A STUDY ON THE PRODUCTIVITY OF POTATO IN HUGLI DISTRICT, WEST BENGAL

Abstract:

In spite of its industrial affluence, Hugli is one of the leading potato producing Districts of West Bengal with momentous productivity. But the production has shown considerable variation in its quantity and area under potato over the last few decades. The present study strives to assess the spatio-temporal dynamics and inter-Block variations of potato productivity in Hugli District from 1990-91 to 2013-14. Time series analysis (3 year moving average curve), Coppock's Instability Index and Sahu's Simple Achieved Variation have been used to analyze the trend, instability and sustainability of the productivity, whereas, Crop Yield and Concentration Indices Ranking Coefficient is employed to identify productivity regions of potato. The result has revealed a unique oscillating nature of output and yield rate of potato over the study period governed by the sequential changes in area under the crop. The Blocks have also revealed wide inter-disparity and shifting nature in productivity during the defined time span.

Comment [A1]: you should mention the results clearly.

Key Words: *Crop Yield and Concentration Indices Ranking Coefficient, Coppock's Instability Index, Sahu's Simple Achieved Variation, Productivity regions*

Introduction:

Comment [A2]: You have explained the background of your study well, especially those related to spatial-temporal variation. However, you have not explained what is related to inter-block variability. Also note writing words with uppercase letters and typos

Agricultural Productivity may be defined as 'the power of agriculture in particular locality to produce crops' regardless of the sources/causes of the power (Kendall, 1939). Simply, it is calculated as the ratio of total agricultural output to total input used and is often been considered as a measure of agricultural efficiency (Kravis, 1976; Aktar, 2015). Various scholars have used multiple quantitative methods and techniques to assess crop productivity in global as well as in national and regional scale. Thomson (1926) has emphasized on gross output, whereas Kendall (1939) has proposed four coefficients such as 'Productivity Coefficient', 'Ranking Coefficient', 'Money Value Coefficient' and 'Starch or Energy Coefficient' for computation of agricultural productivity. Khusro (1965) has explained the agricultural productivity as the output per unit of a single input and output per unit of cost of all inputs used in the production system. In 1965, Shafi has measured the agricultural productivity in terms of the labour efficiency by dividing the gross production in any unit of area by the number of labours employed in the cultivation process. Yang (1965) has

introduced a crop yield index in this context, which has further been exercised by Siddiqui and Usmani (1999) and Aktar (2015) for the areas of Northern Bihar and West Bengal respectively. Shafi has tried to assess the agricultural efficiency in India in 1967 and 1969 by applying Stamp's Standard Nutrition Unit technique, proposed in 1958 (Stamp, 1958); whereas Mohammad and Singh (1981) have proposed to do the same by using net total productivity. Dayal (1984) has computed the agricultural productivity in India in terms of 'land productivity', 'labour productivity' and 'aggregate productivity', whereas Rosegrant and Evenson (1992) have used Tornquist-Theil total factor productivity index for the same purpose (for the period of 1956-87). Dharmasiri (2012) has employed 'Average Productivity Index' (API) to appraise the agricultural productivity in Sri Lanka. On contrary, Singh (1976) has measured the regional disparity in agricultural productivity by delineating productivity regions with his technique called the 'crop yield and concentration indices ranking coefficient (*RCYiCi*)'. In 2018, Saha and Mondal have applied the same technique in their study on the spatio-temporal variations of productivity of *boro* paddy in West Bengal for the period of 1994-95 to 2013-14.

Since its introduction as an important cash crop during the last quarter of the last century, Hugli has attained a notable position in the production of potato (*Solanum tuberosum*) among the districts of West Bengal. More than 1/4th of the geographical area and almost 3/4th of the total farmers of the District have been familiar with potato cultivation since the 1970s (Ghosh, 2017). In 2013-14, the District has possessed the second place (after Paschim Midnapore) by producing 2087514 metric tonnes of potato (comprising 27.93% of the state's total production) and nearly 33.25 % (99.8 thousand hectares) agraricultural land was used for the purpose. Concurrently, it has reported the highest average yield rate of 20811 kg/hectare among the districts of the state (District Statistical Handbook, Hugli, 2013-14). Potato ranked the highest produced crop of the District followed by Aman and Boro in 2013-14 and had achieved 2nd position in terms of area under the crop. Even in major Blocks of the District, potato has acquired the prime position instead of paddy and thus it has played a key role in the agrarian system of the area as well as in the life of the farmars.

