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Deciphering agricultural growth trends: a case study of Kupwara District in the Kashmir valley

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Abstract
Agriculture dominates the economic landscape of Kupwara in the Kashmir Valley. With growing population and the imperative of ensuring food security, understanding agricultural growth patterns becomes essential for achieving sustainable development. Thus the parameters that provide valuable insights into the efficiency of resource allocation, the diversification of crops, and the temporal trends in agricultural productivity are very essential to study in the given area. The present study scrutinizes the agricultural growth patterns, employing key indices such as agricultural efficiency, crop concentration, and Mann-Kendall trend analysis. The findings expose a decline in agricultural efficiency between 2010 and 2022, notwithstanding the prevalent cultivation of intensive paddy and maize. Nevertheless, pulses and vegetables exhibit a noticeable lack of diversity, highlighting the necessity for cultivating a more varied crop portfolio. Despite an increase in major crop yields since the early 2000s, the concomitant reduction in total cultivated area poses challenges for the long-term sustainability of agricultural practices in the region. Therefore, the study underscores the importance of enhancing agricultural efficiency, promoting diversification, and safeguarding the ecological and economic well-being of the Kupwara region.

Keywords: *Agricultural efficiency, Crop concentration, Kupwara, Sustainable development*

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I. Introduction

The agricultural land in the Kashmir Valley is fragmented while the population continues to rise, underscoring an urgent need to examine agricultural practices to ensure sustainability and food security (Hussain et al. 2019; Alam et al. 2020; Ganaie et al. 2021). Therefore, there has been a growing demand in recent years for a more comprehensive, multidisciplinary approach to address a variety of aspects of agriculture, including productivity and production upgrades (Evenson 1967; Hayami and Ruttan 1970; Ahearn 1998; Tsuji 1998; Passioura and Angus 2010; Acharya et al. 2012; Darku et al. 2013), the assessment of agricultural efficiency that provides valuable insights into how well resources are being utilized in farming to produce crops and livestock (Arnade 1994; Bravo-Ureta and Evenson 1994; Shafi 1960; Trueblood and Coggins 2003; Marin and Carvalho 2012; Mendes et al. 2012; Conant et al. 2013), trend analysis to predict future agricultural dynamics (Lu et al. 1978; VonWitzke et al. 2008; Baker et al. 2017; Rehman and Khan 2019; Bhattacharyay et al. 2020) and crop concentration and diversification analysis (Bhatia 1965; Mengxiao 2001; Mehta 2009; Saha 2013; Nayak 2016), and to understand spatial and temporal trends in crop cultivation (Raju et al. 198; Madhukar et al. 2020; Gao et al. 2022). Agricultural efficiency pertains to the optimal utilization of resources such as land, water, and labor to maximize output and reduce waste (Ganaie et al., 2017). The crop concentration index, which evaluates the degree to which certain crops dominate specific areas, serves as a key indicator of potential risks, such as the overreliance on monoculture.

The present study undertakes a detailed analysis of the trend patterns for the predominant crops cultivated in Kupwara, and assessing the crop concentration and the agricultural efficiency in the region. These studies offer strategic insights for fostering balanced crop distribution, enhancing food security, and promoting environmental sustainability by encouraging diversification and resource-efficient practices particularly in Himalayan regions like Kupwara, where households rely on integrated crop-livestock farming systems that encompass food grain, horticulture, and livestock production.

II. Study Area

Kupwara, located between 34° 15´ to 34° 45´ N latitude and 74° 35´ to 74° 45´ E longitude, is a district in the north-western part of Jammu Kashmir union territory. It spans an area of 2,379 sq. km with a population of 870,354 as per the 2011 census. The district is primarily agricultural, with minimal industrial presence. Its mountainous topography includes rugged terrain. Kupwara's geology encompasses Panjal Volcanics and Precambrian rocks. Streams like Kahmil, Pohru, and Mawar, originating from extensive catchment areas, shape the landscape and support economic activities (Fig.1).

