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Computation of Z-Score for an Analytical Study Identifying the Involvement of Agricultural Workers in the Production of Food Grains, Fruits and Flowers in Uttarakhand

Dr. Prakash Vir Singh

Associate Professor Department of Geography, Tilak Mahavidyalaya, Auraiya-206122, U.P., India (Affiliated to C.S.J.M. University, Kanpur, INDIA)

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ABSTRACT

Agricultural workers play a significant role in food grain production in Uttarakhand, a predominantly mountainous state characterised by difficult terrain and fragile ecosystems. Due to steep slopes, small and fragmented landholdings, and limited access to modern agricultural machinery, farming in the region relies heavily on agricultural workers. Agricultural workers contribute through traditional practices such as terraced cultivation, contour farming, and indigenous water management systems, which help conserve soil and moisture. They actively cultivate major food grains, including *mandua* (finger millet) and *jhangora* (barnyard millet), as well as local varieties of fruits and flowers, all well adapted to the hill environment. Their knowledge of climate-resilient crops and sustainable farming methods supports food security and biodiversity conservation. Despite challenges such as migration, climate variability, and declining agricultural returns, agricultural workers remain central to sustaining food grain production and maintaining the ecological balance of Uttarakhand's hill agriculture.This research paper is intended to conduct an analytical study on the involvement of agricultural workers in the per-hectare agricultural production of food grains, fruits, and flowers in the study area. Uttarakhand plays a pivotal role in sustaining food grain production despite challenging environmental and socio-economic conditions.

Keywords: Cultivation, yield, agricultural worker, food grains.

INTRODUCTION

Their involvement spans land preparation, crop management, harvesting, post-harvest handling, and, increasingly, participation in horticultural and floricultural value chains. The state's terrain, climate, and crop diversity shape the nature of this involvement. Three specific factors are considered to assess agricultural workers' per-hectare yields for selected crops. These are –

a. Per Hectare Yield of Food Grains.
b. Per Agricultural Worker Production of Food Grains.

c. Per Cultivator Production of Main Fruits and Flowers.

Per-hectare yield of food grains

Although the transition from a purely subsistence economy to a market economy has been underway since independence, food grains, cereals, and pulses still dominate total cropping in the region, as in the rest of Uttarakhand. Rice and wheat are the state's main food grains. The productivity of these main food crops depends on land quality, water availability, the types of agricultural implements used, farmers' economic conditions, the use of high-quality seeds and fertilisers, and access to financial facilities. The state has an average yield of 16.57 quintals of food grains, which is quite low compared to the adjoining states of Haryana and Uttar Pradesh but higher than Himachal Pradesh. The region has district-wise striking disparities. Udham Singh Nagar holds the

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highest rank with 30.46 quintals per hectare, and Pauri Garhwal the lowest with 08.94 quintals per hectare. Three districts in the state have exceeded the state's average yield.

The high category of food grain production is associated with three districts, among which Udham Singh Nagar is highest (30.46 quintals per hectare of cultivated area), followed by Haridwar (28.92) and Nainital (22.33) (Table 1.1). All these districts have assured means of irrigation and high-quality land. Food grain production has been commercialised and mechanised. The tractors have made inroads in the agricultural development of these areas.

The moderate category of food grains is occupied by five districts of Uttarakhand, in which Dehra Dun holds the highest rank with 16.12 quintals, followed by Bageshwar (14.96), Tehri Garhwal (14.80),

Table 1.1 Standard Score Values of per Hectare Yield of Food Grains (in quintals): 2004-05

Classes & Z-Score Values	No. of Districts	%	Districts (Z-Scores)
(i) High > 0.00	03	23.08	Udham Singh Nagar (2.19), Haridwar (1.95), Nainital (0.94)
(ii) Moderate- 0.50 to 0.00	05	38.46	Dehra Dun (-0.07), Bageshwar (-0.25), Tehri Garhwal (-0.28), Champawat (-0.37), Chamoli (-0.43)
(iii) Low < - 0.50	05	38.46	Rudraprayag (-0.55), Pithoragarh (-0.59), Uttarkashi (-0.61), Almora (-0.83), Pauri Garhwal (-1.21)

Source: Uttarakhand, Directorate of Economics & Statistics

Chamawat (14.22) and Chamoli, with yields of 13.85 quintals per hectare from the cultivated area. All these districts adjoin the state's high-yielding food-grain production areas. These districts are well suited for agriculture, supporting higher food-grain yields per hectare of cultivated area.

