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Paritosh Kumar

Joint Directorate of Extension
Education, ICAR- Indian
Veterinary Research Institute,
Izatnagar, Uttar Pradesh, India

Vikash Kumar

Dairy Extension Division, ICAR-
National Dairy Research Institute,
Karnal, Haryana, India

Rakesh Choudhary

Department of Dairy Trade and
Dairy Business Management,
College of Dairy and Food
Technology, Bassi, Jaipur,
Rajasthan, India

Deepankar Pandey

Agronomy Section, ICAR-
National Dairy Research Institute,
Karnal, Haryana, India

Spatio-temporal dynamics of major millets (Shree Anna) cultivation in Uttarakhand

Paritosh Kumar, Vikash Kumar, Rakesh Choudhary and Deepankar Pandey

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Abstract

Millets are climate-resilient and nutrient-rich crops that play a crucial role in ensuring food security, nutritional security, and sustainable agriculture, particularly in the Himalayan region of India. This study analysed the spatio-temporal dynamics of major millets in Uttarakhand, Barnyard millet (*Echinochloa frumentacea*) and Finger millet (*Eleusine coracana*) cultivation across eleven millet-growing districts of Uttarakhand during 2020-21 to 2024-25. Secondary data on cultivated area, production, and productivity were obtained from the Department of Agriculture, Government of Uttarakhand. Descriptive statistics, Annual Growth Rate (AGR), Compound Annual Growth Rate (CAGR), and panel data regression models were employed to assess district-wise trends and temporal changes. Results revealed a continuous decline in the cultivated area of both crops during the study period. The area under Barnyard millet declined from 39,246 ha to 28,651 ha, while Finger millet decreased from 85,427 ha to 56,530 ha. Tehri Garhwal and Almora emerged as the leading Barnyard millet-producing districts, whereas Almora and Chamoli dominated Finger millet cultivation. Finger millet recorded a higher mean cumulative productivity (81.70 q ha^{-1}) than Barnyard millet (77.38 q ha^{-1}). AGR and CAGR analyses indicated similar declining trends in area and production for both crops; however, Finger millet exhibited a significantly higher CAGR in productivity ($p = 0.005$), suggesting superior long-term yield improvement. Panel regression analysis identified a significant temporal decline in cultivated area and production from 2022-23 onwards, whereas productivity remained relatively stable. The Hausman specification test supported the Random Effects model for all dependent variables. The findings highlight the need for targeted policy interventions, improved production technologies, and strengthened value chains to sustain millet cultivation and enhance climate-resilient agriculture in Uttarakhand.

Keywords: Shree anna, crop productivity, growth analysis, panel data analysis, climate-smart agriculture, Himalayan farming

1. Introduction

Millets are among the oldest cultivated cereal crops and have sustained human civilizations for thousands of years, particularly in arid, semi-arid, and mountainous regions where conventional cereals perform poorly. Owing to their adaptability to diverse agro-climatic conditions, low input requirements, and resilience to drought, heat, and marginal soils, millets have gained global recognition as climate-smart crops capable of enhancing food security, nutritional security, and sustainable agricultural development under changing climatic conditions (Food and Agriculture Organization [FAO], 2024; Intergovernmental Panel on Climate Change [IPCC], 2023) ^[6, 5]. Compared with rice and wheat, millets require less irrigation, fertilizers, and pesticides while maintaining stable productivity under environmental stress (FAO, 2024; Muthamilarasan & Prasad, 2021) ^[6, 10]. In addition to their environmental benefits, millets are rich in complex carbohydrates, dietary fibre, proteins, essential amino acids, minerals, vitamins, and antioxidants, and their low glycaemic index and gluten-free nature make them valuable for improving human health and combating malnutrition (Saleh *et al.*, 2013; Goron & Raizada, 2015; Taylor & Emmambux, 2008) ^[11, 7, 12]. Recognizing these advantages, the United Nations declared 2023 as the International Year of Millets to promote research, production, value addition, and sustainable millet-based food systems while contributing to several Sustainable Development Goals (FAO, 2023; United Nations, 2023) ^[8].