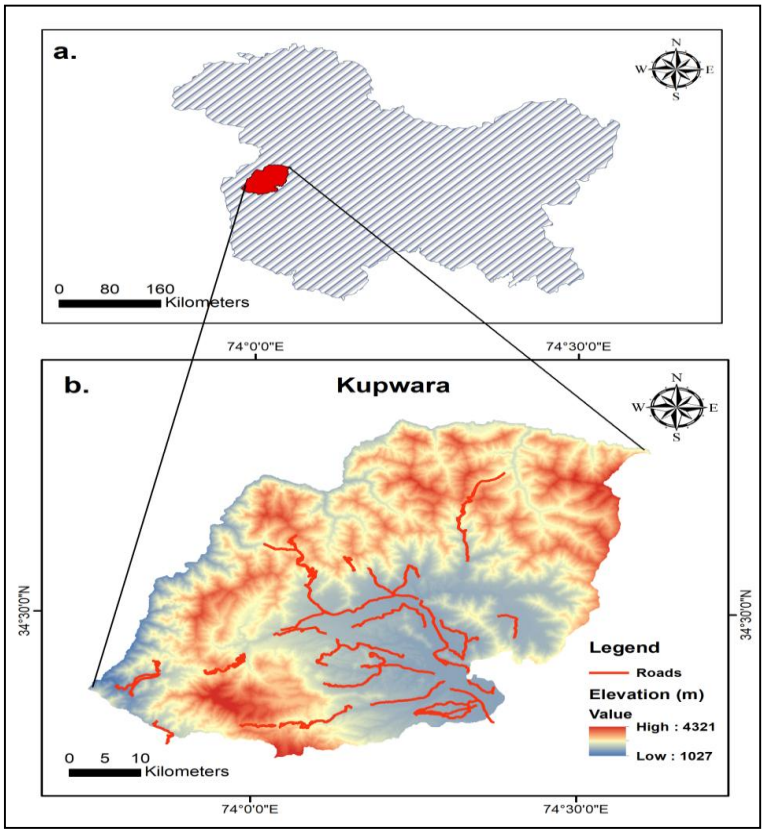

Fig. 1 Location of Study area (a) Jammu and Kashmir and (b) Kupwara District

III. Material and Methods

3.1 Collection of Agricultural Data

The agricultural data for the study region Kupwara of Kashmir Valley was obtained from the District Statistical Handbook; Chief Agricultural Officer, Kupwara; Office of Finance Commissioner Revenue, Jammu and Kashmir; Directorate of Economics and Statistics, Jammu and Kashmir. Furthermore, all the data was systematically analyzed, processed, and presented in graphical and tabular formats to facilitate comprehensive interpretation.

To comprehensively assess the agricultural landscape of the region, various parameters have been examined. The study assesses agricultural growth in Kupwara district using the agricultural efficiency index and crop concentration index to quantify productivity and diversification. Additionally, the Mann-Kendall trend test identifies trends in agriculture patterns over time, crucial for understanding agricultural dynamics and development in the region.

3.2 Agricultural Efficiency Index

The measurement of agricultural efficiency, first introduced by Bhatia (1967), has been used in a number of studies, including those by Darku et al. (2013), Biswas (2022), and Govindasamy et al. (2023) The agricultural efficiency index (Ei), which is determined by adding the weighted sum of the yield indices (Iya, Iyb, Iyc, etc.) for different crops and adjusting for the percentage of cropland allocated to each crop (Ca, Cb, etc.), is a crucial tool for assessing the productivity and sustainability of agricultural practices. The formula for calculating the index is given below:

$$\boldsymbol{Iya} = \left(\frac{\boldsymbol{Yc}}{\boldsymbol{Yr}}\right) * 100 \qquad (1)$$

where Iya is the Yield Index of Crop 'a', Yc is the Acar-Yield of the crop 'a' in a component unit, Yr is average acre yield crop a in the entire region (eq. 1).

$$Ei=\frac{(Iya \times Ca)+(Iyb \times Cb)+(Iyc \times Cc).....+(Iyn \times Cn)}{Ca+Cb+Cc.....+Cn} \quad (2)$$

where Agricultural Efficiency Index is represented by Ei and Yield Indices of different crops are represented by Iya, Iyb……Iyn; Ca, Cb. Cc….Cn are the percentage of cropland under the different crops (eq. 2).