Food-grain productivity is low in five districts of the study area. At the top of the list is Pithoragarh, with 13.43 quintals per hectare of cultivated area, followed by Rudraprayag (13.10), Uttarkashi (12.71), Almora (11.32), and Pauri Garhwal (08.94) in food grain production per hectare. This is mainly because of small landholdings, limited arable land, and poor mechanisation in these areas. It is concluded that the degree of mechanisation, the use of high-quality seeds, the economic condition of farmers, the means of irrigation, and the enrichment of soil with high-yielding fertilisers affect this feature of agricultural development.

Per agricultural worker, the production of food grains

The human element has played a major role in agricultural development in Uttarakhand. This indicates average productivity per agricultural worker and, hence, worker efficiency. As agriculture is the mainstay of Uttarakhand's economy, the state has a large population. Food grain production is essential to a developed economy. Therefore, food grain production per agricultural worker is a good indicator of agricultural development in Uttarakhand. In Uttarakhand, the overall average food grain production per agricultural worker is 6.32 quintals. Udham Singh Nagar ranks highest, with 22.25 quintals per agricultural worker, while Chamoli ranks lowest, with 03.25 quintals per agricultural worker. These two districts are in *the Tarai* area of the Kumaon division and the Pindar basin of the Garhwal division.

The spatial distribution shows a core of high per-agricultural-worker food grain production across three districts of the region. In this category, Udham Singh Nagar was highest, followed by Haridwar (07.97) and Nainital (07.25) quintals of food grains per agricultural worker. In the Tarai belt, land productivity is very high (Table 1.2).

The state's seven districts fall into the moderate category. Dehra Dun, with 06.02 quintals of food grains per agricultural worker, scores the highest, followed by Champawat (05.58), Bageshwar (05.21), Pithoragarh (04.71), Almora (04.62), Tehri Garhwal (04.36), and Pauri Garhwal (03.91). Most districts are in the Sarju-Kali

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basin, while the rest lie in the Bhillangana and Alaknanda basins. This region has a large area under cultivation, but comparatively few agricultural workers.

Table 1.2 Standard Score Values of per Agricultural Worker Production of Food Grains (in quintals): 2004-05

Classes & Z-Score Values	No. of Districts	%	Districts (Z-Scores)
(i) High > 0.00	03	23.08	Udham Singh Nagar (3.32), Haridwar (0.34), Nainital (0.19)
(ii) Moderate - 0.50 to 0.00	07	53.85	Dehra Dun (-0.06), Champawat (-0.15), Bageshwar (-0.23), Pithoragarh (-0.34), Almora (-0.35), Tehri Garhwal (-0.41), Pauri Garhwal (-0.50)
(iii) Low < - 0.50	03	23.08	Rudraprayag (-0.55), Uttarkashi (-0.63), Chamoli (-0.64)

Source: Uttarakhand, Directorate of Economics & Statistics

The remaining three districts of Uttarakhand fall under the low category. Food grain production in this category ranges from 03.70 quintals in Rudraprayag district to 03.25 quintals in Chamoli district. Limited arable land, poor economic conditions for farmers, and limited communication systems hinder agricultural workers' efficiency in growing food crops. Because these districts fall within the Zaskar ranges of the Garhwal region, they face reduced efficiency in cultivating food grains at high altitudes. Thus, this remarkable situation is governed by many physical, social, economic, and demographic factors that vary spatially across the state. As a result, food-grain production also varies sharply. Hence, it is an important indicator of agricultural development in Uttarakhand.