Corresponding Author:

Vikash Kumar

Dairy Extension Division, ICAR-
National Dairy Research Institute,
Karnal, Haryana, India

India is the world's largest producer of millets and cultivates diverse species, including pearl millet, finger millet, barnyard millet, foxtail millet, little millet, kodo millet, and proso millet across varied agro-ecological regions (FAO, 2024; Ministry of Agriculture & Farmers Welfare, 2024) ^[1, 11]. Millets play a crucial role in supporting the livelihoods of smallholder farmers, particularly in rainfed and tribal areas, and their cultivation has been strengthened through initiatives such as the National Food Security Mission (NFSM), the Sub-Mission on Nutri-Cereals, Rashtriya Krishi Vikas Yojana (RKVY), and other government programmes (Government of India, 2024). Among these, Barnyard millet (*Echinochloa frumentacea*) and Finger millet (*Eleusine coracana*) are nutritionally important and well suited to low-input production systems because of their resilience to climatic stress and adaptability to rainfed agriculture (Saleh *et al.*, 2013; Goron & Raizada, 2015) ^[11, 7].

Uttarakhand is one of the traditional centres of millet cultivation in India, where Barnyard millet and Finger millet are extensively grown under predominantly rainfed mountain farming systems (Government of Uttarakhand, 2024). These crops contribute to household food and nutritional security, livestock feeding, income generation, and the conservation of indigenous farming systems. However, millet cultivation in the state has undergone considerable changes due to rural outmigration, shrinking agricultural land, changing cropping patterns, labour shortages, wildlife damage, climatic variability, and evolving market conditions, resulting in substantial spatial and temporal variations in cultivated area, production, and productivity across districts. Previous studies have largely focused on the nutritional properties, agronomic practices, climate resilience, and growth trends of millets using descriptive statistics and Compound Annual Growth Rate (CAGR) (Muthamilarasan & Prasad, 2021; Saleh *et al.*, 2013) ^[10, 11]. However, district-level analyses using panel data remain limited. Therefore, this study examines the spatio-temporal dynamics of Barnyard millet and Finger millet cultivation across major millet-growing districts of Uttarakhand during 2020-21 to 2024-25 using descriptive statistics, Annual Growth Rate (AGR), Compound Annual Growth Rate (CAGR), and panel data regression. (Baltagi, 2021; Wooldridge, 2020) ^[14].

Objectives of the Study

The study was undertaken with the following specific objectives:

1. To analyse the temporal trends in area, production, and productivity of Barnyard millet and Finger millet across the major districts of Uttarakhand during 2020-21 to 2024-25.
2. To estimate the Annual Growth Rate (AGR) and Compound Annual Growth Rate (CAGR) of area, production, and productivity of Barnyard millet and Finger millet.
3. To examine district-specific temporal variations in millet cultivation using panel data regression models.

2. Materials and Methods

2.1 Study Area

The study was conducted in the state of Uttarakhand, India, located in the central Himalayan region between 28°43'–31°27' N latitude and 77°34'–81°02' E longitude. The state is characterized by diverse topography, ranging from the Shivalik foothills to the higher Himalayan ranges, with elevations varying from approximately 300 to over 7,000 m above mean sea level. Its varied agro-climatic conditions and predominantly rainfed farming systems provide favourable environments for cultivating traditional millets, particularly Barnyard millet (*Echinochloa frumentacea*) and Finger millet (*Eleusine coracana*). Out of 13

districts, the study included 11 millet-growing districts: Almora, Bageshwar, Chamoli, Champawat, Dehradun, Nainital, Pauri Garhwal, Pithoragarh, Rudrapur, Tehri Garhwal, and Uttarkashi excluding Haridwar and Udham Singh Nagar where the crop is not cultivated.

