Sweet and Timely Income?
Beekeeping and Seasonal Food Insecurity in Chiapas, Mexico *

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Abstract

Diversification into tradable crops is often advanced as a key weapon against food insecurity, providing access to higher off-farm prices, insuring against idiosyncratic shocks, and smoothing intra-annual income. Here we identify an unusually isolated sample of smallholder farmers in a coffee cooperative in highland Chiapas, Mexico to see whether beekeeping, a common diversification crop, achieves its goals. Beekeepers have higher total income, take out more loans for working capital, and own more livestock, indicative of generally being larger and more capitalized firms. However honey income, which arrives during the hungry season, is only weakly effective at reducing food insecurity. Our results indicate that diversification may not meaningfully improve food security even as it moves hand-in-hand with farm growth.

Highlights:

- Coffee delivers nearly all its annual value in December–April, prompting many to adopt beekeeping as diversification.
- Beekeepers have higher total income, 1.79 more TLUs of livestock, and take out more business loans.
- Beekeepers report 3.8 pp less food insecurity in April–June as honey arrives, none in the July–August peak or annually.
- Results indicate that even under ideal take-up conditions farm diversification may have limited food security benefits.

JEL Codes: Q12, I32, O13.
Keywords: Seasonal food insecurity, Livelihood diversification, Beekeeping, Coffee smallholders, Mexico.

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Use of AI Technologies

The authors used Anthropic's Claude, via Claude Code, as a research assistant between February and September 2026, to revise prose, modify analysis code, and check citations. The research questions, identification decisions, interpretation and conclusions are the authors', who specified each task, reviewed the code, verified the results, edited all text, and take full responsibility for the manuscript.

1 Introduction

Smallholder farmers face substantial intra-annual food security risk due to the concentrated nature of harvest incomes. Lean season food insecurity can have disastrous effects on welfare (Dercon & Krishnan, 2000; Khandker, 2012), leading to substantial scarring to human capital and health in the long run (Christian & Dillon, 2018; Fink et al., 2020). The lean season interacts with aggregate inter-annual harvest volatility (Boyd & Bellemare, 2020) to produce a consumption smoothing problem coupled to harvest cycles, requiring a persistent and distinct set of adaptive mechanisms from those responding to idiosyncratic shocks (Morduch, 1995; Paxson, 1993). Food insecurity thus tends to persist concentrated in particular months rather than spread across them (Bacon et al., 2014; Morris et al., 2013).

In response, households may adopt a variety of temporal smoothing strategies in order to adapt to this seasonal problem, including borrowing against the coming harvest (Basu & Wong, 2015; Fink et al., 2020), storing output and selling it later (Aggarwal et al., 2018; Burke et al., 2019), sending a member to migrate (Bryan et al., 2014), asking the buyer to hold their money and pay it out after the season (Casaburi & Macchiavello, 2019), saving a portion of harvest income for use later on in the year, or diversifying production into other crops whose harvest falls at a different time of year (Barrett et al., 2001; Ellis, 1998).

Of these strategies, diversification of production is a particularly attractive choice in theory and popular with both government agricultural extension agencies and food security NGOs (Makate et al., 2022). In particular, producer organizations often offer diversification as one of a package of interventions to improve the welfare of smallholder producers (Bizikova et al., 2020). By providing additional income at a different time of year, diversifying farm production can lessen the need for adjusting on other margins via seasonal credit, savings arrangements, or changing when the cooperative pays (Casaburi & Macchiavello, 2019).

This paper asks whether a specific smallholder diversification strategy, adopting beekeeping, alleviates intra-annual food insecurity in a sample of indigenous coffee producers in a Tseltal producers' cooperative in the highlands of Chiapas, Mexico. The setting provides several unique advantages to our approach. It is in mountainous terrain that is extremely difficult to travel to, making it relatively cut off from the rest of the world and broader markets in Mexico; most households have neither a bank account nor a cell phone. The two agricultural products in question, coffee and honey, are both non-indigenous technologies requiring learning and adoption, and provide an unusually clean case of a diversification strategy (Goulson, 2003). Coffee is the principal export crop, and the narrow timing of its harvest — 99.98% of annual value arrives between December and April, January alone accounting for 40.7% — produces sharply seasonal food insecurity: under 5% of households report difficulty feeding themselves in the months after the coffee harvest, but 47.3% do in July, with 93% of all reported food-insecure months falling between April and September. Honey, meanwhile, requires little capital (Tseltal producers typically begin with a single hive) and little land, so it does not compete with coffee for the household's principal asset. Its harvest falls several months after the coffee harvest, placing its income in the months when coffee earnings have been exhausted. Because bees pollinate the coffee itself, adoption carries a plausible agronomic complementarity rather than a tradeoff. Honey production is further explicitly recommended by the cooperative as a diversification strategy.

We take advantage of the cooperative's rich data to quantify outcomes for coffee producers that also produce honey, merging administrative records from 2013-2025 and a household survey we conduct in summer 2022. On paper, honey production seems to be associated with much better outcomes. Beekeeping seems to substantially increase household income, with mean income for honey producers 15,210 MXN ($756)[1] higher than non-producers, nearly all of that resulting from

[1]Peso figures are converted throughout at 20.12 MXN per US dollar, the 2022 annual average (FRED series

honey itself. Beekeeping is also associated with better credit outcomes suggestive of improved firm investments, with beekeepers more likely to take out loans from the cooperative for working capital. Beekeeping is also associated with higher wealth in the form of livestock, as well as in terms of family size.

Whatever the causal link between beekeeping and these various pieces of evidence suggesting healthier and wealthier firms, beekeeping does not translate into meaningfully improved food security outcomes. At an annual scale, we find no difference in food security, measured as the total number of months the household had difficulty finding sufficient food. We find some evidence that the specific months of the honey harvest, which fall at the beginning of the lean season, are associated with a lower likelihood of hunger — 3.8 percentage points, and 7.2 before controls for interview timing and enumerator identity — but the difference disappears during the peak hunger months of July and August. We try a variety of specifications and approaches and across all specifications find small and noisy estimated differences in food insecurity experienced by honey producers vs. their non-adopting counterparts.

This paper makes several contributions. The first is the data. The food security literature typically summarizes a household with a single annual figure, the count of lean months, or a score constructed from one (Barrett, 2010; Bellemare & Novak, 2017), which is adequate for comparing households but cannot represent the within-year timing that is the substance of the seasonal-deprivation problem (Fink et al., 2020; Morris et al., 2013). We are able to directly observe monthly measures of food insecurity as well as a variety of other household level outcomes in an isolated setting, allowing us to focus on how food security responds within the most vulnerable periods of the year. Secondly, the remote setting of our paper and central nature of the cooperative institution allows us to observe equilibrium differences in outcomes between adopters and plausibly similar non-adopters in very similar conditions across multiple adaptive margins. The fact that we find that honey production is associated with multiple signs of improved economic success but minimal change in food insecurity suggests that diversification may be an appropriate strategy for agricultural firm growth but that it may be only weakly coupled with meaningful improvements in

EXMXUS); the June–August window in which the survey was fielded averaged 20.22.

food security.

Lastly, this paper contributes to the small literature on honey as a diversification and climate-adaptation strategy in agroecology. Anderzén et al. (2020) look at outcomes among honey adopters elsewhere in this region of Chiapas; Bacon et al. (2023) meanwhile examine annual food security measures for honey adopters in Nicaragua. Using mixed methods, both papers find little evidence of large benefits from honey production. Our paper is consistent with these results. Nearest to what we do is Anderzén et al. (2024), who survey 25 beekeepers in the Sierra Madre de Chiapas monthly for a year and find that beekeeping fits alongside the coffee and maize calendars without competing for labour. The constraint they identify sits on a different margin from ours: the beekeepers they follow want to expand and name technical knowledge and climate rather than capital, whereas what separates the households in our sample who want bees from the non-producers who do not is assets. Serra and Davidson (2021) examine the welfare effects of a honey cooperative in Ethiopia for women, but lack the broader framing of our paper of honey production as one element of smallholder producers' household economies.