Comment [A3]: agricultural

Comment [A4]: farmers

Historically the District has experienced sequential alterations in cropping pattern from paddy and jute to potato during the last half of the 19th century (Ghosh, 2017). Drastic fall in the demand of jute as fiber crop and increasing demand for potato in the regional and national market both as a food and cash crop have encouraged the farmers to switch over to potato cultivation. As a consequence, the District has witnessed a wider spatio-temporal variation in area and production of potato during the past few decades. Along with the

increment of area and output, it has revealed a significant variation in yield rate too over the study period of 24 years (1990-91 to 2013-14). Further, a significant inter-Block disparity in productivity has also been observed during this phase. Hence, the principal objectives of the study are:

- to analyze the spatio-temporal variations of potato in Hugli district for the period of 1990-91 to 2013-14; and
- to calculate the inter-Block variability of instability and sustainability of productivity of potato

The Study Area:

Extending from 20°30′32″ N to 23°01′20″ North latitude and 87°30′20″ E to 88°30′15″ East longitude**,** the Hugli District is located in the western bank of Hooghly River. It is bounded by Purba Bardhaman and Bankura Districts in the North, Haora District in the South, North 24 Parganas and Nadia Districts in the East and Paschim Medinipur District in West (Fig: 1). Occupying 3149 km^2 of geographical area, the District has accommodated nearly 5.52 million population with a population density of 1753/ km^2 (Census, 2011). Administratively it comprises 4 Sub-Divisions and 18 CD Blocks (Fig: 1).

Comment [A5]: What is CD Blocks?

Materials and Methods:

Comment [A6]: You have already stated a number of measures (indices and coefficients) that have been done by other researchers, but you have not explained which one is the best, including what you have used in your study.

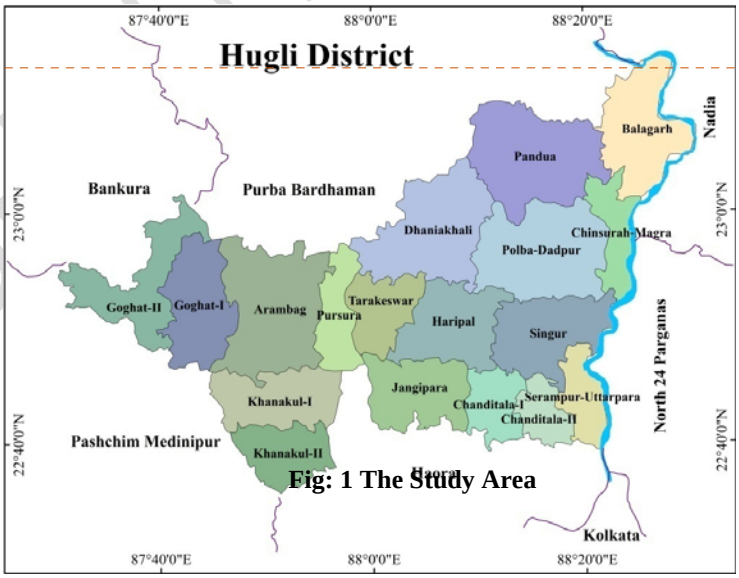

Fig: 1 The Study Area

The study is principally based upon the secondary data that has been obtained from District Statistical Handbooks (1990-91 to 2023-14) and from the Directorate of Agriculture, Government of West Bengal. Block level data has been analyzed by using various simple statistical techniques for the stipulated period (1990-91 to 2013-14). The 3-year moving average curve has been employed to assess the original trend of productivity by smoothing (or straightening) the

fluctuations over the period. Coppock's Instability Index (CII) has been computed for instability analysis of yield by using the formula (Coppock, 1962):

$$\boldsymbol{V\ log} = \frac{\sum(\boldsymbol{log}\frac{\boldsymbol{Xt+1}}{\boldsymbol{Xt}} - \boldsymbol{m})^2}{\boldsymbol{n}}$$

$$\boldsymbol{CII = Antilog}\left(\sqrt{\boldsymbol{V\ log}} - \boldsymbol{1}\right)\boldsymbol{X\ 100}$$

Where, X*t* = Area/ Production/ Yield, t = Year, n = Number of years, M= Mean of the difference between Logs of X_{t+1} and X*t* and Log V = logarithmic variance of the series

For sustainability analysis, Simple Achieved Variation (SAV) measure has been used interchangeably with Sustainability Index (SI) as proposed by Sahu et al. (2005). The formula is:

$$SI = \frac{Y_{max} - \bar{Y}}{\bar{Y}}$$

Where, $\bar{Y}$= Average Area/ Production/ Yield of the crop and Y_{max}= Maximum in this category over the period

In this measure, lower value denotes higher sustainability and vice versa. The index value closer to zero is the most desirable value as it posses greater sustainability.

