

RESEARCH ARTICLE

Adoption Analysis of District Level Beekeeping Development Scheme: A Comparative Study of Doiwala and Raipur Blocks of Dehradun, Uttarakhand

¹Nishtha Vishwakarma, ²R.S.Negi, ³Nabdeep Singh*, ⁴Santosh Singh*

Department of Rural Technology, HNB Garhwal University (A Central University), Srinagar Garhwal, Uttarakhand

ABSTRACT

Beekeeping has emerged as a significant agriculture-based livelihood enterprise in India, offering income diversification opportunities for small and marginal farmers, rural youth, and women. This study presents a comparative analysis of the adoption of the District Level Beekeeping Development Scheme implemented by the Department of Horticulture and Food Processing (DHFP), Uttarakhand, across Doiwala and Raipur blocks of Dehradun district. A systematic sample of 60 beneficiaries (30 per block) was drawn from official DHFP records for the period 2024-2025. Primary data were collected through structured questionnaires, personal interviews, and field observations, while secondary data were sourced from government records and published literature. Statistical analyses included frequency distributions, percentages, standard deviation, independent-sample t-tests, and p-values. Results indicate that beekeepers are predominantly middle-aged men with intermediate to graduate-level education, while youth, women, and socially marginalized communities remain underrepresented. Technologically, universal adoption of *Apis mellifera* and Langstroth hives was observed in both blocks, reflecting uptake of modern practices. Comparative mean analysis of scheme adoption revealed that Raipur beneficiaries demonstrated significantly higher awareness ($p = 0.0268$), greater participation in pre-distribution training ($p = 0.0177$), and greater satisfaction with the bee boxes provided ($p = 0.0373$). These findings underscore that effective awareness outreach and pre-training interventions are pivotal determinants of scheme success. Strengthening institutional support, cooperative marketing, and capacity-building initiatives is recommended to enable inclusive and sustainable apicultural development across both blocks.

Received: 09 Apr 2026

Revised: 01 Jun 2026

Accepted: 03 Jul 2026

Keywords: Apiculture, Beekeeping adoption, District Level Scheme, *Apis mellifera*, Scheme

INTRODUCTION

The term “apiculture” derives from the Latin *apis*, meaning “bee,” combined with the suffix “culture,” as in “agriculture,” referring to the practice of rearing bees in managed colonies

(Kieliszek et al., 2023). Apiculture is the broader, more scientific discipline encompassing all aspects of cultivating, managing, and studying honeybees and their products (Powrel & Mishra, 2024). In

*Corresponding author mail: singhrawat.santosh@gmail.com; nabdeepsinghrananavi@gmail.com



Copyright: © The Author(s), 2026. Published by Madras Agricultural Students' Union in Madras Agricultural Journal (MAJ). This is an Open Access article, distributed under the terms of the Creative Commons Attribution 4.0 License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited by the user.

addition to the practical activity of maintaining bee colonies, apiculture also encompasses research, education, conservation, and the development of new technologies (Iatridou et al., 2019; Lin et al., 2025). Furthermore, apiculture highlights the integral role of bees in ecosystems, particularly their contribution to biodiversity and their significance as pollinators in agricultural systems (Bradbear, 2009; Hailay & Panhwar, 2024). Bees, as primary pollinators, are integral to the reproductive success and genetic diversity of both wild and cultivated flora, thereby underpinning the structure and resilience of terrestrial ecosystems (Lin et al., 2025; Pepinelli et al., 2025).

Among agro-based subsidiary occupations, beekeeping is distinguished by its unique combination of practical skill and technical expertise, making it simultaneously a profitable sideline and, where desired, a full-time occupation (Bihonegn et al., 2021; Ghosh et al., 2025). Unlike many other agricultural professions that require significant land, labour, and capital investment, beekeeping demands comparatively less intensive effort, making it an attractive and accessible option for small, marginal, and landless farmers as well as unemployed youth (Tesema et al., 2023; Ramana et al., 2025). The enterprise can be initiated with readily available equipment and tools, frequently sourced locally, and does not substantially compete with other components of the farming system for resources (Bihonegn et al., 2021; Schouten et al., 2019). It is a viable livelihood strategy for a diverse population and has been shown to contribute meaningfully to household income as a subsidiary enterprise (Mulatu et al., 2021; Moomen & Odame 2023). Beekeeping demands minimal initial investment but offers substantial returns, as a single hive can rapidly produce honey and other marketable products, enabling quick, multiple income generation (Nayak et al., 2024). It offers comparatively immediate financial returns compared with many other agriculture-related activities and can be adopted as a supplementary enterprise to augment the earnings of low-income individuals (Tesema et al., 2023; Mulatu et al., 2021). Its integrated approach with agriculture ensures a more sustainable and productive farming system through pollination services and diversified household income (Mushonga et al., 2019; Singh et al., 2024). It has emerged as a significant and increasingly adopted enterprise, contributing to the enhancement of farmers' incomes (Shyam et al., 2023).

Despite these advantages, India currently harnesses only about 10% of its vast apicultural potential, which could support up to 120 million bee colonies and create sustainable self-employment for more than 6 million rural and tribal households. Full realisation of this capacity promises annual production exceeding 1.2 million tonnes of honey and around 15,000 tonnes of beeswax (Abrol, 2023). With strategic intervention and enhanced regulatory frameworks, India's honey export sector has the potential to reach Rs. 1,500 crore by 2030, solidifying its role as a major player in the global honey market (Manoj et al., 2023).

Recognizing the significance of beekeeping in 2016, Prime Minister Narendra Modi launched the "Sweet Revolution" (Mitthi Kranti) production of honey and other by-products (ClearIAS, 2024). In response, the Government of India approved the National Beekeeping & Honey Mission (NBHM), a Central Sector Scheme led by the National Bee Board (NBB) under the Ministry of Agriculture & Farmers' Welfare, launched under Atmanirbhar Bharat (FY 2020-21 to 2022-23) and extended to FY 2025-26 (RAU'S IAS, 2025). NBHM's main objectives include holistic development of beekeeping industry for income and employment generation among agricultural and non-agricultural households, enhancement of agricultural/horticultural production, development of infrastructure through Integrated Beekeeping Development Centres (IBDCs), honey testing and bee disease laboratories, custom hiring centres and Api-therapy centres, and empowerment of women through beekeeping (Press Information Bureau, 2021) (Singh, et al., 2025a).