The paper proceeds as follows. Section 2 describes the setting, Section 3 the survey and the food-insecurity measure, and Section 4 the empirical strategy and what it can and cannot identify. Section 5 presents and discusses the results, together with the limitations and what they imply for policy, and Section 6 concludes.

2 The Setting

2.1 Households and Land

This study is based on surveys conducted on 275 coffee producers in the months of June, July, and August 2022 in the central highland region of the Mexican state of Chiapas. This region is home to the Tseltal Mayan indigenous community, where most households are involved in agricultural production and the primary source of cash income is coffee production. We partnered with the staff of a coffee cooperative that serves in this region for logistical support, and to ensure that we had both buy-in and an understanding of any potential harms to the community.

A map of the survey regions, labeled with each region's rate of honey adoption, is provided in the supporting information. We visited eleven survey regions over the course of eleven field visits, which corresponded approximately, but not exactly, to each region. The polygons in the figure approximate those regions rather than delineate them: they are Voronoi cells around the villages whose members belong to each. Field visits were announced in advance and were open to anyone who wanted to participate. We conducted the survey after participants completed a lab-in-the-field experiment. Overall, 54 of the 275 participants reported producing honey.

Our household survey asked about household demographics, income and food insecurity, farm characteristics, coffee production, and honey production. In Table 1, we present summary statistics of demographic characteristics separately for honey producers and non-producers and test for statistically significant differences between those demographic characteristics by honey producer status. Honey producers and non-producers do not appear to differ meaningfully by age, gender, or education level. Honey producers do have slightly larger households (1 more member) and tended to live closer to the nearest county seat (by an average of 6 km). They have similar experience with coffee growing, the primary economic activity of the region: neither the number of years growing coffee, the size of the farm, the size of the harvest, nor income excluding honey are significantly different between honey producers and non-producers. That last row is the one relevant to selection, and Table 1 reports it alongside the two it decomposes into: honey income, which non-producers do not have, and the total, which is accordingly higher for producers by construction.

Assets are the only exception. Livestock is the only household-level asset the survey measures, and producers hold roughly twice as much of it: 3.07 tropical livestock units against 1.28, a difference of 1.79 with a t-statistic of 3.02. Three things bear on how much weight it should carry. Most of the gap is regional rather than individual — with region fixed effects it falls to 0.60, a third of its original size, and is no longer distinguishable from zero ($p = 0.26$) — and region enters the producer-level specification below as a control. Among producers, holdings are uncorrelated with both honey earnings and honey output (Spearman 0.09 and 0.08), which is not what accumulation out of honey income would look like, and suggests instead that households which keep animals are the households which keep bees. And because livestock is a household-constant trait, it cannot move the seasonal estimate at all, for the algebraic reason set out in Section 4.2; it matters for the annual comparison, where conditioning on it halves an already insignificant difference. Resources apart from beekeeping are therefore not uniformly balanced: income, land and coffee experience are, and assets are not.

These tests are not powerful. With 54 honey producers against 221 non-producers they can rule out only large differences, so "indistinguishable" here means that we cannot detect a difference rather than that none exists — and several point estimates, larger households and greater proximity to a county seat among them, point in directions that could plausibly bear on food security.

Adoption is also uneven across space, from none in three survey regions to 65.4% in Tsubute'el, and this is not accounted for by the producer characteristics in Table 1, so region enters the producer-level specification below as a control.

2.2 The Income Calendar

Figure 1 sets the cooperative's delivery records beside the survey, with the caveat that not all participants are cooperative members, so the income series describe members rather than our sample exactly. It shows three stylized facts about timing:

1. Coffee income arrives from December through April and is almost entirely absent for the rest of the year.

2. Honey income arrives across a broader window than coffee, running from January through July, but is concentrated in April through June, which carry 91% of its delivered weight, and exceeds coffee income from April onward.

3. Reported food insecurity begins to rise in March, climbs steeply through the spring, and peaks in July before falling sharply in September — three months before the coffee harvest begins.

The three are staggered as the seasonal argument requires: coffee income ends before food insecurity climbs, and honey income spans the interval. What ends the hungry season is not in the figure. Maize is harvested from September through December in this region (Anderzén et al., 2024) and is

Table 1: Summary Statistics: Honey Producers vs. Non-Honey

	(1) Honey Producers		(2) Non-Honey		(3) Difference	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	T-Stat
Demographics:						
Age	43.39	15.31	43.43	15.77	-0.05	(-0.02)
Gender (1 = Female)	0.43	0.50	0.52	0.50	-0.09	(-1.19)
Completed Only Middle School (pct)	12.96	33.90	14.48	35.27	-1.52	(-0.29)
Completed High School (pct)	9.26	29.26	10.86	31.18	-1.60	(-0.36)
Household Size	7.63	3.82	6.62	2.91	1.01^{*}	(1.82)
Number of Dependents	2.85	3.18	2.23	2.23	0.63	(1.37)
Regional Elevation (MASL)	1126.50	267.19	1069.17	267.35	57.33	(1.41)
Distance to Nearest Town (km)*	15.08	12.20	20.79	15.48	-5.71^{***}	(-2.91)
Coffee Experience (Yrs)	18.85	15.17	16.96	12.92	1.89	(0.84)
Farm size (ha)	3.76	2.44	3.62	3.63	0.14	(0.34)
Livestock (TLU)¶	3.07	4.22	1.28	2.14	1.79^{***}	(3.02)
Production and income:						
Coffee Harvest (1 Quintal = 60kg)	7.03	7.83	5.98	5.15	1.05	(0.94)
Income excl. honey (1,000 MXN)‡	17.91	15.33	16.81	15.35	1.10	(0.47)
Honey income (1,000 MXN)§	14.11	15.75	0.00	0.00	14.11^{***}	(6.58)
Total income (1,000 MXN)	32.02	21.44	16.81	15.35	15.21^{***}	(4.91)
Outcome:						
Food Insecure (months)	1.67	1.35	1.85	1.26	-0.18	(-0.89)
Participants	54		221		275	

Source: authors' 2022 household survey of 275 coffee producers, 54 of them beekeepers.
*Distance to nearest town reports distance from regional center where surveys were conducted to the nearest county (municipality) seat.
‡The reported total of coffee sales, off-farm income, and government subsidies, excluding honey. This is the comparison relevant to selection: including honey income would make adopters better off by construction.
§Non-producers report no honey income by definition, so the difference in this row is the adopters' own mean rather than a comparison of two groups. Total income is the sum of the two rows above it.
¶Livestock is in tropical livestock units, one unit being 250 kg of liveweight: cattle .70, horses .80, mules .70, sheep .10, pigs .20 and poultry .01. It is the only household-level asset the survey measures; Section 2 discusses the imbalance in this row.
Peso figures convert at 20.12 MXN per US dollar, the 2022 annual average (FRED series EXMXUS): the three income rows are 0.89, 0.70 and 1.59 thousand USD for adopters, 0.84, 0.00 and 0.84 otherwise.

grown for consumption rather than sale, so it closes the gap in September without appearing in any income series — which is why food insecurity falls three months before the coffee money arrives. Almost every household in our sample grows it, producers and non-producers alike, so it moves the level of food insecurity in these months and not the difference between the two groups.