Crop Yield and Concentration Indices Ranking Coefficient (*RCYiCi*) (Singh, 1976) technique has been applied in order to delineate productivity regions of potato at Block level of Hugli for the years 1993-94, 2003-04 and 2013-14 at an interval of ten years. The method may be described as the average of the ranks of the Blocks, which have been obtained individually through the computation of crop yield index (*Yi*) and crop concentration index (*Ci*).

$$\boldsymbol{RCYiCi} = \frac{\boldsymbol{Yi\ Ranking + Ci\ Ranking}}{\boldsymbol{2}}$$

Where, ***Crop Yield Index*** $(Yi) = \frac{Ya_e}{Ya_r}\ X\ 100$

[Ya_e = Average yield (kg/ha) of potato of a particular Block and

Ya_r = Average yield (kg/ha) of potato]

Crop Concentration Index $(Ci) = \frac{Pa_e}{Pa_r}\ X\ 100$

[Pa_e = Share of Potato area (%) to Gross Cropped Area (GCA) in a particular Block and

Pa_r = Share of Potato area (%) to GCA]

A low value of *RCYiCi* denotes high productivity and vice versa. Three productivity regions i.e. High (<6), Moderate (6-12) and Low (> 12) have been delineated with the computed index value to show the variability as well as the disparity of productivity among the Blocks over the span.

Result and Discussion:

Comment [A7]:
1.You did not mention the CAGR size in the research method but wrote it down on the results of the study? Is this related to the purpose of your study?
2.You only mention indexes of instability, sustainability, production and productivity, but why don't you directly compare them in one table so that the discussion will be more assertive. You only mention the index number but it doesn't explain why it happened.

Growth Trends of Potato Productivity:

In spite of the oscillating nature, total land under potato of the District has been increased from 66082 ha. in 1990-91 to 99830 ha. in 2013-14 (Fig: 2). Hence, almost 51.07% (33748 ha) area has been increased during the overall stipulated period with the Compound Annual Growth Rate (CAGR) of 0.87%. The exponential model [R^2=0.751] indicates a strong positive trend in the area under the crop. Total production of potato has risen from 1572460 metric tonnes in 1990-91 to 2077514 metric tonnes in 2013-14 (Fig: 3), comprising 27.93% of the State's total agricultural production. Therefore, the production has raised almost 32.75% during the study period with 0.83% CAGR. The exponential model [R^2=0.381] signify a moderate but positive trend. The average productivity of potato in Hugli District has revealed a fluctuating nature during the period 1990-91 to 2013-14 with sequential rise and fall owing to the expansion and reduction in area under the crop in every alternate year. It has shown insignificant, almost negligible but positive growth trend in yield of potato. Neither the linear (R^2= 0.035) nor the exponential curve (R^2=0.014) get fitted with the distributional pattern and fails to explain the nature of the data properly. Hence, 3 year moving average curve has been drawn that has revealed the oscillating nature of potato productivity (Fig: 4). Wide variation in productivity has been realised in various years. The District has reported the Compound Annual Growth Rate of 0.23% of productivity during the study period.

