IFPRI Discussion Paper 02126

June 2022

COVID-19 and Extreme Weather

Impacts on Food Security and Migration Attitudes in Rural Guatemala

Francisco Ceballos

Manuel A. Hernandez

Cynthia Paz

Markets, Trade, and Institutions Division

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

The International Food Policy Research Institute (IFPRI), a CGIAR Research Center established in 1975, provides research-based policy solutions to sustainably reduce poverty and end hunger and malnutrition. IFPRI's strategic research aims to foster a climate-resilient and sustainable food supply; promote healthy diets and nutrition for all; build inclusive and efficient markets, trade systems, and food industries; transform agricultural and rural economies; and strengthen institutions and governance. Gender is integrated in all the Institute's work. Partnerships, communications, capacity strengthening, and data and knowledge management are essential components to translate IFPRI's research from action to impact. The Institute's regional and country programs play a critical role in responding to demand for food policy research and in delivering holistic support for country-led development. IFPRI collaborates with partners around the world.

AUTHORS

Francisco Ceballos (f.ceballos@cgiar.org) is a Research Fellow in the Markets, Trade, and Institutions Division of the International Food Policy Research Institute (IFPRI), Washington, DC.

Manuel A. Hernandez (m.a.hernandez@cgiar.org) is a Senior Research Fellow in IFPRI's Markets, Trade, and Institutions Division, Washington, DC.

Cynthia Paz (c.paz@cgiar.org) is a Research Analyst in IFPRI's Markets, Trade, and Institutions Division, Washington, DC.

Abstract

This paper examines the continuing effects of COVID-19 and exposure to weather extremes on income, dietary, and migration outcomes in rural Guatemala. We rely on a comprehensive longitudinal survey of 1,612 smallholder farmers collected over three survey rounds in 2019, 2020, and 2021. We find improvements in incomes, food security, and dietary diversity in 2021 relative to 2020, but with levels still below pre-pandemic ones in 2019. We also find a substantial increase in the intention to emigrate that was not observed in the onset of the pandemic. In terms of the channels mediating the variations in dietary diversity and migration intentions, income shocks seem to have played a role, in contrast to direct exposure to the virus, local mobility restrictions, and food market disruptions. Importantly, households exposed to ETA and IOTA tropical storms, in addition to COVID-19, were considerably more prone to exhibit larger increases in the prevalence of moderate or severe food insecure episodes and larger decreases in their diet quality. The study provides novel evidence on vulnerable households' wellbeing in the aftermath of a global crisis, including the effects of compound shocks.

Keywords: COVID-19; food security; migration; weather extremes; compound shocks; agricultural households

JEL codes: I18, I30, O15, Q12, Q54, R20

Acknowledgments

We specially thank Maria Lucia Berrospi, Francisco Olivet, and the team of O&M Estudios y Proyectos for their valuable collaboration in collecting the data, and Carlos Rivera for his technological support. This publication was made possible through support provided by Feed the Future through the U.S. Agency for International Development. The contents and conclusions of the study are the responsibility of the authors and do not necessarily reflect the views of the U.S. Agency for International Development or the International Food Policy Research Institute.

1. Introduction

Since the beginning of the COVID-19 pandemic, Guatemalan farmers have endured various challenges brought about by national and local restrictions to movement and disruptions both downstream and upstream agricultural value chains.[1] On early March 2020, the government imposed strict travel restrictions followed by a nationwide lockdown on March 21st, in one of the most stringent government policies in the region. During August and September 2021, a second, deadlier wave of COVID-19 resulted in additional mobility restrictions across the country. While the pandemic was not particularly severe compared to other countries in the region (Guatemala is near the median cumulative number of cases and deaths per million in Central America), vaccination rates are among the lowest in Latin America (at 42% as of June 2022, only above Haiti, Jamaica, and Venezuela).

In April 2020, after the initial lockdown, the National Congress approved the COVID-19 Emergency Law with the objective of mitigating the sanitary, social, and financial consequences of the pandemic by providing emergency funding for public aid programs. The second COVID-19 wave led to the renewal of funding for the programs initiated with the Emergency Law. Despite their positive intentions, these programs have met criticism due to limited execution of funds and a general lack of evidence on the programs' results. In addition, two tropical storms (ETA and IOTA) hit the country during November 2020 causing significant flooding, landslides, and mudflows that mainly affected rural areas across 16 of the country's 22 departments (IFRC, 2021).