2.2 Data Source

The study was based exclusively on secondary data covering the agricultural years 2020-21 to 2024-25. District-wise annual data on area (ha), production (metric tonnes), and productivity (quintals ha⁻¹) of Barnyard millet and Finger millet were compiled from the Department of Agriculture, Government of Uttarakhand. The data were checked for consistency and completeness before analysis. The final dataset comprised observations for two millet crops across eleven districts over five consecutive years, forming a balanced panel dataset.

2.3 Research Design

An ex-post facto research design was adopted because the investigation relied entirely on historical secondary data without manipulating any study variables. This design is appropriate for analysing existing datasets to understand temporal changes and growth patterns in agricultural production systems.

2.4 Variables

The analysis considered three major indicators of millet cultivation:

- Area under cultivation (ha)
- Production (metric tonnes, MT)
- Productivity (quintals ha⁻¹)

Productivity was calculated as:

$$\text{Productivity (q ha}^{-1}\text{)} = \frac{\text{Production (MT)} \times 10}{\text{Area (ha)}}$$

where, production is expressed in metric tonnes (MT) and area in hectares (ha).

To assess growth performance, the following indicators were estimated:

- Annual Growth Rate (AGR, %)
- Compound Annual Growth Rate (CAGR, %)

AGR measures year-to-year changes in area, production, and productivity, whereas CAGR estimates the average annual rate of growth over the entire study period.

2.5 Statistical Analysis

Descriptive Statistics

Descriptive statistical measures, including mean, standard deviation, minimum, maximum, variance, and coefficient of variation, were computed to summarize the distribution and variability of area, production, productivity, AGR, and CAGR across districts and years.

Annual Growth Rate (AGR)

The year-to-year growth in area, production, and productivity was estimated as:

$$\text{AGR(\%)} = \frac{Y_t - Y_{t-1}}{Y_{t-1}} \times 100$$

where Y_t is the value in the current year and Y_{t-1} is the corresponding value in the previous year.

Compound Annual Growth Rate (CAGR)
Long-term growth performance was estimated using:

$$CAGR = \left(\frac{V_f}{V_i}\right)^{\frac{1}{n}} - 1$$

- where:
- V_i = initial value
 - V_f = final value
 - n = number of years

Panel Data Regression Analysis

Panel data regression analysis was employed to examine temporal changes in millet cultivation while accounting for district-specific heterogeneity. Separate panel regression models were estimated for cultivated area, production, and productivity, with crop type and year included as explanatory variables. The general model is expressed as:

$$Y_{it} = \alpha + \beta_1 Crop_{it} + \beta_2 Year_{it} + \mu_i + \varepsilon_{it}$$

- where:
- Y_{it} = cultivated area, production, or productivity for district i in year t
 - α = intercept
 - β = regression coefficients
 - $Crop_{it}$ = crop type (Barnyard millet or Finger millet)
 - $Year_{it}$ = study year
 - μ_i = district-specific effect
 - ε_{it} = random error term

Model Selection and Diagnostic Tests

Initially, three panel estimators, Pooled Ordinary Least Squares (Pooled OLS), Fixed Effects Model (FEM), and Random Effects Model (REM) were estimated. The Hausman specification test was employed to identify the most appropriate model. Since the Hausman test was non-significant ($p > 0.05$) for all dependent variables, the Random Effects Model was selected for interpretation. Diagnostic tests for heteroscedasticity, serial correlation, multicollinearity, and cross-sectional dependence were performed to evaluate model assumptions. Where necessary, heteroscedasticity-consistent (robust) standard errors were used

to improve the reliability of the estimated coefficients.

Software

Data management, calculation of AGR and CAGR, and preliminary analyses were performed using Microsoft Excel 2021. Statistical analyses, including descriptive statistics, panel data regression, model diagnostics, and hypothesis testing, were conducted using R software (Version 4.x) with the packages readxl, tidyverse, plm, lmtree, sandwich, and stargazer.

