Zone-wise Assessment of Fruit Crop Concentration and Horticultural Efficiency in Kupwara District

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Abstract
The study provides a comprehensive assessment of zone wise horticultural scenario in the Kupwara district by employing the horticultural efficiency index and fruit concentration index. The results show Ashpora, Langate, Rajwar, and Kralgund emerge as the top-performing zone. In contrast, Teethwal and Tanghdar experienced horticultural efficiency regression. Furthermore, the specialization observed in horticultural concentration such as Langate with apples, Kralgund with pears, Handwara with cherries, and Tanghdar leading in peach cultivation which reflects local adaptation to agro-climatic conditions and market demands. Notably, Tanghdar and Teethwal's high concentration value for walnuts underscore their suitability for specific fruit varieties within the unique geographical and economic context of Kupwara district's border regions. Thus results show shifts in horticultural performance over the past decade, highlighting both successful and underperforming zones. It emphasizes the necessity for planners to devise targeted strategies to address the challenges faced by less efficient zones, aiming to optimize horticultural practices and enhance overall productivity and sustainability in the region.
Key words: *Concentration index, Efficiency index, Horticulture, Kupwara*

Date of Submission: 14-09-2024   Date of acceptance: 28-09-2024

I. Introduction

Kupwara, known for its breathtaking landscapes in the Himalayas, is predominantly an agrarian district of Jammu and Kashmir. With fertile valleys and temperate climates, agriculture forms the backbone of its economy (Mehmood and Kumar 2020). Currently, seven out of ten people are employed directly or indirectly by the agricultural sector in the region. This is because most people either work in sectors that rely significantly on agriculture for their existence or farm themselves (Lone 2019; Ramshoo 2020). Paddy and Maize are the primary crops in the region and are considered the region's core crops. The situation of agricultural sector in the region is alarming due to rapid settlement expansion and increasing population causing the food insecurity and degradation of the resource (Kaloo & Choure 2015). However, horticulture has established itself as an essential subsector (Sheikh et al. 2013) and according to Agricultural Production Department of Jammu and Kashmir; the horticulture sector contributes to around 8% to the state's GDP (Jammu and Kashmir) and supports the livelihoods of roughly 6lac families, who are involved with the sector either directly or indirectly. Horticulture is rapidly surpassing agriculture in Northern Kashmir due to its higher economic returns. Given this shift, the current study focuses on identifying the scenario of horticultural zones within the Kupwara District of Northern Kashmir. The study evaluates these zones based on key factors such as, fruit concentration, and overall horticultural efficiency. This detailed zone-wise analysis aims to provide a clear understanding of how horticulture can be optimized to further enhance economic and agricultural sustainability in the region.

