Sweet and Timely Income: The Effect of Honey Production in Reducing Food Insecurity of Coffee Producers *

Grant X. Storer†, Stephen Pitts‡, Jesse Anttila-Hughes§, and Chris M. Boyd¶

July 18, 2024

Abstract

Smallholder cash crop farmers often struggle to smooth income and consumption throughout the agricultural year, leading to potentially serious food insecurity risk. This study examines the effect of a specific type of adaptive response to this risk, honey production, using a unique sample of indigenous coffee producers in Chiapas, Mexico. We find that honey production is associated with generally reduced food insecurity during the key honey production season, when food insecurity is otherwise generally rising. Leveraging clustering in the spatial distribution of honey production to instrument for adoption via social learning effects, we find that honey production causes a decrease in food insecurity more than large enough to offset the non-honey producing population's worsening outcomes. Our results provide insight into the efficacy of a key alternative livelihood strategies for vulnerable smallholder producers.

JEL Codes: D1, D6, D8, I3, O1, Q1.

Keywords: Coffee, Food Insecurity, Diversification, Honey, Beekeeping, Technology Adoption, Indigenous Communities, Chiapas, Mexico.

---

*We thank Marc Bellemare, Jason Kerwin, Michael Boland, Bruce Wydick, and participants in the invited poster session of the AAEA 2023 Annual Meetings in Washington DC. We are grateful for funding from the Center for International Food and Agriculture Policy and the Minnesota Agricultural Experiment Station in the Department of Applied Economics at the University of Minnesota. We obtained IRB approval through the University of Minnesota (IRB ID STUDY00016085). All errors are our own.

†Research Analysist, Inter American Development Bank. email: gxstorer@usfca.edu. Address: 1300 New York Avenue, N.W. Washington, D.C. 20577. Phone: (+1) 202-942-8211

‡Ph.D. Candidate, Department of Applied Economics, University of Minnesota. Corresponding author. Email: pitts071@umn.edu. Address: 1994 Buford Ave, St. Paul, MN 55108. Phone: (+1) 612-625-1222.

§Associate Professor, Department of Economics, University of San Francisco. Email: jkanttilahughes@usfca.edu. Address: 2130 Fulton St., San Francisco, CA 94117. Phone: (+1) 415-422-2765.

¶Assistant Professor, Department of Economics, Towson University. Email: cboydleon@towson.edu. Address: 8000 York Road, Stephens Hall 101-N, Towson, MD 21252. Phone: (+1) 410-704-2959.

1 Introduction

Smallholder farmers often struggle to smooth income and consumption throughout the agricultural year (Morduch, 1995), leading to potentially large welfare losses in the form of food insecurity, reduced health, and general poverty (Banerjee & Duflo, 2007). This risk is exacerbated for cash crop farmers, who face additional risks above and beyond the normal production uncertainty stemming from disease and climate in the form of output price risk from commodity markets and its volatile effects on local food prices (Boyd & Bellemare, 2020). Farmers may employ a variety of methods to attenuate this risk, including adopting novel agricultural technologies (Feder et al., 1985), forming farmers' cooperatives (Bizikova et al., 2020), and diversifying production to include additional sources of income or nutrition available at other times of year (Bacon et al., 2023).

This paper analyzes the efficacy of consumption smoothing efforts by cash crop farmers in a novel context, focusing on a group of 275 indigenous coffee producers in Chiapas, Mexico, some of whom produce and sell honey in addition to coffee. The sale and production of honey is a classic form of risk smoothing employed by farmers (Anderzén et al., 2020), albeit one that, like coffee itself, is not indigenous to the Americas (Goulson, 2003). Food insecurity in this context ranges widely throughout the year as a function of distance from harvest time, from nearly 0% of families reporting insufficient food in October to nearly half (47%) saying so in July. Honey production, which peaks several months later in the year than the coffee harvest, thus has the potential to provide meaningful diversification to food-insecure households.

Identifying the effect of honey production on food insecurity and separating it from the effect of other strategies, such as working off-farm or migrating, is difficult for at least two reasons. The first is the potential for idiosyncratic farmer characteristics unrelated to their livelihood strategy to influence food security. We use producer-level fixed effects to address this possibility, effectively comparing farmers against themselves at different times of the agricultural calendar. The second is potential endogeneity of the adoption of honey production and our outcome of interest, food insecurity throughout the calendar year, especially during honey production. Producer characteristics and strategies could plausibly coevolve with these variables, hampering identification. In order to address this concern, we draw from the technology adoption literature (Foster & Rosenzweig, 2010), observing that regional variation in the number of honey producers suggests a key role of social learning in the adoption of honey production (Foster & Rosenzweig, 1995). Considering honey production as an introduced, non-native technology (Conley & Udry, 2010), we find an association between the share of a producer's neighbors who produce honey and the probability that an individual producer will produce honey. A 10% increase in the proportion of the producer's neighbors producing honey is associated with a 9% increase in the likelihood that that producer will produce honey as well. We use this share as an instrument for honey production (Sellare et al., 2020), as it clearly satisfies the relevance condition and may plausibly satisfy the exclusion restriction. Producers cannot move easily in this indigenous context, as land parcels are typically passed down through generations. Moreover, we do not find systematic differences between regions with higher and lower shares of honey producers. We thus argue that the honey production decisions of a producer's neighbors should primarily affect a producer's food security through the channel of their own adoption of honey production, as well as any possible increases in general productivity due to increased pollination that should be absorbed by producer fixed effects.

Our results show that honey producers are 7% less likely to report food insecurity during honey production months compared to non-honey producers, who experience a 9% increase in food insecurity, though the difference is not significant. Using the share of neighbors who produce honey as an instrument, we find that a 10% increase in the share of honey-producing neighbors is associated with a decrease of 1.9% in food insecurity, relative to an increase in food insecurity of 1.2%.

This paper contributes to three different strands of the literature. First, it extends the food security literature by considering not only the number of months but also which months in the past year the producers went without food, employing a month-producer panel with twelve observations per producer instead of a cross-sectional data set with one observation per producer (Barrett, 2010). This added precision gives us insight into the temporal dimension of income and food insecurity, an in particular the key role of adaptation during lean seasons. Second, it examines honey production in terms of social learning and technology adoption, taking advantage of the isolated, indigenous context of the study site to both gain leverage in identifying our main effect and to contribute to the literature on agricultural technology adoption in indigenous communities in the Americas. Lastly, this paper contributes to the diversification literature by providing rigorous evidence of the effect of a particular and common livelihood strategy with obvious complements to cash crop production. Together these results suggest that expanding honey production may serve as a valuable addition to existing livelihood strategies among coffee and other cash crop farmers.

The paper proceeds as follows. Section 2 explains the context and describes the data. Section 3 details the empirical strategy: the producer-level regressions, the panel regressions, and the instrumented versions of both regressions. Section 4 presents results from these regressions. Section 5 concludes.

2 Context and Data

2.1 Sampling Area

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.

Figure 1 shows the location of our study within the central highlands of Chiapas, Mexico, and Figure 2 shows this area in more detail, including the county (municipality) seat of the four nearest larger municipalities. The coffee cooperative Yomol A'tel divides the area into eleven regions, shown with polygons, which we visited over the course of eleven field visits, which corresponded approximately, but not exactly, to each region. Field visits were announced in advance and were open to anyone who wanted to participate, with participants compensated with vouchers for dry goods redeemable on-site. Because of the limited amount of dry goods we could transport with us, we restricted participation to one member per household. Overall, 54 of the 275 participants reported producing honey. Our sample is slightly larger than that of Anderzén et al. (2020), who reports 36 honey producers among 176 overall coffee producers, and substantially larger than the sample of 15 producers interviewed by Gerlicz et al. (2019) and the sample of 29 producers interviewed by Morris et al. (2013).