3. Results and Discussion
3.1 Descriptive Statistics of Millet Cultivation

Table 1 presents the descriptive statistics of area, production, productivity, Annual Growth Rate (AGR), and Compound Annual Growth Rate (CAGR) of Barnyard millet and Finger millet cultivated across the selected districts of Uttarakhand during 2020–21 to 2024–25. The average cultivated area was 4,737.63 ha, ranging from 12 to 25,440 ha, while mean production was 7,201.02 MT, with values varying from 18 to 31,625 MT. The relatively high standard deviations for area (4,845.61 ha) and production (6,658.65 MT) indicate considerable spatial variation in millet cultivation across districts. In contrast, productivity averaged 15.91 q ha⁻¹ and showed comparatively lower variability (SD = 2.30 q ha⁻¹), suggesting relatively stable production efficiency despite differences in cultivated area. Similar spatial heterogeneity in agricultural production has been reported in district-level analyses of Indian cropping systems (Government of India, 2024) [9]. The mean AGR for area (−8.27%) and production (−6.75%) indicates an overall decline in millet cultivation during the study period, whereas productivity recorded a marginal positive annual growth (1.29%). Likewise, the average CAGR of area (−9.87%) and production (−9.31%) remained negative, while productivity exhibited a slight positive growth (0.62%), indicating that improvements in production efficiency partially compensated for the reduction in cultivated area. The wide range observed in AGR and CAGR values reflects substantial district-wise variation in growth performance, which may be associated with differences in agro-climatic conditions, technology adoption, resource availability, and management practices (Baltagi, 2021; Wooldridge, 2020) [4, 14]. These findings highlight the need for location-specific interventions to improve the sustainability and productivity of millet cultivation in Uttarakhand.

Table 1: Descriptive statistics of area, production, productivity, AGR, and CAGR of Barnyard and Finger millet (2020–21 to 2024–25)

Variable	N	Minimum	Maximum	Mean	Standard Deviation	Variance
Area (ha)	110	12	25,440	4,737.63	4,845.61	23,479,918.38
Production (MT)	110	18	31,625	7,201.02	6,658.65	44,337,611.12
Productivity (q ha ⁻¹)	110	11.22	24.72	15.91	2.30	5.31
AGR Area (%)	88	-61.04	133.65	-8.27	22.32	498.26
AGR Production (%)	88	-64.34	162.40	-6.75	27.40	750.49
AGR Productivity (%)	88	-21.22	42.96	1.29	12.38	153.34
CAGR Area (%)	22	-44.22	3.67	-9.87	9.89	97.74
CAGR Production (%)	22	-45.09	4.96	-9.31	10.27	105.49
CAGR Productivity (%)	22	-4.98	6.37	0.62	3.19	10.19

3.2 District-wise Trends in Area, Productivity and Growth Performance of Barnyard Millet and Finger Millet

Table 2 presents the district-wise area under Barnyard millet cultivation in Uttarakhand during 2020-21 to 2024-25. Tehri Garhwal recorded the largest cumulative cultivated area (49,235 ha), followed by Almora (45,640 ha) and Pauri Garhwal (27,375

ha), indicating their prominence as major Barnyard millet-producing districts. In contrast, Dehradun (260 ha) and Nainital (749 ha) had the smallest cultivated areas throughout the study period. At the state level, the total area under Barnyard millet declined from 39,246 ha in 2020-21 to 28,651 ha in 2024-25, representing an overall reduction of approximately 27 percent over five years.

