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Multidimensional assessment of apiculture practices and socioeconomic attributes of beekeepers in Madhepura, Bihar

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Abstract- Beekeeping plays a crucial role in sustaining global food security by providing essential pollination services, while simultaneously supporting rural incomes through the production of honey and other hive-derived commodities. In Bihar, and particularly within Madhepura district, the agro-climatic environment is well-suited for extensive apiculture. However, productivity is hindered by a combination of technical limitations, socio-economic challenges, and infrastructural gaps. This research examines the communication channels, socio-personal characteristics, technology adoption patterns, training requirements, and constraints faced by beekeepers in selected blocks of Madhepura district. Employing a mixed-methods design, the study integrated structured interviews, on-site observations, and secondary data analysis. Fieldwork was carried out in Udakishunganj, Bihariganj, Gamharia, and Murliganj blocks, with special attention to villages known for high honey yields. Conducted from April 2023 to March 2024, the survey encompassed all major blooming and honey flow periods. Findings indicate that most beekeepers are in the young to middle-age category, have secondary-level education, and manage small or marginal landholdings. The uptake of advanced apiculture methods is moderate, with the greatest demand for training observed in pest and disease control, colony expansion, and value-added processing. Key challenges identified include unstable market demand, seasonal shortages of nectar, limited extension support, and restricted access to affordable credit. The results underscore the necessity for comprehensive capacity-building initiatives, the formation of cooperative marketing networks, and targeted policy measures to develop apiculture as a sustainable and profitable enterprise in Bihar.

Keywords: Apiculture, Socioeconomic attributes, Honey production, Technological adoption, Extension services

INTRODUCTION

Apiculture, or beekeeping, is a vital branch of agriculture that delivers essential pollination services to over 70% of cultivated crops worldwide.[1] In addition to honey, it yields a variety of high-value products including beeswax, royal jelly, propolis, and pollen. Beekeeping also supports biodiversity conservation, generates rural employment, and poses minimal competition for land resources, making it a sustainable supplementary or primary livelihood option.[2]

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On a global scale, China, Turkey, Argentina, the United States, and Ukraine are the leading honey producers, while India is consistently ranked among the top ten.[3] Within India, major honey-producing states include Punjab, Haryana, Uttar Pradesh, Bihar, and West Bengal. Situated in Bihar's agriculturally rich Kosi belt, Madhepura district offers favorable weather conditions, a wide variety of nectar-rich plants, and a growing culture of beekeeping. Nevertheless, the region's apiculture industry is hampered by technological limitations, environmental constraints, and socio-economic hurdles.

Although past studies in beekeeping have addressed topics such as modern hive management techniques (Langstroth designs), bee foraging behavior, pollination effectiveness, and the nutritional and medicinal attributes of honey,[4,5] there is still limited research that examines apiculture in Bihar from a holistic perspective-particularly in relation to beekeepers' socio-personal profiles, communication networks, levels of scientific practice adoption, and challenges encountered.

This study seeks to address this gap by undertaking a comprehensive evaluation of apiculture in Madhepura district. It focuses on identifying the socio-personal characteristics and communication patterns of beekeepers, assessing their knowledge and the extent to which they adopt improved apiculture technologies, determining their specific training requirements, examining the constraints they face in implementing recommended practices, and evaluating the overall potential of beekeeping as a profitable and sustainable enterprise.

MATERIALS & METHODS

The study was carried out in four blocks of Madhepura district-Udakishunganj, Bihariganj, Gamharia, and Murliganj-with detailed surveys conducted in selected villages recognized for their significant beekeeping activities. Situated in the fertile plains of the Kosi River basin, the district experiences a subtropical climate, with average temperatures ranging between 25°C and 35°C, and offers a rich variety of nectar sources such as mustard, drumstick, litchi, jamun, and sunflower. Its nutrient-rich alluvial soil, combined with a diverse multi-cropping system, creates highly favorable conditions for apiculture.

The field investigation was conducted over a one-year period from April 2023 to March 2024, encompassing all major flowering phases and honey flow seasons to record seasonal fluctuations in nectar availability, colony performance, and honey yields. A descriptive survey research design was adopted, employing structured questionnaires, focus group discussions, and field observations, supplemented by secondary information from government reports, National Bee Board data, and relevant literature. Using purposive and stratified random sampling, 120 beekeepers were selected from the four blocks to ensure representation across varying landholding sizes, experience levels, and degrees of technological adoption. The questionnaire collected detailed information on demographic characteristics, communication channels, knowledge levels, adoption of recommended practices, perceived constraints, and economic returns. Knowledge and adoption were measured using composite scoring techniques, while descriptive statistics such as means, percentages, and frequencies, along with inferential analyses including chi-square tests and correlation coefficients, were applied to interpret the data.