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 total income are significantly different between honey producers and non-producers. Overall, we find scant association between honey production and relevant household demographic characteristics.

The spatial distribution of honey production, however, shows meaningful differences across households, with substantial variation in the number of honey producers in each region. Figure 3 displays the breakdown of honey producers by region, with regions ordered from left to right by the percentage of honey producers. We classify a region as a "honey region" if more than 20% of the participants from that region report producing honey, leaving five of the eleven regions as honey regions. Figure 2 distinguishes between honey regions and non-honey regions.

In Tables 2 and 3 we display summary statistics by region for honey and non-honey regions, as opposed to honey production itself. Table 4 tests for statistically significant associations between regional characteristics and honey region status. We find that in general participants from honey regions are slightly older (4 years) and less likely to complete middle school (8%) or high school (5%). In addition, honey regions are slightly higher altitude (146m) and closer to the nearest county seat (10 km). The large variation in the quantity and percentage of honey producers by region is somewhat surprising, as Table 1 indicates that producer-level differences are not driving this outcome. For this reason we look at the effect of social learning in the next section.

2.2 Social Learning and Honey Production

We consider honey production as an agricultural technology and examine the decision to produce honey in line with other work on technology adoption (Conley & Udry, 2010; Feder et al., 1985; Foster & Rosenzweig, 1995, 2010). We adopt the following conceptual model describing a producer's decision to adopt honey production, informed by conversations with local partners in the coffee cooperative and in the spirit of Conley and Udry (2010), in which a potential pineapple producer updates the expected profits from a particular amount of fertilizer by observing their own plots and the plots of others.

Our model provides two channels by which the decision to adopt a new technology may be affected by a producer's neighbors. Honey production involves an investment of both labor (L) and capital (K), with labor consisting of time spent beekeeping, and capital consisting of the wooden beehive and equipment used to harvest the honey. Our interviews indicate that the Tseltal honey producers almost always start with one beehive, and we normalize the profit from the sale of this first beehive to 1. Moreover, we assume that there are no partial equilibrium effects: in other words, the market price of honey is not affected by the quantity of honey produced in this region, given the relatively small scale of individual production and large number of farmers.

With this framework, we can write the condition for a producer i to produce honey for the first time:

$$L_i + K_i + \mu_i - 1 > 0 \tag{1}$$

where L_i is the expected cost of labor, K_i the expected cost of beekeeping capital expenditures, and μ_i captures producer-level unobservables that may impact the production decision.

We can use the model to illustrate the effect of having honey-producing neighbors on a producer's honey production decision. Consider two otherwise identical producers j and k, such that $\mu_j = \mu_k$. Suppose that producer j lives in a region with no other honey producers and producer k lives in a "honey region" with a critical mass of honey producers. Living in a honey region affects condition 1 through two channels:

1. $L_k < L_j$

2. $K_k < K_j$

First, the expected amount of labor goes down because potential honey producers are able to observe other honey producers, learning by doing in the process and not requiring as much labor as someone trying honey production for the first time solo. Second, the expected amount of capital goes down because a potential honey producer can borrow or rent beekeeping supplies from neighbors, instead of traveling to a market and purchasing the gear. Thus it is possible that condition 1 could hold for producer k but not producer j, and that producer k could decide to produce honey as a result of their honey-producing neighbors. At the aggregate level, this model suggests that each additional honey producer decreases the cost of honey production for all non-producers in the region, and thus increases the likelihood that additional non-producers will adopt honey production. Depending on the distribution of μ, the long run equilibrium could be that nearly all producers in a region adopt honey production.

While our study is based on a monthly farmer panel, the panel is collected via a single cross-sectional sample, so we cannot examine progressive adoption of honey production over time. Such analyses frequently find an S-shaped adoption curve for new technologies (Feder et al., 1985; Griliches, 1957), and Figure 3 notably resembles an S-shaped curve. It thus seems plausible that we could consider regions as capturing distinct moments in the evolution of a fundamentally similar population at different points in time.

2.3 Food Insecurity

We next clarify what we mean by food insecurity and how we measure it. Barrett (2010) describes three dimensions of food insecurity: availability of food, access to food, and utilization of food. The first dimension, availability, roughly corresponds to supply-side issues that can be measured at the national level. The second and third dimensions of access (whether people can eat) and utilization (what people do eat) correspond to demand-side issues that can be measured at the individual or household level. Sen (1982) is credited with beginning the shift in emphasis from availability to access. Sen's exchange entitlement approach proposes that access to food is associated with subsistence farming and cash crop production. The former provides food that can be eaten directly, while the latter provides income that can be exchanged for food. This approach provides the theoretical foundation for this paper, which examines the effect of a second cash crop (honey) in addition to the primary cash crop (coffee) for the producers whom we survey.

Access to food is typically measured in one of two ways: 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). Tables 1, 2, 3, and 4 display the average number of lean months by region and by honey producer status. We do not find a significant difference between the average number of lean months by region or honey production.

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 3300 binary responses for 275 producers over 12 months.

Incorporating this time dimension into the analysis reveals monthly variation in reported food insecurity. Figure 4 displays incidence of food insecurity by month. Here we see the seasonal trends that Anderzén et al. (2020) and Morris et al. (2013) report. Food insecurity was found in all 12 months within the survey, but is highly concentrated during the pre-harvest lean season, with 94% of all reported food insecurity occurring during the months of April through September. Five percent or less of the sample report experiencing food insecurity from November to March, after harvest. Food insecurity incidence then begins to increase in April, reaching its maximum at 47.3% of the sample in July. In August slightly fewer producers report food insecurity, at 44%, and then drops precipitously in September to 14.2% as the harvest begins.

Breaking down food insecurity by month further reveals differences between honey producers and non-producers, as illustrated in Figure 5. The general trend of increasing incidence of food insecurity is the same as in Figure 4, with a notable difference: from March through June, during the onset of the hungry season, and during peak honey production, honey producers report less food insecurity than non-producers.

Finally, Figure 6 integrates administrative data from our partner cooperatives and the household survey data that we collected. We present it with the caveat that not all of our participants were cooperative members. Nevertheless, it shows three stylized facts about the timing of income from coffee sales, income from honey sales, and reported food insecurity:

1. Coffee producers receive income from coffee sales beginning in December through April.

2. Honey producers receive income from honey sales beginning in March through June.

3. Reported food insecurity increases beginning in April through September.

We define the honey season as the months in which income from honey sales exceeds income from coffee sales: April, May, and June. In turn, we define the lean season as the months in which reported food insecurity exceeds a quarter of all respondents, i.e., June, July, and August.

3 Empirical Strategy

In this section we present our empirical strategy. First, we test for the effect of honey production on total months of food insecurity at the producer level. Next, we use a producer-month panel to examine the temporal dimension of food insecurity, examining month-to-month variation in food insecurity. Third, we test for the effect of honey production during the honey season on food insecurity. All nine of these first specifications are estimated with ordinary least squares regression. Lastly, we attempt to correct for any potential endogeneity between food insecurity and honey production by using the share of honey producers in the region as an instrument for honey producer status.