3.3 Crop Concentration Index

The concept of crop concentration, crucial for understanding agricultural patterns, was initially outlined by Bhatia (1865) using the Location Quotient Method. This approach assesses the density and distribution of crops in an area, influenced by factors such as soil type, climate, and economic policies (Biswas 2022). Research utilizing the Location Quotient Method as significantly contributed to identifying dominant cropping patterns, vital for agricultural planning (e.g Khursheed and Taufique 2020; Punithavathi and Baskaran 2010). The Crop Concentration Index (CCI) calculation, based on this method is given in equation (3):

Index of determining the crop concentration (Location Quotient)

$$= \frac{Area\ of\ crop\ a\ in\ the\ component\ areal\ unit}{Area\ of\ all\ crops\ in\ the\ component\ areal\ unit} / \frac{Area\ of\ crop\ a\ in\ the\ entire\ region}{Area\ of\ all\ crops\ in\ the\ entire\ region} \quad (3)$$

3.4 Trend Analysis

Furthermore, to examine the monotonic upward and downward trend in the major growing crops of the region, the distribution-free and non-parametric Mann Kendall's test has been executed (Kendall 1975). Theil-Sen technique, a measure of slope in the time series data, is used to calculate the magnitude of the trend variation (Sen 1968).

IV. Results

4.3 Trend analysis of area, production and yield of major crops of Kupwara district (2000-2022)

In the agricultural landscape of Kupwara District, conventional farming practices highlight rice and maize as the main crops, with food grains covering 57% of the cultivated land, fruits 41%, and vegetables only 2%. The present study shows the trend analysis of food grains presented in table 1. Kupwara region displays significant positive trend for total area under rice (0.726, $p < 0.05$) when the Z values are calculated for the time period 2000 to 2022. This indicates that the overall area dedicated to these crops has increased steadily over time. On the other hand, the total area cultivated under maize shows a decreasing trend (-0.349, $p < 0.05$).

The trend analysis of production of rice and maize shows positive trends (rice 0.550, $p < 0.05$ and maize 0.325, $p < 0.05$) indicating continuous increase in production of both crops in the given time period from 2000 to 2022. Furthermore, the trend pattern of average yield depicts significant increasing trend for both rice (0.457, $p < 0.05$) and maize (0.628, $p < 0.05$). This shows an increasing tendency in the average yield per unit area for both crops (Fig. 2).

The Sen's slope estimation represented by the 'Q' values in table 1 provides information on the rate of change of agricultural metrics for maize and rice. In terms of overall area, rice's 'Q' score of 0.297 indicates a gentle upward slope, pointing to a gradual expansion of cultivated land. However, the negative 'Q' value of -0.297 for maize indicates a gentle downward slope, implying a slight decrease in cultivated area over time. The Sen's slope of the total production for rice shows a steeper slope, indicating a more rapid rise in production, with a higher 'Q' value of 21.71. For maize's lower 'Q' score of 3.912 points to a gentle slope and a slower but still positive growth trajectory in the crop's output. Furthermore, when considering the average yield, the 'Q' values for maize and rice, which are 0.337 and 0.973, respectively, show a moderate slope and a consistent rise in yield per unit area for both crops.

Table 1 Attribute data of Man-Kendall trend test and Sens Slope estimation

	Rice		Maize	
Crop	Tau (τ)	Q	Tau (τ)	Q
Total Area	0.726*	0.297	-0.349*	-0.297
Total Production	0.550*	21.71	0.325*	3.912

