



Meliponiculture for Women's Income in Banyumas, Central Java, Indonesia: A Quantitative Study of Livelihood Contribution and Household Decision-Making

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ABSTRACT: Meliponiculture may provide supplementary income, but its measured contribution to rural women's livelihoods remains uncertain. This study aimed to determine whether meliponiculture provides additional net income to rural women in Banyumas, quantify its contribution to household income, and examine the factors associated with that contribution. This cross-sectional survey analyzed 59 women in one supported farmer group in Banyumas, Central Java, Indonesia. Mean net meliponiculture income was IDR 208,050.85 per month and contributed a mean of 7.43% of household income (SD = 4.62 percentage points; range 2.68%–31.25%). A multiple linear regression of income contribution on colony number, weekly time, and years of practice explained 57.6% of variation. With HC3 robust standard errors, colony number was positively associated with income share ($B = 1.14$ percentage points per colony, 95% CI 0.61–1.68); the conditional weekly-time coefficient was negative and borderline ($p = .051$), and practice duration was not clearly associated ($p = .518$). Excluding the respondent with 30 colonies reduced R^2 to .215; the colony association persisted, while the time coefficient was negative ($p = .041$). All women reported being primary colony owner-managers, but the nine-item access/control composite was unreliable (Cronbach's $\alpha = -.05$), precluding a conclusion about empowerment. Meliponiculture provided supplementary net income in this group, but the cross-sectional design cannot determine whether it increased women's income compared with their income before participation

KEYWORDS: Banyumas, livelihoods, meliponiculture, rural, woman

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1. INTRODUCTION

Smallholder agroforestry enterprises increasingly buffer rural poverty across the Global South, and stinglessbee keeping (meliponiculture) has emerged internationally as one such low-barrier enterprise [1], [2]. Because stingless bees lack a functional sting and can often be managed with simple materials, meliponiculture may be relatively accessible, although colony management still requires technical knowledge [1], [3]. In Indonesia, meliponiculture, locally known as budidaya lebah klanceng, has expanded

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rapidly over the past decade as smallholder households, forest-farmer groups, and community-development programs have adopted it for its minimal land demand and compatibility with home gardens [4]–[7]. Nationally, Indonesia hosts more than 40 stingless-bee species alongside its native *Apis* fauna, yet produced an estimated 189,780 litres of honey in 2021, well short of estimated domestic demand, positioning meliponiculture as a still-underexploited nontimber forest product with substantial market headroom [8]. In Banyumas Regency, Central Java, applied research has documented at least nine cultivated klanceng species and identified feed-plant and hive-box configurations that optimize honey yield (*Tetragonula biroi* combined with specific melliferous plants and pine-wood boxes), establishing a growing technical foundation for meliponiculture as a household enterprise in the region [9].

A recurring claim across this literature is that meliponiculture is particularly well suited to women's participation. Devanesan et al. [3] state explicitly that stingless bees are easy enough to handle that even children and women can rear them, and report that a two-decade Indian extension program trained 2,074 women alongside 8,322 men in colony management. Comparable field evidence from Indonesia and other countries reinforces this claim. In North Lombok, Yanuartati et al. [10] found gender participation in *Trigona* sp. beekeeping to be nearly even (51% men, 49% women) and described the activity as gender neutral, with women independently owning hives and managing sales rather than serving only as helper labor. In the Bolivian Chaco, an NGO-led program explicitly aimed at increasing women's income enrolled 52 women meliponiculturists, most of whom treated beekeeping as a supplementary activity layered onto their primary domestic occupation, and found that training was associated with greater use of supplementary feeding and assisted division [11]. In the Philippines, meliponiculture has been a significant driver of women's empowerment, as shown by a widow-headed household that relied on bee-derived income as its primary means of supporting children's schooling [12]. In Nicaragua, Arauz [13] documented women-run biointensive gardens where meliponiculture was deliberately introduced because, unlike the more hazardous management Africanized *Apis* colonies require, it aligned with women's existing gendered labor roles and could be tended safely beside the home. Beyond these women-focused cases, a broader Southeast Asian technical synthesis confirms that meliponiculture's low entry barrier and quantifiable colony/honey market value make it attractive as a supplementary rural livelihood generally [14], a pattern echoed in Nagaland, India, where a state-sponsored beekeeping mission trained over 17,000 people and reported individual beekeeper incomes reaching the equivalent of tens of millions of rupiah annually, albeit without disaggregating outcomes by gender [15], and in Malaysian rubber smallholdings, where a single-mother beekeeping cooperative that adopted stingless-bee cultivation reported improved socioeconomic status [16].