3.1 Effect of Honey Production on Overall Food Insecurity

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

$$y_i = \alpha_1 + \beta_1 T_i + e_{1i,r} \tag{2}$$

$$y_{i,r} = \alpha_2 + \beta_2 T_i + p_r + e_{2i,r} \tag{3}$$

$$y_{i,r} = \alpha_3 + \beta_3 T_i + \gamma_{3i} X_i + p_r + e_{3i,r} \tag{4}$$

The dependent variable y_i is the total months of food insecurity for producer i in region r. T_i is an indicator variable capturing whether the producer is a honey producer. The vector p_r is a set of regional dummies, and X_i is a set of demographic controls, namely: age, gender, education, household size, number of dependents, coffee experience, farm size, coffee harvest, and income. Standard errors are calculated using the Huber-Eicker-White heteroskedasticity-robust estimator (White, 1980). We test the null hypothesises of whether $\beta_1 = 0$, $\beta_2 = 0$, or $\beta_3 = 0$: whether honey producer status is associated with the number of months of food insecurity.

3.2 Monthly Variation in Food Insecurity

Next we take advantage of the panel structure of our data set and estimate the following specifications to determine monthly variation in food insecurity. The results here will add precision to the descriptive statistics of Figure 4, which presents conditional means of food insecurity computed separately by month. The specifications below jointly estimate the monthly effects leveraging the entire panel to yield greater precision.

$$y_{i,m} = \alpha_4 + \sum_{m=2}^{12} \delta_{m1} month_m + \epsilon_{4i,m} \tag{5}$$

$$y_{i,r,m} = \alpha_5 + \sum_{m=2}^{12} \delta_{m2} month_m + \gamma_5 X_i + p_r + \epsilon_{5i,r,m} \tag{6}$$

$$y_{i,r,m} = \alpha_6 + \sum_{m=2}^{12} \delta_{m3} month_m + \tau_i + p_r + \epsilon_{6i,r,m} \tag{7}$$

In all three specifications, the δ_m coefficients capture changes in reported food insecurity by month compared to January, the reference month. Specification (6) adds demographic controls. Specification (7) adds participant-level fixed effects τ_i. Both of these specifications also add regional dummies p_r. Here we account for presumably high intra-individual correlation in food insecurity by clustering standard errors at the level of the respondent. We test the null hypotheses of $\delta_m = 0$ for $1 \leq m \leq 12$: whether a particular month is associated with the presence of food insecurity.

3.3 Effect of Honey Production on Food Insecurity in Honey Months

Next, we estimate the effect of honey production on food insecurity during the specific months in which honey producers receive income from honey sales: April, May, and June, as described in Section 2.3. We construct an indicator variable $I[m \in \{4, 5, 6\}]$ which takes on 1 for a honey month and 0 otherwise. We interact this variable with T_i, a dummy variable which takes on 1 if a producer is a honey producer and 0 otherwise. The coefficient θ of the interaction term thus captures the association between food insecurity and honey producer status in a honey month. We Here we again cluster standard errors by producer. We test the null hypothesis of $\theta = 0$.

We incorporate this interaction term in three different specifications below: a baseline specification 8 with dummies for honey season and honey producer, a specification 9 that incorporates the same regional and demographic controls as above, and a specification 10 that includes participant fixed effects. Specification 10 does not include honey producer status T_i because it is absorbed into the participant-level fixed effect.

$$y_{i,m} = \alpha_7 + \beta_7 T_i + \gamma_7 I[m \in \{4, 5, 6\}] + \theta_7 T_i I[m \in \{4, 5, 6\}] + \epsilon_{7i,m} \tag{8}$$

$$y_{i,r,m} = \alpha_8 + \beta_8 T_i + \gamma_8 I[m \in \{4, 5, 6\}] + \theta_8 T_i I[m \in \{4, 5, 6\}] + \delta_8 X_i + p_r + \tau_i + \epsilon_{8i,r,m} \tag{9}$$

$$y_{i,r,m} = \alpha_9 + \gamma_9 I[m \in \{4, 5, 6\}] + \theta_9 T_i I[m \in \{4, 5, 6\}] + p_r + \tau_i + \epsilon_{9i,r,m} \tag{10}$$

3.4 Instrumental Variable

The directly estimated association between honey production on overall food insecurity and on food insecurity during the honey season could be biased because honey production is a choice variable, and thus could be correlated with unobserved producer-level characteristics that also affect food insecurity. For this reason, in this section we describe an instrument for a producer's decision to adopt honey production: the share of honey producers in the same region.

The instrument is based on similar instruments that are used for the adoption of certification schemes as in Sellare et al. (2020). This logic of the instrument is based on the technology adoption and social learning literature outlined in section 2.2. Each additional honey producer in the region drives down the cost of adopting honey production, both in expected amount of labor and initial capital investment.

$$Z_{ir} = \frac{\sum_{j=1,j\neq i}^{n_r} T_{jr}}{n_r - 1} \tag{11}$$

Here we describe how the instrument is calculated for honey producer i in region r. The subscript $r \in \{1, \cdots, 11\}$ indexes the region. A region r has a total of n_r producers. Recall that the dummy T_{jr} is 1 if producer j in region r is a honey producer and 0 if not. The numerator sums the number of producers in region r other than producer i who are honey producers. Then we divide by the number of producers in the region, excluding producer i.

Once we calculate Z_{ir} for each producer, we then estimate the following first stage regression on honey producer status and compute fitted values $\hat{T}_i$.

$$T_{ir} = \alpha_{10} + \omega_{10} Z_{ir} + \epsilon_{10ir}. \tag{12}$$

We then estimate specifications 4 and 10 using these fitted values.

$$y_{i,r} = \alpha_{11} + \beta_{11}\widehat{T_{ir}} + \gamma_{11} X_i + p_r + e_{11i,r} \tag{13}$$

$$y_{i,r,m} = \alpha_{12} + \gamma_{12} I[m \in \{4,5,6\}] + \theta_{12}\widehat{T_{ir}} I[m \in \{4,5,6\}] + p_r + \tau_i + \epsilon_{12i,r,m} \tag{14}$$

Whether our instrument provides plausibly unbiased estimates rests on the validity of the relevance condition and the plausibility of the exclusion restriction. The estimation results for equation 11 that we present in table 7 show that the relevance condition holds with an F-statistic of 89.5, as one would expect given the strong spatial correlation in honey production.

The exclusion restriction meanwhile requires that the instrument used here, namely the share of honey producers in the producer's region, only affect food insecurity through the channel of the producer's own honey production. There is of course at least one additional possible channel. Recall that we classify some regions as honey regions because of the number of honey producers is greater than 20% of the total number of participants in these regions. These regions could be systematically different from non-honey regions in at least two other ways.

1. The coffee parcels in these regions could have higher yields because of the spillover effects of honey production, i.e., bees from honey producers could pollinate the neighboring coffee fields of non-honey producers. Thus the producers in these regions would receive more income from coffee sales than in the non-honey regions due to pollinator-driven increases in production.

2. Honey producers could differ in other ways, such as being more skilled farmers who are more likely to try their hand at producing various agricultural products, receiving additional income from other sources. If so, and given the highly communitarian nature of the Tseltal communities, it might be plausible for them to share food with non-producers during difficult times.