Table 2: District-wise area under Barnyard millet

District	2020–21	2021–22	2022–23	2023–24	2024–25	Total
Almora	10,600	9,943	8,783	8,531	7,783	45,640
Bageshwar	226	317	278	236	169	1,226
Chamoli	3,425	3,281	3,365	3,182	3,316	16,569
Champawat	718	772	508	607	454	3,059
Dehradun	124	77	30	17	12	260
Nainital	122	104	243	159	121	749
Pauri Garhwal	7,965	6,464	5,169	4,091	3,686	27,375
Pithoragarh	883	595	608	497	451	3,034
Rudraprayag	2,636	3,197	3,138	3,404	3,045	15,420
Tehri Garhwal	10,986	10,792	10,186	9,159	8,112	49,235
Uttarkashi	1,561	2,052	1,848	1,769	1,502	8,732
Total	39,246	37,594	34,156	31,652	28,651	171,299

Table 3 presents the district-wise area under Finger millet cultivation in Uttarakhand during 2020-21 to 2024-25. Almora recorded the highest cumulative cultivated area (101,529 ha), followed by Chamoli (46,118 ha) and Pauri Garhwal (43,544 ha), indicating that these districts are the principal Finger millet-growing regions of the state. Conversely, Dehradun (2,138 ha) and Nainital (5,911 ha) recorded the lowest cumulative cultivated areas. At the state level, the total area under Finger millet declined steadily from 85,427 ha in 2020-21 to 56,530 ha in 2024-25, representing an overall reduction of approximately 33.8 percent during the study period.

Table 3: District-wise area (ha) under Finger millet cultivation in Uttarakhand during 2020–21 to 2024–25

District	2020–21	2021–22	2022–23	2023–24	2024–25	Total
Almora	25,440	24,480	19,744	17,078	14,787	101,529
Bageshwar	4,853	4,841	4,475	3,936	3,163	21,268
Chamoli	9,140	9,975	8,920	9,120	8,963	46,118
Champawat	3,610	3,006	2,359	2,131	2,182	13,288
Dehradun	505	566	417	419	231	2,138
Nainital	1,437	1,531	1,270	759	914	5,911
Pauri Garhwal	13,182	10,009	7,927	6,449	5,977	43,544
Pithoragarh	6,778	5,299	5,421	5,183	4,762	27,443
Rudraprayag	6,445	5,772	6,118	5,444	6,223	30,002
Tehri Garhwal	9,168	7,471	7,320	7,097	5,659	36,715
Uttarkashi	4,869	4,973	4,203	4,170	3,669	21,884
Total	85,427	77,923	68,174	61,786	56,530	349,840

Table 4 presents the district-wise cumulative productivity of Barnyard millet and Finger millet in Uttarakhand during 2020-21 to 2024-25. Among Barnyard millet-growing districts, Uttarkashi recorded the highest cumulative productivity (93.20 q ha⁻¹), followed by Chamoli (85.65 q ha⁻¹) and Tehri Garhwal (84.11 q

ha⁻¹), whereas Almora (65.86 q ha⁻¹) and Nainital (66.94 q ha⁻¹) exhibited comparatively lower productivity. For Finger millet, the highest cumulative productivity was observed in Champawat (99.85 q ha⁻¹), followed by Dehradun (92.60 q ha⁻¹) and Uttarkashi (90.18 q ha⁻¹), while Almora (63.07 q ha⁻¹) recorded the lowest value. Overall, the mean cumulative productivity of Finger millet (81.70 q ha⁻¹) exceeded that of Barnyard millet (77.38 q ha⁻¹), indicating comparatively better yield performance of Finger millet across the study districts.

Table 4: District-wise cumulative productivity (q ha⁻¹) of Barnyard millet and Finger millet in Uttarakhand (2020–21 to 2024–25)

District	Barnyard Millet	Finger Millet
Almora	65.86	63.07
Bageshwar	79.78	75.11
Chamoli	85.65	79.61
Champawat	80.47	99.85
Dehradun	77.73	92.60
Nainital	66.94	79.83
Pauri Garhwal	70.03	74.25
Pithoragarh	72.29	80.80
Rudraprayag	75.10	75.32
Tehri Garhwal	84.11	88.07
Uttarkashi	93.20	90.18
Mean	77.38	81.70