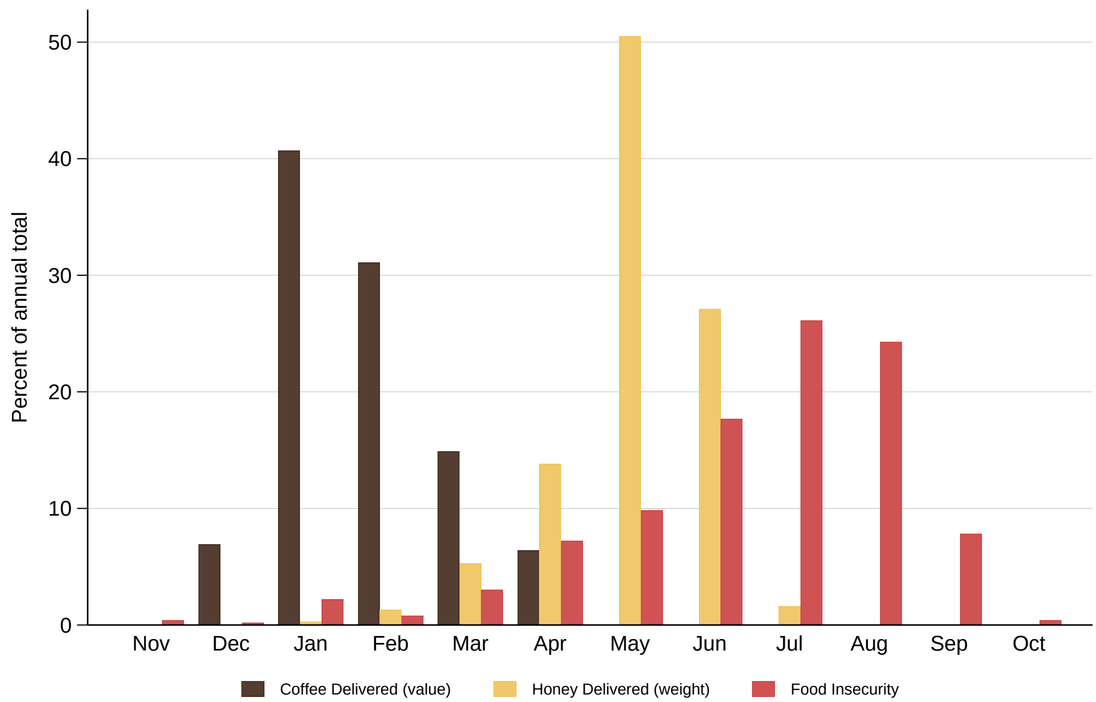

Figure 1: Timing of Coffee Income, Honey Income and Food Insecurity

Notes: Each series is that month's share of its own annual total, so the three are comparable in timing but not in level. Coffee is delivered value and honey delivered weight; Chabtic paid a flat 55 MXN (2.73 USD) per kilogram in 2022, so the two are proportional. Sources and counts are given in the text.

The figure's coffee series is drawn from the 308 dated deliveries by 222 producers that make up the 2021–22 harvest, the season preceding the survey, and it is the source of the concentration figures quoted in Section 1.[2]

[2]Computed from the cooperative's delivery records. The calendar does not depend on the season chosen: across seven earlier harvests, 2013 to 2019 and 2,240 dated deliveries, December–April carries 98.1% of delivered value and May–October 0.9%. Those seasons peak in February at 36.3% rather than in January, which is the one respect in which the survey year differs.

The honey timing in Figure 1 rests on the cooperative's 2022 honey receipts, which are delivery-level and dated: 121 deliveries by 35 producers between 6 January and 5 July 2022, of which 91.5% of delivered weight falls in April, May and June, with May alone accounting for half. A second dated season three years later reproduces it, at 90.5%.[3]

One caveat remains: these are the cooperative's receipts, so they describe honey sold to the cooperative by its members rather than all honey sold by our respondents, only some of whom are members.

The April–June concentration of honey income visible in Figure 1 follows the flowering calendar. Colonies build stores through the dry-season bloom and are harvested as it ends, which places the honey harvest after the coffee harvest has concluded and its income has largely been spent. This is what makes honey interesting for the seasonal question, and it is a feature of bee biology in this environment rather than of market timing or cooperative collection schedules.

2.3 The Honey Market

Honey in this region is produced for sale rather than for home consumption. Producers keep a small number of hives — typically beginning with one — and sell the harvest either to Chabtic, the honey cooperative within the same cooperative group that buys these producers' coffee, or to private buyers operating in the same communities. Both channels are available to any producer, and as noted above our measure captures production regardless of which is used.

For the households that keep bees, honey is not a sideline, and holdings range from a few hives to several dozen. Nor does it appear to come at coffee's expense: adopters report a higher median coffee income than non-adopters (12,000 against 10,000 MXN, or \$596 against \$497) and roughly double the total (26,000 against 12,000, or \$1,292 against \$596), so coffee's share of income falls among adopters only because the denominator grows. Table 1 makes the same comparison in means, and shows what selection would have to look like to explain it: adopters and non-adopters are indistinguishable in income excluding honey, and in coffee harvest, farm size, coffee experience,

[3] Computed from the cooperative's honey receipts for the 2022 and 2025 seasons and from its coffee delivery records. The figure plots delivered value for coffee and delivered weight for honey; the figure's own note gives the price that makes the two proportional.

age and schooling, differing in household size, in proximity to the nearest town, and — as Section 2 discusses — in livestock. Both income figures come from the same survey round, so neither dates to before adoption.[4]

Two features of the price make honey a plausible source of lean-season income. In 2022 Chabtic paid 55 MXN ($2.73) per kilogram on every delivery its book records, and our survey provides an independent check: the median among our 54 producers is exactly 55, with an interquartile range of 50 to 55 ($2.49 to $2.73). Producer reports and cooperative records agree closely. Chabtic's records also report what it believes private buyers pay, 40 MXN ($1.99) in 2022, but these are the cooperative's own round-number estimates rather than observed transactions.

2.4 Alternatives: Day Labour, Migration and Credit

Honey is not the only off-season activity available here. Producers in this region work as day laborers on other farms, migrate seasonally, and in some cases sell surplus maize. The devices listed in the introduction have been evaluated elsewhere with mixed results: lean-season credit raised labor supply, output and wages in Zambia and narrowed the seasonal consumption gap in eastern Indonesia, though without moving staple food consumption, while storage runs backwards for the poorest, who sell at harvest and buy back dear. What distinguishes honey among these is that it requires neither the absence of a household member nor land that would otherwise grow coffee, and that its capital requirement is a single wooden hive.

They also borrow, and the pattern of that borrowing is itself evidence that the seasonal gap binds. The cooperative group operates a small credit arm, and its lending records show a clear seasonal signature: of 620 loans issued between November 2013 and June 2023, 56% originate between May and October, the months in which coffee income has been exhausted, while only 24% originate during the January–April harvest window. Repayments run the other way — 60% fall between January and April, the months in which coffee is delivered and paid for. The median loan is 2,000 MXN ($99), and the median term is six months. Borrowing on these terms is not cheap: 79% of the loans carry a stated interest rate of 4% per month, or roughly 48% per year, with a

[4] Medians, one observation per household.

further 1% monthly charge on arrears written into every contract. Interest on a median loan held to term therefore comes to about 480 MXN ($24), close to a quarter of the principal. This is the behavior a seasonal liquidity constraint predicts (Fink et al., 2020): borrowing against the coming harvest to cover the lean season, and settling out of harvest receipts.[5]

Splitting those records by honey producer status shows that the two devices are not used in the same months. Figure 2 reports the share of each group's loans originated in each month, alongside month-by-month interactions estimated on a borrower-by-month panel in the same form as Figure 4. Members who keep bees do not borrow less in total; they borrow later. Of the 608 loans that carry an origination date, honey producers place 21.4% in the April–June honey window against 35.4% for other members, and 63.1% against 35.6% between July and November. A joint test that the eleven monthly interactions are zero is rejected ($F = 2.947$, $p = 0.0011$), and the two months carrying it are July (+0.350, 95% CI $[0.082, 0.618]$) and November (+0.581, $[0.218, 0.945]$).

The records also give the reason. Purpose is stated on every application, and it differs sharply by group: among honey producers 61.0% of approved applications are for work — in the free-text justifications, overwhelmingly coffee-grove maintenance and hired labor — against 36.3% for other members, who borrow more often for food (24.1 against 13.3%) and for health (28.9 against 16.2%). Beekeepers are also likelier to borrow at all, 33 of the 39 we can identify against 214 of 697 other members. So the lean-season bridging described above characterizes the membership as a whole; among beekeepers the same credit line is used more often as working capital.[6]

We read this as descriptive rather than causal. These are cooperative members rather than our survey households; honey producers are identified here by delivery to Chabtic rather than by the survey question; and the borrower fixed effects remove level differences between the two groups but not differences in the shape of their year. What the figure does rule out is the simplest substitution story, in which honey income displaces borrowing altogether.