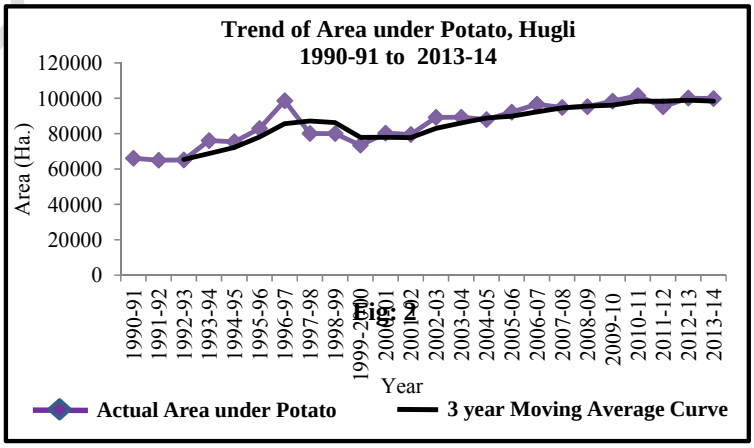

Fig: 2

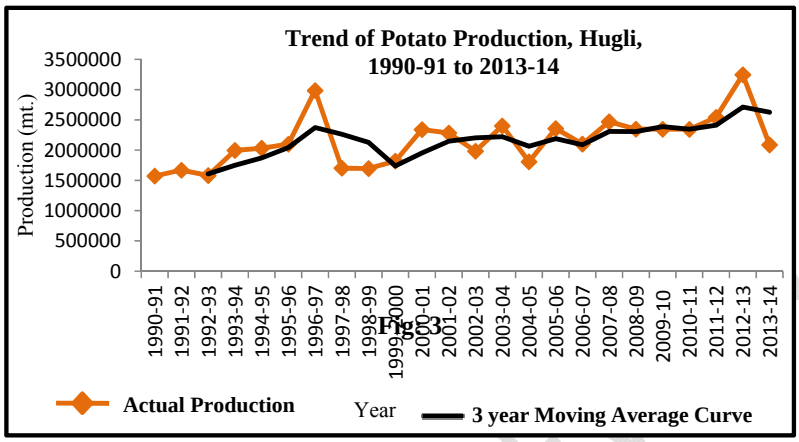

Fig: 3

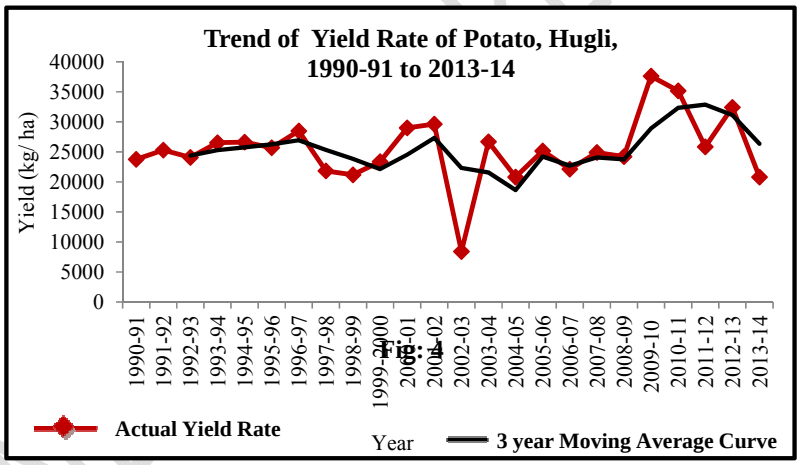

Fig: 4

Instability and Sustainability Analysis:

To examine the extent of variability of area, production and yield of potato, Coppock's Instability Index (CII) has been computed for the entire period. The index value of the area and production for the entire District are 0.26 and 1.97 respectively, whereas the yield rate of the crop shows a significantly high instability of 7% for the period. Serampur-Uttarpara has shown the highest instability (17.68%) in the area under potato, followed by Chanditala-I (17.04%), Goghat-I (14.25%) and Chanditala-II (10.31). On the other, Pursura Block has reported least instability (0.02%) in the area under potato for the entire period. Polba-Dadpur (0.18%), Jangipara (1.71%), Tarakeswar (2.21%), Dhaniakhali (2.34%),

Haripal (2.60%) and Pandua (2.68%) Blocks have also accounted lower instability for the area under potato. Regarding production, Serampur-Uttarpara (17.63%), Goghat-I (17.97%) and Chanditala-I (16.54%) have recorded higher instability than the others, whereas, Goghat-II (0.40%), Pursura (2.25%) and Jangipara Block (2.43%) have comprised lower instability. Other Blocks have shown moderate instability in the production of potato over the study period. Among the Blocks, Balagarh has shown the highest instability of 11.22% for the yield of potato, higher than the District's value. Another five Blocks, namely, Tarakeswar (6.19%), Serampur-Uttarpara (5.49%) Khanakul-I (4.76%), Dhaniakhali (4.64%) and Goghat-I (4.09%) have shown moderate instability. Rest of the Blocks has recorded lower instability in productivity (Table: 1).

Table: 1 Computation of Instability and Sustainability Index, Hugli, 1990-91 to 2013-14

Name of the Block	Area		Production		Yield	
	CII (%)	SI	CII (%)	SI	CII (%)	SI
Arambag	5.75	0.67	12.99	0.74	3.71	0.27
Balagarh	8.7	0.86	11.09	1.16	11.22	0.25
Chinsurah-Magra	9.61	4.94	12.35	5.79	2.85	0.34
Chanditala-I	17.04	0.68	16.54	0.83	2.83	0.39
Chanditala-II	10.31	1.43	12.72	1.58	1.04	0.22
Dhaniakhali	2.34	0.40	7.72	1.20	4.64	0.58
Goghat-I	14.25	0.90	17.97	0.83	4.09	0.35
Goghat-II	5.23	0.60	0.40	0.73	3.35	0.39
Haripal	2.60	0.29	5.48	0.52	2.52	0.45
Jangipara	1.71	1.07	2.43	1.26	1.23	0.38
Khanakul-I	4.44	0.76	7.62	1.24	4.76	0.69
Khanakul-II	6.96	1.09	13.85	1.37	3.78	0.46
Pandua	2.68	0.71	4.66	1.03	1.95	0.38
Polba-Dadpur	0.18	0.49	5.38	0.59	3.59	0.38
Pursura	0.02	0.11	2.25	0.34	2.97	0.31
Serampur-Uttarpara	17.68	2.28	17.63	2.03	5.49	0.64
Singur	8.11	1.02	13.23	1.16	1.34	0.22
Tarakeswar	2.21	0.23	10.63	0.45	6.19	0.35

*CII= Coppock's Instability Index *Source: Computed by the authors*
SI= Sustainability Index