Average yield	0.457*	0.973	0.628*	0.337

*significant at 0.05

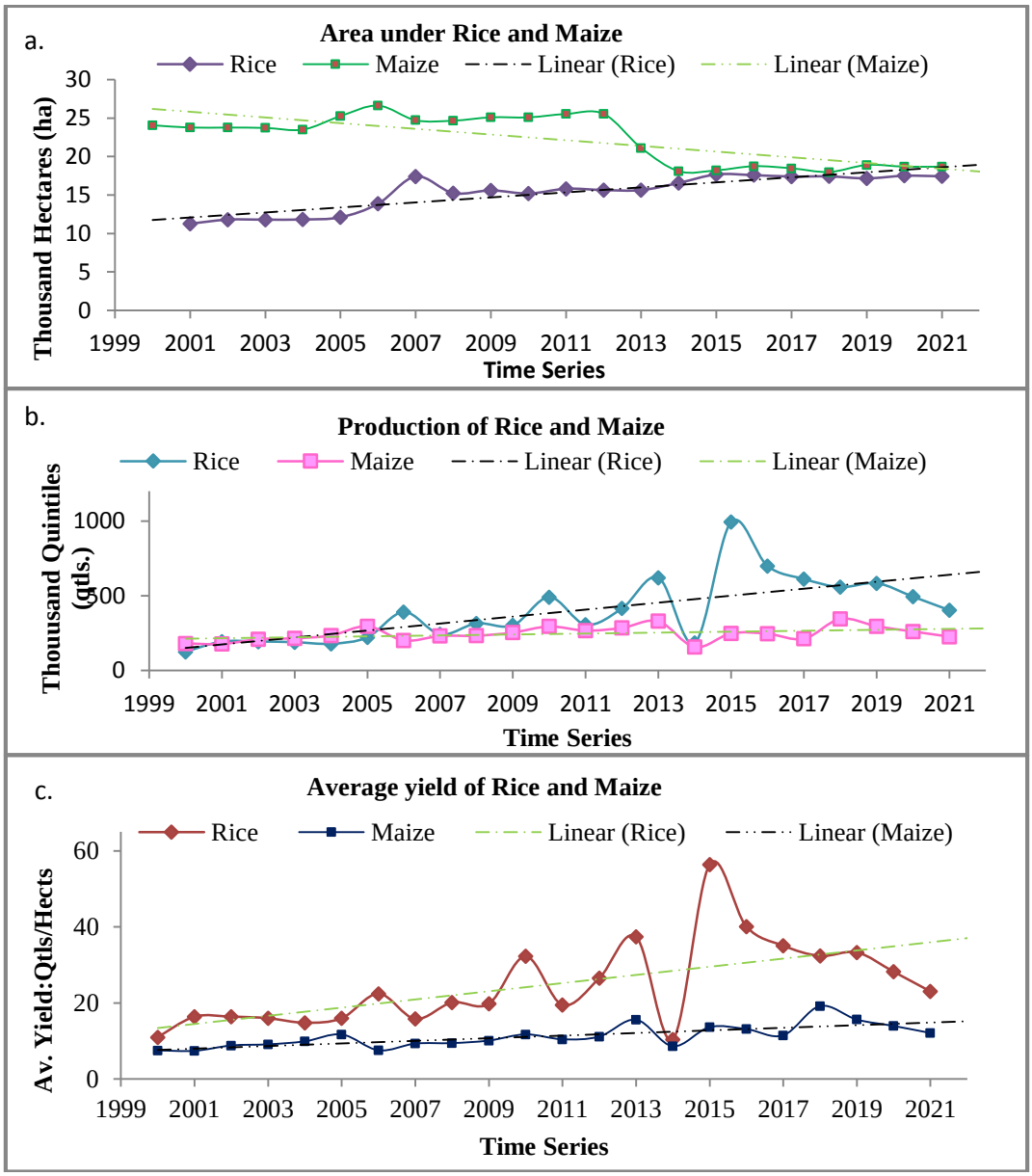

Fig. 2 Trend analysis of Rice and Maize (a) area, (b) production and (c) average yield from 2000 to 2021

4.1 Analysis of agricultural efficiency from 2010-2022

Agricultural efficiency has been thoroughly evaluated using the given precise formula that takes yield and area as the main inputs throughout a number of time intervals, calculated for 2010, 2015, and 2022. The agricultural area under rice, maize, pulses, vegetables, cereals, and non-food grains is shown in Fig. 2a, and their corresponding production is depicted in Fig. 2b.