Despite growing interest, direct evidence on meliponiculture's contribution to women's household income in Banyumas remains limited. Previous work documents technical aspects and the potential of group-based cultivation [4]–[9], while international studies show that women can participate in hive management [10], [11]. Participation, however, does not itself measure control over income. This study measures the income contribution of meliponiculture and its associations with enterprise scale, time investment, and experience among women in one supported farmer group. Access and decision-making responses are described separately because the proposed composite does not form a reliable scale.

This study examines whether meliponiculture provides net income to rural women in Banyumas, quantifies its contribution to household income, and tests associations with colony number, weekly time investment, and years of practice. The cross-sectional data cannot establish whether women's income increased after entering meliponiculture or whether income generation changed their decision-making power.

2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1. Meliponiculture as a Gender-Accessible Livelihood

A consistent thread across the international meliponiculture literature is the claim that stingless-bee keeping lowers the physical and infrastructural barriers that otherwise exclude women from beekeeping-based livelihoods. This claim rests on three recurring observations. First, stingless bees lack a functional sting and can generally be managed with limited protective equipment, making colony inspection compatible with routine domestic activity rather than a separate, hazard-managed task [3], [1], [2]. Second, the enterprise requires minimal capital and land; colonies can be kept in simple boxes beside the home, aligning with women's typically constrained access to land and formal credit relative to men [13], [6]. Third, empirical studies that measure gender participation directly report either near-parity ([10], North Lombok: 51% men, 49% women) or women-majority samples under deliberate development-program targeting ([11], Bolivia: 52 women meliponiculturists; [3], India: 2,074 women trainees).

These studies converge on meliponiculture's gender accessibility, but they diverge on a critical point relevant to the present study: whether accessibility translates into women's independent economic control or merely into women's labor participation within male-managed enterprises. Yanuartati et al. [10] report that Lombok women independently owned hives and sold products themselves, while Adler et al. [11] found that most Bolivian women treated meliponiculture as supplementary to domestic work, and that NGO training's singlespecies focus risked narrowing traditional multi-species knowledge while encouraging the use of selected management techniques. Garrigues and Garrigues [12] and Arauz [13] both document cases in which meliponiculture income directly supported women's household provisioning, but neither establishes whether this occurred through women's autonomous decision-making or through income channeled into existing household arrangements. This unresolved distinction, participation

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versus control, is precisely the gap this study addresses in the Banyumas context, where meliponiculture is technically established [9] but its gendered economic dynamics are undocumented.

Indonesian evidence adds further texture to this picture without resolving it. In a West Java hamlet, Noorahya et al. [20] found that most household respondents available for interview were women, largely housewives, and linked this directly to meliponiculture's compatibility with women's domestic schedules and its low physical risk; yet the same study found that positive community attitudes toward stingless-bee cultivation did not reliably translate into actual participation, since only 4% of households were currently involved despite 99% expressing support, a gap the authors attribute to limited practical cultivation knowledge rather than reluctance. Income-uplift evidence from other Indonesian sites reinforces meliponiculture's economic potential in principle: in Riau, an indigenous-community empowerment program raised average honey production by 63% within a single year and lifted one community's income by more than 90% [21], while a formal feasibility analysis in West Halmahera found a stingless-bee enterprise's return on investment reached 215%, a top-tier result by the study's own rating criteria [22], though that same study reported a respondent pool that was 78% male, reflecting a wider pattern in which men are treated as the default agricultural labor force and women as occasional helpers. Community-level klanceng enterprises in Lampung and Klaten similarly report expanding colony numbers and premium honey prices, though income gains remain modest and constrained by weak market organization and product-quality standardization [23], [24]; notably, Pertiwi et al. [24] cite a klanceng-producing community-forest group in Pekuncen sub-district, Banyumas Regency, as a lower-yielding comparison site, indicating that meliponiculture's productivity and profitability are locally uneven even within Banyumas itself. A parallel diffusion pattern outside the home-garden setting appears in West Sumatra, where a single entrepreneur's transition from coal-mining work to full-time galo-galo honey farming, supported by a corporate-and-provincial-government partnership, went on to train more than twenty smallholders across several villages [25]. None of these Indonesian sources, however, disaggregates outcomes by gender or asks whether the household member who manages the colonies also controls the resulting income, the same participation-versus-control gap identified in the international literature above.