In both of these cases, there would be surplus food in the region that would reduce food insecurity for all of the producers there. We examine Table 4 to see if this is the case. The table shows that producers in honey regions on average harvest one more quintal (60kg) compared to 5.76 quintales in non-honey regions. Moreover, they report receiving 1500 MXN more income compared to 16200 MXN in the non-honey regions. Neither one of these differences, however, is significant at the 10% level because of large standard deviations, as the table illustrates. Moreover, the difference between average length of food insecurity spell in a honey region and a non-honey region is only 0.1 months (3 days), suggesting that if the honey regions are wealthier, the additional income is not going toward food, or least not enough food to meaningfully mitigate food insecurity. Thus we argue that these two other channels are not operative in this case and that the exclusion restriction likely holds.

4 Results

4.1 Overall Effect of Honey Production

Table 5 presents results from specifications 2, 3, and 4, which estimate the effect of honey production on overall food insecurity as measured by the number of months in the past year that a producer reports food insecurity. In the baseline specification, honey producers experience -0.18 months (5 days) less food insecurity. Adding first regional and then demographic controls reduces this difference to nearly zero. These results differ from those of Bacon et al. (2014) and Anderzén et al. (2020), both of whom find overall differences in the duration of the hungry season depending on whether coffee farmers diversify. The results here suggest that honey production is one of several diversification strategies for these farmers.

4.2 Temporal Variation in Food Insecurity

Table 6 presents results from specifications 5, 6, and 7 which estimate the monthly variation in reported food insecurity. Here we find similar point estimates to Figure 4, but as these estimates use the entire 3300 month-producer panel, the resulting estimates have much smaller standard errors. The month dummies for April through December are significant either at the 5% or the 1% level. Columns (2) and (3) show that the point estimates and significance levels are robust to the inclusion of regional controls and either participant fixed effects or demographic controls, corroborating the qualitative evidence of a hungry season or "thin months" provided by Morris et al. (2013), Gerlicz et al. (2019), Anderzén et al. (2020).

4.3 Effect of Honey Production in Honey Months

Table 8 presents results from specifications 8, 9, and 10. All of these specifications estimate the effect of being a honey producer in the honey season: April, May, or June. Here we find an overall increase of food insecurity by 9% in these months. Honey producers, however, experience a decrease of 7% in food insecurity these months. These estimates are noisy, and hover just above the 10% threshold for statistical significance, indicating that while honey producers are on average able to mostly reverse the marginal food insecurity effects of these months there is ample variation in individual producers' ability to do so. These results are robust to the inclusion of regional controls and either household fixed effects or demographic controls.

4.4 Instrumental Variable Results

In this section we present the results from estimating specifications 4 and 10 with two-stage least squares (2SLS), instrumenting honey producer status with the share of honey producers in the same region. Table 11 shows the results of the first stage. An increase of 10% in the number of honey producers in a producer's region is associated with a 9% increase in the probability that a producer will produce honey. The F-statistic is 89.5, safely exceeding the typical threshold for a valid instrument.

Next we turn to column 4 of Table 5, which presents the effect of honey production on overall food insecurity. Estimating the effect of honey production with 2SLS does not change the point estimate, which is still very close to zero.

Third, we turn to column 4 of Table 8. Here estimating the effect of honey production by 2SLS more than doubles the point estimate from 7% to 19% reduction in food insecurity. We interpret this effect as follows. An increase in 10% of the number of honey producers in a region decreases food insecurity for the average producer by 1.9% in the honey months (April, May, and June) through the channel of the adoption of honey production. This result is significant at the 5% level.

4.5 Robustness Check

Finally, as a robustness check, we estimate the effect of honey production on food insecurity using an indicator variable for lean months (June, July, and August) instead. If we do not find an association between honey production and food insecurity in these months, then the lack of an association lends credence to our results showing a direct effect of honey production on food security during honey months. If we do find an association, then there could be systematic differences between honey producers and non-producers not captured by our econometric approach. Alternately, there could be differential dynamics between honey producers and non-honey producers, due to, e.g., differential consumption smoothing using honey earnings.

Table 10 presents the results. The first three columns estimate specifications 8, 9, and 10 with OLS and the fourth column estimates specification 10 with 2SLS. In all four specifications, households experience 35% higher mean food insecurity during the lean months, with honey producers not differing in overall reported food insecurity risk in specifications 1 and 2 where the exclusion of producer fixed effects allows us to identify average differences. OLS estimates in columns 1-3 show no effect systematic difference in food security among honey producers during the lean season, while IV results show an insignificant point estimate of -0.08. This result could indicate an effect that some of the benefits of honey production may last beyond the honey season for some producers. Overall, the results of the robustness check support our main finding: the association between honey production and food insecurity during the honey months.

5 Conclusion

This paper examines the effect of honey production as a livelihood diversification strategy for indigenous coffee producers in Chiapas, Mexico. Our month-producer panel allows us to estimate not only the overall effect of honey production on food insecurity but also the temporal dimension of food insecurity. Our results support existing studies of the association between honey production and increased food security, and more broadly of the value of introducing diversified sources of agricultural income into cash crop production. A clear policy implication of our work is the importance of alternative livelihood strategies in general and beekeeping in particular for coffee producers in this region. NGOs and government organizations who promote these strategies should keep in mind the importance of social learning and peer effects.

Future work could address limitations of our study. First, we only consider the region that producers live in as a source of social learning about honey production. We do not ask them exactly how or from whom they learned to produce honey, and may as a result our instrumental variable estimates be vulnerable to a variety of homophily and contagion biases (Shalizi & Thomas, 2011). Second, our survey only captures producers' honey production and food insecurity at one point in time. Repeat annual visits would allow us to construct a richer panel and dig deeper into producers' ongoing experience with honey production, its evolution, as well as the source and nature of their food insecurity.

References

Anderzén, J., Guzmán Luna, A., Luna-González, D. V., Merrill, S. C., Caswell, M., Méndez, V. E., Hernández Jonapá, R., & Mier y Terán Giménez Cacho, M. (2020). Effects of on-farm diversification strategies on smallholder coffee farmer food security and income sufficiency in Chiapas, Mexico. *Journal of Rural Studies*, *77*, 33–46. https://doi.org/10.1016/j.jrurstud.2020.04.001

Bacon, C. M., Flores Gomez, M. E., Shin, V., Ballardo, G., Kriese, S., McCurry, E., Martinez, E., & Rivas, M. (2023). Beyond the bean: Analyzing diversified farming, food security, dietary diversity, and gender in Nicaragua's smallholders coffee cooperatives. *Agroecology and Sustainable Food Systems*, *47*(4), 579–620. https://doi.org/10.1080/21683565.2023.2171172

Bacon, C. M., Sundstrom, W. A., Flores Gómez, M. E., Ernesto Méndez, V., Santos, R., Goldoftas, B., & Dougherty, I. (2014). Explaining the 'hungry farmer paradox': Smallholders and fair trade cooperatives navigate seasonality and change in Nicaragua's corn and coffee markets.

