Assessment of Agriculture Productivity Performance in the Tarai Region of Nepal

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Abstract

Improvement in agriculture is crucial for the food security of growing population. Land efficiency is enlightened by crop production in terms of yield per unit of land. Spatial assessment of agricultural productivity highlighted to explore the relation of the land structure and complexity on production through efficiency measurement of farmers. The present paper attempts to assess the spatial performance of agriculture productivity by the districts in the Tarai region of Nepal. The secondary data sources have been collected from Ministry of Agriculture and Livestock Development, Kathmandu for the period of 1967/68 to 2020/21. Composite Agriculture Productivity Index (CAPI) method has been adopted to identify the spatial performance. Yield of principal food crops (paddy, maize, wheat, millet and barley) and cultivated area has been used in the districts of Tarai region of Nepal to assess the spatial performance of agriculture productivity. The districts have been classified as High Productivity, Moderate Productivity and Low Productivity districts based on the productivity index of major crops. It is concluded that the scenario of agriculture productivity in Tarai during the study period is not encouraging. It is noticed that nearly 75 percent districts have been observed with low and moderate productivity. Among them, Nawalparasi, Sunsari, Jhapa, Rupandehi and Sarlahi districts have been found under high productivity districts. There has been no significant change in productivity during the study period.

Keywords: *composite index, immigrants, irrigation, performance, spatial analysis*

Introduction

The agricultural development of a country or region is depending on the production of crops. Agriculture is the backbone of Nepalese economy; it provides food security for the population and also provides the goods and raw materials required to the non-agricultural sectors. Agriculture has been contributing to employment to more than 61.4 percent households (World Bank, 2022) and 23.9 percent share to National Gross Domestic Product (GDP) (MoF, 2022) in Nepal. Nepal has three agroecological regions having diverse geological, climatic and hydrological characteristics that are responsible for country's distinct and varied agricultural land uses (CBS, 2011). The mountain region has covered by mainly rugged and barren land whereas the hilly region contains some agricultural and pastures land. Farther, the tarai, in the foothills of Mahabharata extend the altitude below 300 meters having a flat and fertile zone supplies most of the food grains to the country. Tarai region known as the food granary and comprises 23 percent of the total land area of the nation. Over 40 percent of the available agricultural land in the tarai is cultivated which can be irrigated throughout the year (DoIB, 2024). This region has huge potential for crop productivity having increased access of irrigation facilities, use of machineries and other inputs. The agricultural land in tarai region produces a variety of crops including paddy, wheat, maize, sugarcane, jute and vegetables (MoI, 2017). Nepal has faced many challenges in the agriculture production over the past decades that is differs from region to region. Internal migration to the Tarai region has increased rapidly after the establishment of democracy in Nepal in 1951 (KC, 2003), the eradication of malaria in 1958 (WHO, 2010), state-sponsored resettlement and rural land-consolidation programs in 1964 and 1984 (Shrestha, 1990) and restoration of democracy in 1990 (CBS, 2014).

The concept of agricultural productivity has been extensively used to explain the spatial organization and pattern of agriculture (Upadhaya & Alok, 2016). Spatial analysis of agriculture productivity is very important that highlights the structure and pattern of production (Dharmasiri, 2009). Development of irrigation is an important input for increasing food production. Only about 71 percent of the cultivated area has some form of irrigation infrastructure but only 40 percent of the cultivated area has year-round and dependable irrigation with surface water and groundwater as a source of water (DWRI, 2019). Inadequate resources for the development of irrigation facilities, poor operation and maintenance of infrastructures, lack of appropriate irrigation technology, poor supply of electricity for the operation of pumps in the ground water irrigation and poor strengthening of institutional capacity are responsible for the disparity in the agricultural development in Tarai (FAO, 2018). Urbanization, LULC change, poor urban planning and inattentive policies controlling the conversion and fragmentation of peri-urban cultivated lands in the tarai region are also significant in a context of agricultural development (Rimal et al, 2016). Further, the provision of agricultural infrastructures development, such as market centers, road networks, cold storage etc. is considered important factors for improving the agriculture sector. The main objective of this study has to assess the agricultural performance through spatial productivity in the districts of the Tarai region of Nepal. However, the specific objectives have to measure the agricultural productivity in terms of different crops and also find out the productivity zones at different levels (e.g., high, moderate and low).

