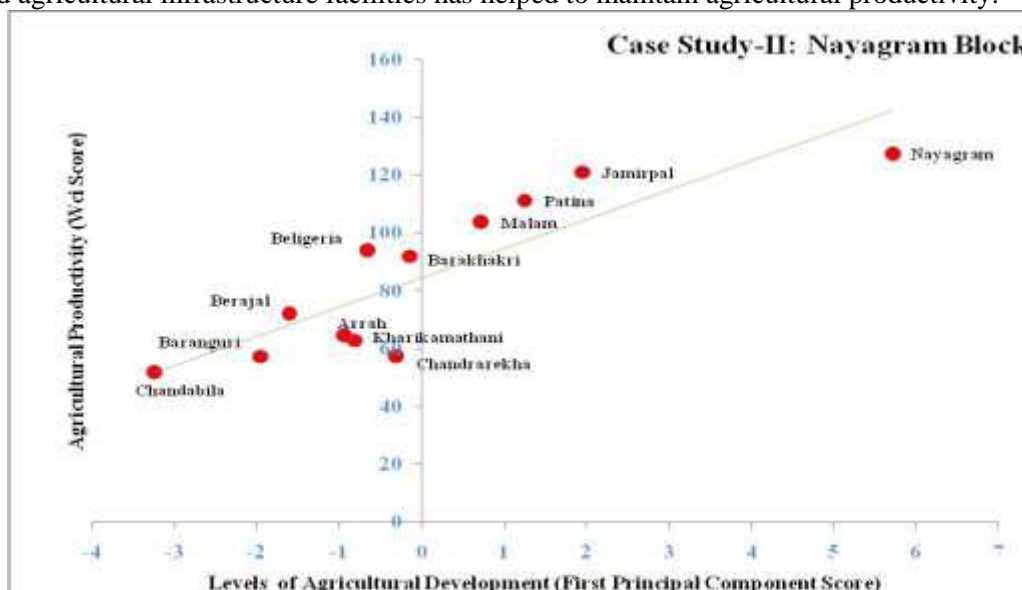


Figure No.-2 Correlation between agricultural development and agricultural productivity

## 7. CONCLUSION:

Panchayat-level analysis of co-relation between agricultural development and agricultural productivity shows a very strong positive relationship in case of both Daspur-II and Nayagram blocks. Among the sixteen indicators percentage of irrigated land, number of agricultural banks per 10 hectares of NCA, the percentage of literates, number of marginal farmers and agricultural labourers play a significant role in agricultural development which contributes also in higher productivity. The inter-panchayat disparity in levels of agricultural development and productivity is much wider in Nayagram block in comparison to Daspur-II. Being a developed block, the performance of Daspur-II in all the development indicators is higher and an inter-panchayat level of disparity is minimum. However, annual floods and water logging conditions continue to remain the main constraints of agricultural development and result in mono-cropping pattern with low productivity in Benai, Kamalpur, Ranichak and Khanjapur panchayets of this block. In Nayagram block, the Nayagram panchayat being block administrative headquarter, performs comparatively better in terms of levels of agricultural development. Conditions of severe drought and lack of irrigation facilities result in frequent crop failures in Nayagram. Along with these, lower levels of agricultural mechanization in terms of power tillers, pump sets, threshers, sprayers and low consumption of fertilizers and pesticides cumulatively hinder the agricultural development of panchayets. To overcome the natural hindrances (flood and drought) it requires area specific crop as well as selected varieties to be introduced. It is only through these practices that agricultural productivity and development can be achieved.

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