Honey and seasonal credit are therefore complementary rather than competing instruments, and

[5] Computed from the credit arm's contract and payment records, which cover the cooperative group's membership rather than our survey sample specifically; we use them to characterise the setting, not our respondents.

[6] Purpose is what the borrower reported to the loan officer, and money is fungible; the eighty-six free-text justifications corroborate the coding without removing that caveat. One loan coded as work reads *para la compra de alimentos*.

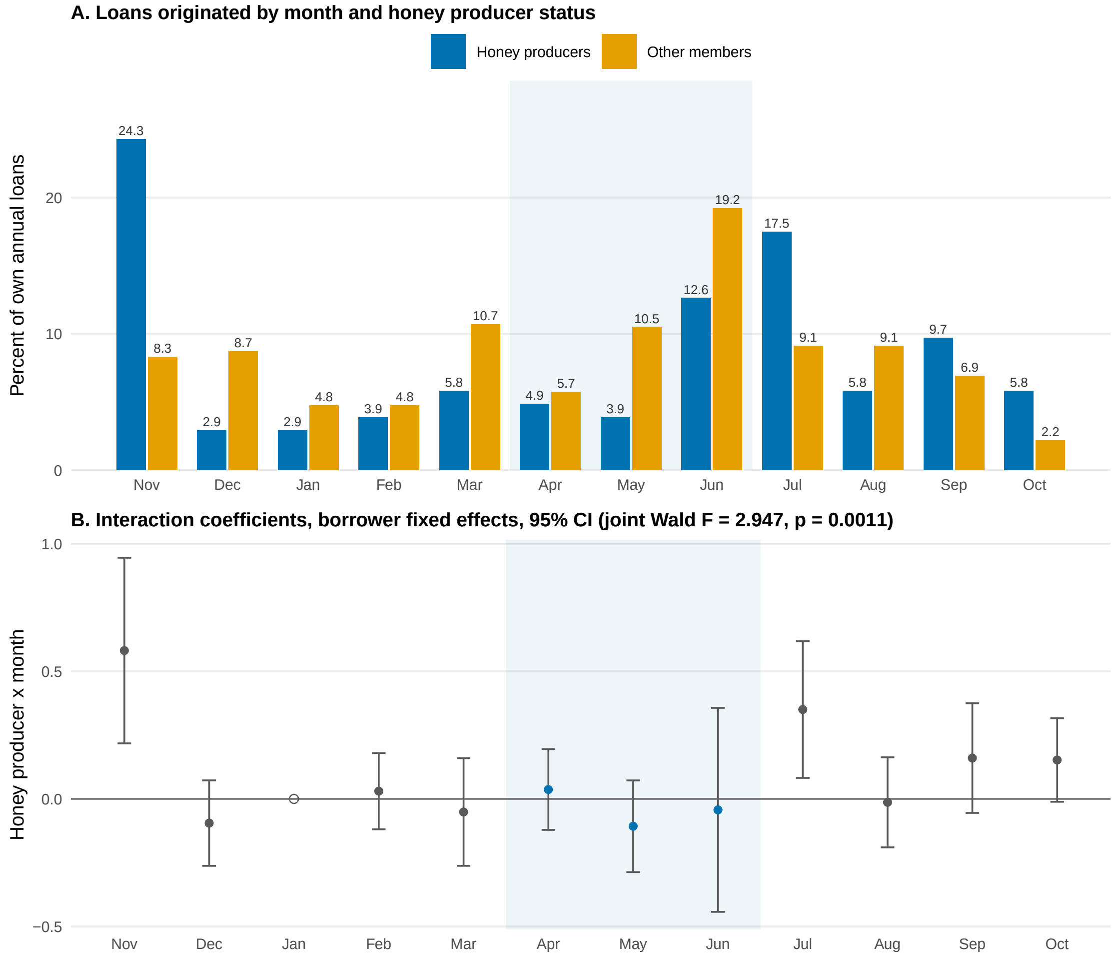

Figure 2: Seasonal Borrowing by Honey Producer Status

Notes: Panel A, each group's loans by month as a share of its own annual total. Panel B, month-by-month interactions, January omitted (hollow point at zero), borrower and month fixed effects, clustered on the borrower; the outcome is loans originated in that month. Shading marks April–June. Honey producers are members who ever delivered to Chabtic. Cooperative credit records, November 2013 to June 2023.

not equally costly ones: a hive accrues no interest, while a median loan carried to term costs close to a quarter of its principal.

2.5 Who Keeps Bees?

The survey allows us to say more than that, because non-producers were asked how interested they would be in keeping bees, on a scale of one to ten. This separates the 221 non-producers into groups that a simple treated/untreated split conflates, and the comparison is informative about selection in a way the balance table is not.

Table 2 splits them by that answer, with the forty-six who did not answer shown as their own row.

Table 2: Non-Adopters by Stated Interest in Keeping Bees

	n	Age	Hungry months	Income† (000s)	Livestock‡	Hectares	Crops
Keeps bees	54	43	1.67	13.6	3.07	4	9.4
Wants to, does not	**32**	**43**	**1.91**	**9.6**	**0.65**	3	9.7
Middling interest	58	41	1.59	16.6	1.49	3	10.2
Not interested	85	46	1.92	12.0	1.56	3	8.5
Interest not reported	46	42	2.00	10.3	0.95	3	8.5

Source: authors' 2022 household survey of 275 coffee producers. *Notes*: Non-producers were asked how interested they would be in keeping bees on a scale of one to ten; the four lower rows split the 221 non-producers by that answer into high (seven to ten), middling (four to six), low (one to three), and the forty-six who did not answer, who are kept separate because they differ from the middling group. "Hungry months" is the reported number of months in the past year in which the household lacked sufficient food. †Income excludes honey. ‡Livestock is in tropical livestock units, defined in Table 1. Income and hectares are medians; crops and livestock are means. Peso figures convert at 20.12 MXN per US dollar. See Section 2.5.

The 32 households who want to keep bees and have not are the most informative group in the sample, and the instructive comparison is not with producers but with the other 189 non-producers. On every other margin the survey records, the two groups are the same: both farm three hectares at the median, both are about a third cooperative members, and in both exactly half know someone who already keeps bees. Stated interest is uncorrelated with that exposure ($r = 0.017$). What separates them is assets. Aspirants hold 0.65 tropical livestock units against 1.39 for the other 189 non-producers, while producers hold 3.07 — a gradient running against the direction of wanting to adopt.

The barrier is therefore neither information nor preference. The households that most want this strategy are the poorest in the sample, and they report more hungry months than the producers who took it up; the households that do take it up are those who could already afford to. This sits awkwardly beside the observation in Section 2.4 that honey's capital requirement is nominally a single hive: nominally small, it nonetheless appears to bind. Which market is responsible we cannot say — the cost of starting, the 48% annual credit that would finance it, and the capacity to wait a season for returns are all consistent with what we observe, and the survey carries no question that separates them.

3 Measuring Food Insecurity

3.1 The Item and Its Recall Window

We measure food insecurity on the access dimension of Barrett (2010): whether a household can obtain enough food, a demand-side question answered at the household level, rather than whether food is available in the aggregate. This is the tradition that runs from Sen (1982), in which a cash crop matters because it provides income to exchange for food, and it is why a second cash crop is the object of interest here. Access is typically measured either by the overall duration of the hungry season or by the number of lean months in which producers report not having enough food (Anderzén et al., 2020; Bacon et al., 2014; Bellemare & Novak, 2017).

For this reason, we follow Morris et al. (2013) and consider the timing of the lean months as well. We asked participants specifically in which months they did not have enough food to feed themselves or their families. In turn, we use this information to construct a balanced panel of month-producer cells, representing 3,300 binary responses for 275 producers over 12 months.