The sustainability index of the entire District for area, production and yield of potato is found as 0.18, 0.50 and 0.68 respectively. Therefore, the District shows higher sustainability in area under potato and lesser sustainability in production and crop yield. Chinsurah-Magra has reported the lowest sustainability in area (4.94) and production (5.79) of potato due to the higher degree of urbanization (Siddique and Mukherjee, 2017). Some other highly urbanized Blocks like Serampur-Uttarpara (2.28), Chanditala-II (1.43), Khanakul-I (1.09), Jangipara (1.07) and Singur (1.02) also have shown lesser sustainability in area under the crop. On contrary, Pursura (0.11) has shown the highest sustainability in the area followed by Tarakeswar (0.23) and Haripal (0. 29) during the time span. Another eight Blocks of the District, namely, Serampur-Uttarpara (2.03), Chanditala-II (1.58), Khanakul-II (1.37), Jangipara (1.26), Khanakul-I (1.24), Dhaniakhali (1.20), Balagarh (1.16) and Singur (1.16) have reported lower sustainability in production of potato, whereas, Pursura (0.34) has shown the highest sustainability in production followed by Tarakeswar (0.45) and Haripal (0. 52). It has been observed that the Blocks have shown lesser variability regarding the sustainability in yield rate. Khanakul-I (0.69) has reported the lowest sustainability (less than the district's figure), whereas Singur (0.22) has recorded the highest sustainability in crop yield. Another two Blocks, namely, Serampur-Uttarpara (0.64) and Dhaniakhali (0.58) have also recorded comparatively lower sustainability regarding yield of potato (Table: 1).

Productivity Regions of Potato:

In order to assess the Block level variations of productivity of potato in spatio-temporal context, high, moderate and low productivity regions have been recognized for the years of 1993-94, 2003-04 and 2013-14 respectively. It is found that many Blocks have shown rapid and significant changes in productivity during the specific time frame.

In 1993-94, Jangipara shows the highest Yield (*Yi*) of potato, whereas, Haripal had recorded the lowest *Yi*

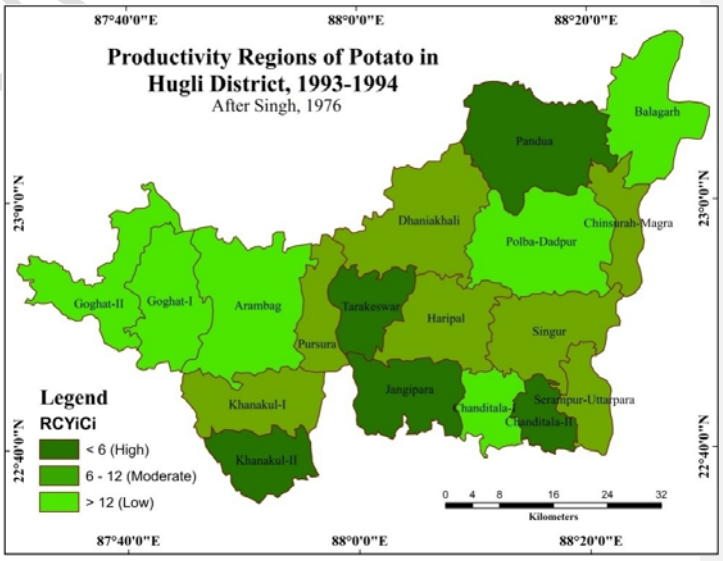

Fig: 5

value. Another five Blocks, like Chanditala-II, Khanakul-II, Pandua, Tarakeswar and Chinsurah-Magra have shown high Crop Yield index. On the contrary, five other Blocks had shown low crop yield index. In case of Crop Concentration Index (*Ci*), again Jangipara holds the highest position, followed by five other Blocks like Haripal, Tarakeswar, Dhaniakhali, Singur and Chanditala-II. On contrary, Balagarh has reported least *Ci* Index in that year. Another five Blocks namely, Chanditala-I, Chinsurah-Magra. Goghat-I, Pursura and Serampur-Uttarpara have also shown lower crop concentration index. As a whole, Jangipara Block has recorded the highest productivity in that year. Besides, Pandua, Tarakeswar, Khanakul-II and Chanditala-II have comprised high productivity region of potato in the specified year. Another seven Blocks (38.89%) like Chinsurah-Magra, Serampur-Uttarpara, Singur, Haripal, Dhaniakhali, Pursura and Khanakul-I have occupied the moderate productivity region. Rest six Blocks have recorded lower productivity of potato during the period (Fig: 5; Table:3 in annexure). Goghat-I and II have shown lower productivity owing to the less favourble agro-ecological suitability for potato production. In spite of the lowest yield rate, Haripal has placed itself in moderate productivity regions due to the higher percentage of area under potato to total gross cropped area.

The productivity regions have been rearranged in 2003-04. Tarakeswar Block has shown the highest crop yield index of 121.51%, followed by Arambag (113.59%) and Pursura (113.41%). On contrary, Goghat-II has shown the lowest yield (Yi value = 71.93%). Balagarh (85.81%), Haripal (86.57%), Chanditala-II (87.07%), Jangipara (93.71%) and Serampur-Uttarpara (94.41%) have also shown a lower yield of potato. Rest of the Blocks have comprised moderate yield of potato. Pursura Block has shown the highest percentage of area under potato to the gross cropped area (GCA) and has ranked first with the highest crop