Uttarakhand has emerged as a leading state in honey production. The Government of Uttarakhand has also consistently taken initiatives to support beekeepers and promote beekeeping in the state. In 2018, the 'Uttarakhand Beekeeping Policy' was implemented, under which training, financial assistance, and subsidies were provided, with the objective of achieving a 30% increase in honey production by 2025. Consequently, more than 10,000 beekeepers benefited through training and equipment (Manoj et al., 2023). Also launched the 'Maun Palan Yojana' to promote self-employment among unemployed youth. Under the State Horticulture Mission, this scheme facilitates the establishment of honey production units across the state and provides an 80% subsidy to young beekeepers. More recently,

Chief Minister Pushkar Singh Dhami has promoted beekeeping in the state, describing the hilly regions as suitable for producing honey with medicinal properties and urged residents to take up beekeeping to improve their livelihoods (ANI, 2026).

Department of Horticulture, Uttarakhand

The Horticulture Department of Uttarakhand has launched a comprehensive scheme to promote beekeeping and generate employment across the state. This scheme helps farmers and entrepreneurs establish sustainable enterprises by providing a 40% government subsidy (Rs. 2,000 per box) on equipment and bee colonies. Farmers in the plains receive up to 50 boxes, and those in the hilly areas receive up to 25 boxes. The department also provides a 7-day training program, with each participant receiving a subsidy of Rs. 1,050 (Rs. 100 per day, and an additional Rs. 350) (Government of Uttarakhand, 2023).

Department of Horticulture and Food Processing

The Department of Horticulture and Food Processing (DHFP), Dehradun, has launched a 'District Level Scheme' for the development and support of beekeeping and to generate sustainable employment across the state. The scheme provides each beneficiary with an 80% subsidy for 4 bee boxes and a 7-day training (Rs. 350 per week), equipping participants with the skills necessary for successful operations in Uttarakhand (Department of Horticulture and Food Processing, 2023).

Given the scheme's potential impact on rural livelihoods, agricultural sustainability, and the promotion and the development of beekeeping, it became imperative to conduct an empirical assessment of its implementation and effectiveness at the grassroots level. The need to understand how this well-structured policy translates into tangible benefits for beekeepers, particularly regarding awareness, adoption, and satisfaction, motivated the decision to conduct a comprehensive survey. The objectives aim to assess the socio-economic and demographic characteristics of beekeepers and to evaluate and compare the sources of awareness, adoption, participation, and satisfaction regarding the program. 'District Level Scheme' for Beekeeping Development and Support under DHFP among beekeepers in Doiwala and Raipur blocks of Dehradun, Uttarakhand.

MATERIAL AND METHODOLOGY

Study Area and Sampling Technique

Dehradun district of Uttarakhand, located in the Himalayan foothills, was selected as the study area due to its favourable climate and biodiversity, which support beekeeping activities. Doiwala and Raipur blocks were purposively and randomly selected for their blend of traditional and modern beekeeping practices and their proximity to Dehradun city. Villages were chosen using an official list of beekeepers participating in the 'District Level Scheme' for Beekeeping Development and Support under DHFP, ensuring data accuracy. From these villages, 60 beneficiaries, 30 from each block, were systematically selected from the lists provided by the horticultural officers during the period of 2024-2025.

Data Collection Method

Primary data were gathered through PRA tools, including structured questionnaires, interviews, and field observations with beekeepers.

Statistical Analysis

Appropriate Scaling techniques were used to measure the variables in this research. The statistical techniques used for data analysis and interpretation were as follows: frequencies, percentages, standard deviation, independent-samples t-test, and p-value.

RESULTS AND DISCUSSION

RESULT

The socio-economic profile of beekeepers

Table 1 presents the results by the socioeconomic profile of the beekeepers. The majority of beekeepers in Doiwala and Raipur are between 41 and 60 (33.33% and 46.67%, respectively). There was a notable gender-based distinction between the Doiwala and Raipur blocks. Only 26.67% of beekeepers in Doiwala were women, compared to 73.33% who were men. In contrast, 90% of the beekeepers in Raipur were men, with only 10% representing women. The General Category comprised 76.67% of all beekeepers in both blocks. In Doiwala and Raipur, the Other Backward Class (OBC) category comprised 16.67% and 13.33% of the population, respectively, for a total percentage of 15.0. The percentage of Scheduled Caste people stayed at 6.67% in both blocks. While they made up 3.33% of the population in Raipur block, there were no Scheduled Tribe responders in Doiwala block. With 33.33% of respondents, graduation was the most common educational category in the Doiwala block. At 36.67%, the intermediate level

Table No. 1. Socio-economic profile of beekeepers

	Categories	Doiwala		Raipur		Total	
		F	%	F	%	F	%
Age	18-30	8	26.67	5	16.67	13	21.67
	31-40	7	23.33	10	33.33	17	28.33
	41-60	10	33.33	14	46.67	24	40.00
	More than 61	5	16.67	1	3.33	6	10.00
	Mean	2.400		2.367		2.383	
Standard Deviation		1.052		0.795		0.933	
Gender	Categories	F	%	F	%	F	%
	Female	8	26.67	3	10.00	11	18.33
	Male	22	73.33	27	90.00	49	81.67
Mean		1.733		1.900		1.817	
Standard Deviation		0.442		0.300		0.387	
Caste	Categories	F	%	F	%	F	%
	General	23	76.67	23	76.67	46	76.67
	OBC	5	16.67	4	13.33	9	15.00
	SC	2	6.67	2	6.67	4	6.67
	ST	0	0.00	1	3.33	1	1.67
Mean		1.300		1.367		1.333	
Standard Deviation		0.586		0.137		0.675	
Education	Categories	F	%	F	%	F	%
	Non-Formal	0	0.00	0	0.00	0	0
	Primary	0	0.00	0	0.00	0	0
	Secondary	2	6.67	3	10.00	5	8.33
	High School	4	13.33	7	23.33	11	18.33
	Intermediate	8	26.67	11	36.67	19	31.67
	Graduation	10	33.33	5	16.67	15	25.00
	Post-Graduation	5	16.67	4	13.33	9	15.00
	Ph.D.	1	3.33	0	0.00	1	1.67
Mean		5.500		5.000		5.250	
Standard Deviation		0.204		1.155		1.206	
Occupation	Categories	F	%	F	%	F	%
	Farmer	12	40	13	43.33	25	41.67
	Civil Service	5	16.67	3	10.00	8	13.33
	Private job	8	26.67	12	40.00	20	33.33
	Laborer	1	3.33	6	20.00	7	11.67
	Self-employed/Entrepreneur	3	10.00	5	16.67	8	13.33
	Unemployed	5	16.67	2	6.67	7	11.67