RESULTS

The study revealed that a majority of respondents (53%) were between 18 and 35 years of age, followed by 36% in the 36-53 age bracket, and only 11% above 54 years. Educational attainment was predominantly at the secondary level (60%), with 22% holding graduate degrees and 18% having only primary education. Most beekeepers (55%) operated on marginal landholdings of less than one hectare, while 25% were landless and 20% possessed medium to large holdings. In terms of communication and information access, the most frequently used sources were fellow beekeepers (82%), Krishi Vigyan Kendras (58%), and agricultural extension officers (40%), while 42% relied on radio or television for updates on new practices. Knowledge assessment indicated that 65% of participants had a medium level of understanding of scientific beekeeping, 21% had a high level, and 14% demonstrated low knowledge.

Adoption was highest for hive cleaning (94%) and colony migration (85%), but considerably lower for advanced practices such as queen rearing (30%) and the use of modern extractors (26%). Training needs were most acute in pest and disease management (89%), followed by colony multiplication techniques (74%) and value addition in honey products (63%). The primary constraints faced by beekeepers included irregular market demand and fluctuating prices (80%), seasonal nectar scarcity-especially during summer months (73%), inadequate extension support (65%), and limited access to affordable credit (54%) (table 1). On the economic front, the mean annual honey yield per colony was 16.6 kg, with an average selling price of ₹220 per kilogram. Profitability varied significantly depending on the scale of operation and management efficiency, with migratory beekeeping proving more lucrative than stationary systems.

Table 1. Consolidated Demographic, Technological Adoption, Training Needs, and Constraint Profile of Beekeepers in Madhepura District, Bihar

Category	Sub-category / Indicator	Value (%)
Beekeeper Age Distribution	18–35 years	53
	36–53 years	36
	54+ years	11
Education Levels	Primary	18
	Secondary	60
	Graduate	22
Adoption of Practices	Hive cleaning	94
	Colony migration	85
	Queen rearing	30
	Modern extractors	26
Training Needs	Pest/Disease control	89
	Colony multiplication	74
	Value addition in honey products	63
Key Constraints	Market instability	80
	Seasonal nectar shortage	73
	Inadequate extension support	65
	Limited access to affordable credit	54

DISCUSSION

The demographic pattern observed in this study corresponds with earlier research indicating that apiculture is predominantly practiced by younger individuals, likely due to its labor-intensive nature combined with flexible work requirements. The dominance of small landholdings among participants suggests that beekeeping is generally pursued as a supplementary rather than a primary agricultural activity. The moderate levels of knowledge and adoption recorded point to partial familiarity with scientific beekeeping methods, yet considerable gaps remain in specialized skills such as queen rearing. This finding is in agreement with Khan *et al.* (2007)[6], who identified limited technical expertise as a key barrier to improved productivity. The pronounced demand for training in pest management reflects the persistent threat posed by issues like Thai sac brood virus and wax moth infestations, consistent with the observations of Mattu (2017)[7]. Among the constraints, market instability emerged as the most pressing, emphasizing the necessity for structured marketing systems and cooperative networks among honey producers, as also advocated in national apiculture development frameworks.[8] Seasonal shortages of nectar, identified in this study, represent an ecological limitation that could be alleviated through the diversification of forage resources, as proposed by Zima (2007)[9]. From an economic perspective, the higher profitability associated with migratory beekeeping underscores its potential as a viable and sustainable rural enterprise, contingent upon the availability of adequate infrastructure and supportive policy measures.

CONCLUSION

The results of this research highlight that Madhepura district holds considerable promise for the growth and commercialization of apiculture, supported by its favorable climate, abundant floral diversity, and a well-established yet steadily developing beekeeping tradition. The predominance of young and middle-aged practitioners, coupled with a moderate level of scientific practice adoption, reflects a workforce capable of expanding the sector if provided with appropriate technical guidance and market support. Nonetheless, persistent challenges-such as fluctuating market demand, seasonal shortages of nectar, insufficient extension services, and restricted access to affordable financing-continue to limit both productivity and profitability.

Overcoming these challenges calls for an integrated strategy. Developing cooperative marketing systems can help stabilize prices and strengthen producers' negotiating power. Focused training programs, particularly in pest and disease control, queen rearing, colony multiplication, and value addition, are essential to closing current knowledge and skill gaps. Increasing the availability of nectar sources

by planting and incorporating nectar-rich species into farming systems can reduce seasonal shortages, enhance colony strength, and boost yields. In addition, ensuring timely access to credit and advisory support will enable small and marginal beekeepers to invest in modern tools and improved techniques, thereby improving their competitiveness in both national and international markets.

When implemented cohesively, these measures can position apiculture in Madhepura as a driver of rural economic growth, biodiversity preservation, and crop pollination services. Transforming beekeeping from a supplementary livelihood into a profitable commercial venture could make the district a leading example of rural entrepreneurship built on ecological sustainability and market resilience.

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