II. Material and Methods

2.1 Study Area

Kupwara which is the north-western district of Jammu and Kashmir union territory situated between 34° 15´ to 34° 45´ N Lat. and 74° 35´ to 74° 45´ E Long. at an average elevation of 1612m above sea level (Fig. 1). The district's geological profile is rich, encompassing Panjal Volcanics and low-grade metamorphosed Precambrian rocks widespread across the region alongside early to middle Palaeozoic Formations found along the Shamsabari Syncline. The drainage system of the region, highlighted by streams such as Kahmil, Pohru, and Mawar, originate from extensive catchment areas traverses through varied rock terrains, shaping Kupwara's landscape and supporting its agriculture and other economic activities
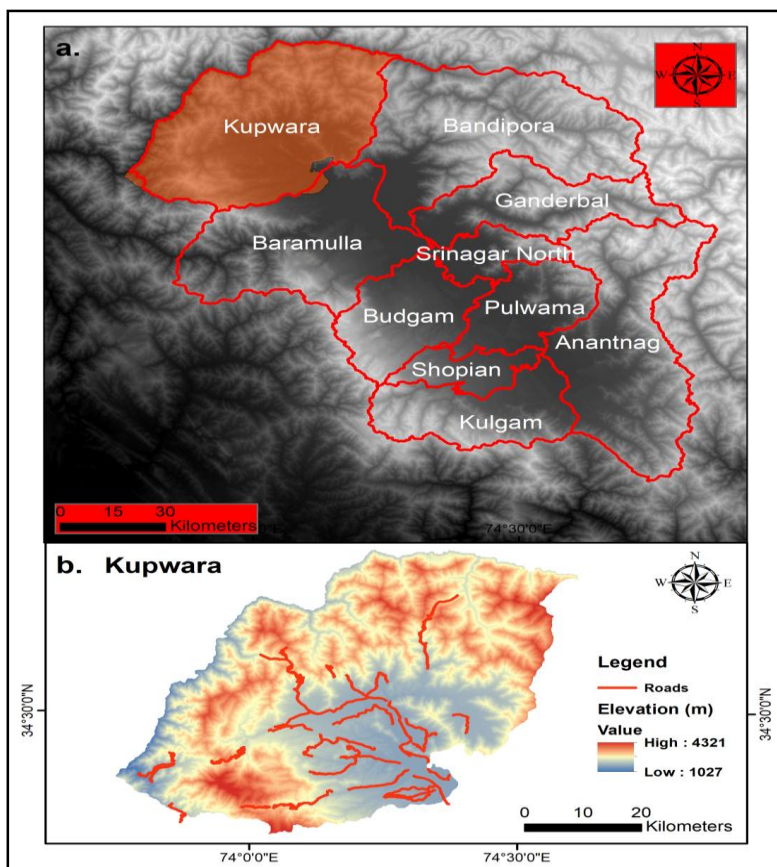
Fig. 1 Location map of the study area (a) Kashmir valley and (b) Kupwara district

2.2 Collection of Horticultural Data

Horticultural data for the Kupwara region was sourced from key institutional records, including the District Statistical Handbook, Chief Horticultural Officer, and the Directorate of Economics and Statistics (Jammu and Kashmir). This comprehensive dataset facilitated a zone-wise analysis of horticultural production and yield. Additionally, indices such as the Horticultural Efficiency Index and Fruit Concentration Index were calculated to evaluate productivity and assess the spatial distribution of fruit cultivation, highlighting both high-performance zones and areas in need of targeted interventions.

Horticultural Efficiency Index

The horticultural efficiency index (Ei), initially introduced by Bhatia (1967) and utilized in subsequent studies, is a key tool for assessing horticultural productivity and sustainability. It is calculated by summing the weighted yield indices for different fruit crops and adjusting for the proportion of land allocated to each crop. This index helps evaluate the efficiency of horticultural practices and is crucial for understanding horticultural performance.

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

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).

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

where Horticultural 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).

Fruit Concentration Index

The Fruit Concentration Index (CCI), based on Bhatia's (1865) Location Quotient Method, assesses fruit density and distribution, considering soil, climate, and economic factors. This approach helps identify key fruit cultivation patterns essential for horticultural planning (Kim et al. 2019; Ganaie et al. 2017). The Fruit Concentration Index (CCI) calculation, based on this method is given in equation (3):

Index of determining the crop concentration (Location Quotient)

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

III. Results

3.1 Horticultural efficiency of major fruit producing zones of Kupwara

Horticulture is an important source of income in the region. The favorable climatic and soil characteristics of the area enable abundant fruit production, particularly for apples and walnuts followed by pears, cherries, plums, peaches, and apricots. Since apples and walnuts are cultivated on a large amount of land, their yield naturally exceeds that of other main fruits grown in the area.

For assessing horticultural efficiency, understanding both the area dedicated to cultivation and the production yields of each variety is essential. The total area under horticultural zones and their production in the year 2011-2012 and 2021-2022 is shown in Fig. 2a and Fig. 2b.

The evaluation of horticultural efficiency across the diverse zones of the Kupwara region unveils notable disparities and trends, illuminating nuanced variations in performance over time (Fig. 2c). In the period spanning 2011-2012, distinct differences were discerned, with certain zones demonstrating markedly superior efficiency compared to others (table 4.4). Foremost among these was the Langate zone, distinguished by a commendable efficiency index of 111%, closely trailed by Rajwar (99%), Kralgund (98%), Ashpora (97%), Mawar (94%), Handwara (94%), Vilgam (94%), Sogam (90%), Kralpora (87%), Trehgam (85%), Drugmulla (85%), and Dooniwari (83%). Moreover, zones such as Teethwal (66%), Kupwara (64%), and Tanghdar (59%) grappled with achieving comparable levels of efficiency.