Four main paths have been identified for the economic development of agriculture; changing the prices of inputs and outputs determines the level of individual decision-making and affects farmers choice of what to produce and how to produce it; gaining or losing the income limitation affects investment decision and input use, increasing or decreasing of risk exposure may reduce the incentives to produce efficiently or adopt productivity-enhancing innovations to adopt the risk like climate change, in addition, structural change in farm and market also determine the level of agricultural development (DeBoe, 2020). Productivity is generally considered from two directions; (a) productivity of land and (b) development of infrastructure engaged in agriculture. Productivity of land is closely linked with the development of infrastructure. So, attempts have been made to examine the spatial differences through the present study.

Methods and Materials

This study has an attempt to assess the agriculture productivity performance in Tarai region of Nepal covering 20 districts during the past five decades. The study has entirely based on secondary data. For this analysis, the district level data on yield and cultivated area of selected principal food crops (paddy, maize, wheat, millet and barley) cultivated in the districts of Tarai region of Nepal have been selected to assess the spatial performance of agriculture productivity. The data has been collected from Ministry of Agriculture and Livestock development and Central Bureau Statistics (CBS), Kathmandu for the period of 1967/68 to 2020/21.

There is a long tradition of measuring agricultural productivity for developed and developing countries. Scholars have attempted many statistical tools to analyze agricultural performance. Composite Agricultural Productivity Index (Bhatia, 1967), Single Factor Productivity (Hayami and Ruttan, 1971), Average Productivity Index (Dharmasiri, 2006), Total Factor Productivity (Fuglie, 2015), Measuring Aggregate Productivity (Lips, 2017). However, the present study has attempted to apply the Composite Agriculture Productivity Index (CAPI) statistical technique suggested by Bhatia (1967) for measuring spatial agricultural productivity. According to Bhatia (1967), per hectare yield expresses all the physical and human factors connected with the production of crops and the distribution of area under cultivation among various crops. Thus, a weighted average of yield productivity of all crops would give a measure of composite agricultural productivity. This study has followed the following equation to estimate Composite Agriculture Productivity Index (CAPI);

$$I_{ya}=\frac{Y\mathrm{d}}{Y_s}\mathrm{x}100$$

Where I_{ya} is the yield index of crop 'a',

Y_d is the yield of crop ‘a’ per hectare in a particular district;

Y_s is the yield of crop ‘a’ per hectare in the entire state.

Then, the Composite Agricultural Productivity Index (CAPI) is estimated as follows;

$$CAPI = \frac{Iya\ x\ Ca+Iyb\ x\ Cb+\ldots+Iyn\ x\ Cn}{Ca+Cb+\ldots+Cn}$$

Where, $I_{ya}+\ldots I_{yn}$ are the yield indicators of various crops and

$C_a+C_b+\ldots+C_n$ are the percentage share of crop and under different crops.

Using the above formula the productivity index was calculated for twenty districts in Tarai region of Nepal.