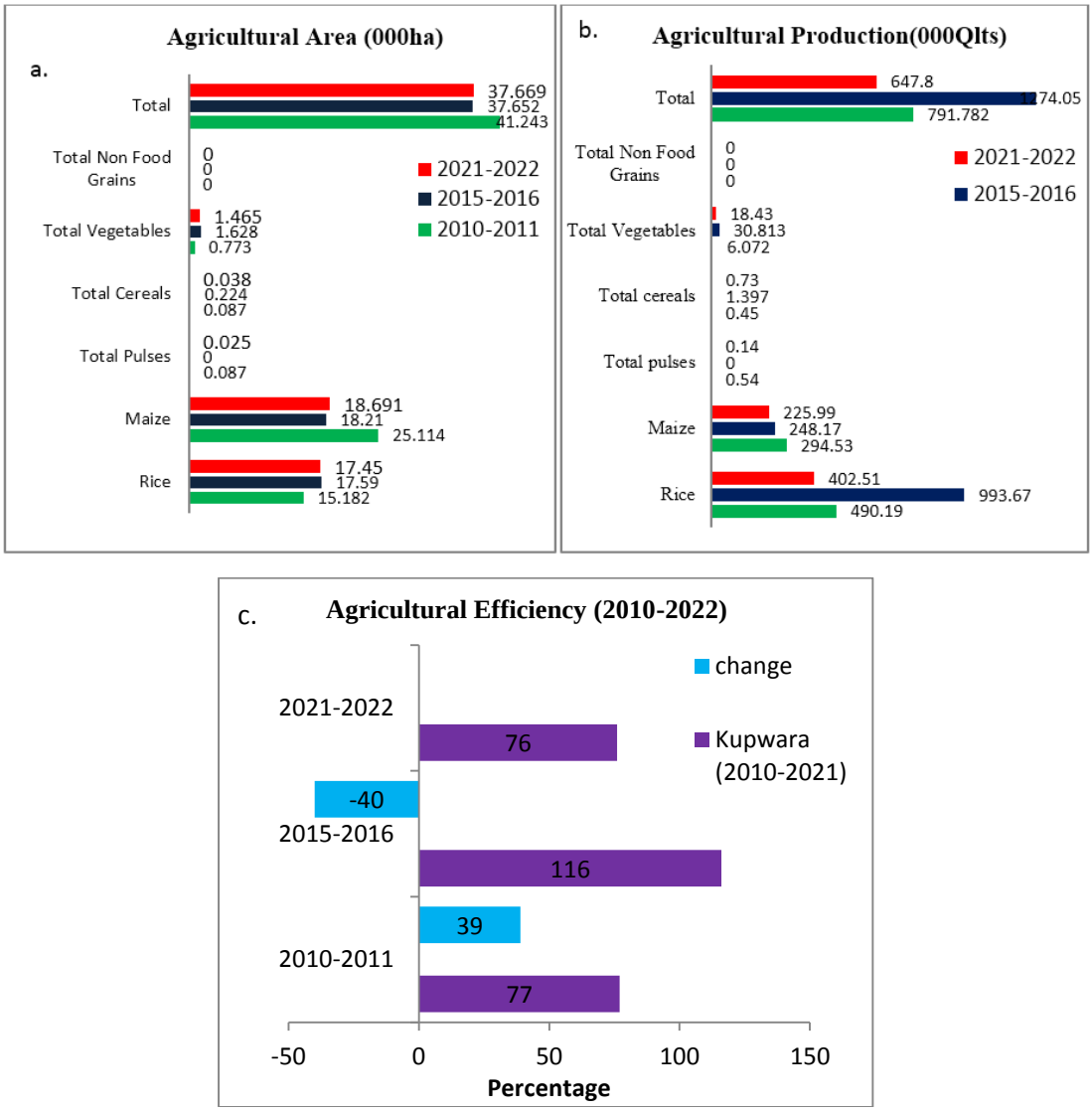

Fig. 2 Temporal agricultural area (a), agricultural production (b) and (c) agricultural efficiency index of kupwara district

Analyzing the trend in agricultural efficiency, it was found that the efficiency was 77% during the 2010–2011. By the year 2015–2016 year, the percentage had increased to 113%, indicating a growing period. Nevertheless, there was a following decline, with efficiency reaching 76% in the 2021–2022. According to this graph, agricultural efficiency increased first between 2010 and 2015 before declining until 2022. The region has not seen the expected gains in agricultural efficiency, despite technological developments and the introduction of high-yield seed varieties. However, the 2015–2016 year was notable for its remarkable rise in paddy production which is reflected in overall efficiency of agriculture as seen in figure 2c.