F-Frequency, %-Percentage (Data Source: Primary Data)

had the most prominent share in Raipur. The most prevalent educational level, accounting for 31.67% of the total data from both blocks, was intermediate education, followed by graduation at 25.00%. In terms of occupation, the Raipur block had greater rates of

self-employment (16.67%), labor work (20.00%), private employment (40.00%), and farming (43.33%). On the other hand, Doiwala also revealed a significant percentage of respondents who were farmers (40.00%) and had relatively



higher representation in both unemployment and civil service jobs (16.67%). When the data from both blocks were merged, farming accounted for 41.67% of respondents, with private work coming in second at 33.33%.

Beekeeping Adoption

The majority of beekeepers were relatively new to the sector, as seen by the significant percentage of beekeepers (63.33%) who had only one to five years of experience. In comparison with Raipur (50.00%), this percentage was especially high in Doiwala (76.67%). The analysis also showed that 11.67% of beekeepers had 11–15 years of experience, whereas just 6.67% had 6–10 years of experience. Just 5% of the beekeepers had between 16 and 20 years of experience, and they were located only in Raipur (Figure 1). *Apis mellifera* was used by every beekeeper in Doiwala and Raipur, demonstrating the widespread acceptance of this European honeybee species in the study area. The Asian honeybee, *Apis cerana indica*, on the other hand, showed a more varied adoption pattern, with 23.33% of beekeepers in Doiwala and 26.67% in Raipur raising this local species. In both blocks, the overall adoption rate of *A. cerana indica* was 25%. (Figure 2). In Doiwala, only 6.67% of beekeepers had more than 40 boxes, 13.33% had 11–20 boxes, and 80.00% had 1–10 boxes. The prevalence of larger commercial operations in the area is demonstrated by the fact that in Raipur, 53.33% of beekeepers had 1–10 boxes, 16.67% had 21–30 boxes, 6.67% had 31–40 boxes, and 23.33% had more than 40 boxes (Figure 3). Langstroth hives were adopted 100% of the time in both Doiwala and Raipur. There was relatively little use of traditional hives; in Doiwala, three beekeepers utilized wall hives (10.00%), while only one beekeeper used log hives (3.33%). Marthandam and Jyoalikot hives were not used by any beekeepers in the study area (Figure 4). Subsistence beekeeping was the most common type of beekeeping in Doiwala, accounting for 46.67% of all beekeepers. Commercial beekeeping only made up 10.00%, while sideline beekeeping came in second at 43.33%. It is evident from Doiwala's high rate of subsistence beekeeping that people in this area primarily produce honey for domestic and regional needs. Commercial beekeeping accounted for 46.67% of all beekeeping in Raipur, followed by sideline beekeeping (36.67%) and subsistence beekeeping (16.67%) (Figure 6). With a total production rate of 95.00%, mustard honey was the most widely produced

kind. With 66.67% of the total yield, multi-flora honey came in second. Other kinds of honey accounted for 58.33% of total production and were more common in Raipur (70.00%) than in Doiwala (46.67%) (Figure 5). The majority of beekeepers in both areas produced moderate amounts of honey; the largest percentage (51.67%) produced 10–50 kg a year. This category included 56.67% of beekeepers in Doiwala and 46.67% in Raipur. Interestingly, compared to just 6.67% in Doiwala, 23.33% of beekeepers in Raipur produced more than 600 kg of honey annually (Figure 7). Based on the findings, 51.67% of beekeepers reported that the most typical price range for honey in the study area was between Rs. 201 and Rs. 400/kg. There was a notable regional difference: only 30.00% of beekeepers in Doiwala sold honey in this price range, compared to 73.33% in Raipur. With 26.67% of honey sold for less than Rs. 100/kg and 20.00% sold for Rs. 401–600, Doiwala showed a broader range of price categories. Interestingly, only Doiwala beekeepers sold honey in the higher-priced segments (6.67% at Rs. 601–800/kg and 10.00% at Rs. 801–1000/kg). Regarding income from beekeeping, 26.67% of beekeepers earned an annual income between Rs. 5,000 and 10,000, while 21.67% earned between Rs. 10,000 and 50,000 annually. In Raipur, 16.67% of beekeepers earned between Rs. 50,000 and 1 lakh annually, compared to 10.00% in Doiwala. Furthermore, 11.67% of the total respondents belonged to the income category above Rs. 1.50 lakh, including 16.67% in Raipur and 6.67% in Doiwala. This disparity may be attributed to the fact that beekeepers in Raipur possessed a larger number of bee boxes, resulting in higher average annual production, with a mean value of 2.600 in Raipur compared to 1.633 in Doiwala (Figure 9).

Comparing Scheme Adoption Status among Beekeepers

Regarding the adoption status of the “District Level Scheme” for Beekeeping Development and Support under DHFP, the comparative mean analysis of scheme adoption between Doiwala and Raipur blocks revealed differences in respondents' participation, awareness, and satisfaction regarding various components of the beekeeping scheme. The results are shown in Table 2. The awareness and outreach channels used to introduce the concept differed significantly between the two blocks. Raipur had a higher mean score (3.30) than Doiwala