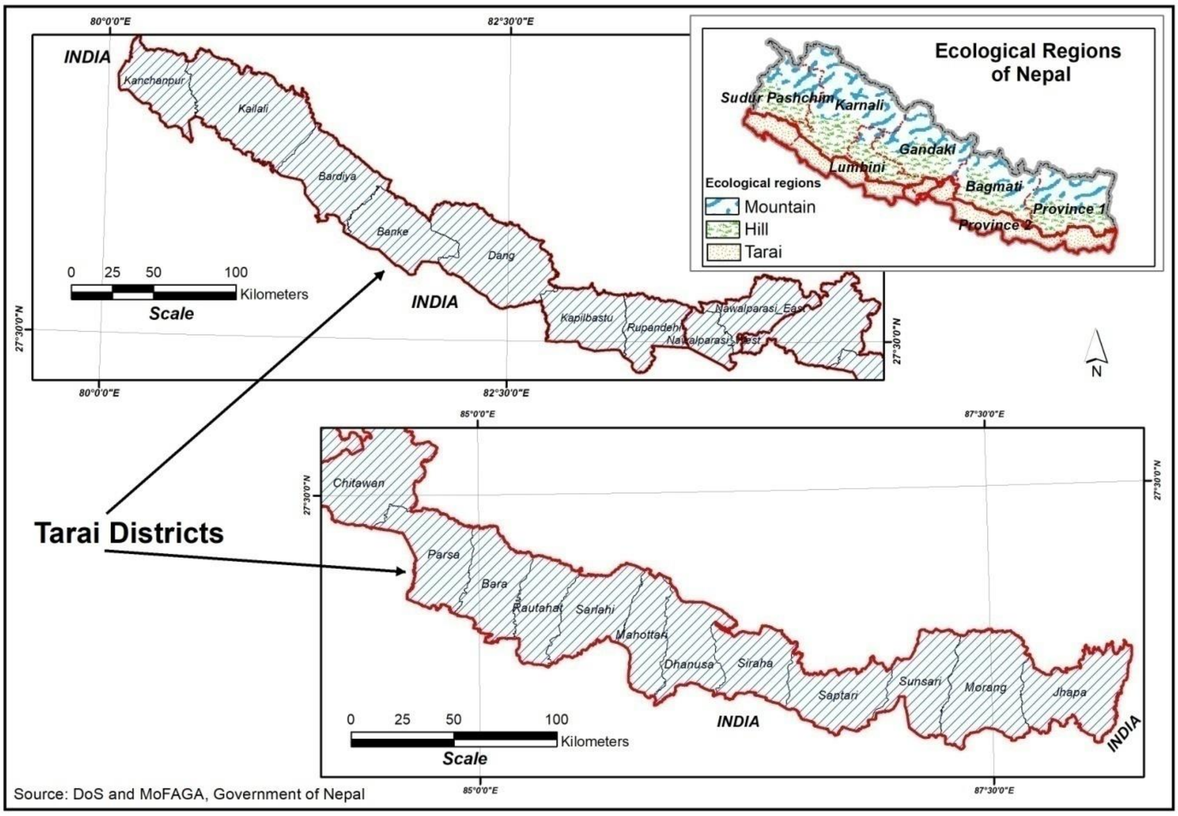
To assess and classify the district the statistical method quartiles was applied to the productivity indices. Quartiles are three points that divide a range of data set into four equal parts. The first quartile is the number below which lies the 25 percent of the bottom data. The second quartile divides the range in the middle and has 50 percent of the data below it. The third quartile has 75 percent of the data below it and the top 25 percent of the data above it. The algorithm for classification procedure is as follows: The index value which lies below in the first quartile has named as Low Productivity Districts (LPD), the districts which have the index value lies between first and third quartiles is marked as Moderate Productivity Districts (MPD) and the districts index values which lies above the third quartile is named as High Productivity Regions (HPD).

Study Area

Nepal is geographically divided into three regions: the Himalaya to the north, the middle hills consisting of the Mahabharat range and the Churia Hills, and the Tarai to the south. The land in the Tarai region is extremely fertile and is the main agricultural region of the country. It is also called the bread basket of Nepal as the plain land is ideal for cultivating crops. The region comprises 20 districts with 23 percent total area of the nation (Figure 1). This study area has the sub-tropical climate with summer temperatures ranging from 32^{0C} to 35^{0C} and winter temperatures ranging from 8^{0C} to 15^{0C}, with an average annual rainfall of 270 mm. Tarai has experienced remarkable population growth in recent decades, more than doubling over 1981-2021 from 6.5 million inhabitants (44% of the national population) to 15.6 million (53.6%) (NSO, 2021).

Figure 1

Location of Study Region



Result and Discussion

In this paper an attempt has been made to assess the agriculture productivity performance of various districts in Tarai region of Nepal over the decade. Composite Agriculture Productivity Index (CAPI) has been calculated and these values have used to classify the districts as High Productivity Districts (HPD), Moderate Productivity Districts (MPD) and Low Productivity Districts (LPD) (Table 1).