2.2. Women's Economic Roles under Patriarchal Culture in Rural Indonesia

A parallel body of literature on rural Indonesian women's economic roles provides the structural context against which meliponiculture's potential must be evaluated. Safriyanto et al. [18] characterize patriarchal culture as a deeply entrenched social system, reproduced through family, religious interpretation, education, and media, that positions men as primary household decision-makers and confines women to a subordinate domestic role even when women contribute substantially to household income, a pattern the authors term a "double burden." Priminingtyas [17] quantifies this pattern in an East Java farming village: women's earnings contributed an average of 48.22% of household income (rising to 100% among widow-headed households), and 94.34% of women cited increasing family income as their primary motivation for taking on this dual productive-domestic role, yet men retained greater control over productive assets, land, tools, machinery, and dominated formal decision-making forums despite women constituting the majority of the village population.

In Banyumas specifically, Indiahono [19] examined women's position within the PNPM-Mandiri Perdesaan poverty-alleviation program across three sub-districts (Ajibarang, Kedung Banteng, and Sumbang) and found that women's social capital, shared norms, group solidarity, and adaptability were decisive to program success, even though patriarchal culture had historically constrained women's educational access and left policymakers initially uncertain about women's capacity to lead economic groups. Notably, Indiahono [19] found that credit access functioned less as strict productive investment and more as a social-intermediation tool that built women's economic agency and household decision-making input over time, suggesting that economic participation and cultural constraint are not fixed opposites but are negotiated and can shift over the course of a livelihood program. Together, these studies show that rural Indonesian women's income is economically substantial but culturally contested terrain, where income alone does not guarantee proportional control or recognition; a dynamic in which meliponiculture, a new and still-informal income source in Banyumas, has not yet been examined.

This patriarchal-constraint pattern recurs across other rural Indonesian settings. Iqbal et al. [26] find that village women's leadership remains stigmatized nationally, occupying only an estimated 5.16% of village-head and 12.56% of village-secretary positions, and that economic participation persists alongside, rather than replacing, women's primary identification with domestic duties, producing what the authors likewise term a continuing double burden. In North Sumatra, Napitupulu and Suriadi [27] document rural women farmers who manage nearly all household agricultural labor while their husbands pursue non-farm work, yet whose contribution remains socially framed as secondary and subject to community stigma. In North Lombok, Saputra [28] reports that women's income-generating garden work is customarily contingent on their husband's explicit permission, illustrating that household authority over women's time, not only over income, is itself a site of patriarchal control; and in Aceh, Fanzikri [29] documents that despite legal mandates for women's inclusion in village governance, their institutional participation frequently amounts to tokenistic consultation rather than substantive decision-making authority. Even in a peri-urban micro-enterprise context, Hasugian and Panggabean [30] find that capital assistance alone does not translate into improved bargaining power for women entrepreneurs, arguing that a gender-equitable environment, not resources alone, is the binding constraint on women's economic advancement. Taken together, this literature suggests that the double burden and the participation-versus-control gap identified in Section 2.1 are

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not specific to meliponiculture but reflect a broader structural pattern in rural Indonesian gender relations, one this study examines in the specific context of a growing home-garden enterprise in Banyumas. Evidence from a survey of rural women in Pakistan similarly documents income-generating activities alongside domestic responsibilities and reports that household decisions remained shaped by patriarchal norms [34]. Its setting and mix of enterprises differ from meliponiculture in Banyumas, but it reinforces the need to measure income contribution separately from decision-making authority.

2.3. Theoretical Framework

The sustainable-livelihoods perspective [10] provides a framework for examining whether physical capital (colonies) and human inputs (time and experience) are associated with financial returns. Gender analysis [17] distinguishes women's participation in production from their access to resources and control over income. The latter dimensions are reported descriptively at item level because the nine proposed items do not support a reliable single scale (Section 3.4).