Per cultivator, production of main fruits and flowers

Uttarakhand's bountiful nature has bestowed varied climatic conditions, ranging from subtropical to temperate. Agro-climatic suitability, coupled with an abundance of natural resource endowments, equips Uttarakhand with a unique comparative edge in the cultivation of a variety of fruit crops, sub-tropical as well as temperate, vegetables, traditional as well as exotic, flowers, etc. However, the horticulture industry faces low productivity and poor-quality produce on the one hand, and rising competition from other states on the other.

The main fruits produced in Uttarakhand include apples, pears, plums, peaches, walnuts, apricots, nashpati, adu, khumbani, lemons, mangoes, and strawberries. In contrast, flowers include varieties such as zarbera, karneshan, gladiolus, genda, rose, *rajnigandha,* etc. Most farmers grow these fruits and flowers along the margins of their farmland. Some land is used exclusively for producing fruits and flowers. Rich farmers own these pieces of land, give contracts to labourers and others, and take great care in production.

The southern part of Kumaon and the northern part of the Garhwal division are mainly known for the good production of fruits and flowers. As a result, the state averages 0.37 metric tons of fruits and flowers. Here, large gardens cover 186,660 hectares for fruits and 693.22 hectares for flowers. In production, Almora district ranked highest with 0.7 metric tons of fruits and flowers, while Rudraprayag, with a low rank, had 0.08 metric tons (Table 1.3).

Table 1.3 Standard Score Value of per Cultivator Production of Main Fruits and Flowers(in metric tons): 2006-07

Classes & Z-Score Values	No. of Districts	%	Districts (Z-Scores)
(i) High > 0.00	05	38.46	Almora (1.54), Chamoli (1.50), Haridwar (1.17), Uttarkashi (0.88), Nainital (0.88)
(ii) Moderate -0.50 to 0.00	02	15.38	Dehra Dun (-0.29), Champawat (-0.46)

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(iii) Low < - 0.50	06	46.16	Pithoragarh (-0.54), Bageshwar (-0.79), Udham Singh Nagar (-0.79), Pauri Garhwal (-0.92), Tehri Garhwal (-1.00), Rudraprayag (-1.21)

Source: Uttarakhand, Directorate of Economics & Statistics

The former lies in the Ramganga-Kosi basin, whereas the latter lies in the Mandakini basin. The highest category of fruit and flower production is recorded in Almora (0.74 quintals per cultivator), followed by Chamoli (0.72), Haridwar (0.65), Nainital (0.58), and Uttarkashi (0.58). These species are so popular that most production is exported directly to other countries. Because these states have favourable climatic conditions conducive to high fruit and flower growth, demand is strong in domestic and national markets. Thus, the marked unit of production, in quintals, across these districts indicates regional disparities in cultivation ratios. It is evident here that districts with high agricultural productivity are also known for producing major fruit and flower crops. The farmers in these districts use the land so rationally that they have commercialised agriculture and developed parts of it into fruit and flower orchards.

Only two districts fall in the moderate category: Dehra Dun, with 0.30 metric tons per cultivator, and Champawat, with 0.26 metric tons per cultivator. These districts are scattered in the western and eastern parts of the Garhwal and Kumaon divisions. These districts are spatially adjacent to high-category districts. Limited cultivable land in both districts affects the share of production allocated to fruits and flowers. The low-production districts, with ranges of 0.24 metric tons in Pithoragarh and 0.13 metric tons in Tehri Garhwal, rank sixth. Among these districts, Udham Singh Nagar (0.18 metric tons), Bageshwar (0.18 metric tons), and Pauri Garhwal (0.15 metric tons) rank second. These districts mostly occupy a contiguous area within the central Garhwal division. Here, farmers' limited engagement in fruit and flower cultivation hinders their growth.

Thus, it is concluded that fruit and flower production is dominant in districts where agricultural productivity, especially of cash crops, is high.

CONCLUSION

Thus, per-agricultural-worker food-grain production and per-hectare agricultural value reflect, respectively, the system's sustainability types and the peasantry's relative prosperity in different areas.

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