The question took the form of a single select-multiple item: respondents were asked in which months of the past year their household had not had enough food, and could name any subset of the twelve. Their answers were recorded as a list of months and expanded into twelve binary indicators, one per month, which are the panel's dependent variable. A separate item asked whether the respondent had felt hungry that morning, before arriving at the session; 30.5% said yes, consistent with fieldwork having taken place in June through August, the peak of the lean season. That item is individual and momentary, and we use it only as context.[7]

[7] The item reads, verbatim from the KoboToolbox form: *"Durante el año pasado, ¿en qué meses usted no tuvo*

Two features of this measure require emphasis. First, it is *retrospective recall*, not a repeated panel. Each respondent was interviewed once, during June, July, or August 2022, and asked to report the months of the preceding year in which their household lacked sufficient food. The twelve observations per producer come from a single interview, and the resulting panel therefore carries whatever error a twelve-month recall introduces.

The direction of that error works in favour of the seasonal pattern we report, not against it, and we want to be explicit about that. Months near the interview are recalled more readily than distant ones. Our fieldwork ran June through August, so the months of peak reported food insecurity are also the months nearest the interview, while the months of lowest reported insecurity — October through December — sit seven to ten months back for most respondents. If distant months are under-reported, the measured seasonal amplitude is *overstated*. Section 3.2 quantifies this and reports our results with the interview date absorbed. Those same controls absorb a second ambiguity in the elicitation: *el año pasado* does not name the recall window, so a respondent may have reported a trailing twelve months, which moves with the interview date, or calendar 2021, which does not.

Second, the respondent was the household member who attended the field visit, and the question concerns the household rather than the individual.

3.2 Survey Process: Interview Timing and Enumerators

Two features of how the survey was administered bear directly on the measure this paper is built around.

First, the reference window moves with the interview date. Interviews ran across three months — 71 households in June, 123 in July, 81 in August — and each respondent was asked about *the past twelve months.* For a household interviewed in June, "August" can only mean August 2021;

suficiente comida para alimentarse usted o alimentar a su familia? Puede seleccionar mas de uno." The twelve months were displayed as check boxes, January first, with no screening question. It is question 2 of the FANTA Months of Adequate Household Food Provisioning (MAHFP) indicator (Bilinsky & Swindale, 2010), which Anderzén et al. (2020) use in this region, without the final step that collapses the months to a count; it departs from the guide in showing the month list rather than eliciting it unprompted, and in saying "el año pasado" rather than naming the trailing twelve months explicitly. Interviews were conducted in Tseltal and Spanish. The hunger item reads *"Antes de venir aquí hoy, ¿usted sentía hambre?"*.

for one interviewed in August, it means August 2022. The consequence is large: reported food insecurity in August runs at 35.2% among June interviews and 58.0% among August interviews, a 23-point gap for a nominally identical month. September and July show gaps of 12.5 and 9.6 points in the same direction. April moves the other way (21.1% to 9.9%), which is what plain recall decay predicts; a survey experiment in rural Malawi finds that annual recall lowers reported labor participation and months worked by about a fifth relative to ninety-day windows, with the largest reductions for activities furthest in the past (Ambler et al., 2025).

Second, ten enumerators conducted the interviews and the share of respondents recorded as honey producers ranges from 3% to 33% across them. This is not geographic: each enumerator worked seven to eleven of the eleven regions, and enumerator identity still predicts recorded honey status after conditioning on region ($F = 2.17$, $p = 0.024$). Since honey production is self-reported, who asked is a plausible source of variation in the treatment variable itself.

We therefore report the seasonal specification against a ladder of survey-process controls — interview-wave × month, enumerator × month, and both — in Section 5.3. We regard the fully-controlled estimate as the most credible.

We also note that honey producer status is self-reported production, not delivery to a cooperative. This distinction matters more than it may appear: a producer who keeps bees but markets the honey through channels other than the cooperative is a honey producer for our purposes and would be invisible in administrative delivery records. Since the mechanism at issue is whether honey generates income in particular months, production is the correct measure here. The administrative measure — ever having delivered to Chabtic — is the one behind the delivery and credit evidence in Section 2, which describes the cooperative's membership rather than our respondents. The two populations overlap but are not the same, and no estimate in this paper combines them.

3.3 Defining the Honey and Lean Seasons

Incorporating this time dimension into the analysis reveals monthly variation in reported food insecurity. Figure 3 displays the incidence of food insecurity by month. It is present in all twelve months but heavily concentrated in the pre-harvest months: 93% of all reported food insecurity falls between April and September, and fewer than six percent of the sample report it in any month from November to March. Section 5.3 gives the monthly figures and their intervals.

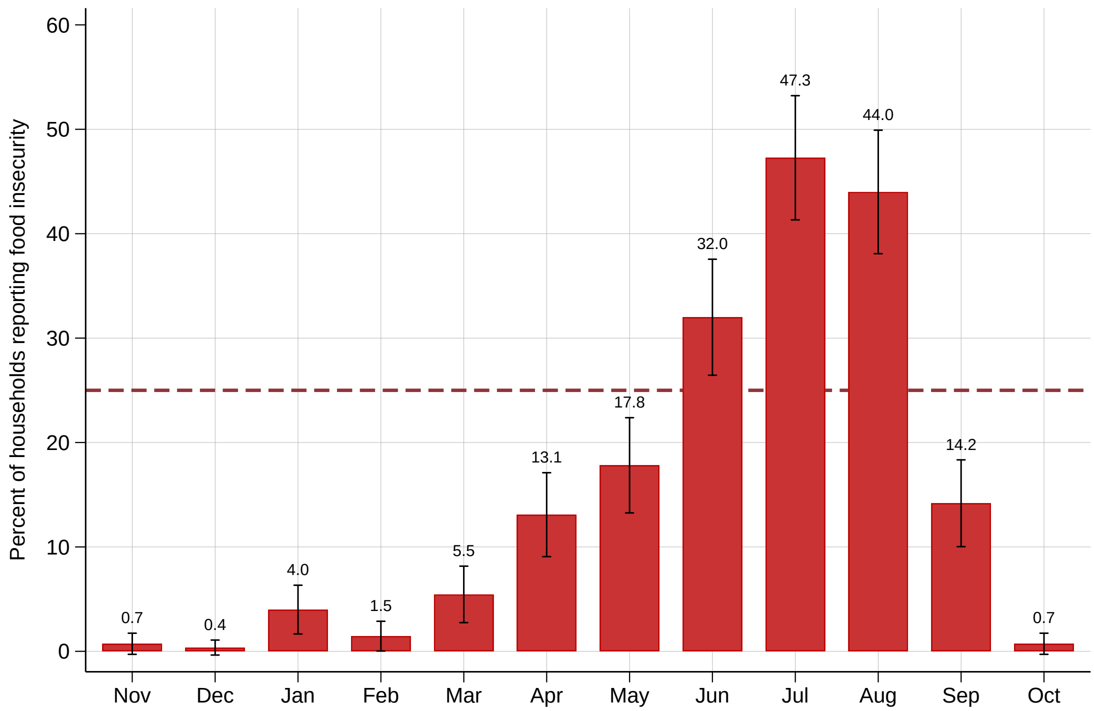

Figure 3: Food Insecurity Exposure. Comparable to Figure 5 in Anderzén et al. (2020).

Notes: Bars are the share of the 275 surveyed households reporting food insecurity in each month; caps are 95% confidence intervals from standard errors clustered at the household level. The dashed line marks 25%; June, July and August are the months above it.

Splitting the same months by honey producer status, as Panel A of Figure 4 does, leaves that shape intact but adds one difference worth previewing: from March through June — the onset of the hungry season, and the months of peak honey production — honey producers report less food insecurity than non-producers.

We define the honey season as the months in which honey delivers more of its annual total than coffee delivers of its own — the comparison Figure 1 plots, which is one of timing rather than of level: April, May, and June. We refer to June, July and August as the lean season: they are the three months in which reported food insecurity exceeds a quarter of respondents. That is a descriptive label, not a window we estimate on.

The honey window's edges deserve a word, because the rule is decisive in the middle and not at the margins. May and June satisfy it overwhelmingly: they carry 50.5% and 27.1% of the year's delivered honey, and coffee delivers essentially nothing in either. April satisfies it by 13.8% against 6.4%, and July satisfies it as well, on 1.6% of honey against no coffee at all. We hold to April through June because July carried 1.6% of delivered honey in the survey year, too little to smooth anything. That is a statement about 2022 rather than a rule: the second dated season put 9.5% of its honey in July, so the window's lower edge is firm and its upper edge is not.