Global Environmental Change, *25*, 133–149. https://doi.org/10.1016/j.gloenvcha.2014.02.005

Banerjee, A. V., & Duflo, E. (2007). The Economic Lives of the Poor. *Journal of Economic Perspectives*, *21*(1), 141–168. https://doi.org/10.1257/jep.21.1.141

Barrett, C. B. (2010). Measuring Food Insecurity. *Science*, *327*(5967), 825–828. https://doi.org/10.1126/science.1182768

Bellemare, M. F., & Novak, L. (2017). Contract Farming and Food Security. *American Journal of Agricultural Economics*, *99*(2), 357–378. https://doi.org/10.1093/ajae/aaw053

Bizikova, L., Nkonya, E., Minah, M., Hanisch, M., Turaga, R. M. R., Speranza, C. I., Karthikeyan, M., Tang, L., Ghezzi-Kopel, K., Kelly, J., Celestin, A. C., & Timmers, B. (2020). A scoping review of the contributions of farmers' organizations to smallholder agriculture. *Nature Food*, *1*(10), 620–630. https://doi.org/10.1038/s43016-020-00164-x

Boyd, C. M., & Bellemare, M. F. (2020). The Microeconomics of Agricultural Price Risk. *Annual Review of Resource Economics*, *12*(1), 149–169. https://doi.org/10.1146/annurev-resource-100518-093807

Conley, T. G., & Udry, C. R. (2010). Learning about a New Technology: Pineapple in Ghana. *American Economic Review*, *100*(1), 35–69. https://doi.org/10.1257/aer.100.1.35

Feder, G., Just, R. E., & Zilberman, D. (1985). Adoption of Agricultural Innovations in Developing Countries: A Survey. *Economic Development and Cultural Change*, *33*(2), 255–298. https://doi.org/10.1086/451461

Foster, A. D., & Rosenzweig, M. R. (1995). Learning by Doing and Learning from Others: Human Capital and Technical Change in Agriculture. *Journal of Political Economy*, *103*(6), 1176–1209. https://doi.org/10.1086/601447

Foster, A. D., & Rosenzweig, M. R. (2010). Microeconomics of Technology Adoption. *Annual Review of Economics*, *2*(1), 395–424. https://doi.org/10.1146/annurev.economics.102308.124433

Gerlicz, A., Méndez, V. E., Conner, D., Baker, D., & Christel, D. (2019). Use and perceptions of alternative economic activities among smallholder coffee farmers in Huehuetenango and

El Quiché departments in Guatemala. *Agroecology and Sustainable Food Systems*, *43*(3), 310–328. https://doi.org/10.1080/21683565.2018.1532480

Goulson, D. (2003). Effects of Introduced Bees on Native Ecosystems. *Annual Review of Ecology, Evolution, and Systematics*, *34*(1), 1–26. https://doi.org/10.1146/annurev.ecolsys.34.011802.132355

Griliches, Z. (1957). Hybrid Corn: An Exploration in the Economics of Technological Change. *Econometrica*, *25*(4), 501. https://doi.org/10.2307/1905380

Morduch, J. (1995). Income Smoothing and Consumption Smoothing. *Journal of Economic Perspectives*, *9*(3), 103–114. https://doi.org/10.1257/jep.9.3.103

Morris, K. S., Mendez, V. E., & Olson, M. B. (2013). 'Los meses flacos': Seasonal food insecurity in a Salvadoran organic coffee cooperative. *The Journal of Peasant Studies*, *40*(2), 423–446. https://doi.org/10.1080/03066150.2013.777708

Sellare, J., Meemken, E.-M., Kouamé, C., & Qaim, M. (2020). Do Sustainability Standards Benefit Smallholder Farmers Also When Accounting For Cooperative Effects? Evidence from Côte d'Ivoire. *American Journal of Agricultural Economics*, *102*(2), 681–695. https://doi.org/10.1002/ajae.12015

Sen, A. (1982). *Poverty and Famines: An Essay on Entitlement and Deprivation*. OUP Oxford.

Shalizi, C. R., & Thomas, A. C. (2011). Homophily and Contagion Are Generically Confounded in Observational Social Network Studies. *Sociological Methods & Research*, *40*(2), 211–239. https://doi.org/10.1177/0049124111404820

White, H. (1980). A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity. *Econometrica*, *48*(4), 817–838. https://doi.org/10.2307/1912934

6 Tables and Figures

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)
Outcome Variables:						
Coffee Harvest (1 Quintal = 60kg)	7.03	7.83	5.98	5.15	1.05	(0.94)
Income (1,000 MXN)‡	17.91	15.33	16.81	15.35	1.10	(0.47)
Food Insecure (months)	1.67	1.35	1.85	1.26	-0.18	(-0.89)
Participants	54		221		275	

*Distance to nearest town reports distance from regional center where surveys were conducted to the nearest county (municipality) seat.
‡Income is the reported total of coffee sales, off-farm income, and government subsidies, excluding income from honey sales.

Table 2: Summary Statistics by Region (Non-Honey Regions)

	Overall	1	2	3	6	8	11
Demographics:							
Age	41.8	47.2	39.9	37.6	43.7	45.3	42.7
Gender (1 = Female)	0.5	0.2	0.4	0.6	0.4	0.5	0.6
Completed Only Middle School (pct)	17.8	0.0	12.0	23.7	4.8	20.0	25.7
Completed High School (pct)	13.2	25.0	16.0	13.2	9.5	12.0	11.4
Household Size	6.5	6.4	6.1	6.4	7.9	5.6	6.9
Number of Dependents	2.3	0.8	2.8	2.3	4.0	2.3	1.5
Regional Elevation (MASL)	1015.0	936.0	946.0	1150.0	613.0	900.0	1259.0
Distance to Nearest Town (km)*	24.3	40.3	41.3	15.6	53.5	12.0	9.3
Coffee Experience (Yrs)	17.0	25.5	18.2	11.2	15.9	23.7	16.2
Farm size (ha)	3.6	4.2	3.1	2.9	6.0	2.6	4.0
Outcome Variables:							
Coffee Harvest (1 Quintal = 60kg)	5.8	2.2	5.1	5.2	6.2	3.5	9.0
Income (1,000 MXN)‡	16.2	8.1	17.8	16.5	21.7	11.8	16.4
Food Insecure (months)	1.9	1.6	1.7	1.7	1.3	2.2	2.3
Region Honey Pop. (pct)	2.6	0.0	8.0	2.6	0.0	4.0	0.0
Participants	152	8	25	38	21	25	35

*Distance to nearest town reports distance from regional center where surveys were conducted to the nearest county (municipality) seat.
‡Income is the reported total of coffee sales, off-farm income, and government subsidies, excluding income from honey sales.

Table 3: Summary Statistics by Region (Honey Regions)

	Overall	4	5	7	9	10
Demographics:						
Age	45.5	39.0	48.0	40.6	51.0	49.4
Gender (1 = Female)	0.5	0.5	0.5	0.4	0.3	0.6
Completed Only Middle School (pct)	9.8	8.0	0.0	7.7	17.4	17.4
Completed High School (pct)	7.3	12.0	11.5	0.0	13.0	0.0
Household Size	7.2	8.5	5.8	10.2	5.2	5.8
Number of Dependents	2.4	2.3	1.9	3.7	1.7	2.2
Regional Elevation (MASL)	1161.3	962.0	983.0	1331.0	848.0	1701.0
Distance to Nearest Town (km)*	13.9	17.9	4.4	5.3	32.7	11.3
Coffee Experience (Yrs)	17.8	14.5	20.7	13.7	22.1	18.5
Farm size (ha)	3.7	3.6	3.5	3.6	4.1	3.5
Outcome Variables:						
Coffee Harvest (1 Quintal = 60kg)	6.7	5.9	7.3	9.9	6.0	4.1
Income (1,000 MXN)‡	18.0	14.6	22.0	22.7	16.7	13.4
Food Insecure (months)	1.8	1.6	2.0	1.2	2.0	2.0
Region Honey Pop. (pct)	40.7	28.0	34.6	65.4	52.2	21.7
Participants	123	25	26	26	23	23

*Distance to nearest town reports distance from regional center where surveys were conducted to the nearest county (municipality) seat.
‡Income is the reported total of coffee sales, off-farm income, and government subsidies, excluding income from honey sales.