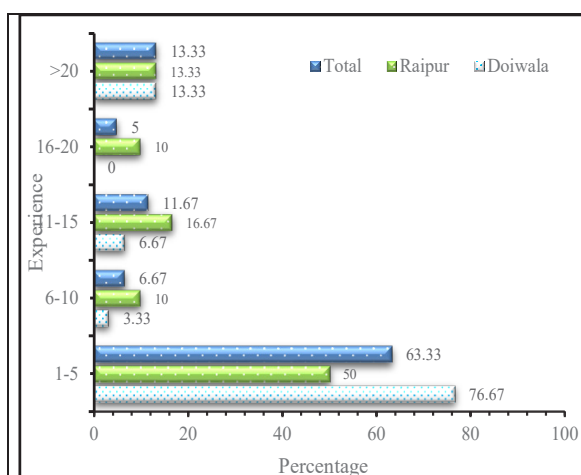


Figure 1: Experience in Beekeeping

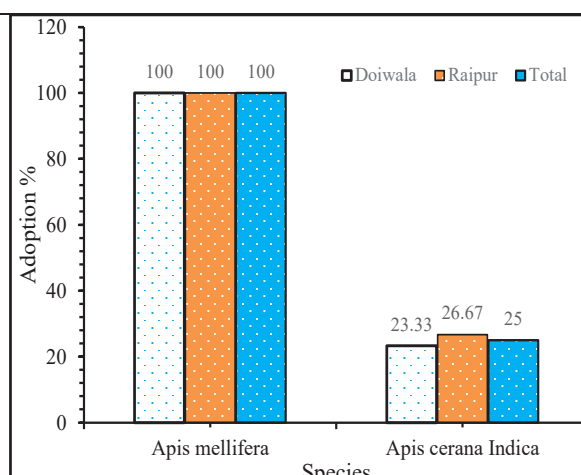


Figure 2: Adoption Rate of Bee Species

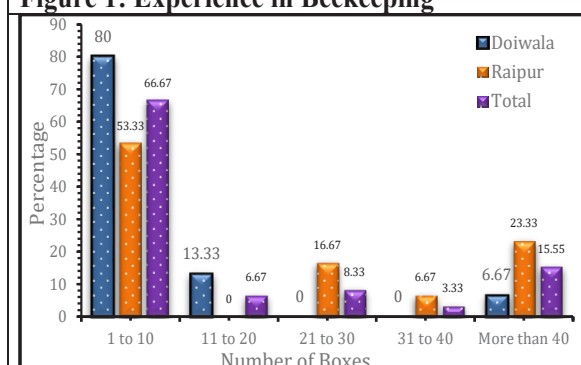


Figure 3: Number of boxes

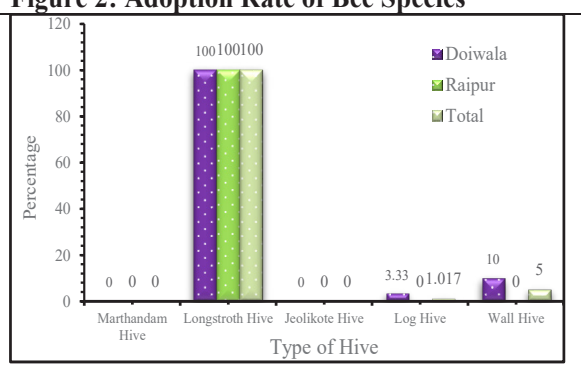


Figure 4: Types of Hives

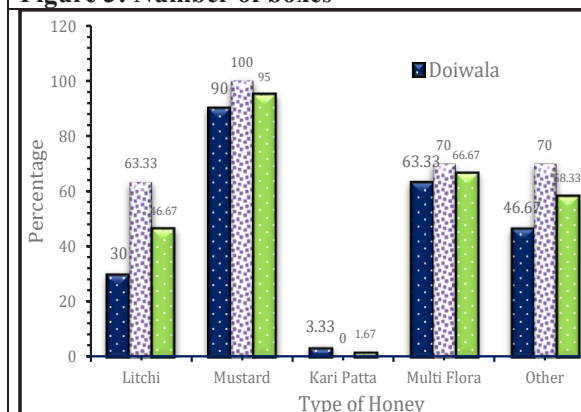


Figure 5: Type of Honey

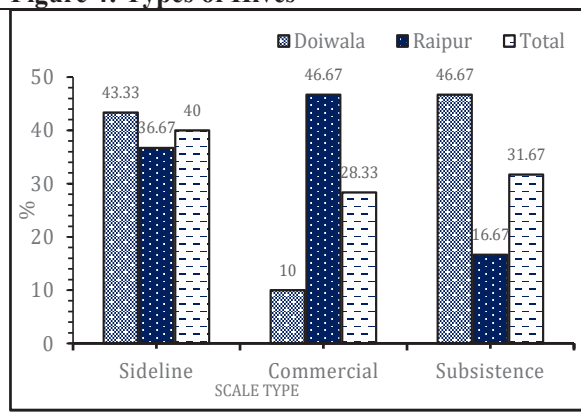


Figure 6: Scale type of Honey

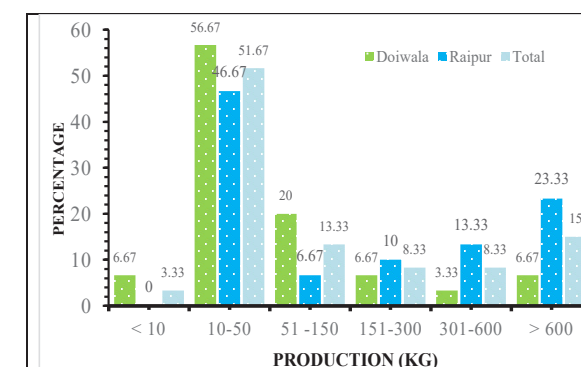


Figure 7: Production of Honey in Kg

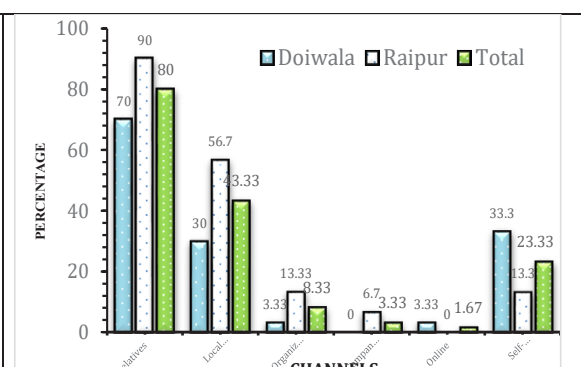


Figure 8: Channels of Honey Selling

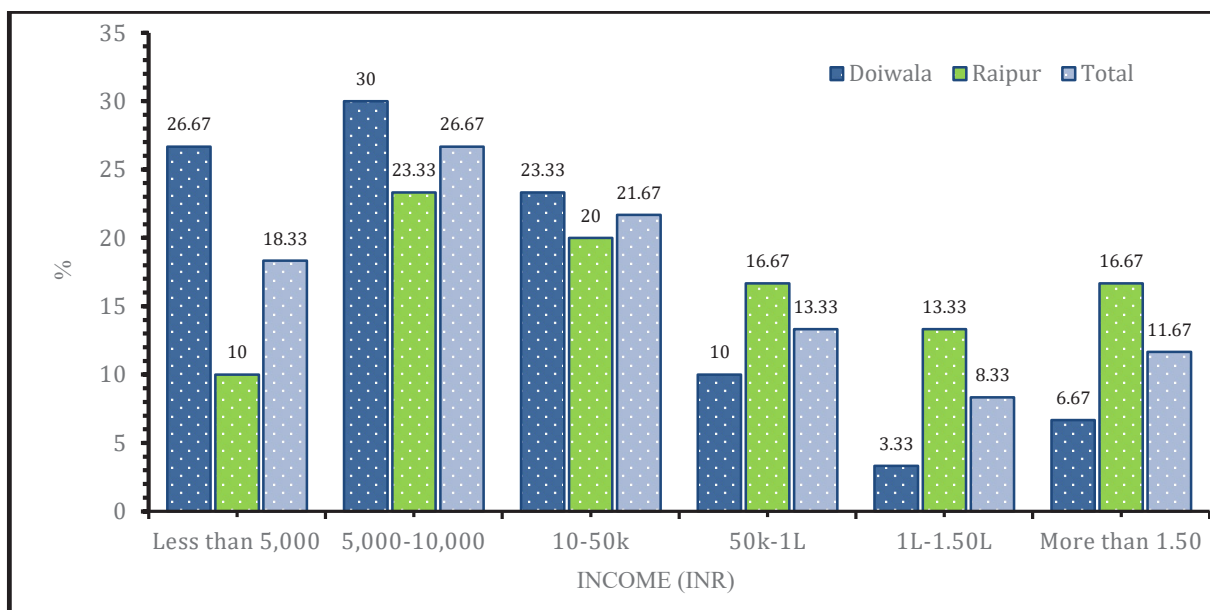


Figure 9: Annual income generation through beekeeping practice

(2.37). This suggests that Raipur had greater success with the communication channels used under the DHFP (p-value 0.0268). Additionally, respondents in Raipur recorded a considerably higher mean for pre-distribution training (0.73) than their counterparts in Doiwala (0.47), indicating that they were better prepared for the implementation phase. The much higher satisfaction levels with the given bee boxes in Raipur (2.80) compared to Doiwala (2.33), both significant at the 5% probability level, were probably

due to this greater resilience. On the other hand, several components of scheme implementation did not exhibit statistically significant differences, indicating a degree of standardized administration across particular regions. Comparable enrollment-year means and a high p-value of 0.8594 indicate that both blocks joined the program during a comparable period. Even though Doiwala's nominal mean for financial support was significantly higher (4.07) than Raipur's (0.60), the difference was not statistically significant

Table 2. Comparing Mean Analysis of Scheme Adoption in Doiwala and Raipur Blocks

S.No	Character	Blocks	Mean	t-Test Value	p- Value
1.	Awareness and Outreach Channels for Introducing the Scheme	Doiwala	2.37	1.97	0.0268*
		Raipur	3.30		
2.	Enrolment Year in the Scheme	Doiwala	1.40	1.09	0.8594 ^{NS}
		Raipur	1.27		
3.	Training Undertaken Before Bee Boxes Distribution	Doiwala	0.47	2.15	0.0177*
		Raipur	0.73		
4.	Financial Support under the Scheme	Doiwala	4.07	1.03	0.1544 ^{NS}
		Raipur	0.60		
5.	Yearly Participation in other Capacity Building Programs	Doiwala	0.77	1.64	0.0536 ^{NS}
		Raipur	1.23		
6.	Overall Satisfaction Rate for Provided Training	Doiwala	1.57	0.08	0.5336 ^{NS}
		Raipur	1.53		