4.2 Crop concentration index of Kupwara

In the absence of zone-specific agricultural data, district-level data from the Kashmir division was used to analyze crop concentration in the Kupwara region. This method produced interesting findings about the crop concentration indices in several categories (Fig. 3). In terms of paddy, the score was 1.05, which indicates that Kupwara cultivates a lot of rice compared to other districts, implying that the area practices intensive paddy agriculture. This demonstrates the region's low level of crop diversity. Maize followed with an index of 2.11, the highest among the districts, highlighting Kupwara's dominance in maize cultivation. Cereals, with an index of 2.83, are predominantly grown in three districts, including Kupwara, which again falls into the high concentration zone for this category. Conversely, pulses and vegetables fell into the very low concentration class with far lower indices of 0.07 and 0.63, respectively. Kupwara did not cultivate non-food grains, reflecting the region's specialized agricultural scope. Table 2 shows the crop concentration index for the entire Kashmir

Valley, paying particular emphasis to Kupwara's position within the division, which is indicative of its distinct agricultural profile.

Table 2 Crop Concentration Index of Kashmir Valley (Kupwara)

Area	Paddy	Maize	Cereals	Pulses	Vegetables	Non_Food_Grains
Kupwara	**1.05**	**2.11**	**2.83**	**0.07**	**0.63**	**0.00**
Srinagar	1.21	0.06	0.00	4.35	4.14	0.61
Ganderbal	1.19	0.62	5.52	0.09	1.34	0.96
Budgam	1.12	0.58	1.96	1.89	0.89	1.17
Anantnag	0.87	0.72	0.00	0.39	0.90	1.53
Kulgam	1.00	0.54	0.00	2.20	1.43	1.28
Pulwama	0.66	0.33	0.00	0.74	1.15	2.19
Shopian	0.27	0.70	0.00	16.29	5.03	0.99
Baramulla	1.08	1.98	0.00	0.21	0.63	0.07
Bandipora	1.19	1.16	0.00	0.87	0.65	0.61