Subsequently, during the period of 2021-2022, a discernible enhancement in efficiency was observed across the majority of zones, with the average efficiency surpassing 100% relative to 2011 levels. This positive trajectory underscores overarching improvements in horticultural methodologies. Nevertheless, the performance of Teethwal and Tanghdar exhibited a regression during this period, failing to keep pace with the advancements witnessed in other zones. Ashpora emerged as the zone exhibiting the highest efficiency, boasting a notable index value of 137%, closely followed by Rajwar (136%), Mawar (134%), Vilgam (133%), Drugmulla (131%), Sogam (131%), Kralpora (114%), and Trehgam (113%). Zones registering moderate efficiency levels encompassed Dooniwari (106%) and Kupwara (99%). However, Teethwal (63%) and Tanghdar (53%) continued to languish, showcasing the lowest efficiency levels among all zones (table 1).

Table 1 Horticultural efficiency zone wise classification

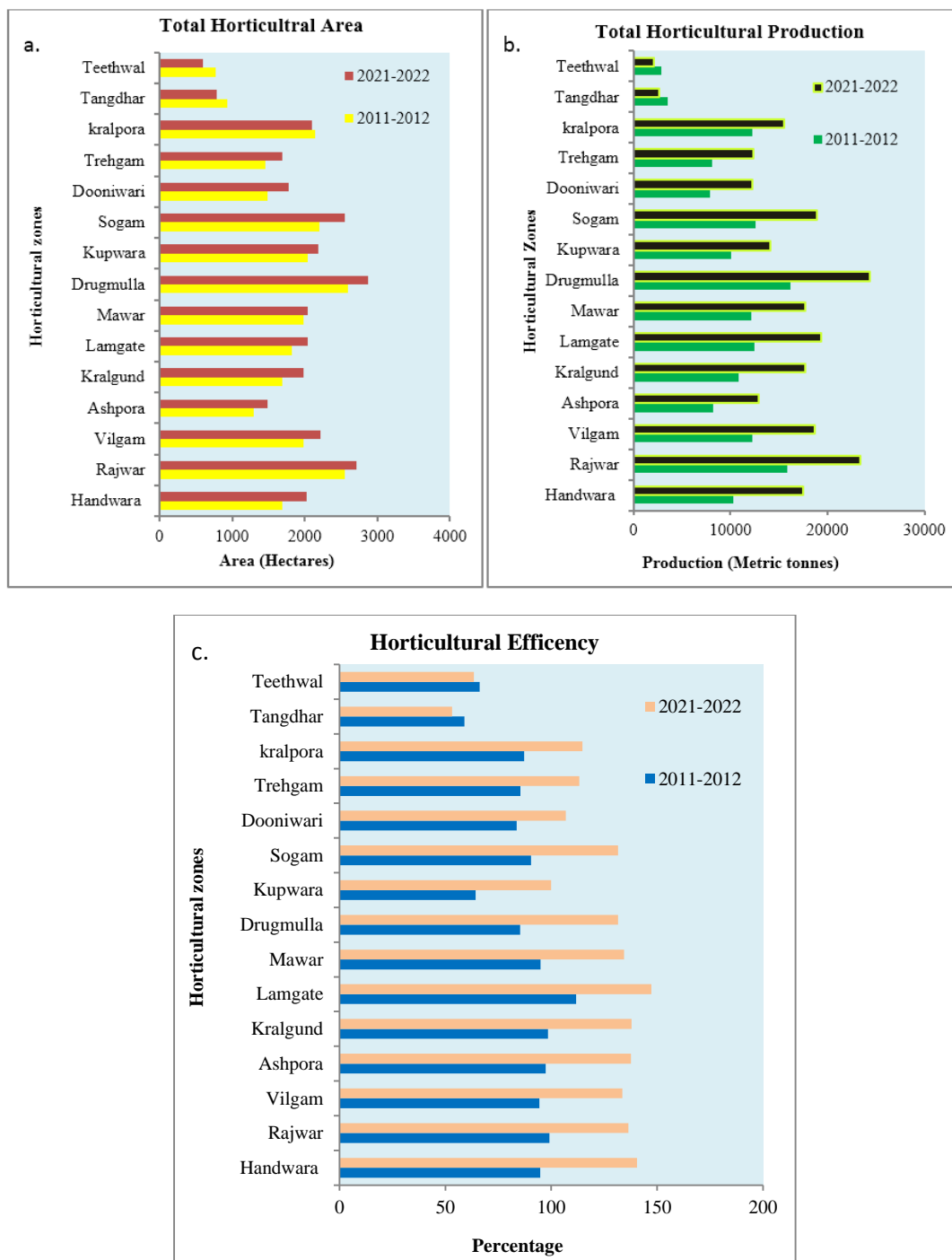| Class	Value (%)	Zones (2011-2012)	Zones (2021-2022)
High	Above 95	Langate, Rajwar, Kralgund, Ashpor	Langate, Hnadwara, Kralgund, Ashpora, Rajwar, Mawar, Vilgam, Drugmulla, Sogam, Kralpora, Trehgam, Dooniwari, Kupwara
Medium	95-85	Mawar, Handwara, Vilgam, Sogam, Kralpora, Trehgam, Drugmulla	-
Low	below 85	Dooniwari, Teethwal, Kupwara, Tangdhar	Teethwal, Tangdhar