7.	Overall Satisfaction with the Provided Bee Boxes	Doiwala	2.33	1.82	0.0373*
		Raipur	2.80		

(NS- Not significant, *- Significant level at 5% probability)

(p-value 0.1544), most likely due to excessive variance or outliers in the dataset. Similarly, Raipur had a modest advantage in capacity-building involvement, but the difference was not statistically significant. Finally, Raipur (1.53) and Doiwala (1.57) showed no significant difference in satisfaction levels, indicating that although access to training varied, the perceived value of the instruction was consistent throughout the study area. The perceived quality of training was almost identical across both blocks.

Discussion

The socio-economic profile of beekeepers in Doiwala and Raipur clearly indicates that the participants in this profession are primarily middle-aged men with good educational qualifications. The predominance of beekeepers in the 41–60 age group, similar to (Mishra et al., 2022) (33.33% in Doiwala and 46.67 % in Raipur), shows that this enterprise is currently being adopted more by individuals who handle various family agricultural tasks and bear significant family responsibilities, enabling them to earn additional income alongside agriculture and other businesses. On the other hand, the limited participation of the 18–30 age group suggests that the government needs to implement promotional programs for current beekeeping schemes to attract youth toward this field. The dominance of men in the gender distribution is clearly visible, especially in Raipur, where male participation is 90%, in line with Gupta et al., (2015). This situation indicates that, despite the objective of “District Level Schemes” being women’s empowerment, several barriers to gender inclusion persist in the beekeeping sector. Limited participation suggests that the government needs to implement programs to promote existing beekeeping schemes and attract women to beekeeping. From a social and educational perspective, the dominance of the General Category (76.67%) in both development blocks indicates a need for more inclusive awareness and outreach programs to ensure that the benefits of government schemes and subsidies reach Castes and Scheduled Tribes equally. This indicates that caste plays a crucial role in the adoption of beekeeping. (Rawat et al., 2024). The prevalence of education levels among respondents shows that most beekeepers are educated and capable of understanding and adopting modern, scientific beekeeping techniques.