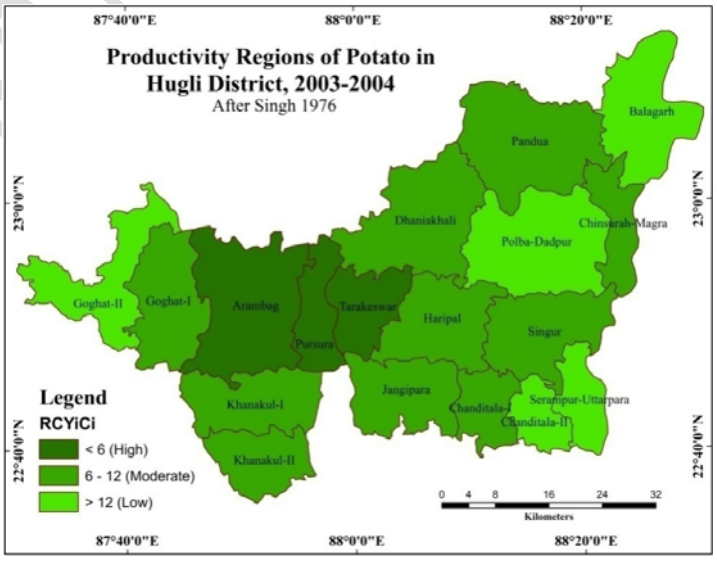

Fig: 6

concentration index value of 173.23% by replacing Jangipara Block. Tarakeswar (154.94%), Haripal (138.34%), Singur (133.14%), Jangipara (118.08%) and Arambag (109.28%) have also recorded higher value in Crop Concentration (*Ci*). On the other, Serampur-Uttarpara has shown the lowest concentration of area under potato to GCA (*Ci* value 3.71, Rank: 18). Balagarh (40.07%), Chanditala-I (49.72%), Chinsurah-Magra (72.19%), Chanditala-II (72.64%) and Pandua (73.79%) also have shown a lower concentration of percentage of area under potato. Finally, three Blocks, namely, Tarakeswar, Arambag and Pursura have comprised the highly productive region, whereas Balagarh, Chanditala-II, Goghat-II, Polba-Dadpur and Serampur-Uttarpara have occupied low productive region. Rest of the Blocks (10 Blocks) have comprised moderate productivity region of potato (Fig: 6; Table: 3 in annexure).

Jangipara again has ranked first in yield of potato with the highest value of 144.50% in 2013-14. Chanditala-I (139.74%), Chinsurah-Magra (138.42%), Pandua (137.83%) and Chanditala-II (131.68%) Blocks also have reported a considerable higher yield of potato compared to other Blocks. On the other hand, Khanakul-II has occupied the last position with the *Yi* value of 37.61%, followed by Arambag (59.96%), Goghat-II (60.65%). It should be noted that Pursura Block has acquired the first position with highest *Ci* value of 258.79%, but has held the 15th rank in crop yield index (*Yi* =78.15%). Blocks like Chinsurah-Magra (212.96%), Khanakul-I (193.18%), Pandua (185.25%), Chanditala-II (152.60%) and Chanditala-I (149.46%) have accounted for the higher share of area under potato (%) in gross cropped area. The Block Serampur-Uttarpara (*Ci*= 32.60) has shown the least share in area under potato. Some other Blocks like Goghat-II (32.83%), Balagarh (43.02%), Singur (54.33%) and

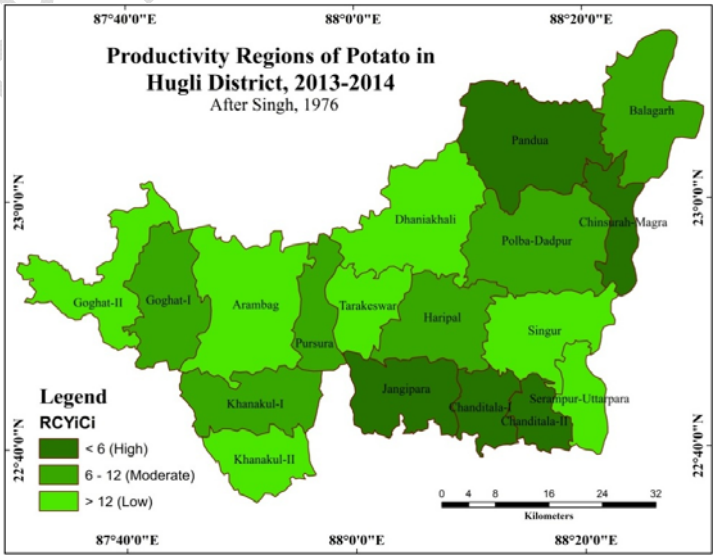

Fig: 7

Tarakeswar (56.44%) have also comprised lower concentration in terms of area under potato. In totality, five Blocks, namely, Pandua, Chinsurah-Magra, Jangipara, Chanditala-I and II have comprised high productivity region (*RCYiCi* = <6) of potato in 2013-14. On the other, the low productivity region (*RCYiCi* = >12) contains seven Blocks of the District namely Arambag, Goghat-II, Tarakeswar, Dhaniakhali, Singur, Serampur-Uttarpara and Khanakul-II. The Moderate productivity region (*RCYiCi* = 6-12) consists of the rest six Blocks of the District (Fig: 7; Table: 3 in annexure).

