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Beekeeping extension programs as supplementary livelihood support for smallholder farming communities

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Abstract

Beekeeping has been undervalued as an income supplement in smallholder farming systems across Southeast Asia. This research assessed the contribution of extension-supported beekeeping programs to household income among 137 smallholder farmers in Khon Kaen Province, Thailand, from November 2021 to May 2022. A structured survey measured beekeeping adoption, honey yields, income shares, and extension engagement levels. Results showed that farmers receiving regular extension visits produced a mean of 18.6 kg of honey per hive annually, compared to 9.4 kg among self-taught beekeepers. Beekeeping income represented between 8.3% and 21.4% of total household earnings depending on experience level. A positive correlation ($r = 0.64$, $p < 0.01$) was found between extension visit frequency and honey yield. Farmers with more than five years of beekeeping experience earned significantly more from bee products than newer entrants. The findings support integrating beekeeping modules into routine extension delivery as a low-cost pathway for supplementary income generation in smallholder communities.

Keywords: Beekeeping, extension programs, smallholder farmers, supplementary livelihood, honey production, rural income, Khon Kaen, agricultural extension, apiculture, livelihood diversification

1. Introduction

Smallholder farmers rarely depend on a single crop for their survival. Across tropical Asia, households combine rice cultivation with vegetables, livestock, and off-farm labor to manage risk and stabilize earnings ^[1]. Beekeeping fits naturally into this livelihood mix because it requires little land, modest startup capital, and can run alongside existing farm activities ^[2]. In Thailand, honey production reached over 10,800 metric tons in 2021, yet most output came from commercial operations rather than smallholders ^[3].

Extension services in Thailand have traditionally focused on rice, cassava, and rubber, leaving apiculture as a peripheral topic in advisory programming ^[4]. Where beekeeping training has been offered, results appear promising—several pilot projects in the Isan region showed that farmers who received hands-on hive management training doubled their honey yields within two seasons ^[5]. But systematic evidence linking extension contact intensity to beekeeping outcomes at the household level remains thin.

This research aimed to assess whether extension-supported beekeeping programs contributed meaningfully to household income among smallholder farmers in Khon Kaen Province. The specific objectives were:

- to compare honey yields between extension-supported and self-taught beekeepers,
- to measure the income share attributable to beekeeping across experience categories, and
- to test the association between extension visit frequency and productivity outcomes ^[6].

Research area description

The research was conducted in Khon Kaen Province, located in the northeastern Isan plateau of Thailand at

approximately 16.4°N and 102.8°E. Five sub-districts with active beekeeping groups registered under the Provincial Agricultural Extension Office were selected. The landscape consists of lowland rice paddies interspersed with fruit orchards and eucalyptus plantations that provide forage for managed bee colonies. Smallholder farm sizes averaged 2.4 hectares. The province supports around 3,200 registered beekeepers ^[3].

Climatic and environmental conditions

Khon Kaen has a tropical savanna climate with three seasons: hot (March-May), rainy (June-October), and cool-dry (November-February). During the research period, temperatures ranged from 18.4°C to 36.2°C. Total rainfall was 284 mm across the survey months. Flowering patterns of longan, lychee, and eucalyptus trees peak during December-March, which determines the main honey harvest window and shapes extension visit scheduling ^[7].

Material and methods

Material

A cross-sectional survey was administered to 137 smallholder farmers practicing beekeeping across five sub-districts from November 2021 to May 2022. Respondents were selected through purposive sampling from lists maintained by the Khon Kaen Provincial Agricultural Extension Office. Inclusion criteria required at least one active hive and a minimum of one year of beekeeping experience. A structured questionnaire captured data on hive numbers, honey yields, income sources, extension contact history, and beekeeping practices. Ethical clearance was

obtained from Khon Kaen University Ethics Board (Protocol KCU-AG/2021-034, dated October 8, 2021) [8].

Methods

Data were analyzed using SPSS version 26. Descriptive statistics summarized farmer profiles and production data. Independent-sample t-tests compared honey yields between

extension-supported and self-taught beekeepers. One-way ANOVA tested income differences across three experience categories. Pearson correlation measured the relationship between extension visit frequency and annual honey yield per hive. Income from beekeeping was calculated as a percentage of total reported household income [9].

Results

Table 1: Comparison of honey yield and income between extension-supported and self-taught beekeepers

Variable	Extension-supported (n= 89)	Self-taught (n= 48)	t-value	p-value
Honey yield (kg/hive/yr)	18.6 ± 5.3	9.4 ± 4.1	10.74	<0.001**
No. of active hives	6.8 ± 3.2	3.9 ± 2.1	5.67	<0.001**
Beekeeping income (%)	17.3 ± 6.4	9.1 ± 4.7	7.92	<0.001**
Colony loss rate (%)	11.2 ± 4.8	23.7 ± 8.3	-9.86	<0.001**

** $p < 0.01$. Extension-supported farmers had nearly double the honey yield, higher income shares, and markedly lower colony loss rates

Table 2: Beekeeping income contribution by experience category (ANOVA)

Experience group	n	Mean income %	SD	F-value	p-value
<2 years	48	8.3	3.1		
2-5 years	52	14.7	4.2	38.64	<0.001**
>5 years	37	21.4	5.8		