The quantitative research question is whether colony number, weekly time investment, and years of practice are associated with meliponiculture's percentage contribution to household income after adjustment for the other two variables.

H1. Colony number, weekly time investment, and years of practice are associated with the percentage contribution of net meliponiculture income to household income. This hypothesis concerns associations, not causal effects.

3. METHOD

3.1. Study Area

This study was conducted primarily in Langgongsari and Pageraji villages, Cilongok District, Banyumas Regency, Central Java, Indonesia. One additional respondent resided in Notog village, Patikraja District, and another in Pajerukan village, Kalibagor District. Langgongsari and Pageraji were selected because both have active women meliponiculture practitioners. Previous applied research in Notog documented cultivated klanceng species and tested forage-plant and hive-box configurations [9], providing a local technical context for the study.

3.2. Research Design

This cross-sectional quantitative survey collected socio-demographic, meliponiculture-practice, income, and access/control responses through a structured questionnaire. Descriptive analyses and a three-predictor multiple regression addressed the income contribution and H1.

3.3. Population and Sampling

The study population comprised women actively engaged in meliponiculture within a stingless bee farmer group that the research team supported through previous community-extension activities. The group was based in Langgongsari and Pageraji and included members residing in Notog and Pajerukan. The team used total sampling to recruit all 59 eligible women in this group. This was a census of eligible group members, not all women meliponiculture practitioners in Banyumas. The pre-existing extension relationship facilitated recruitment but may have influenced self-reported responses, as discussed in Section 4.4.

3.4. Data Collection and Measures

Socio-demographic profile: age, education, marital status, household size, and primary occupation. Education was described by category; 58 of the 59 respondents reported primary-school completion, making it an unsuitable regression predictor in this sample. Meliponiculture practice characteristics: number of colonies, years of practice, hours per week dedicated to meliponiculture, division of labor tasks (following the task-division categories documented by Yanuartati et al. [10] and Al Awwally et al. [6]).

Income measures: gross and net income from honey/propolis sales; percentage contribution of meliponiculture income to total household income, following the household-income-contribution measure used by Priminingtyas [17].

Access and control measures: nine 1–5 items covered access to and control over land, colonies, tools, and income, plus one household decision-making item. The original workbook calculates their mean, but internal consistency was poor (Cronbach's $\alpha = -0.048$; $\alpha = -0.050$ after removing the two constant colony items). The composite is therefore not treated as a validated measure or as a predictor in the final regression. Item responses are presented descriptively and do not establish economic empowerment.

Data were collected via a face-to-face structured questionnaire administered between 1–15 September 2025.

3.5. Data Analysis

The income-contribution percentage was calculated for each respondent as net monthly meliponiculture income divided by total monthly household income, multiplied by 100. Descriptive statistics use all 59 complete quantitative records. Ordinary least squares regression included colony number, hours per week, and years of practice simultaneously; coefficients are reported with HC3 heteroskedasticity-robust standard errors and 95% confidence intervals. A sensitivity analysis omitted the respondent with 30 colonies (the next largest observed value was substantially lower) and refitted the same model. The sample is small, and all regression findings are observational associations. The nine access/control items were assessed descriptively; no qualitative interview findings were incorporated.

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3.6. Ethical Statement

This study did not undergo formal institutional ethics-committee review. Before data collection, all participating women provided verbal informed consent, and the researchers obtained permission to conduct the study from the respective village heads (kepala desa) of Desa Langgongsari and Desa Pageraji.

4. RESULTS AND DISCUSSION

4.1. Sample Characteristics and Household Income Contribution

The survey contains 59 distinct women with complete quantitative data. Mean age was 39.24 years (SD = 7.08); 58 had primary-school education, and one had junior-secondary education. Fifty-three were married and six were widowed. All reported being primary colony owner-managers. They managed a mean of 4.12 colonies (SD = 3.82; range 2–30), had practiced for 2.63 years (SD = 0.72), and spent 2.58 hours per week on meliponiculture (SD = 0.95). The mean net monthly meliponiculture income was IDR 208,050.85 (SD = 129,275.22), and the mean total household income was IDR 2,913,559.32 (SD = 536,417.76). Respondents' mean individual income-contribution percentage was 7.43% (SD = 4.62 percentage points; range 2.68%–31.25%). The figure is the mean of individual percentages, rather than the ratio of the two reported income means. Table 1 gives the full sample description.