Fig. 2 Horticultural area (a), Horticultural production (b) and (c) Horticultural Efficiency Index of Kupwara district

3.2 Horticultural concentration index
Apple

The concentration index values for apple cultivation across various horticultural zones with the Kupwara district highlight differing levels of concentration (table 2). Langate exhibits the highest concentration index of 1.35, reflecting significant specialization in apple farming. In contrast, Teethwal and Tangdhar show the lowest concentration indexes of 0.11, indicating minimal focus on apple cultivation in these areas. The degree of emphasis on apple farming varies across the zones, with other areas displaying moderate to high levels of concentration: Handwara (1.12), Rajwar (1.16), Vilgam (1.10), Ashpora (1.16), Kralgund (1.19), Mawar (1.13), Drugmulla (1.16), Sogam (0.92), Dooniwari (0.79), Trehgam (0.89), and Kralpora (0.92). These varying values of concentration index reflect the diverse agricultural landscapes and priorities across the district.

Pear

The results of the concentration index for Pear cultivation among the different hoerticultural zones in the region shows that the Kralgund stands out with the highest concentration index of 1.94, reflecting a strong focus on pear farming. Vilgam follows closely with a concentration index of 1.85. In contrast, Teethwal and Tangdhar show the lowest concentration, with values of 1.45 and 1.06, respectively, suggesting a lesser emphasis on pear cultivation in these areas. Other regions display a range of concentration values, such as Handwara (1.58), Rajwar (1.03), Ashpora (1.04), Langate (1.01), Mawar (1.44), Drugmulla (0.29), Kupwara (0.35), Sogam (0.54), Dooniwari (0.61), and Kralpora (0.82).

Cherry

The concentration index for cherry cultivation reveals that the Handwara exihibts a notable index of 1.72, indicating a significant emphasis on cherry farming, while Rajwar, with a low index of 0.47, indicates relatively less focus. In contrast, Langate (1.51) and Teethwal (1.27) also exhibit high specialization. Meanwhile, regions like Vilgam (0.88), Kralgund (1.24), Mawar (1.02), Trehgam (1.03), Tangdhar (1.19), and areas such as Drugmulla, Kupwara, Sogam, Dooniwari, and Kralpora (ranging from 0.74 to 0.85) reflect moderate concentration indexes.