The honey window is read from the income series with no reference to the outcome, which is what lets the estimate in Section 5.3 be something other than a window chosen to fit. The placebo in Section 5.4 runs on July and August, which share no month with it.

4 Empirical Strategy

We test first for an association between honey production and the total months of food insecurity a producer reports, then turn to the producer-month panel. All specifications are estimated by ordinary least squares.

4.1 Effect of Honey Production on Overall Food Insecurity

We begin by estimating the following specifications at the producer level.

$$y_{i,r} = \alpha + \beta T_i + \gamma X_i + p_r + e_{i,r} \tag{1}$$

The dependent variable $y_{i,r}$ is the total months of food insecurity for producer i in region r, and T_i indicates whether the producer keeps bees. The vector p_r is a set of regional dummies, and X_i a set of demographic controls: age, gender, education, household size, number of dependents, coffee experience, and farm size. We deliberately exclude coffee harvest and household income, both of which we observe. Beekeeping may raise coffee yields through pollination — a complementarity we describe in Section 1 — so both are plausibly outcomes of the treatment rather than predetermined characteristics, and conditioning on them risks absorbing part of what we are trying to measure. Including them changes nothing of substance: the annual estimate moves from +0.033 to +0.020, well inside its standard error, and the seasonal interaction is unchanged, since the producer fixed effects absorb any household-constant regressor. Standard errors use the Huber-Eicker-White heteroskedasticity-robust estimator (White, 1980). The parameter of interest is β, and we test $\beta = 0$.

We report three nested versions of (1), corresponding to the columns of Table 3: column (1) omits both X_i and p_r, column (2) includes p_r alone, and column (3) includes both.

Table 3: Effect of Honey Production on Total Months of Food Insecurity

	(1)	(2)	(3)
	OLS	OLS	OLS
	Baseline Food Insecurity[1]	**Regional Controls** Food Insecurity[1]	**All Controls** Food Insecurity[1]
Honey Producer	-0.18	-0.04	0.03
	(0.20)	(0.26)	(0.26)
Constant	1.85***	1.62***	0.96*
	(0.08)	(0.31)	(0.53)
Observations	275	275	275
R^2	0.003	0.066	0.101
Regional Controls	NO	YES	YES
Demographic Controls[2]	NO	NO	YES

Robust standard errors in parentheses

1. Dependent variable is the total number of months that producers reported experiencing food insecurity in the past 12 months. Sample mean: 1.81 months (s.d. 1.27).

Source: authors' 2022 household survey of 275 coffee producers, fielded in partnership with the cooperative.

2. Demographic Controls: Age, Gender, Education Level, Household Size, Dependents, Coffee Experience, Farm Size.

* $p < .10$, ** $p < .05$, *** $p < .01$

4.2 Food Insecurity in Honey Months

The remaining specifications use the producer-month panel. The dependent variable $y_{i,m}$ is now a binary indicator equal to one if producer i reported insufficient food in month m, distinct from the annual count in (1), and standard errors are clustered on the producer throughout to accommodate the high intra-individual correlation in food insecurity. Figure 3 reports the monthly means of that indicator with their confidence intervals, which is what a regression of it on a full set of month dummies returns.

We then estimate the association between honey production and food insecurity in the months when honey income arrives: April, May and June, fixed in Section 3.3 from the income data. The indicator $I[m \in \{4,5,6\}]$ marks those months, and its interaction with honey producer status T_i carries the coefficient of interest, θ:

$$y_{i,m} = \alpha + \gamma I[m \in \{4,5,6\}] + \theta T_i I[m \in \{4,5,6\}] + \tau_i + \epsilon_{i,m} \tag{2}$$

Participant fixed effects τ_i absorb honey producer status, the demographic controls X_i and the regional dummies p_r together; this is column (1) of Table 4. Entering those terms directly in place of τ_i recovers the level difference β between producers and non-producers — reported for the annual outcome in Table 3 — but leaves θ unchanged. That invariance is exact rather than approximate, and it is worth stating once because it determines what the estimate can be accused of: the interaction decomposes into a between-producer part, collinear with T_i, and a within-producer part orthogonal to every time-invariant regressor, so no household-constant characteristic can move θ — including characteristics we do not observe. It also means p_r never appears alongside τ_i in any specification we report.

Because the April–June window is one we impose, we also estimate a specification that imposes no window, interacting honey producer status with each month separately:

$$y_{i,m} = \alpha + \sum_{m=2}^{12} \delta_m month_m + \sum_{m=2}^{12} \theta_m T_i \cdot month_m + \tau_i + \epsilon_{i,m} \tag{3}$$

January is the omitted month and τ_i absorbs honey producer status, so the eleven θ_m trace out the full difference in seasonal profile between producers and non-producers. We test each $\theta_m = 0$ and, jointly, $\theta_2 = \cdots = \theta_{12} = 0$. We additionally assess the pooled April–June estimate by randomization inference, permuting honey producer status across producers, since with 54 treated units the asymptotic justification for clustered standard errors is thin.

Table 4: Food Insecurity in the Honey Season and the Placebo Window

	Honey Season (April–June)	Placebo Window (July–August)
	(1)	(2)
	OLS	OLS
	Participant FE	**Participant FE**
	Food Insecurity[1]	Food Insecurity[1]
Honey Producer x Season[2]	-0.07	0.03
	(0.04)	(0.07)
Season[2]	0.09***	0.36***
	(0.02)	(0.03)
R^2	0.098	0.233
Observations	3,300	3,300
Participants	275	275
Months	12	12
Participant Fixed Effects	YES	YES

Clustered standard errors in parentheses
Clustering is at the participant level.
1. Dependent variable is a dummy which equals 1 if the producer reports food insecurity in a given month, 0 otherwise. Sample mean: 0.151.
2. Season equals 1 in April–June in column (1) and in July–August in column (2).
The two windows share no month: June is both a honey month and one of the three hungriest (Section 3.3), so a placebo run on June–August would contain a treatment month.
3. Both columns carry participant fixed effects, which absorb honey producer status.
The interaction is identified from within-household variation alone, so it is orthogonal to every time-invariant regressor: dropping the fixed effects, or adding the demographic and regional controls used elsewhere, leaves it unchanged to fourteen decimal places. Earlier versions of this table reported those columns alongside; they duplicated these on every row.
Source: authors' 2022 household survey of 275 coffee producers, 54 of them beekeepers; 3,300 producer-months.
* $p < .10$, ** $p < .05$, *** $p < .01$

4.3 What These Specifications Identify

Honey production is a choice, so the coefficients above are associations rather than causal effects. A producer who keeps bees may differ from one who does not in ways we neither observe nor absorb with the controls in X_i, and nothing in this design isolates the effect of taking up beekeeping. What the seasonal specifications do recover is a comparison that no time-invariant household characteristic can generate, for the reason given in Section 4.2; what they cannot rule out is selection on characteristics that vary across months. Section 5.3 returns to what can and cannot be inferred from the seasonal pattern.

5 Results and Discussion

5.1 Overall Effect of Honey Production

Table 3 reports the three nested versions of (1), which relate honey production to overall food insecurity, measured as the number of months in the past year that a producer reports food insecurity.

Across all specifications, honey production is not associated with the total annual duration of food insecurity. The baseline estimate is -0.18 months, or roughly five days; adding regional and then demographic controls moves the point estimate to -0.04 and then to $+0.03$. None of the three is distinguishable from zero.

We should be precise about how much this null establishes, because it is less than it may appear. The sample mean is 1.81 months, and the 95% confidence interval on the baseline estimate runs from -0.57 to $+0.21$ months — that is, from a 32% reduction to a 12% increase. The data are therefore consistent with beekeeping shortening the hungry season by nearly a third. What we can rule out is a *large* effect on the annual total, not a modest one. Readers should treat this as an imprecise zero rather than a demonstration of no effect, and the same caution applies to the comparisons that follow.