The following table (Table: 2) represents the detail zonation of Blocks according to the calculated productivity values that have depicted the temporal variability of the performance of the Blocks in potato cultivation.

Table: 2 Productivity Regions of Potato in Hugli, 1993-94, 2003-04 and 2013-14

Year	Productivity Regions	Number of Blocks	Name of the Blocks
1993-94	High (< 6)	5	Jangipara, Pandua, Tarakeswar, Chanditala-II, Khanakul-II
	Moderate (6 - 12)	7	Dhaniakhali, Pursura, Haripal, Singur, Serampur-Uttarpara, Khanakul-I, Chinsurah-Magra
	Low (> 12)	6	Goghat-I and II, Arambag, Polba-Dadpur, Balagarh, Chanditala-I
2003-04	High (< 6)	3	Tarakeswar, Arambag, Pursura
	Moderate (6 - 12)	10	Pandua, Dhaniakhali, Chinsurah-Magra, Singur, Haripal, Chanditala-I, Jangipara, Goghat-I, Khanakul-I and II
	Low (> 12)	5	Goghat-II, Polba-Dadpur, Balagarh, Chanditala-II, Serampur-Uttarpara
2013-14	High (< 6)	5	Pandua, Chinsurah-Magra, Jangipara, Chanditala-I and II
	Moderate (6 - 12)	6	Goghat-I, Khanakul-I, Pursura, Haripal, Polba-Dadpur, Balagarh
	Low (> 12)	7	Arambag, Goghat-II, Tarakeswar, Dhaniakhali, Singur, Serampur-Uttarpara, Khanakul-II.

Conclusion:

The overall discussion clearly reveals the spatio-temporal dynamism of the productivity of potato in District level as well as in Block level from the period of 24 years (1990-91 to 2013-14). But is it difficult to identify any spatial pattern of productivity of

Comment [A8]: You have not answered the overall research objectives. In fact, you make conclusions that are not your research objective, namely some other factors like urbanization, cost of production, infrastructure facilities, post-harvest market price, farmers' preferences and profitability of the crop and government policies that are influenced by the crop productivity of potato in the area. You did not discuss this in the results of the study.

potato within this time span. It has been observed that the production and yield of potato has a direct relationship with the quantity of area engaged in potato cultivation, which has been governed by the market forces related to the post-harvest sale price of potato. Besides, some other factors like urbanization, cost of production, infrastructural facilities, post-harvest market price, farmers' preferences and profitability of the crop and governmental policies also have influenced the crop productivity of potato in the area.

References:

Comment [A9]: Quite relevant even though there are some references that are not up to date. Maybe there is no recent literature on the aspect in question

1. Aktar, N. (2015). Agricultural Productivity and Productivity Regions in West Bengal, *The NEHU Journal. XIII (2)*: 49-61.
2. Coppock, J. D. (1962). *International Economic Instability*. McGraw-Hill, New York, pp 523-525.
3. Dayal, E. (1984). Agricultural Productivity in India: A Spatial Analysis. *Annals of the Association of American Geographers*. 74 (1): 98-123.
4. Dharmasiri, L. M. (2012). Measuring Agricultural Productivity using the Average Productivity Index (API), *Sri Lanka Journal of Advanced Social Studies.* 1(2): 25-44.
5. Ghosh, N. P. (2017). *Problems and Prospects of Potato Cultivation in Hugli District, West Bengal*, Unpublished Doctoral Thesis, The University of Burdwan.
6. Kendall, M. G. (1939). The Geographical Distribution of Crop Productivity in England. *Journal of the Royal Statistical Society. Wiley for the Royal Statistical Society* 102(1): 21-62.
7. Khusro, A. M. (1965). Measurement of productivity at Macro and Micro levels, Journal of the Indian Society of Agricultural Statistics, 27 (2): 278-288.
8. Kravis, I.B. (1976). A Survey of International Comparison of Productivity. *The Economic Journal.* 86(341): 1-44.
9. Mohammad, N. and Singh, R. (1981). Measurement of Crop Productivity, In Noor Mohammad (ed.), *Perspective in Agricultural Geography*, Concept Publishing Company, New Delhi.
10. Rosegrant, M. W. and Evenson, R. E. (1992). Agricultural Productivity and Sources of Growth in South Asia. *American Journal of Agricultural Economics.* 74(3): 757-761.
11. Saha, M. and Mondal, T. K. (2018). Productivity of Boro Paddy in West Bengal: A Spatio-Temporal Analysis. *Indian Journal of Landscape Systems and Ecological Studies.* 41 (1): 70-82.