Table 4: Summary Statistics: Honey Regions†vs. Non-Honey

	(1) Honey Region†		(2) Non-Honey Region		(3) Difference	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	T-Stat
Demographics:						
Age	45.46	15.87	41.78	15.34	3.67*	(1.94)
Gender (1 = Female)	0.46	0.50	0.53	0.50	-0.06	(-1.04)
Completed Only Middle School (pct)	9.76	29.79	17.76	38.35	-8.01*	(-1.95)
Completed High School (pct)	7.32	26.15	13.16	33.91	-5.84	(-1.61)
Household Size	7.15	3.54	6.54	2.73	0.61	(1.58)
Number of Dependents	2.37	2.50	2.33	2.42	0.05	(0.15)
Regional Elevation (MASL)	1161.31	307.36	1014.97	210.17	146.34***	(4.50)
Distance to Nearest Town (km)*	13.92	10.30	24.32	16.62	-10.40***	(-6.35)
Coffee Experience (Yrs)	17.79	13.39	16.97	13.41	0.82	(0.51)
Farm size (ha)	3.66	2.65	3.64	3.95	0.02	(0.05)
Outcome Variables:						
Coffee Harvest (1 Quintal = 60kg)	6.71	6.04	5.76	5.53	0.94	(1.34)
Income (1,000 MXN)‡	18.05	15.54	16.20	15.15	1.84	(0.99)
Food Insecure (months)	1.76	1.40	1.86	1.16	-0.10	(-0.63)
Participants	123		152		275	

*Distance to nearest town reports distance from regional center where surveys were conducted to the nearest county (municipality) seat.

†Survey regions >20% honey producer representation are categorized as a honey region.

‡Income is the reported total of coffee sales, off-farm income, and government subsidies, excluding income from honey sales.