With that qualification, the result is consistent with the only two comparable studies we are aware of. Anderzén et al. (2020), working in the same region of Chiapas, and Bacon et al. (2023), working in Nicaragua, both find that on-farm diversification does not shorten the hungry season for coffee households. Ours is a third independent sample pointing the same way. We would not describe three imprecise nulls as settling the question — none of the three, ours included, is powered to detect the effect sizes at issue — but the accumulation is at least suggestive that the annual-duration effect, if it exists, is not large.

The core idea is that an annual count cannot detect a strategy that moves food insecurity intra-annually without changing the total, which is what the monthly panel lets us check.

5.2 Temporal Variation in Food Insecurity

Figure 3 reports the share of households reporting food insecurity in each month, with 95% confidence intervals from standard errors clustered at the household level. Reported food insecurity is negligible from October through March, never exceeding 5.5%, then rises through April and May to 32.0% in June, peaks at 47.3% in July and 44.0% in August, and falls back to 14.2% in September. The intervals separate the June–August peak from the rest of the year cleanly, and April through September each exceed the January reference at conventional levels. The pattern corroborates the qualitative evidence of a hungry season or "thin months" provided by Morris et al. (2013), Gerlicz et al. (2019), and Anderzén et al. (2020).

The seasonal amplitude here is large — food insecurity runs from under 6% of the sample in every month from October to March to 47.3% in July — and it is invisible in an annual count.

5.3 Honey Production in Honey Months

Column (1) of Table 4 reports specification (2), which relates honey producer status to food insecurity during the honey season: April, May, and June.

The sample as a whole reports 9 percentage points more food insecurity in these months than in the rest of the year, an estimate that is significant at the 1% level. The interaction between honey producer status and the honey season is -0.07, identical with and without participant fixed effects for the algebraic reason given in Section 4.2: selection on fixed household traits cannot generate it, though selection on traits that vary across months, the subject of the next two subsections, remains open. Summing the component terms, a honey producer's food insecurity in the honey season is about 2 percentage points above their own off-season baseline, against 9 points for a non-producer — the honey season is worse for both groups, and somewhat less so for producers.

This estimate is sensitive to the survey-process problems described in Section 3.2. Table 5 gives the seasonal interaction under a progressively fuller set of survey-process controls.

Table 5: Seasonal Interaction under Survey-Process Controls

	Interaction	s.e.
Producer fixed effects	−0.072	(0.045)
+ interview wave × month	−0.057	(0.047)
+ enumerator × month	−0.046	(0.040)
+ both	**−0.038**	(0.041)

Notes: Each row reports the honey-producer × honey-season interaction from specification (2) under a progressively fuller set of survey-process controls. The dependent variable is a binary indicator of reported food insecurity in the month-producer cell; the honey season is April–June. Interview wave is the month of interview (June, July or August 2022); enumerator is the identity of the ten interviewers. Both are interacted with calendar month, so each absorbs a full set of month effects specific to when the household was interviewed and to who interviewed them. Standard errors are clustered on the producer. $N = 3{,}300$ producer-months for 275 producers, 54 of whom keep bees. The bottom row is the estimate we ask readers to carry away; see Section 3.2 for why these controls are necessary and Section 5.3 for interpretation. *Source*: authors' 2022 household survey of 275 coffee producers, fielded in partnership with the cooperative.

Roughly half the raw estimate is attributable to survey process rather than to beekeeping. Households interviewed later report worse conditions in the months nearest their interview, and enumerators differ in how many respondents they record as honey producers; absorbing both reduces the association of producing honey to −0.038, roughly half the raw estimate. Table 5 gives the sequence. The sign is unchanged throughout and no version is statistically distinguishable from zero. This is our preferred specification, and we report this estimate in the abstract and introduction.

At the same time, we present this estimate as suggestive and not as an established difference.

5.3.1 Letting the data choose the months

A natural objection to the estimate above is that April–June is a window we selected. We therefore replace the honey-season indicator with the full set of month-by-honey-producer interactions, which imposes no window at all. Panel B of Figure 4 reports them, with January omitted and producer fixed effects throughout; Panel A shows the underlying monthly profiles of the two groups.

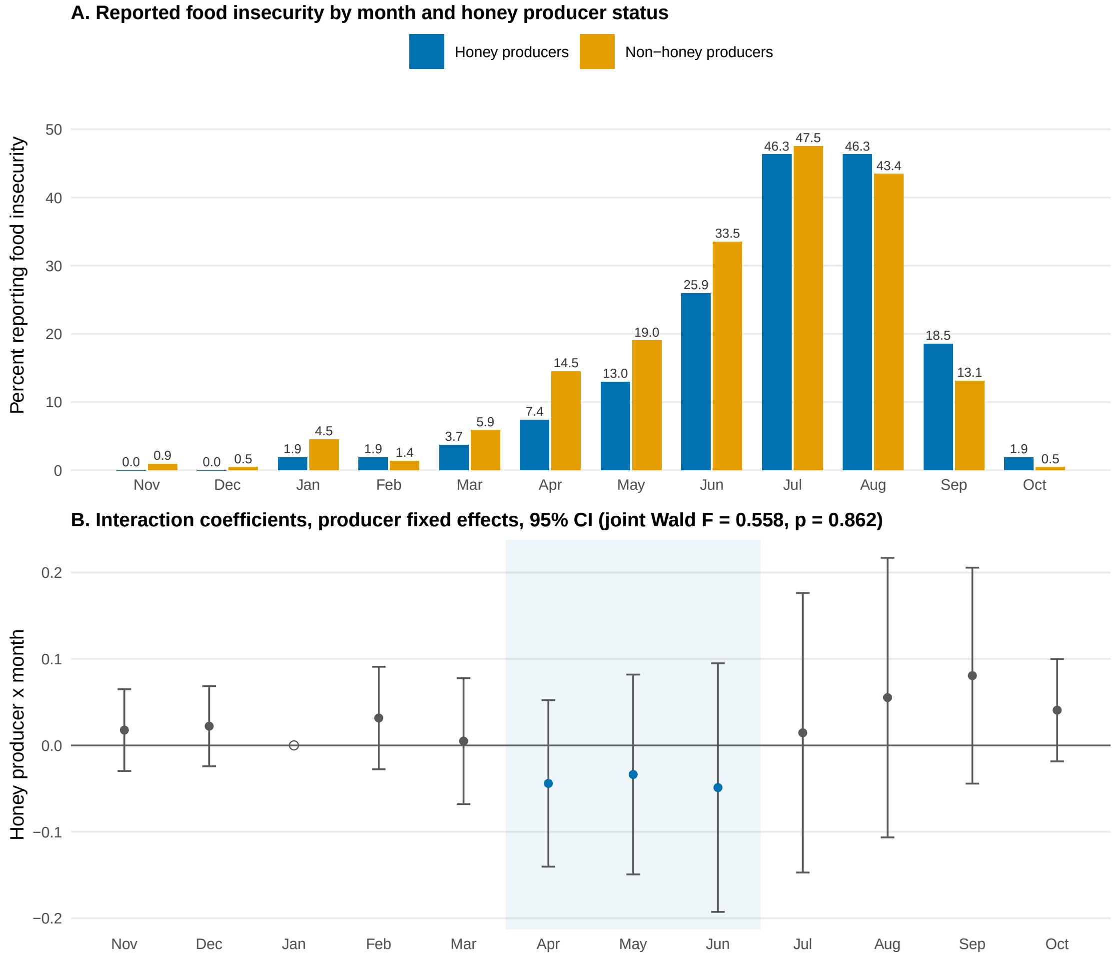

Figure 4: Food Insecurity by Month and Honey Producer Status

Notes: Panel A, monthly rates for the 54 honey-producing and 221 non-producing households. Panel B, month-by-month interactions, January omitted (hollow point at zero), producer fixed effects, clustered at the household level. Shading marks the pre-specified April–June honey season. Each coefficient equals the corresponding difference of Panel A differences.