Table 1

Composite Agricultural Productivity Indices (CAPI)

Districts	I_{ya}	*Iyb*	*Iyc*	*Iyd*	*Iyn*	C_a	C_b	C_c	C_d	C_n	*CAPI*	Rank
Jhapa	124.89	126.25	107.64	111.02	118.94	86.61	11.50	23.25	2.03	0.02	209.45	HPD
Morang	118.84	113.41	115.18	113.84	76.01	79.04	15.76	12.07	1.24	0.03	185.48	MPD
Sunsari	115.19	123.83	110.53	112.07	102.49	72.67	21.42	8.29	1.23	0.02	219.58	HPD
Saptari	99.02	110.06	103.58	109.19	65.03	79.43	21.62	3.32	0.37	0.02	166.84	MPD
Siraha	93.40	104.26	103.22	101.65	65.03	74.90	18.93	2.80	1.18	0.02	161.15	LPD
Dhanusha	87.59	89.03	97.44	101.62	83.04	78.19	30.96	4.29	1.40	0.30	158.87	LPD
Mahottari	82.36	81.71	92.41	99.82	94.15	74.62	26.52	6.39	1.70	0.29	164.36	MPD
Sarlahi	85.14	86.73	102.14	94.40	102.33	53.35	21.46	9.85	1.04	0.20	189.78	HPD
Rautahat	83.76	91.47	96.56	102.38	102.50	81.79	23.79	6.78	0.51	1.00	173.71	MPD
Bara	113.46	108.07	114.68	110.03	100.85	96.32	40.70	8.60	0.65	0.69	181.61	MPD
Parsa	112.77	106.49	117.21	98.72	106.92	88.85	35.55	6.39	0.46	0.62	186.50	MPD
Chitwan	106.02	103.63	106.13	104.52	110.88	69.28	20.59	54.08	3.29	0.57	146.50	LPD
Nawalparasi	131.49	113.53	109.80	102.62	118.60	53.09	21.11	11.90	1.15	0.09	249.77	HPD
Rupandehi	99.07	98.54	103.96	99.81	118.61	95.55	33.44	2.93	0.47	0.38	186.80	HPD
Kapilbastu	80.16	92.69	96.62	93.40	112.82	95.57	30.66	3.42	0.47	0.33	162.69	MPD
Dang	99.17	87.96	90.43	102.42	103.72	56.09	20.38	33.17	0.42	0.31	164.70	MPD
Banke	84.05	91.50	78.91	52.05	103.67	72.24	27.42	18.54	1.29	0.10	118.85	LPD
Bardiya	102.41	98.83	95.04	87.85	105.56	73.81	26.58	19.12	0.76	0.08	163.37	MPD
Kailali	91.27	85.90	76.69	100.88	104.62	78.01	26.66	16.67	1.04	0.24	164.65	MPD
Kanchanpur	89.94	86.12	81.83	101.70	104.22	81.99	36.35	15.84	0.64	0.23	157.66	LPD

Note. Compiled by author. **Nawalparasi East and West both districts are included as Nawalparasi due to lacking of disintegrated data.* ** $I_{ya}+...I_{yn}$ are the yield indicators of various crops and $C_a+C_b+...+C_n$ are the percentage share of crop and under different crops

According to the CAPI index Nawalparasi, Sunsari, Jhapa, Rupandehi and Sarlahi districts are found under high productivity districts whereas Banke district ranks in lowest productivity district along with other four districts (Chitwan, Kanchanpur, Dhanusha and Siraha), similarly other rest districts are found under moderate productivity districts. Development of agriculture depends on various factors like infrastructure development (irrigation, road, market, cold storage and agricultural service centers), land holding size, land use change, availability of inputs (land, labor, fertilizers and pesticides) and government policies are the responsible factors for the divergence of agricultural development in the same geographic region. The classification of districts based on indices is shown in Table 2 and Figure 2.