Figure 1: Chiapas Map

Figure 2: Survey Regions

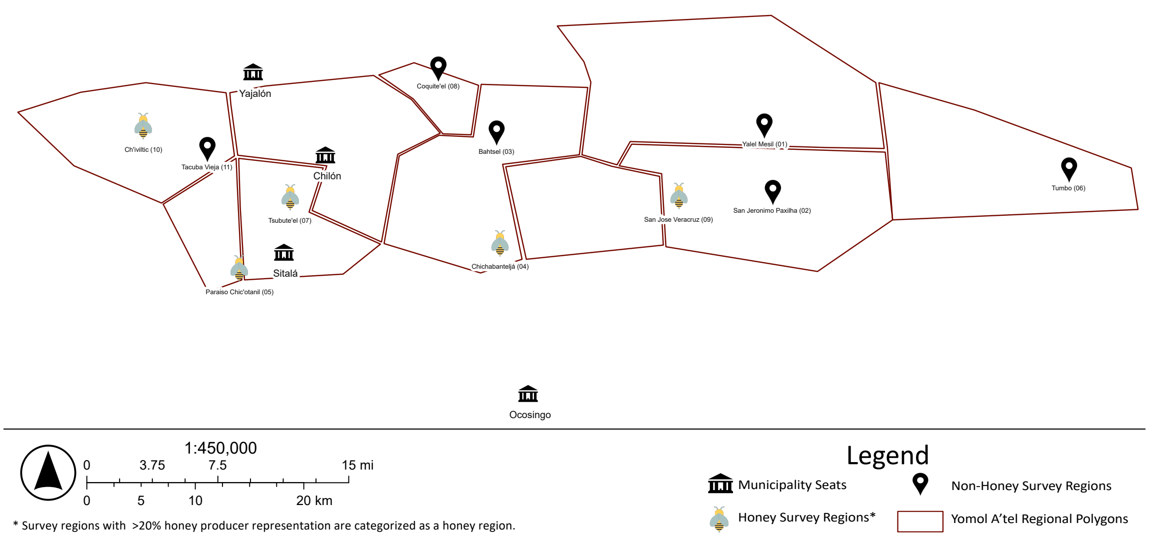


Figure 3: Honey Producers Count in Each Survey Region

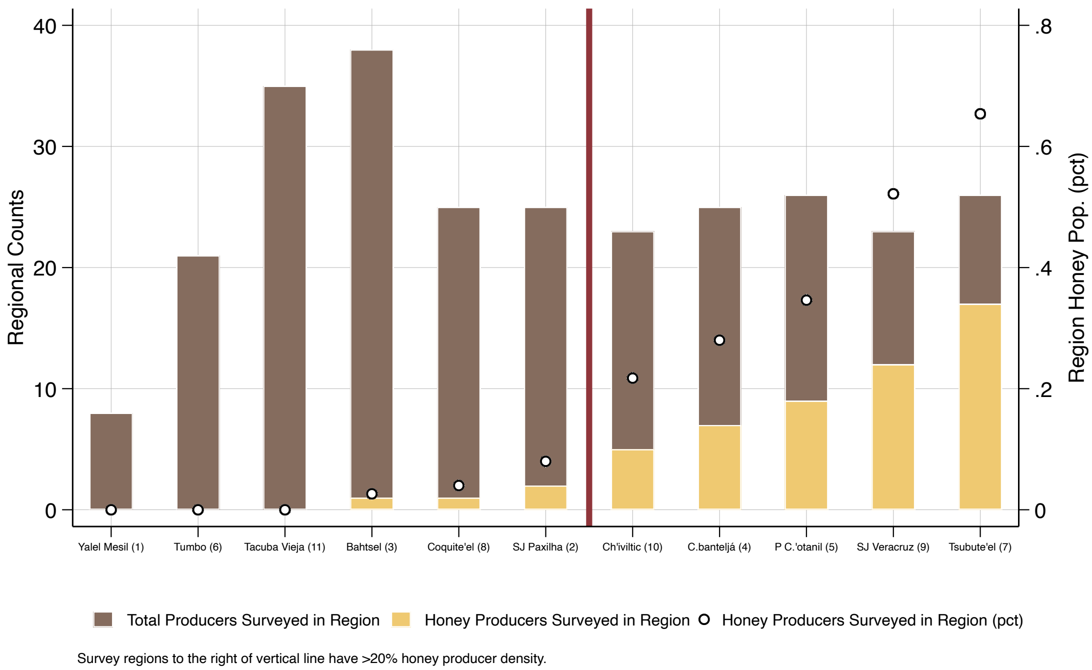
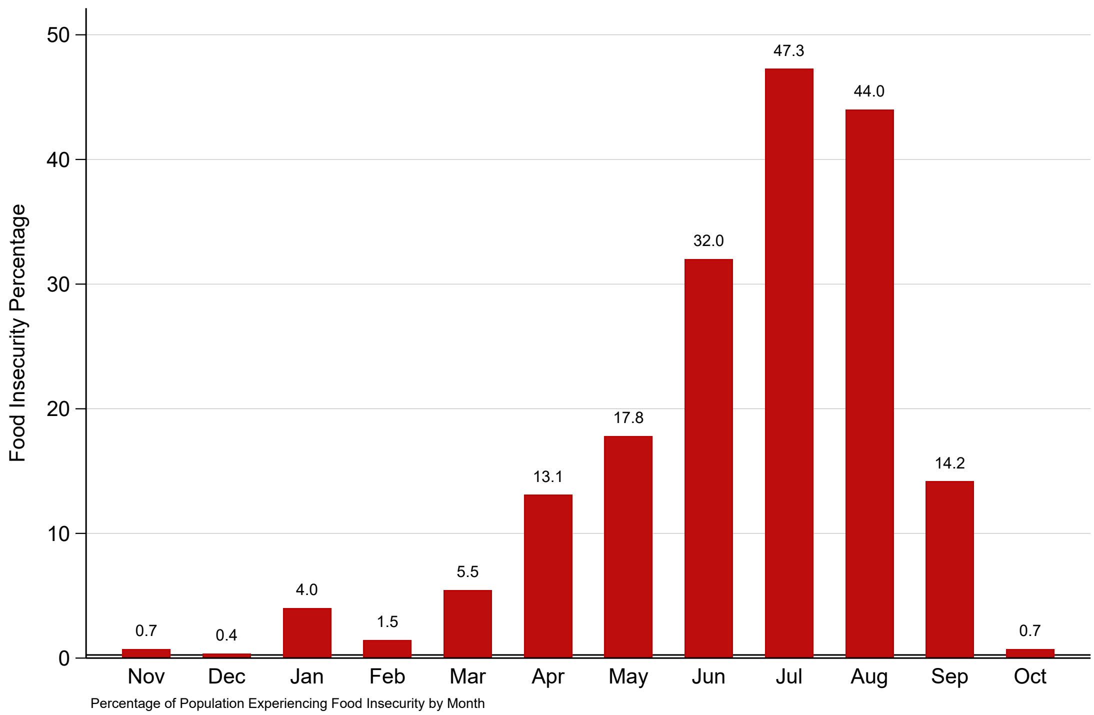
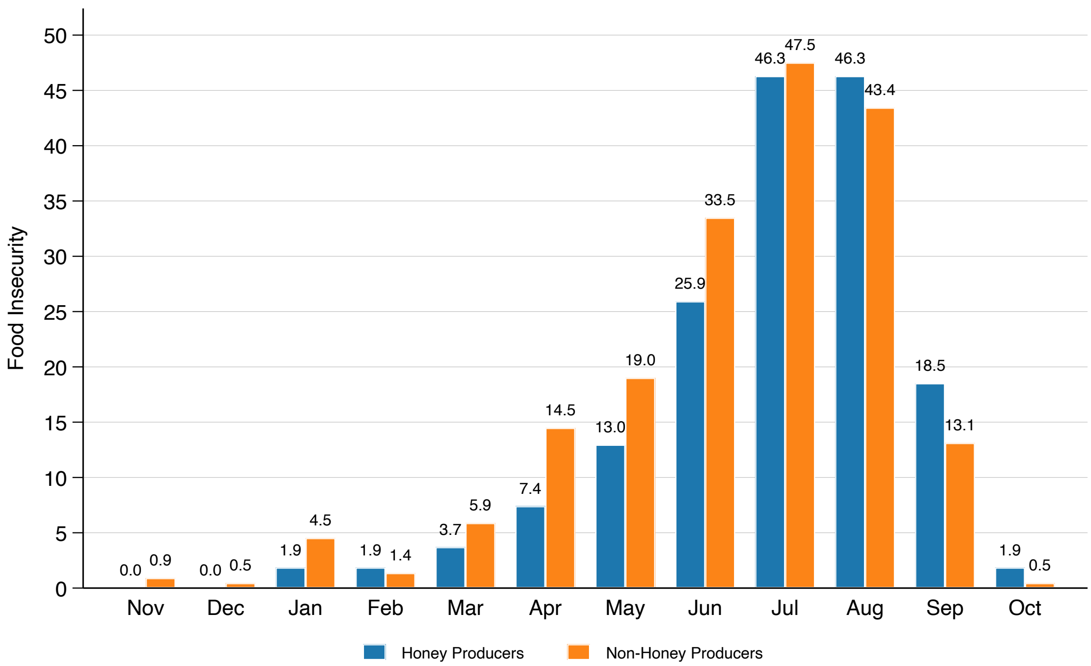


Figure 4: Food Insecurity Exposure



This figure is comparable to Figure 5 in Anderzén et al. (2020).

Figure 5: Food Insecurity: Honey vs Non-Honey



Honey season: April - June.
Lean Season: June - August

Figure 6: Seasonal Effects

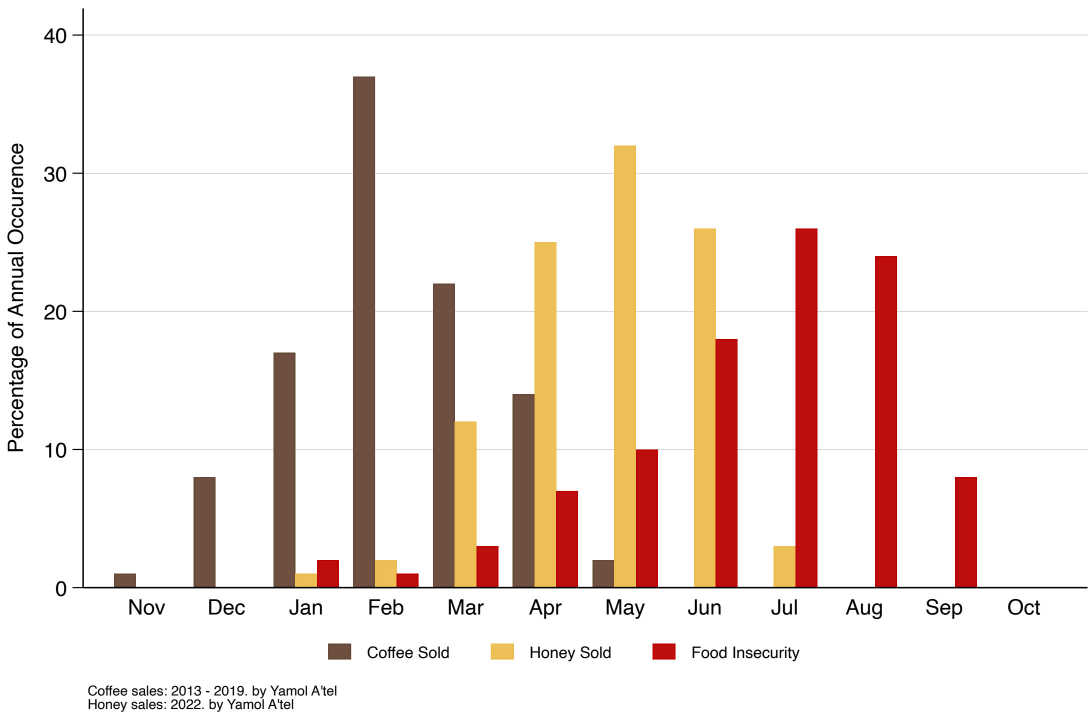


Table 5: Effect of Honey Production on Total Months of Food Insecurity

	(1)	(2)	(3)	(4)
	OLS	OLS	OLS	IV
	Baseline	**Regional Controls**	**All Controls**	**All Controls**
	Food Insecurity[1]	Food Insecurity[1]	Food Insecurity[1]	Food Insecurity[1]
Honey Producer	-0.18	-0.04	0.02	-0.03
	(0.20)	(0.26)	(0.26)	(0.25)
Constant	1.85***	1.62***	0.92*	0.92*
	(0.08)	(0.31)	(0.54)	(0.52)
Observations	275	275	275	275
R^2	0.003	0.066	0.105	0.105
Regional Controls	NO	NO	YES	YES
Demographic Controls[2]	NO	YES	YES	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.