Table 5 compares the Annual Growth Rate (AGR) and Compound Annual Growth Rate (CAGR) of Barnyard millet and Finger millet during 2020-21 to 2024-25. The mean AGR for area, production, and productivity did not differ significantly between the two crops ($p > 0.05$), indicating comparable short-term growth patterns. Similarly, the mean CAGR for cultivated area and production showed no statistically significant differences ($p > 0.05$), suggesting that both crops experienced a similar long-term decline in area and production over the study period. However, a significant difference was observed for CAGR of productivity ($t = -3.162, p = 0.005$), with Finger millet recording a positive mean CAGR ($2.42 \pm 2.74\%$) compared with the negative CAGR of Barnyard millet ($-1.18 \pm 2.60\%$). This indicates that, despite comparable reductions in cultivated area and production, Finger millet demonstrated significantly better long-term improvement in productivity than Barnyard millet during the study period. Similar trends have been reported in studies highlighting the superior yield stability and productivity gains of Finger millet under improved crop management and climate-resilient production systems (Food and Agriculture Organization of the United Nations, 2023) ^[13].

Table 5: Comparison of Annual Growth Rate (AGR) and Compound Annual Growth Rate (CAGR) between Barnyard Millet and Finger Millet

Variable	Barnyard Millet (Mean $\pm$ SD)	Finger Millet (Mean $\pm$ SD)	Test Statistic	p-value	Interpretation
AGR Area (%)	-7.47 ± 28.81	-9.07 ± 13.29	$t = 0.335$	0.739	NS
AGR Production (%)	-7.55 ± 33.74	-5.95 ± 19.47	$U = 831.0$	0.253	NS
AGR Productivity (%)	-0.38 ± 13.43	2.97 ± 11.14	$t = -1.272$	0.207	NS
CAGR Area (%)	-9.82 ± 13.15	-9.91 ± 5.68	$U = 47.0$	0.375	NS
CAGR Production (%)	-10.86 ± 13.54	-7.77 ± 5.75	$U = 54.0$	0.670	NS
CAGR Productivity (%)	-1.18 ± 2.60	2.42 ± 2.74	$t = -3.162$	0.005	Significant

Note: Values are presented as mean $\pm$ standard deviation. Independent samples t -test was used for normally distributed variables, whereas the Mann-Whitney U test was used for variables violating normality. NS = Not significant ($p \geq 0.05$).

Table 6: Random Effects panel regression estimates for area, production and productivity of Barnyard millet and Finger millet in Uttarakhand (2020–21 to 2024–25)

Variables	Area (ha)	Production (MT)	Productivity (q ha ⁻¹)
Intercept	4043.85** (1402.55)	5927.21**	15.322***
Finger Millet	3246.20† (1958.81)	4857.67†	0.864
Year 2021–22	-416.18	-370.23	-0.191
Year 2022–23	-1015.59**	-1245.41*	-0.003
Year 2023–24	-1419.77***	-1760.45***	0.494
Year 2024–25	-1795.09***	-2399.05***	0.465
Observations	110	110	110
District × Crop Panels	22	22	22
R ²	0.266	0.243	0.043
Model Statistic	$\chi^2 = 37.657***$	$\chi^2 = 33.342***$	$\chi^2 = 4.713$
Selected Model	Random Effects	Random Effects	Random Effects

Note: Values in parentheses represent standard errors. † $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table 7: Hausman specification test for panel regression model selection

Dependent variable	χ^2	df	p-value	Selected model
Area	0.000	4	1.000	Random Effects
Production	0.000	4	1.000	Random Effects
Productivity	0.000	4	1.000	Random Effects