The adoption patterns of beekeeping in the Doiwala and Raipur blocks indicate that the sector

is in a transitional phase: on the one hand, a large number of new beekeepers are emerging, while on the other hand, a clear regional distinction exists between subsistence-level and commercial-scale beekeeping. A total of 63.33% of the respondents had 1–5 years of experience, which was particularly high in Doiwala (76.67%), similar to Gupta et al. (2015). This indicates that recent government initiatives such as the “Sweet Revolution” and the “District Level Scheme” have been successful in attracting new individuals toward beekeeping as an enterprise. In contrast, Raipur has a relatively more experienced beekeeping community, as reflected by the presence of beekeepers with 16–20 years of experience. Overall, these findings suggest that the region is currently emerging as a major center for the early-stage development of apiculture. The growing number of new beekeepers is largely attributable to government schemes, training programs, and awareness campaigns. Furthermore, the regional variation between subsistence and commercial beekeeping is influenced by differences in economic resources, technical knowledge, market facilities, and practical experience (Singh et al., 2025b).

The technological profile of the study area demonstrates that modern beekeeping practices have been fully adopted, with a 100% adoption rate of *Apis mellifera* and Langstroth hives, similar to Sharma and Das (2018). The universal preference for the European honeybee is likely due to its higher honey production capacity and better adaptability to commercial beekeeping systems. In contrast, the indigenous *Apis cerana indica* is reared by only 25% of the beekeepers. The adoption of *Apis mellifera* is primarily driven by its higher honey yield, gentle nature, and suitability for modern commercial beekeeping management systems. In contrast, the comparatively lower productivity and limited utility of *Apis cerana indica* under commercial management conditions have resulted in its lower adoption rate. Despite this modernization, a clear operational difference exists between the two blocks. Doiwala is predominantly characterized by small-scale subsistence beekeeping (46.67%), where most beekeepers possess fewer than 10 bee boxes. On the other hand, Raipur has successfully transitioned toward a commercial model, with 46.67% of beekeepers operating on a larger scale and nearly one-fourth managing more than 40 bee boxes. This operational



Plate.1 Commercial & migratory beekeeping practice in Thanu, Bhogpur

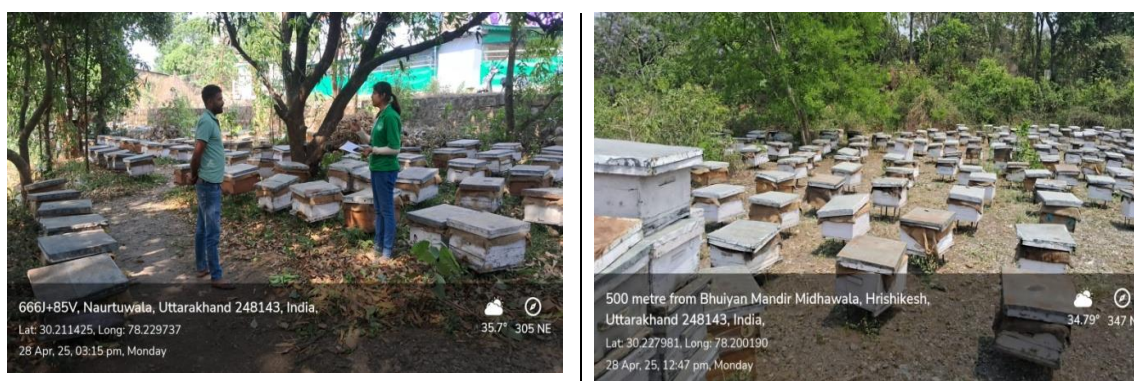


Plate.2 Commercial-level beekeepers in Midhawala, hive management in a forest area



Plate.2: Different Honey bee activities found during the field visit in the study area

disparity directly influences production and market integration. Although mustard honey remains the primary product for 95% of the beekeepers, Raipur's commercial orientation ensures significantly higher annual production, with 23.33% of the beekeepers producing more than 600 kg of honey annually. Marketing strategies also differ considerably between the two regions. Beekeepers in Raipur exhibit greater price stability, with 73.33% selling honey within the standard price range of INR 201-400 per kilogram, similar to findings reported by Midhun et al., (2022). In contrast, Doiwala beekeepers exhibit a more fragmented pricing structure, with some selling honey below INR 100 per kilogram, while others target niche and premium markets. These variations suggest that while Raipur benefits from production-driven market

stability, Doiwala's subsistence-oriented model leads to inconsistent market participation. This highlights the need to strengthen cooperative marketing systems and processing infrastructure to help small-scale beekeepers obtain better value for their products.

A comparative mean analysis of the implementation of the "District Level Scheme" reveals a clear correlation between institutional reach and beneficiary satisfaction in the Doiwala and Raipur development blocks. A major reason for regional variations was the effectiveness of communication media. Regarding awareness, the mean value for Raipur (3.30) was significantly higher than that of Doiwala (2.37), indicating that the Department of Horticulture and Food Processing achieved a more

effective reach in the Raipur block (p-value 0.0268). This initial lead in awareness was also reflected in technical readiness, as respondents in Raipur recorded higher participation in training programs held before the distribution of beehives. This “readiness gap” appears to be a crucial factor in determining the utility of the equipment, as beneficiaries who received better training reported higher satisfaction (2.80) with the provided beehives than those in Doiwala (2.33). These findings suggest that although the physical resources provided under the scheme were identical in both regions, their utility and effectiveness depended on the level of technical training beneficiaries received. Even though the scheme was implemented simultaneously in both blocks, greater awareness, institutional reach, and pre-training arrangements in Raipur led to a more successful and satisfactory adoption of the scheme. In contrast, the impact of the scheme in Doiwala appeared less consistent due to a subsistence-oriented beekeeping system and an inconsistent support structure. For effective implementation of the scheme, there is a need to strengthen awareness programs, technical training, and institutional support in the Doiwala development block. Beneficiaries should receive pre-training in modern beekeeping techniques, disease management, honey processing, and marketing to enable a transition from a subsistence-based system to commercial beekeeping (Arya et al., 2022). In addition, regular technical guidance, follow-up, and financial assistance should be provided by the Agriculture and Horticulture departments. The scheme can be made more sustainable, profitable, and satisfactory by increasing market connectivity through successful beekeeper models, exposure visits, cooperative societies, and FPOs (Singh et al., 2026).