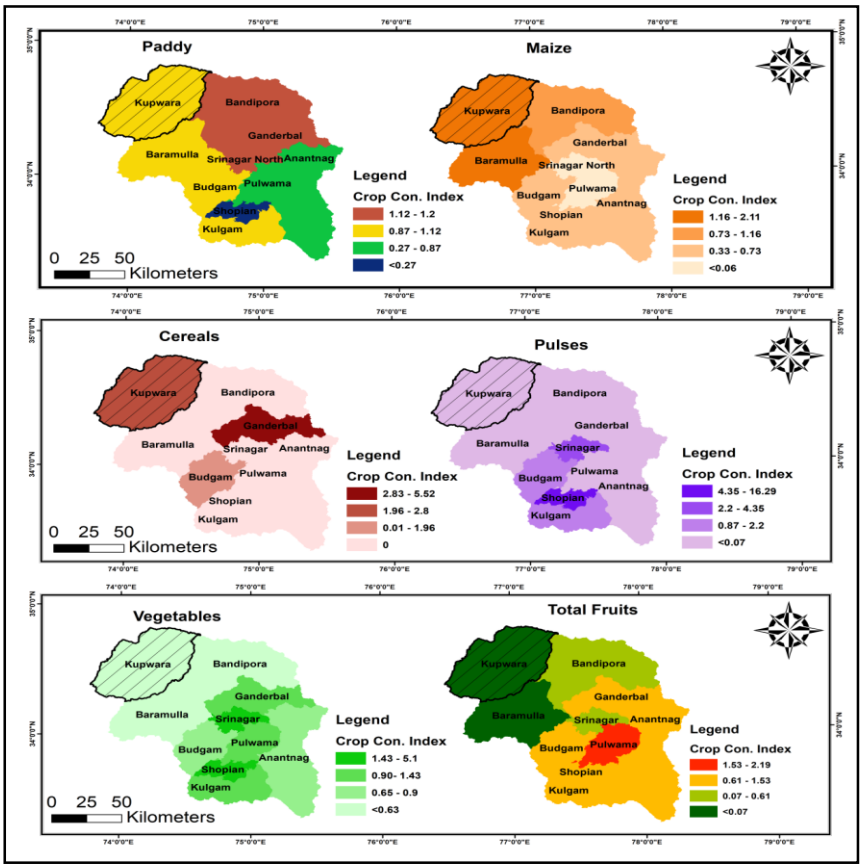

Fig. 3 Crop Concentration Index of Kashmir valley (Kupwara)

V. Conclusion

The study highlights a consistent rise in rice and maize yields from 2000 to 2022, with rice exhibiting large production, while maize achieves a higher yield per unit area. Agricultural efficiency in Kupwara has been varying from 2010 to 2022 with its peak in 2015-2016. Paddy and maize dominate the district's cultivation, with maize holding the highest concentration index, whereas pulses and vegetables show limited concentration compared to other districts of Kashmir division, underscoring a lack of agricultural diversity. Therefore, the findings suggest that in order to reduce the discrepancy between the amount of land allotted and the agricultural output, measures focused at increasing productivity and maximizing resource use are required.

References

[1]. Acharya, S. P., Basavaraja, H., Kunnal, L. B., Mahajanashetti, S. B., & Bhat, A. R. S. (2012). Growth in area, production and productivity of major crops in Karnataka. Karnataka Journal of Agricultural Sciences, 25(4), 431-436.

[2]. Ahearn, M. (1998). Agricultural productivity in the United States (No. 740). US Department of Agriculture, Economic Research Service.