3.6 Panel Regression Analysis

The results of the Random Effects panel regression model are presented in Table 6, while the Hausman specification test used for model selection is reported in Table 7. Panel regression analysis was performed to examine temporal changes in cultivated area, production, and productivity of Barnyard millet and Finger millet across the major millet-growing districts of Uttarakhand during 2020–21 to 2024–25. The Hausman specification test (Table 7) indicated that the Random Effects model was the most appropriate specification for all three dependent variables, as the null hypothesis of no systematic difference between the Fixed Effects and Random Effects estimators could not be rejected ($p = 1.000$). As shown in Table 6, the Random Effects model indicated that Finger millet occupied a relatively larger cultivated area than Barnyard millet, although the difference was only marginally significant ($\beta = 3246.20$, $p < 0.10$). Cultivated area exhibited a significant declining trend from 2022–23 onwards, with the largest decline observed during 2024–25 ($\beta = -1795.09$, $p < 0.001$). Similarly, production decreased significantly during the later years of the study period, indicating a gradual reduction in millet output across districts. In contrast, productivity remained statistically unchanged across years and between crop types, suggesting that yield performance was relatively stable despite reductions in cultivated area and total production. Overall, the Random Effects model explained 26.60 percent of the variation in cultivated area, 24.30 percent in production, and 4.3 percent in productivity (Table 6).

4. Conclusion

The study revealed a consistent decline in the cultivated area and production of Barnyard millet and Finger millet across the major millet-growing districts of Uttarakhand during 2020–21 to 2024–25, despite relatively stable productivity. Finger millet demonstrated significantly better long-term productivity growth than Barnyard millet, indicating greater resilience and yield improvement under prevailing production conditions. The panel regression further confirmed a significant temporal decline in area and production from 2022–23 onwards, highlighting the need for targeted interventions to reverse the shrinking cultivation of these climate-resilient crops. Promoting improved varieties, climate-

smart production technologies, quality seed systems, value addition, and market linkages can enhance millet cultivation and contribute to sustainable mountain agriculture, nutritional security, and climate resilience in the Himalayan state of Uttarakhand (FAO, 2023; ICAR-Indian Institute of Millets Research [ICAR-IIMR], 2019; Intergovernmental Panel on Climate Change [IPCC], 2023) ^[5].

References

- Ministry of Agriculture and Farmers Welfare. Agricultural Statistics at a Glance 2024. <https://agriwelfare.gov.in>.
- Department of Agriculture, Government of Uttarakhand. Agricultural Statistics at a Glance 2024-25. <https://agriculture.uk.gov.in>.
- Department of Agriculture, Government of Uttarakhand. Agricultural Statistics. <https://agriculture.uk.gov.in>.
- Baltagi BH. Econometric analysis of panel data. 6th ed. Cham: Springer; 2021.
- Intergovernmental Panel on Climate Change. Climate change 2023: Synthesis report. <https://www.ipcc.ch/report/ar6/syr/>.
- Food and Agriculture Organization of the United Nations. FAOSTAT. <https://www.fao.org/faostat/en/>.
- Goron TL, Raizada MN. Genetic diversity and genomic resources available for the small millet crops to accelerate a new green revolution. *Frontiers in Plant Science*. 2015;6:157.
- United Nations. International Year of Millets 2023. <https://www.un.org/en/observances/year-of-millet>.
- Indian Institute of Millets Research. Millets in the Indian Himalaya. <https://www.millet.res.in/publications.php>.
- Muthamilarasan M, Prasad M. Small millets for enduring food security amidst pandemics. *Trends in Plant Science*. 2021;26(1):33-40.
- Saleh ASM, Zhang Q, Chen J, Shen Q. Millet grains: Nutritional quality, processing, and potential health benefits. *Comprehensive Reviews in Food Science and Food Safety*. 2013;12(3):281-295.
- Taylor JRN, Emmambux MN. Gluten-free foods and beverages from millets. In: Arendt EK, Dal Bello F, editors. *Gluten-free cereal products and beverages*. London: Academic Press; 2008. p. 119-148.
- Food and Agriculture Organization of the United Nations. The International Year of Millets 2023. <https://www.fao.org/millet-2023>.
- Wooldridge JM. Introductory econometrics: A modern approach. 7th ed. Boston: Cengage Learning; 2020.