Table 2

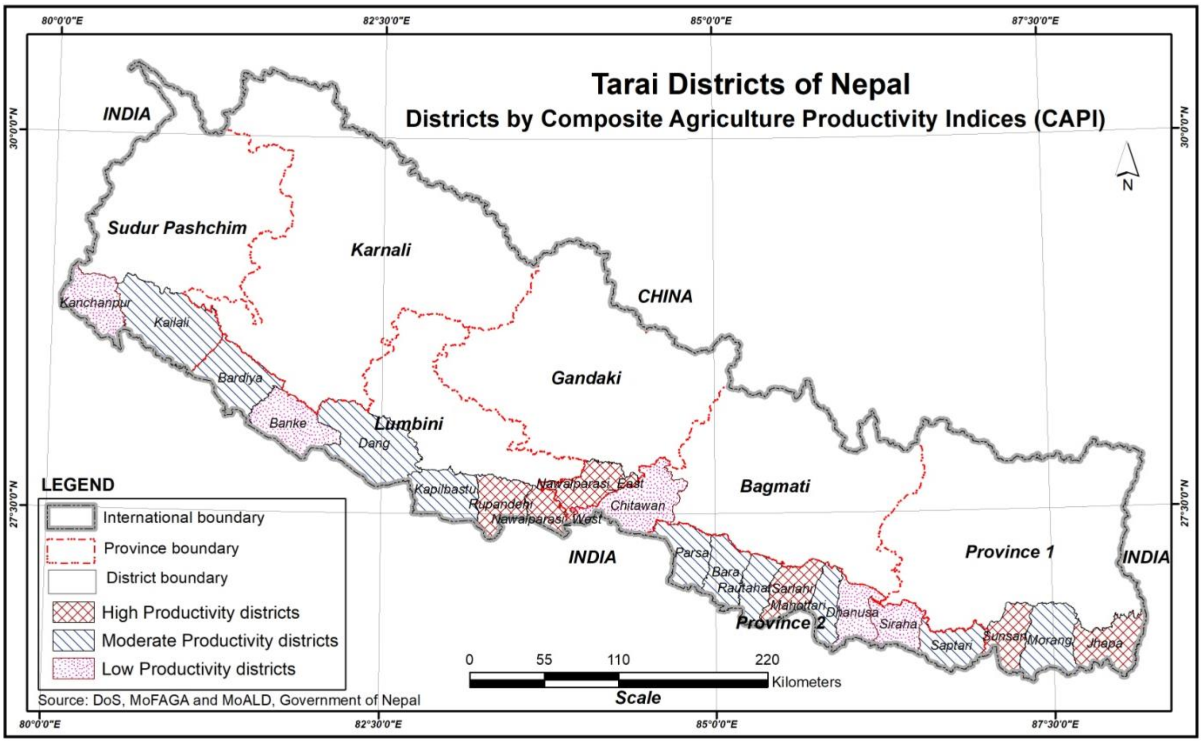
Classification of Districts

Degree of agricultural efficiency	Range of agricultural efficiency value	Name of districts	Remarks
High	186.58 to 249.77	Nawalparasi, Sunsari, Jhapa, Sarlahi, Rupandehi	5
Medium	165.77 to 186.58	Parsa, Morang, Bara, Dang, Kailali, Saptari, Mahottari, Rautahat, Bardia, Kapilbastu	10
Low	162.31 to 165.77	Banke, Kanchanpur, Chitwan, Dhanusha, Siraha	5

Note. Compiled by author

Figure 2

Districts by Composite Agricultural Productivity Indices (CAPI)



The impact of population growth and population rearrangement has probably established the greatest consideration in agricultural expansion of any region (Malthus, 1989; Boserup, 1981 and 1985). This approach argues that rising population effect rural people to migrate to barren areas where they clear the land for establishing agricultural livelihoods. However, she also established that population growth may not necessarily lead to land degradation, but also it can encourage more rigorous agricultural practices and more constructive technological and organizational innovation that will not only increase productivity but develop environmental superiority as well. The internal migration emerged in the mid-50s with the accomplishment of the state sponsor relocation programme of hill people to Tarai for land colonization and increased agricultural production (Suwal, 2014). Introduction of market-oriented vegetable-based production, socio-economic conditions and access to road and markets with the development of infrastructure in Tarai (Dahal et al., 2009) are also the indicators of development in agricultural sector.