12. Sahu, P. K., Kundu, A. L., Mani P. K., and Pramanick, M. (2005) Sustainability of Different Nutrient Combinations in a Long-Term Rice-Wheat Cropping System, *Journal of New Seeds* 7(3): 91-101. DOI: 10.1300/J153v07n03_06
13. Shafi, M. (1965). Approaches to the Measurements of Agricultural Efficiency, Proceedings of the Summer School in Geography (Memeo), Nainital.
14. Shafi, M. (1967). Food Production Efficiency and Nutrition in India. The Geographer, 4: 23- 27.
15. Shafi, M. (1969). Can India Support Five Times her Production? Science Today. 3: 21-27.
16. Siddique, G. and Mukherjee, *N. (2017).* Transformation of Agricultural Land for Urbanisation, Infrastructural Development and Question of Future Food Security: Cases from Parts of Hugli District, West Bengal. *Space and Culture 5(2)*: 47-68. DOI: https://doi.org/10.20896/saci.v5i2.269
17. Siddiqui, S. H. and Usmani, T. M. (1999). Pattern of Agricultural Productivity in Bihar, The Geographer, 46(1):107-117.
18. Singh, J. (1976). *An Agricultural Geography of Haryana*, Kurukshetra, India: Vishal Publications, pp 318-319.
19. Stamp, L. D. (1958). The Measurement of Land Resource, The Geographical Review, 48 (1): 1-15.
20. Thompson, R. J. (1926). The productivity of British and Danish Farming, Journal of the Royal Statistical Society, 89, (2):217-255.
21. Yang, W. Y. (1965). Methods of Farm Management Investment for Improving Farm Productivity', F.A.O., Agricultural Development, Paper No. 80, Rome.

Table:3 Computation of *Crop Yield and Concentration Indices Ranking Coefficient, Hugli, 1993-94, 2003-04 and 2013-14*

Sl No.	Name of the Blocks	1993-94					2003-04					2013-14				
		Yi	**R**	***Ci***	**R**	***RCYiCi***	***Yi***	**R**	***Ci***	**R**	***RCYiCi***	***Yi***	**R**	***Ci***	**R**	***RCYiCi***
1	Arambag	86.02	15	79.54	10	**12.5**	113.59	2	109.28	6	**4**	59.96	17	96.00	10	**13.5**
2	Balagarh	99.75	8	8.28	18	**13**	85.81	17	40.07	17	**17**	104.08	8	43.02	16	**12**
3	Chanditala-I	80.51	17	36.37	15	**16**	102.96	8	49.72	16	**12**	139.74	2	149.46	6	**4**
4	Chanditala-II	106.55	6	110.89	6	**6**	87.07	15	72.64	14	**14.5**	131.68	5	152.60	5	**5**
5	Chinsurah-Magra	111.25	4	15.95	16	**10**	108.70	5	72.19	15	**10**	138.42	3	212.96	2	**2.5**
6	Dhaniakhali	92.94	11	155.07	4	**7.5**	101.60	10	95.23	11	**10.5**	81.88	12	72.09	13	**12.5**
7	Goghat-I	84.83	16	45.70	14	**15**	97.77	12	104.28	9	**10.5**	89.49	11	77.60	11	**11**
8	Goghat-II	92.02	14	73.70	11	**12.5**	71.93	18	98.28	10	**14**	60.65	16	32.83	17	**16.5**
9	Haripal	78.12	18	176.09	2	**10**	86.57	16	138.34	3	**9.5**	102.53	9	125.59	7	**8**

10	Jangipara	140.82	1	192.62	1	**1**	93.71	14	118.08	5	**9.5**	144.50	1	98.32	9	**5**
11	Khanakul-I	93.50	10	94.76	8	**9**	105.68	6	107.35	8	**7**	81.81	13	193.18	3	**8**
12	Khanakul-II	108.47	5	108.16	7	**6**	104.01	7	109.14	7	**7**	37.61	18	72.59	12	**15**
13	Pandua	120.53	2	80.03	9	**5.5**	98.16	11	73.79	13	**12**	137.83	4	185.25	4	**4**
14	Polba-Dadpur	92.03	13	73.40	12	**12.5**	86.57	16	74.36	12	**14**	126.15	6	125.09	8	**7**
15	Pursura	97.59	9	46.00	13	**11**	113.41	3	174.23	1	**2**	78.51	15	258.79	1	**8**
16	Serampur-Uttarpara	102.34	7	14.12	17	**12**	94.41	13	3.71	18	**15.5**	110.25	7	32.60	18	**12.5**
17	Singur	92.74	12	126.46	5	**8.5**	102.33	9	133.14	4	**6.5**	95.16	10	54.33	15	**12.5**
18	Tarakeswar	120.00	3	168.22	3	**3**	121.51	1	154.95	2	**1.5**	79.73	14	56.44	14	**14**

Yi = Crop Yield Index, Ci =Crop Concentration Index, $RCYiCi$ = Crop Yield and Concentration Indices Ranking Coefficient and R= Rank