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

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

Table 6: Monthly Variation in Food Insecurity

	(1) Baseline		(2) All Controls		(3) Participant FE	
	Food Insecurity[1]	SE	Food Insecurity[1]	SE	Food Insecurity[1]	SE
February	-0.03*	(0.01)	-0.03*	(0.01)	-0.03*	(0.01)
March	0.01	(0.02)	0.01	(0.02)	0.01	(0.02)
April	0.09***	(0.02)	0.09***	(0.02)	0.09***	(0.02)
May	0.14***	(0.03)	0.14***	(0.03)	0.14***	(0.03)
June	0.28***	(0.03)	0.28***	(0.03)	0.28***	(0.03)
July	0.43***	(0.03)	0.43***	(0.03)	0.43***	(0.03)
August	0.40***	(0.03)	0.40***	(0.03)	0.40***	(0.03)
September	0.10***	(0.03)	0.10***	(0.03)	0.10***	(0.03)
October	-0.03**	(0.01)	-0.03**	(0.01)	-0.03**	(0.01)
November	-0.03**	(0.01)	-0.03**	(0.01)	-0.03**	(0.01)
December	-0.04***	(0.01)	-0.04***	(0.01)	-0.04***	(0.01)
Constant[3]	0.04***	(0.01)	-0.03	(0.05)	0.04***	(0.01)
Observations	3300		3300		3300	
R^2	0.208		0.217		0.296	
Observations	3,300		3,300		3,300	
Participants	275		275		275	
Months	12		12		12	
Regional Controls	NO		YES		YES	
Demographic Controls[2]	YES		YES		NO	
Participant fixed effects	NO		NO		YES	

Clustered[4] standard errors in parentheses

1. Dependent variable is a dummy which equals 1 if the producer reports food insecurity in a given month, 0 otherwise.

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

3. January is the reference month.

4. The standard errors are clustered at the participant level.

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

Table 7: Effect of Regional Honey Producer Share on Producer Status

	Honey Producer[1]
Share of Honey Producers In Region[2]	0.90***
	(0.10)
Constant	0.02
	(0.03)
R^2	0.247
F-Statistic	89.50
Observations	275

Standard errors in parentheses

1. Dependent variable is a dummy which equals 1 if the participant is a honey producer, 0 if otherwise.

2. Independent variable is the share of participants in the same region that are honey producers, excluding the participant themselves.

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

Table 8: Effect of Honey Production in Honey Season on Food Insecurity

	(1)	(2)	(3)	(4)
	OLS	OLS	OLS	IV
	Baseline	**All Controls**	**Participant FE**	**Participant FE**
	Food Insecurity[1]	Food Insecurity[1]	Food Insecurity[1]	Food Insecurity[1]
Honey Producer x Honey Season[2]	-0.07	-0.07	-0.07	-0.19**
	(0.04)	(0.04)	(0.04)	(0.08)
Honey Season[2]	0.09***	0.09***	0.09***	0.12***
	(0.02)	(0.02)	(0.02)	(0.03)
Honey Producer	0.00	0.02	Absorbed[3]	Absorbed[3]
	(0.02)	(0.02)		
Constant	0.13***	0.05	0.13***	0.13***
	(0.01)	(0.04)	(0.00)	(0.00)
R^2	0.010	0.019	0.098	
Observations	3,300	3,300	3,300	3,300
Participants	275	275	275	275
Months	12	12	12	12
Participant Fixed Effects	NO	NO	YES	YES
Regional Controls	NO	YES	YES	YES
Demographic Controls[4]	NO	YES	NO	NO

Clustered[5] standard errors in parentheses

1. Dependent variable is a dummy which equals 1 if the producer reports food insecurity in a given month, 0 otherwise.

2. Honey Season is a dummy which equals 1 if the observed month is between April-June, 0 for all other months.

3. Honey producer status is a participant level characteristic, therefore it is absorbed into the participant fixed effects.

4. Demographic Controls: Age, Gender, Education Level, Household Size, Dependents, Coffee Experience, Farm Size, Coffee Harvest, Income.

5. Clustered[5] standard errors are clustered at the participant level.

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

Table 9: Effect of Honey Production in Honey Season on Food Insecurity

	(1)	(2)	(3)	(4)
	OLS	OLS	OLS	IV
	Baseline Food Insecurity[1]	**All Controls** Food Insecurity[1]	**Participant FE** Food Insecurity[1]	**Participant FE** Food Insecurity[1]
Honey Producer x Honey Season[2]	-0.07	-0.07	-0.07	-0.19**
	(0.04)	(0.04)	(0.04)	(0.08)
Honey Season[2]	0.19***	0.19***	0.19***	0.21***
	(0.02)	(0.02)	(0.02)	(0.03)
Lean Season	0.42***	0.42***	0.42***	0.42***
	(0.03)	(0.03)	(0.03)	(0.03)
Honey Producer	0.00	0.02	Absorbed[3]	Absorbed[3]
	(0.02)	(0.02)		
Constant	0.04***	-0.04	0.04***	0.04***
	(0.01)	(0.04)	(0.01)	(0.01)
R^2	0.187	0.196	0.274	
Observations	3,300	3,300	3,300	3,300
Participants	275	275	275	275
Months	12	12	12	12
Participant Fixed Effects	NO	NO	YES	YES
Regional Controls	NO	YES	YES	YES
Demographic Controls[4]	NO	YES	NO	NO

Clustered[5] standard errors in parentheses

1. Dependent variable is a dummy which equals 1 if the producer reports food insecurity in a given month, 0 otherwise.

2. Honey Season is a dummy which equals 1 if the observed month is between April-June, 0 for all other months.

3. Honey producer status is a participant level characteristic, therefore it is absorbed into the participant fixed effects.

4. Demographic Controls: Age, Gender, Education Level, Household Size, Dependents, Coffee Experience, Farm Size, Coffee Harvest, Income.

5. Clustered[5] standard errors are clustered at the participant level.

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

Table 10: Robustness Check: Lean Season as Treatment Period

	(1)	(2)	(3)	(4)
	OLS	OLS	OLS	IV
	Baseline	**All Controls**	**Participant FE**	**Participant FE**
	Food Insecurity[1]	Food Insecurity[1]	Food Insecurity[1]	Food Insecurity[1]
Honey Producer x Lean Season[2]	-0.01	-0.01	-0.01	-0.08
	(0.05)	(0.05)	(0.05)	(0.12)
Lean Season[2]	0.35***	0.35***	0.35***	0.36***
	(0.03)	(0.03)	(0.03)	(0.03)
Honey Producer	-0.01	0.00	Absorbed[3]	Absorbed[3]
	(0.01)	(0.02)		
Constant	0.07***	-0.01	0.06***	0.06***
	(0.01)	(0.04)	(0.01)	(0.01)
R^2	0.176	0.185	0.263	
Observations	3,300	3,300	3,300	3,300
Participants	275	275	275	275
Months	12	12	12	12
Participant Fixed Effects	NO	NO	YES	YES
Regional Controls	NO	YES	YES	YES
Demographic Controls[4]	NO	YES	NO	NO

Clustered[5] standard errors in parentheses

1. Dependent variable is a dummy which equals 1 if the producer reports food insecurity in a given month, 0 otherwise.

2. Lean Season is a dummy which equals 1 if the observed month is between June-August, 0 for all other months.

3. Honey producer status is a participant level characteristic, therefore it is absorbed into the participant fixed effects.

4. Demographic Controls: Age, Gender, Education Level, Household Size, Dependents, Coffee Experience, Farm Size, Coffee Harvest, Income.

5. Clustered[5] standard errors are clustered at the participant level.

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