[3]. Alam, A., Bhat, M. S., & Maheen, M. (2020). Using Landsat satellite data for assessing the land use and land cover change in Kashmir valley. GeoJournal, 85, 1529-1543.
[4]. Arnade, C. A. (1994). Using data envelopment analysis to measure international agricultural efficiency and productivity (No. 1831). US Department of Agriculture, Economic Research Service.
[5]. Baker, S., Volova, T., Prudnikova, S. V., Satish, S., & Prasad, N. (2017). Nanoagroparticles emerging trends and future prospect in modern agriculture system. Environmental toxicology and pharmacology, 53, 10-17.
[6]. Bhatia, S. S. (1965). Patterns of crop concentration and diversification in India. Economic Geography, 41(1), 39-56.
[7]. Bhattacharyay, D., Maitra, S., Pine, S., Shankar, T., & Pedda Ghouse Peera, S. K. (2020). Future of precision agriculture in India. Protected Cultivation and Smart Agriculture, 1, 289-299.
[8]. Biswas, B. (2022). Changing crop concentration and agricultural efficiency: A study in West Bengal, India. GeoJournal, 87(2), 491-513.
[9]. Bravo-Ureta, B. E., & Evenson, R. E. (1994). Efficiency in agricultural production: the case of peasant farmers in eastern Paraguay. Agricultural economics, 10(1), 27-37.
[10]. Conant, R. T., Berdanier, A. B., & Grace, P. R. (2013). Patterns and trends in nitrogen use and nitrogen recovery efficiency in world agriculture. Global Biogeochemical Cycles, 27(2), 558-566.
[11]. Darku, A. B., Malla, S., & Tran, K. C. (2013). Historical Review of Agricultural Productivity Studies. Alberta, Canada: CAIRN Research Network.
[12]. Evenson, R. (1967). The contribution of agricultural research to production. Journal of Farm Economics, 49(5), 1415-1425.
[13]. Ganaie, T. A., Jamal, S., & Ahmad, W. S. (2021). Changing land use/land cover patterns and growing human population in Wular catchment of Kashmir Valley, India. GeoJournal, 86, 1589-1606.
[14]. Gao, Y., Zhao, H., Zhao, C., Hu, G., Zhang, H., Liu, X., ... & Li, X. (2022). Spatial and temporal variations of maize and wheat yield gaps and their relationships with climate in China. Agricultural Water Management, 270, 107714.
[15]. Govindasamy, P., Muthusamy, S. K., Bagavathiannan, M., Mowrer, J., Jagannadham, P. T. K., Maity, A., ... & Tiwari, G. (2023). Nitrogen use efficiency—a key to enhance crop productivity under a changing climate. Frontiers in Plant Science, 14, 1121073.
[16]. Hayami, Y., & Ruttan, V. W. (1970). Agricultural productivity differences among countries. The American economic review, 60(5), 895-911.
[17]. Hussain, M., & Warr, M. A. (2019). Depeasantization: A study of Nature, Magnitude and Possession of Land in Pulwama District of Kashmir Valley (India). International Journal of Research in Social Sciences, 9(6), 44-57.
[18]. Kendall, M. G. (1948). Rank correlation methods.
[19]. Khursheed, V., & Taufique, M. (2020). Spatial analysis of horticulture efficiency and fruit production concentration in Kashmir Valley. GeoJournal, 85, 1635-1643.
[20]. Lu, Y. C., Quance, L., & Liu, C. L. (1978). Projecting agricultural productivity and its economic impact. American Journal of Agricultural Economics, 60(5), 976-980.
[21]. Madhukar, A., Kumar, V., & Dashora, K. (2020). Spatial and temporal trends in the yields of three major crops: wheat, rice and maize in India. International Journal of Plant Production, 14, 187-207.
[22]. Marin, F. R., & Carvalho, G. L. D. (2012). Spatio-temporal variability of sugarcane yield efficiency in the state of São Paulo, Brazil. Pesquisa Agropecuária Brasileira, 47, 149-156.
[23]. Mehta, P. K. (2009). Role of crop diversification in output growth in India: A state-level analysis. IUP Journal of Agricultural Economics, 6(2), 24.
[24]. Mendes, A., da Silva, E. L. S., & Santos, J. M. A. (Eds.). (2012). Efficiency measures in the agricultural sector: with applications. Springer Science & Business Media.
[25]. Mengxiao, Z. (2001). Crop diversification in China. Crop Diversification in the Asia-Pacific Region, 24-31.
[26]. Nayak, D. K. (2016). Changing cropping pattern, agricultural diversification and productivity in Odisha-A district-wise Study. Agricultural economics research review, 29(1), 93-104.
[27]. Passioura, J. B., & Angus, J. F. (2010). Improving productivity of crops in water-limited environments. Advances in agronomy, 106, 37-75.
[28]. Punithavathi, J., & Baskaran, R. (2010). Changes in the cropping pattern, crop concentration, agricultural efficiency in Papanasam Taluk, Thanjavur district, Tamil Nadu, India. Recent Research in Science and Technology, 2(5).
[29]. Raju, V. T., Rao, D. V., & Ravishankar, C. (1987). Spatio-temporal growth and distribution of fruit crops in Andhra Pradesh. Indian Journal of Agricultural Economics, 42(902-2018-2583), 438-445.
[30]. Rehman, T., & Khan, M. U. (2019). Early trends, current status and future prospects of farm mechanization in Asia. Agricultural Engineering International: CIGR Journal, 21(3), 76-87).
[31]. Sen, P. K. (1968). Estimates of the regression coefficient based on Kendall's tau. Journal of the American statistical association, 63(324), 1379-1389.
[32]. Shafi, M. (1960). Measurement of agricultural efficiency in Uttar Pradesh. Economic Geography, 36(4), 296-305.
[33]. Trueblood, M. A., & Coggins, J. (2003). Intercountry agricultural efficiency and productivity: a Malmquist index approach. mimeo, World Bank, Washington DC.
[34]. Tsuji, G. Y., Hoogenboom, G., & Thornton, P. K. (Eds.). (1998). Understanding options for agricultural production (Vol. 7). Springer Science & Business Media.
[35]. Von Witzke, H., Noleppa, S., & Schwarz, G. (2008). Global agricultural market trends and their impacts on European Union agriculture (No. 897-2016-65397).