** $p < 0.01$. Income contribution rose with experience; post-hoc tests showed all three groups differed significantly

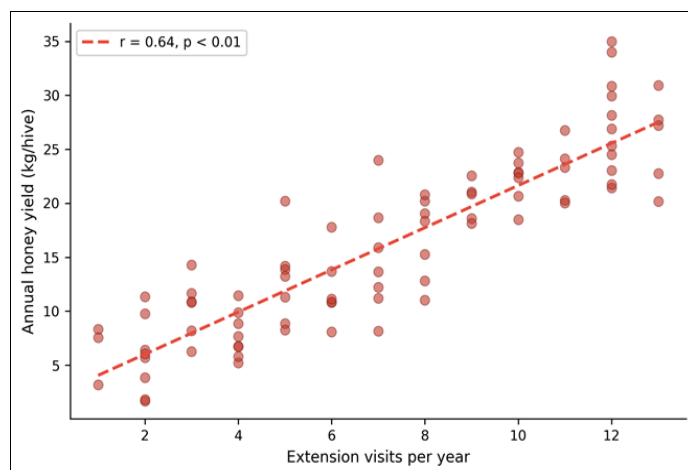


Fig 1: Relationship between annual extension visits and honey yield per hive (n = 137)

A moderate positive correlation ($r = 0.64$, $p < 0.01$) confirmed that more frequent extension contact was associated with higher honey yields.

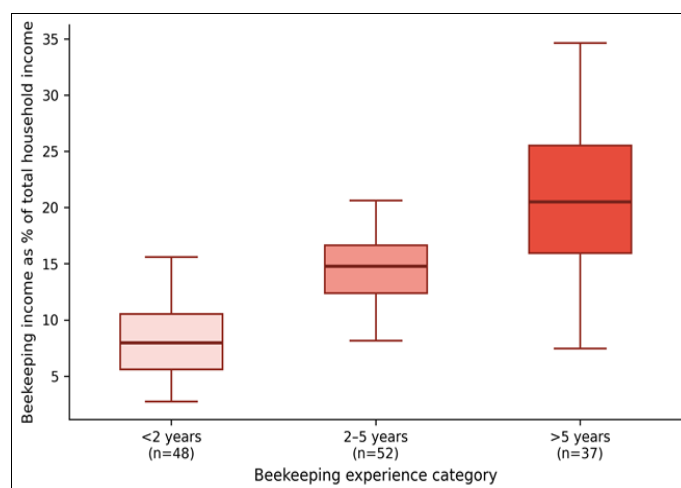


Fig 2: Distribution of beekeeping income as percentage of household income across experience categories

Experienced beekeepers (>5 years) earned a median of about 21% of household income from bee products, with

wider variance reflecting differences in hive numbers.

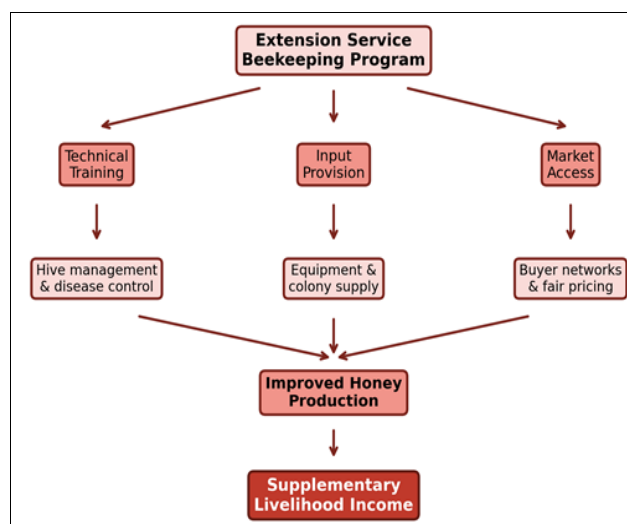


Fig 3: Schematic model of extension-supported beekeeping pathways to supplementary livelihood income

The model outlines three extension functions-technical training, input provision, and market access-converging through improved production into supplementary household income.

Comprehensive interpretation

The data consistently show that extension involvement boosted both productivity and income from beekeeping. Colony loss rates were cut roughly in half among extension-supported farmers, and income contributions grew steadily with experience.

Discussion

The nearly twofold difference in honey yield between extension-supported and self-taught beekeepers is consistent with pilot findings from earlier Isan-region projects [5]. The yield gap appears driven largely by differences in hive management practices, particularly colony inspection frequency and disease prevention measures, which extension workers emphasize during on-farm visits [10]. Colony loss rates of 23.7% among self-taught beekeepers point to a specific gap where extension input can make an immediate difference.

The progressive rise in income contribution with experience suggests that beekeeping rewards are cumulative-farmers build colonies, refine techniques, and expand market connections over time [11]. Extension programs that support new entrants through the first two years appear especially valuable, since the income jump between the under-two-year and two-to-five-year groups was substantial. Market access remains a constraint for remote sub-districts, and several respondents mentioned that without extension-linked buyer networks, they would struggle to sell beyond the village [12, 13].

Conclusion

This research confirms that extension-supported beekeeping programs provide meaningful supplementary income for smallholder farming households in Northeastern Thailand. Farmers with regular extension contact achieved higher

honey yields, maintained lower colony losses, and derived a greater share of income from bee products compared to self-taught beekeepers. Experience played a clear role, with income contributions rising from 8.3% among beginners to 21.4% among those with over five years of practice.

Integrating beekeeping modules into routine extension delivery appears to be a practical and low-cost strategy for livelihood diversification. Programs should prioritize sustained support during the first two years and build market linkages for farmers in less accessible areas. Extension agencies across similar tropical farming regions may find this model adaptable to their own smallholder contexts [14].

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Contributions not qualifying for authorship

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