CONCLUSION

The study evaluates the adoption of district-level beekeeping development schemes in Doiwala and Raipur blocks of Dehradun district, Uttarakhand. In Doiwala and Raipur, beekeeping is becoming a viable livelihood opportunity, largely due to ambitious government initiatives like Sweet Revolution and the District Level Scheme. The socio-economic profile reveals that middle-aged (41–60) individuals, while youth, women, and underprivileged communities are still underrepresented, underscoring the need for inclusive awareness and empowerment initiatives. Doiwala remains largely subsistence-oriented, whereas Raipur has progressed toward commercial beekeeping with higher production, better market integration, and

stronger institutional support. Technological adoption, particularly of *Apis mellifera* and Langstroth hives, reflects growing modernization. However, regional disparities persist in production scale, training exposure, and beneficiary satisfaction. Raipur’s greater awareness, institutional reach, and pre-training arrangements led to more effective scheme adoption and higher satisfaction, whereas Doiwala’s inconsistent support and limited technical readiness undermined outcomes. Strengthening training, awareness, financial support, cooperative marketing, and market linkages is essential. With targeted policy support and capacity building, beekeeping holds strong potential for rural livelihoods and socio-economic development in Uttarakhand.

Acknowledgement and Funding

We want to express our deepest gratitude to the Department of Rural Technology, Hemvati Nandan Bahuguna Garhwal University, Srinagar, Uttarakhand, for their invaluable guidance, encouragement, and support throughout our research journey. The author(s) received no specific funding for this research work

Ethics Statement:

Ethical approval was not applicable for this research experiment as only plant materials were used.

Originality and Plagiarism:

The author confirms that this manuscript is original, has not been published previously, and is not under consideration for publication elsewhere. All sources used have been appropriately cited, and the manuscript has been prepared in compliance with plagiarism and publication ethics standards.

Consent for Publication:

The Galley proof has been reviewed and approved by all Authors and consent to permission for publication.

Competing Interests:

The authors declare no conflict of interest related to this research. .

Data Availability:

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions:

RSN and SS conceptualized the study and designed the research framework; NV

carried out the field experiment; RSN, SS and NS contributed to the implementation and logistical support of the research; NV, NS and SS drafted the original manuscript; SS coordinated the review and editorial revisions. All authors have read and approved the final version of the manuscript

REFERENCES

- Abrol, D. P. (2023). Beekeeping for sustainable economic development of India: Challenges and opportunities. *Journal of the Indian Institute of Science*, 103(4), 997-1017. <https://link.springer.com/article/10.1007/s41745-023-00374-9>
- ANI. (2026). Uttarakhand has immense potential for beekeeping: Chief Minister Dhami. ANI News. <https://www.aninews.in/news/national/general-news/uttarakhand-has-immense-potential-for-beekeeping-chief-minister-dhami20260324234322/>
- Arya, S., Kumar, A., Kumar, K., & Kumar, D. (2021). Major constraints faced by the beekeepers in production and marketing of honey in the Nainital district of Uttarakhand. *The Pharma Innovation Journal*, 10(8), 276-279. <https://www.thepharmajournal.com/archives/2021/vol10issue8S/PartE/S-10-7-76-615.pdf>
- Bihonegn, A., Begna, D., & Muzzalupo, I. (2021). Beekeeping production system, challenges, and opportunities in selected districts of South Wollo Zone, Amhara, Ethiopia. *Advances in Agriculture*, 2021, Article 2278396. <https://doi.org/10.1155/2021/2278396>
- Bradbear, N. (2009). Bees and their role in forest livelihoods: A guide to the services provided by bees and the sustainable harvesting, processing and marketing of their products. *Food and Agriculture Organization of the United Nations*. <https://openknowledge.fao.org/items/09aab029-3f89-435d-9a56-8816a2c75327>
- ClearIAS Editorial Team. (2024). Sweet revolution & honey mission. ClearIAS. <https://www.clearias.com/sweet-revolution-honey-mission/>
- Department of Horticulture and Food Processing, Government of Uttarakhand. (2023) *State Horticulture Mission, Uttarakhand*. Retrieved January 25, 2025, from <https://shm.uk.gov.in/>
- Ghosh, S., Abrol, D., & Jung, C. (2025). The state of beekeeping in India: Insights, gaps, and emerging opportunities. *Entomological Research*, 55(10), Article e70069. <https://doi.org/10.1111/1748-5967.70069>
- Government of Uttarakhand. (2023). *Meri Yojana* [Book]. Retrieved January 27, 2025, from <https://uk.gov.in/pages/meri-yojna-book>
- Gupta, S., Sachdeva, K., & Kushwaha, R. (2015). Beekeeping in Haryana and Uttar Pradesh: A comparative study. *DU Journal of Undergraduate Research and Innovation*, 1(2), 365-373. <https://journals.du.ac.in/ugresearch/pdf/sonal%20gupta%2023.pdf>
- Hailay G. K., & Panhwar, S. (2024). Beekeeping practices and honey bee diversity for biodiversity conservation and sustainable agricultural systems. *International Journal of Agronomy*, 2024, Article 5998962. <https://doi.org/10.1155/2024/5998962>
- Iatridou, D., Brennan, M. L., & Dean, R. S. (2019). The current state of veterinary education relating to bees in Europe. *Veterinary Record*, 186(9), <https://doi.org/10.1136/vetreco-2019-000343>
- Kieliszek, M., Piwowarek, K., Kot, A. M., Wojtczuk, M., Roszko, M., Bryła, M., & Trajkovska Petkoska, A. (2023). Recent advances and opportunities related to the use of bee products in food processing. *Food Science & Nutrition*, 11(8), 4372–4397. <https://doi.org/10.1002/fsn3.3411>
- Lin, Z., Yang, L., Wang, Z., & Ji, T. (2025). Conservation of honey bee genetic diversity and pollination services for sustainable agriculture. *Conservation Letters*, 18(2), Article e13156. <https://doi.org/10.1111/conl.13156>
- Lin, Z., Yang, L., Wang, Z., Wang, K., Niu, Q., & Ji, T. (2025). Honey bee breeding and breed: Advancements, challenges, and prospects. *Animal Research and One Health*, 3(4), 350–357. <https://doi.org/10.1002/aro2.70003>
- Manoj, M. S., Sharma, P., & Paschapur, A. U. (2023). Current scenario of beekeeping and honey production in India. *HEXAPODA*, 43-55. <https://hexapoda.in/index.php/hexapoda/article/view/591>
- Midhun, V. M., Velavan, C., Palanichamy, N. V., & Ramesh, D. (2022). A Study on Price Spread and Marketing Efficiency of Honey Value Chains in Thrissur District of Kerala. *Asian Journal of Agricultural Extension, Economics & Sociology*, 40(10), 668-676.
- Mishra, I., Rana, K., Beri, G., Sharma, A., Joshi, A., Kholiya, M., & Chaudhary, S. (2022). *A Study on Adoption of Recommended Beekeeping Practices in Kumaon Hills of Uttarakhand* (Doctoral dissertation, GB Pant University of Agriculture and Technology,