The sign pattern is exactly what the seasonal argument predicts. April, May, and June are the only three months with negative coefficients; the remaining eight are all positive. The window was defined in Section 3.3 from the income data — the months in which honey income exceeds coffee income — with no reference to the food insecurity outcome, so this correspondence was not built in. Enumerating all 220 three-month subsets of the calendar, April–June yields the most negative pooled interaction of any of them, though the subsets overlap heavily and the ranking is not a test.

The sign pattern survives the interview-timing correction. Re-estimating with interview-wave $\times$ month fixed effects, April, May and June remain the only three months with negative coefficients and the other eight remain positive. The magnitudes shrink substantially — April moves from -0.044 to -0.007, June from -0.049 to -0.031 — so the pattern is weaker than the raw estimates suggest, but it is not an artifact of when households were interviewed.

None of these point estimates are statistically significant. No individual monthly interaction approaches conventional levels in either version, the standard errors in the months at issue, 0.05 to 0.08, being of the same order as the coefficients themselves, and a joint test of all eleven interactions does not come close to rejecting: $F = 0.558$, $p = 0.862$ as specified above, and $F = 0.588$, $p = 0.838$ with interview timing absorbed. On the evidence of this specification, one cannot reject the hypothesis that honey producers and non-producers share the same monthly profile of food insecurity.

We also subject the pooled April–June estimate to randomization inference, permuting honey producer status across the 275 producers and re-estimating. With 54 treated units, clustered asymptotics may be optimistic, and here they are: the randomization null has a standard deviation of 0.047 against an analytic clustered standard error of 0.045. The randomization two-sided p-value is 0.12.

We therefore describe the seasonal result as suggestive: a coherent regularity in the signs that our data lack the power to establish. The pattern is consistent across an independently chosen window, the full month-by-month specification, and the placebo test below; it is not statistically distinguishable from chance in any of them. A sample with more than 54 honey producers, or repeated observation of the same households, could settle it. Ours cannot.

5.3.2 The late-season reversal

One feature of Panel B deserves comment because it threatens to contradict the paper's argument if left unexplained. The largest positive coefficient is September (+0.081), and August and October are positive as well: honey producers appear somewhat *worse off* than non-producers late in the year. We did not anticipate it. The month-by-month specification was estimated at a referee's suggestion, after the April–June window had already been fixed from the income series, so the reversal is something those estimates volunteered rather than something we set out to test.

What can be said is that the months in which it appears were selected in advance. Honey income ends in June or early July and the coffee harvest does not begin until December, so the calendar in Section 2.2 identifies August through October as the one stretch of the year in which honey producers have no income advantage remaining. The reversal falls there.

Reading levels rather than interactions makes the magnitude clearer. Food insecurity falls steeply for both groups in September, from 43 to 13 per cent among non-producers and from 46 to 19 among producers, as the maize harvest begins. The September coefficient is a difference in how quickly that collapse resolves, not evidence that beekeepers go hungry while others do not. Like the negative coefficients, these estimates are individually insignificant and we do not build on them.

5.4 Placebo Test

Finally we re-estimate the seasonal specification on July and August, in place of the honey months. If the pattern in Section 5.3 reflects honey income arriving in particular months, it should appear when that income arrives and not once it has been spent. Column (2) of Table 4 reports it. The interaction is $+0.028$ against -0.072 in the honey window, while the season main effect is $+0.36$ against $+0.09$: the peak is four times worse for everyone, and honey producers are not distinguishable within it.[8]

Neither window shows an advantage that the data can distinguish from zero, and the honey-window estimate is itself imprecise. That is the paper's result rather than a failure to confirm one: where honey income arrives, producers are slightly better off; where the year is hardest, they are not.

[8] We use July and August rather than the June–August lean season of Section 3.3 because June belongs to both — it is both a honey month and one of the three hungriest — so a placebo run on June–August would contain a treatment month. On June–August the interaction is -0.006; dropping June moves it to $+0.028$, the direction that contamination predicts. We do not extend the window to September, whose interaction is the most positive of the twelve months and which would widen the contrast by construction rather than by evidence.

5.5 Limitations

The most important limitation is that this study does not identify a causal effect of honey adoption. Adoption is a choice and our controls are unlikely to capture everything that drives it. What Section 2.5 shows about who does not keep bees has two consequences for the estimates above, and they run in opposite directions.

The annual comparison in Table 3 sets beekeepers against non-beekeepers, and beekeepers are better resourced, which Section 2 gives reason to think predates adoption; since better-resourced households are less food insecure whatever they farm, that comparison flatters honey. The seasonal comparison in Table 4 instead asks whether a beekeeper's April–June rises less above their own off-season baseline than a non-beekeeper's does, so producer fixed effects remove the resource advantage. What they cannot remove is selection on something that varies across months, and there the evidence runs the other way: among non-producers alone, where no consequence of adoption can exist, the households who say they want bees are more food insecure in precisely the April–June window, by +0.131. They want bees because their problem falls in the months honey would cover; if beekeepers came from that pool, their untreated April–June would have been worse, so the seasonal comparison understates honey instead. We cannot net the two, and put no weight on the second beyond reporting it: 32 households, weakening to +0.080 under the survey-process controls.

A second limitation is that our treatment and outcome are both self-reported, in a single interview, by enumerators whose recorded honey-producer shares differ substantially from one another. Absorbing interview timing and enumerator identity halves the seasonal estimate. We regard the fully-controlled figure as the right one, but it is a smaller number resting on the same 54 producers, and a reader who concludes that the survey design cannot support the question will not be wrong.

Third, the monthly panel is constructed from retrospective recall within one survey wave rather than from repeated visits, so we cannot observe adoption as it happens or track producers as their circumstances change. Repeat annual visits would allow a genuine panel and make it possible to study the evolution of honey production directly.

5.6 Policy Implications

Our results counsel against expecting beekeeping programs to reduce the annual burden of food insecurity among coffee producers, since we find no evidence that they do, and two comparable studies in the region find the same. The more promising question is whether the timing of honey income aligns with the months when households are most exposed. If it does, the relevant policy comparison is not diversification against no diversification, but honey against other instruments that move income into the lean season — seasonal credit, savings arrangements, or adjusting when the cooperative pays. Evaluating that comparison requires measuring food insecurity monthly.

6 Conclusion

This paper examines honey production as a livelihood diversification strategy for indigenous coffee producers in Chiapas, Mexico, in a setting that should favour it. Honey needs almost no capital and no land, its harvest falls when coffee income has run out, and the cooperative that buys the coffee buys the honey too.

Beekeeping is associated with materially larger and better capitalised households. Their total income is roughly double (32.0 against 16.8 thousand MXN, or $1,591 against $835), they hold more than twice the livestock (3.07 against 1.28 tropical livestock units), and they borrow both more often and more often for work: 33 of the 39 beekeepers we can identify in the credit records have taken a loan, against 214 of 697 other members, and 61% of their applications are for working capital against 36% for everyone else. Whatever its direction, the association between beekeeping and the size of the household enterprise is not subtle.

The association with food security is. On the annual measure — the count of months a household lacked sufficient food — we find nothing, matching Anderzén et al. (2020) in the same region and Bacon et al. (2023) in Nicaragua. We read the three together as evidence that on-farm diversification does not *substantially* shorten the hungry season for Mesoamerican coffee households, and deliberately not as evidence that it does nothing: our own interval admits a reduction of nearly a third. The monthly data locate what there is. Food insecurity is concentrated between April and

September, and beekeepers fare better in exactly the three months honey income arrives — 3.8 percentage points, and the only negative months of the twelve — but no better in July and August, when the season is at its worst. The pattern matches the mechanism and is not distinguishable from chance, and we have been explicit throughout that it is a regularity in the signs rather than an estimated effect.

Two things follow. The first is that diversification here travels with the growth of the farm enterprise without carrying food security along with it, which is a weaker claim for the strategy than the one usually made on its behalf. The second is that an annual measure could not have shown this either way: the object of interest is a few percentage points in three particular months, and a yearly count cannot see it. A study designed to settle the question would need more than 54 adopters — though the comparable studies are smaller, at 36 honey producers in Anderzén et al. (2020) and fewer still elsewhere — and, ideally, repeated observation across years — but it would also need to ask which months rather than how many, and that is a design choice available to anyone.

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