Conclusion

This study has attempts to formulate Composite Agriculture Productivity Index' or CAPI model for measuring agricultural productivity. The agricultural productivity performance of various districts in Tarai region of Nepal has been studied during 1967/68 to 2020/21 using Composite Agriculture Productivity Index (CAPI). The districts have been classified as High Productivity, Moderate Productivity and Low Productivity districts based on the productivity index of major crops. It is found that the scenario of agriculture productivity in Tarai during the study period is not encouraging. It is noticed that nearly 75 percent districts observed with low and moderate productivity. There are no significant changes in the productivity during the study period.

The CAPI would be helpful for determining the suitability and productivity of agricultural crops for demarcating and identifying agricultural regions. It would lead to evaluate the performance in agricultural sector for planners and decision makers. It emphasizes the need for an increase in food crop production in the Tarai plains by strengthening the year-round irrigation system, improving agricultural roads, enhancing farming technology, promoting effective agricultural extension, and strengthening the implementation mechanism of the local government. Improvement of agricultural productivity of the Tarai plains is therefore one of the crucial issues in the agricultural development of the country.

Limitations and Scope of Future Research

This study is based on the secondary sources of data that are compiled from Statistical Information on Nepalese Agriculture, Statistic division, Ministry of Agriculture and Livestock Development, Government of Nepal and finding has been derived based on statistical formula Composite Agriculture Productivity Index (CAPI) developed by Bhatia (1967). Based on this finding, it is recommended that primary data should be also included for more realistic result. In addition to area, production and yield data of major crops, there should be analyzed and included the information on infrastructure development condition of that particular area.

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Annex 1

Average Area, Production and Yield of Cereal Crops in Tarai Districts of Nepal (1967/68_2020/21) 53 Years

Districts	Paddy			maize			millet			Wheat			barley		
	A	P	Y	A	P	Y	A	P	Y	A	P	Y	A	P	Y
Jhapa	88727	275769	3108	23814	51832	2177	2078	2205	1061	11782	21671	1839	22	24	1096
Morang	86897	266443	3066	13270	24404	1839	1367	1512	1106	17328	30437	1757	30	31	1029
Sunsari	54605	162363	2973	6233	11798	1893	921	1000	1086	16093	31964	1986	18	17	963
Saptari	58703	149696	2550	2455	5357	2183	275	287	1044	15978	31084	1945	17	17	1000
Siraha	59021	142365	2412	2203	4615	2095	930	906	974	14915	26833	1799	12	12	1000
Dhanusha	56534	128173	2267	3102	5548	1788	1010	924	916	22389	44124	1971	215	167	778
Mahottari	48484	99691	2056	4150	8042	1938	1104	1047	949	17231	30296	1758	189	147	777
Sarlahi	43043	95143	2210	7944	13811	1739	842	727	864	17315	32978	1905	159	146	920
Rautahat	53030	109528	2065	4393	8188	1864	328	318	969	15422	27456	1780	647	565	873
Bara	54773	161629	2951	4892	10674	2182	370	357	965	23143	35143	1519	391	280	716
Parsa	43445	128250	2952	3126	5455	1745	227	220	969	17383	23527	1353	304	219	722
Chitwan	28150	78130	2776	21973	45198	2057	1335	1347	1009	8367	16479	1969	232	229	985
Nawalparasi	59598	191873	3219	13362	29437	2203	1292	1268	981	23699	50254	2121	102	116	1142
Rupandehi	68019	175257	2577	2087	4195	2010	333	291	874	23805	49457	2078	271	224	826
Kapilbastu	68334	142016	2078	2449	4630	1891	334	294	882	21919	42802	1953	240	224	936
Dang	34751	90592	2607	20546	38846	1891	260	257	990	12625	21919	1736	192	172	894
Banke	31873	70575	2214	8181	13775	1684	569	512	899	12096	23972	1982	46	44	956
Bardiya	34861	96579	2770	9030	15772	1746	359	330	921	12557	21313	1697	36	35	972
Kailali	51997	128124	2464	11109	17447	1570	696	658	946	17773	34165	1922	162	174	1076
Kanchanpur	36365	89808	2470	7025	11713	1667	286	282	985	16120	31850	1976	101	93	924
Average Tarai			2622			1930			988			1858			868

Note. A = Area in Hectare, P = Production in Metric Ton and Y = Yield in Kg. per Hectare. Data adopted from Statistical Information on Nepalese Agriculture, MoALD, Government of Nepal