Peach

With respect to peach cultivation the concentration index shows that the Tangdhar (2.92), Kupwara (2.07), Trehgam (1.70), Handwara (1.66), and Teethwal (1.60), indicating high specialization. On the other hand, Rajwar (0.40), Ashpora (0.49), Mawar (0.42), and Sogam (0.01) exhibit lower indexes, reflecting less emphasis on peach farming. Meanwhile, areas like Vilgam (1.60), Kralgund (1.20), Drugmulla (0.87), Kralpora (0.88), Langate (0.71), and Dooniwari (0.25) show moderate indexes.

Apricot

The concentration index values for peach cultivation reveal that Rajwar has a lower emphasis index score of 0.40, while Ashpora (0.49), Mawar (0.42), and Sogam (0.01) also exhibit lower attention. Langate has a moderate index of 0.71, with Drugmulla (0.87), Kralpora (0.88), and Dooniwari (0.25) falling into the same moderate category. Vilgam (1.60), Handwara (1.66), and Kralgund (1.20) show a higher concentration of peach cultivation, while Tangdhar (2.92), Kupwara (2.07), Trehgam (1.70), and Teethwal (1.60) demonstrate a very high concentration and significant focus on peach farming.

Walnut

The concentration index values for walnut cultivation reveal significant specialization in Teethwal (2.96), Tangdhar (2.92), Kupwara (1.73), Dooniwari (1.48), Trehgam (1.25), and Sogam (1.23), indicating a high focus on walnut farming. Kralpora (1.19) also demonstrates considerable emphasis. Moderate index value is observed in Vilgam (0.73), Drugmulla (0.71), Handwara (0.68), Mawar (0.68), Rajwar (0.66), and Ashpora (0.61). In contrast, Kralgund (0.51) and Langate (0.21) reflect low contration index value of walnut cultivation.

Table 2 Horticultural zone wise concentration index of Kupwara

Area	Apple	Pear	Cherry	Plum	Peach	Apricot	Walnut
Handwara	1.12	1.58	1.72	0.79	1.66	0.79	0.68
Rajwar	1.16	1.03	0.47	1.32	0.40	0.60	0.66
Vilgam	1.10	1.85	0.88	1.25	1.60	0.94	0.73
Ashpora	1.16	1.04	1.18	1.44	0.49	1.04	0.61
Kralgund	1.19	1.94	1.24	0.63	1.20	0.77	0.51
Langate	1.35	1.01	1.51	0.40	0.71	0.88	0.21
Mawar	1.13	1.44	1.02	0.78	0.42	1.16	0.68
Drugmulla	1.16	0.29	0.74	0.77	0.87	0.53	0.71
Kupwara	0.69	0.35	0.78	0.81	2.07	0.82	1.73
Sogam	0.92	0.54	1.02	0.91	0.01	0.43	1.23
Dooniwari	0.79	0.61	0.85	1.33	0.25	1.06	1.48
Trehgam	0.89	0.57	1.03	0.79	1.70	1.10	1.25
Kralpora	0.92	0.82	0.78	1.61	0.88	1.09	1.19
Tangdhar	0.11	1.45	1.19	1.39	2.92	5.68	2.92
Teethwal	0.11	1.06	1.27	1.26	1.60	1.84	2.96

IV. Conclusion

The analysis of horticultural efficiency and concentration indices for the Kupwara district reveals a dynamic landscape in the region's fruit production. The horticultural efficiency index demonstrates that Langate was the top-performing zone in 2011-2012, with an efficiency index of 111%, while Ashpora emerged as the highest-performing zone in 2021-2022, indicating advancements in horticultural practices. Conversely, Teethwal and Tanghdar experienced a regression in efficiency, highlighting potential challenges in their horticultural management. Moreover, Langate remains prominent in apple cultivation, evidenced by a concentration index of 1.35, while Kralgund excels in pear farming with the highest concentration index of 1.94. Handwara leads in cherry cultivation (index: 1.72), and Tanghdar is distinguished for peach cultivation (index: 2.92). Both Tanghdar and Teethwal have the highest indices for walnut concentration. Therefore, these findings underscore the region's diverse horticultural performance and highlight the need for targeted interventions to address declining areas and optimize productivity across different fruit crops.

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