Table 1. Socio-demographic profile and meliponiculture practice characteristics of respondents (N = 59).

Variable	n / Mean	% / SD
Age (years)	39.24	7.08 (range 27–62)
Household size (members)	3.07	0.87
Education level	Primary school (SD): 58; Junior secondary (SMP): 1	98.3%; 1.7%
Marital status	Married: 53; Widowed: 6	89.8%; 10.2%
Primary occupation (outside meliponiculture)	Housewife: 55; Small-scale trader: 4	93.2%; 6.8%
Role in colony management	Primary owner-manager: 59	100%
Practice duration (years)	2.63	0.72
Number of colonies owned/managed	4.12	3.82 (range 2–30)
Hours/week on meliponiculture	2.58	0.95 (range 2–6)
Gross monthly income (Rp)	237,457.63	151,493.64
Net monthly income (Rp)	208,050.85	129,275.22
Total household income (Rp/month)	2,913,559.32	536,417.76
Variable	n / Mean	% / SD
Meliponiculture income contribution (% of household income)	7.43	4.62 (range 2.68–31.25)
Access/control item mean (descriptive composite; not validated)	3.41	0.20 (range 3.11–4.00)

In the primary regression, the three predictors jointly accounted for 57.6% of the variation in income contribution ($R^2 = .576$; adjusted $R^2 = .553$; HC3 robust joint $F(3, 55) = 7.24$, $p < .001$). Each additional colony was associated with a 1.14-percentage-point higher income contribution when hours and experience were held constant ($B = 1.14$, HC3 SE = 0.27, 95% CI 0.61–1.68, $p < .001$). Weekly hours had a negative conditional coefficient ($B = -1.04$, 95% CI -2.08 to 0.01 , $p = .051$), whereas years of practice were not clearly associated ($B = -0.57$, 95% CI -2.32 to 1.18 , $p = .518$). In sensitivity analysis excluding the 30-colony respondent ($n = 58$), model R^2 fell to .215; the colony association persisted ($B = 1.39$, 95% CI 0.65–2.12, $p < .001$), while the negative conditional hours coefficient crossed the conventional significance threshold ($B = -1.29$, 95% CI -2.52 to -0.05 , $p = .041$). These hours results are

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sensitive to the sample and the correlation between hours and colony number; they should not be interpreted as an effect of reducing work time. Table 2 reports both models.

Table 2. Regression of meliponiculture income contribution on colony number, hours per week, and years of practice, with HC3 robust standard errors. The intercept is omitted for compactness. Income-share coefficients are in percentage points.

Model/predictor	B	HC3 SE	95% CI	p	R ²	n
Full / colonies	1.14	0.27	0.61 to 1.68	<.001	.576	59
Full / hours	−1.04	0.52	−2.08 to 0.01	.051		
Full / years	−0.57	0.88	−2.32 to 1.18	.518		
Without 30-colony case/colonies	1.39	0.37	0.65 to 2.12	<.001	.215	58
Without 30-colony case/hours	−1.29	0.62	−2.52 to −0.05	.041		
Without 30-colony case/years	−0.69	0.85	−2.39 to 1.02	.423		

4.2. What the Findings Mean in Relation to Previous Research

The first finding is a mean income contribution of 7.43%, indicating that meliponiculture was a supplementary source of household income in this group. The relatively small mean enterprise scale and limited reported weekly hours support this interpretation, although the study did not measure production, sale frequency, or household allocation of other income as explanatory mechanisms. Adler et al. [11] likewise described meliponiculture as an alternative activity alongside household work for many women in the Bolivian Chaco; their study examined practices and knowledge, not a directly comparable household-income percentage. Studies reporting women's earnings from all agricultural or other activities [17], [31] use a different numerator and should not be compared numerically with this meliponiculture-only contribution.

The second finding is a positive association between colony number and income share in the adjusted model. More colonies could provide a larger production base, but the survey does not measure output per colony, forage, prices, or whether higher earnings enabled women to acquire more colonies. Prior work describes meliponiculture as a potential supplementary livelihood [14], [16], while Indonesian studies discuss production and economic prospects [21]–[24]. Those reports provide context for enterprise scale, but their outcomes and settings differ from the adjusted household-income association estimated here. The association persists after excluding the 30-colony respondent, supporting the observed pattern, while the drop in R² shows how strongly that observation influenced the model's overall fit.