- Pantnagar). <https://krishikosh.egranth.ac.in/server/api/core/bitstreams/5281f424-9dad-492b-bfd4-ab1b1dc6f697/content>
- Moomen, A. W., & Odame A.F. (2023). Beekeeping, rural livelihoods, and household income in sub-Saharan Africa: Evidence from northern Ghana. *Natural Resources Forum*, 47(3), 412–428. <https://doi.org/10.1111/1477-8947.12274>
- Mulatu, K., Admasu, A., & Gemedu, A. (2021). Contribution of beekeeping for household income and livelihood in the Bench Sheko zone, Southwest Ethiopia. *Advances in Agriculture*, 2021, Article 4714020. <https://doi.org/10.1155/2021/4714020>
- Mushonga, B., Hategekimana, L., Habarugira, G., Kandiwa, E., Samkange, A., Segwagwe, B. V. E., & Tsadilas, C. (2019). Characterization of the beekeeping value chain: Challenges, perceptions, limitations, and opportunities for beekeepers in Kayanza District, Rwanda. *Advances in Agriculture*, 2019, Article 5982931. <https://doi.org/10.1155/2019/5982931>
- Nayak, J., Mohanty, L., Saha, G., Panda, A. K., & Devi, M. (2024). Socio-economic status and opportunities of beekeeping for farm women: A case study. *Indian Journal of Extension Education*, 60(1), 89-94.
- Pepinelli, M., Rios-Montano, J. F., & Zayed, A. (2025). Managed honey bee genomics and their role in sustaining plant reproductive success and food security. *Environmental DNA*, 7(1), Article e70150. <https://doi.org/10.1002/edn3.70150>
- Powrel, P. J., & Mishra, S. (2024). Competitiveness, specialization, and structural shifts in India's honey exports: An analysis of global market dynamics from 2003 to 2022. *Agribusiness*, 41(1). <https://doi.org/10.1002/agr.22008>
- Press Information Bureau, Government of India. (2021). National Beekeeping & Honey Mission (NBHM) aims to achieve the goal of 'Sweet Revolution' as part of Atmanirbhar Bharat Abhiyaan. <https://www.pib.gov.in/Pressreleaseshare.aspx?PRID=1697113>
- Ramana, V., Bhargava, M., & Rao, K. S. (2025). Apiculture integration in farming systems for sustainable rural livelihoods in South Asia. *Food and Energy Security*, 14(2), Article e70064. <https://doi.org/10.1002/fes3.70064>
- RAU'S IAS. (2025). National beekeeping and honey mission: Accelerating India's sweet revolution. <https://compass.rauias.com/current-affairs/national-beekeeping-honey-mission>
- Rawat, G., Pande, M. C., Jalal, H., Verma, N., Sharma, R., & Tabish, A. (2024). Beekeeping as a pathway for rural development in rural Uttarakhand, India. *Tuijin Jishu/Journal of Propulsion Technology*, 45(3), 2905. <https://doi.org/10.52783/tijpt.v45.i03.7672>
- Schouten, C. N., Otieno, S., & Mumbi, C. (2019). Beekeeping as a livelihood strategy for economically marginalised groups: Evidence from Kenya. *Outlook on Agriculture*, 48(4), 321–329. <https://doi.org/10.1111/1745-5871.12380>
- Sharma, S., & Das, D. (2018). Factors affecting adoption of beekeeping and associated technologies in Kamrup (rural) district, Assam state, India. *Biodiversity International Journal*, 2(3), 279-284. <https://d1wqtxts1xzle7.cloudfront.net/98688799/BIJ-02-00069-libre.pdf?1676440397=&response-content-type=application/pdf>
- _Shyam, C., Shekhawat, K., Rathore, S. S., Babu, S., Singh, R. K., Upadhyay, P. K., Dass, A., Fatima, A., Kumar, S., Sanketh, G. D., & Singh, V. K. (2023). Development of Integrated Farming System Model, A Step towards Achieving Biodiverse, Resilient and Productive Green Economy in Agriculture for Small Holdings in India. *Agronomy* 13(4), 955. <https://www.mdpi.com/2073-4395/13/4/955>
- Singh, N., Negi, R. S., Singh, S., Negi, E., Sati, A., & Kothiyal, K. (2024). Beekeeping: A scientific approach to biodiversity conservation and pollinator protection. *Scope*, 14(4), 730 -766. <https://www.scopus-journal.com>
- Singh^a, N., Negi, R. S., Singh, S., Sati, A., Singh, E., Tiwari, S., & Singh, A. (2025). The potential of api-tourism in India: A sustainable development opportunity. *BioThink E-Magazine*, 2(3). <https://www.biothink.in>
- Singh^b, N., Negi, R. S., Singh, S., & Sati, A. (2025). Factors influencing adoption of beekeeping practices for sustainable livelihood in a rural community: A case study. *Indian Journal of Entomology*, 87(Special Issue), 154-160. <https://doi.org/10.55446/IJE.2025.3529>
- Singh, N., Negi, R. S., Singh, S., & Sati, A. (2026). Adoption of beekeeping practices, constraints and opportunities for rural sustainability in Uttarakhand. *Journal of Mountain Research*, 21(S1), 83-92. <https://doi.org/10.51220/jmr.v21-S1.9>
- Tesema, T., Adugna, M., & Xiao, X. (2023). Analysis of determinants of economic efficiency in honey production in Horo Guduru Zone, Ethiopia: Stochastic dual cost frontier model approach. *Advances in Agriculture*, 2023, Article 5813388. <https://doi.org/10.1155/2023/5813388>