Weekly hours illustrate why bivariate and adjusted findings must be separated. Hours and income share were positively correlated without adjustment ($r = .41$), but hours and colony number were also correlated ($r = .71$). Once colony number and years of practice were included, the estimated hours coefficient became negative, was borderline in the primary model, and was negative with $p = .041$ after excluding the 30-colony respondent.

Time may capture different tasks, productivity constraints, or responses to colony condition, none of which were measured. The data therefore do not support a claim that additional hours necessarily increase or decrease income. Reports of training and management practices among women meliponiculturists [11] help motivate future measurements of actual management tasks, rather than validate a causal interpretation of hours here.

Years of practice showed no clear adjusted association with income contribution ($p = .518$). Its correlation with colony number ($r = .60$) and with hours ($r = .52$), the short range of reported experience, and the small sample make it difficult to separate experience from current enterprise scale. This result does not show that experience is unimportant; it indicates that the specified model did not detect an independent relationship.

All 59 women described themselves as primary owner-managers. This establishes their reported operational role but does not establish who controls product sales or the proceeds. The average responses for access to income, control over income, and household decision-making were 2.75, 2.24, and 2.93, respectively, on the stated 1–5 items, while both colony access and colony control were uniformly scored 5. These descriptive differences warrant follow-up, but the nine-item composite had negative internal consistency and cannot support an inferential claim about a single empowerment construct. This distinction between participation and control also matters for studies documenting women's involvement in meliponiculture [10], [11]; the current data cannot determine whether income changed decision-making power. Jabeen et al. [34] also distinguished rural women's economic activity from household decision-making in their Pakistan study. That comparison supports interpreting the present decision items separately; it does not establish the same household dynamics in Banyumas.

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The findings apply to the 59 women in one supported group. Differences by marital status or education are not interpreted as effects: only six respondents were widowed, and only one had junior-secondary education. The data better describe income contribution and colony association than they do subgroup or empowerment claims.

4.3. Practical Implications

Programs working with similar groups can examine whether support for viable colonies, forage, honey handling, and market access is associated with sustained net income. The positive association with colony numbers makes enterprise scale a reasonable subject for evaluation, but it does not establish that adding colonies would increase household income. Time spent on distinct activities and costs of expansion should be measured before recommending a management strategy. Future assessments of women's economic agency should collect separate, validated measures of sales decisions and control over proceeds.

4.4. Limitations

The cross-sectional, observational design cannot establish the direction of association. Income share is a ratio affected by both meliponiculture income and total household income. The respondent with 30 colonies and 31.25% income contribution had substantial influence; removing her lowered R^2 from .576 to .215 and changed the conditional inference for hours. Correlations among the three predictors also complicate interpretation of independent associations. The sample is restricted to one group supported by the research team and cannot be generalized to all practitioners in Banyumas.

The access/control instrument combines distinct domains, and its nine-item internal-consistency estimate was negative; the two colony items had no variation. It cannot be used as a validated empowerment scale without revising the construct, coding, and items. Self-reported income, time, and decision responses may contain recall or social-desirability errors. No verified qualitative interview material was incorporated in this analysis.

4.5. Future Research

A larger study should measure colony productivity, forage, input costs, sale prices, and distinct management tasks to examine why colony number and time have different adjusted associations. Follow-up over time could clarify whether income allows expansion or expansion precedes income gains. Analyze access to resources, sale decisions, and control over income as separately defined constructs with validated items; interviews may explain how women negotiate these decisions, provided interview records are independently verified.

5. CONCLUSION

Among 59 women in a supported meliponiculture group in Banyumas, net meliponiculture income contributed a mean of 7.43% of household income. Colony number was positively associated with income share in a model adjusting for weekly time and years of practice ($B = 1.14$ percentage points per colony, 95% CI 0.61–1.68). The association persisted after the 30-colony respondent was excluded, while model fit fell substantially. The conditional association for time was unstable, and experience was not clearly associated. Reported colony management does not demonstrate control over income, and the access/control composite lacks adequate measurement support. The findings describe supplementary income and an association with enterprise scale; they do not establish causal income gains or women's economic empowerment.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

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