[1] As in other countries, the government of Guatemala imposed a nationwide lockdown on March 21, 2020, just eight days after the first reported case in the country. The Government Stringency Index, which is a daily composite index measuring the strictness of government policy responses to COVID-19 on a scale 0-100, was 96.3 between April and July 2020, one of the highest in the region (Hale et al., 2021). The index dropped to 87 in August 2020 and has fluctuated around 50-60 between October 2020 and December 2021.

Rising food prices since 2020 have also been continuously putting pressure on vulnerable households' livelihoods. According to data from the Famine Early Warning Systems Network (FEWS NET), nominal maize and bean prices in January 2022 were higher than those in 2021 and above the average for the previous five years. In particular, wholesale maize and black bean prices increased between 22% and 45% from January 2020 to January 2022, while the consumer price index only rose by 8% over the same period.[2]

In this paper, we aim to provide direct evidence of the effects of the ongoing COVID-19 environment on rural farmers' livelihoods, including the degree of persistence of these effects up to 2021, as well as those stemming from exposure to ETA and IOTA tropical storms, representing a compound shock to many households. We build upon a previous study (Ceballos et al., 2021) that analyzed the short-term effects of the COVID-19 environment on incomes, food security, and dietary diversity on a sample of rural households in the Western Highlands of Guatemala. This study found decreases in incomes between 2019 and 2020 across all main sources (agricultural, non-agricultural, and remittances), leading households to rely on savings, assets, and public and private assistance. Households also reported higher food insecurity and lower dietary diversity at the household level, with a decrease in animal source foods (ASF) diversity and an increase in fruits and vegetables (F&V) diversity, and a somewhat higher dietary diversity in the case of children under two years old. Previous findings were arguably driven by reduced food availability in local markets and increased food prices, combined with lower earnings.

This paper updates and expands the previous study, providing an extended perspective on the dynamics since the start of the pandemic and identifying new and ongoing issues among the

[2] Most of the price increases materialized during April and May 2020, shortly after the onset of COVID-19, and have not adjusted downwards since.

same sample of households followed over three years, thus shedding light on the medium-term consequences of the COVID-19 crisis. We pay special attention to impacts on incomes, food security, dietary diversity, and migration attempts. Our contributions can be summarized as follows. First, we provide an additional round of primary data collected during 2021 by phone across a panel of rural households in the Western Highlands, which can help depict recent economic and nutritional situation and trends in the region. While numerous studies and reports focus on the immediate aftermath of the COVID-19 pandemic during 2020, there is surprisingly little updated information for 2021, a gap which we try to fill. Second, we evaluate the degree of persistence of the impacts brought about by the COVID-19 environment, with particular emphasis on uncovering potential factors triggered by the pandemic that could explain these impacts, while accounting for a wide set of household characteristics. Third, following up the same set of households allows us to closely keep track of potential fluctuations in migration attitudes and intentions, introducing an important dimension of the consequences of a pandemic in vulnerable contexts. Finally, we analyze the impact of compound shocks on households' wellbeing, by incorporating a measure for whether a household was affected by ETA and IOTA tropical storms.

The results show that while there are improvements in incomes, food security, and dietary diversity in 2021 compared to 2020, 2021 levels are still below the pre-pandemic ones registered in 2019. In particular, more than half of the households in the study sample still report experiencing lower overall incomes with respect to 2019, with a worrisome shift towards borrowing as a way to cope with this. Most households report a significant recovery in local food availability, though this was accompanied with higher food prices. We also find a lower incidence of mild and moderate food insecure episodes, in contrast to severe ones, which have slightly increased. The overall decrease in household dietary diversity observed during 2020 persists and we continue to observe

a shift away from ASF diversity towards more F&V diversity, as well as a prioritization of young children in the household. Importantly, there is a noticeable increase in the intention to emigrate among households in our sample, which was not observed during the initial months of the pandemic. When examining potential factors that could be associated with the observed variations in the outcomes of interest, we find that household income shocks appear to have played a role in the variations in dietary diversity and migration intentions, in contrast to direct exposure to the virus, local mobility restrictions, and food market disruptions, which show mixed results. More critically, households that amidst the COVID-19 environment were affected by ETA and/or IOTA tropical storms are considerably more likely to exhibit larger increases in the prevalence of moderate or severe food insecure episodes and sharper decreases in their diet diversity.

The study contributes to four different strands of the literature. First, our study relates to the literature on the effects of COVID-19 on agricultural livelihoods and incomes and on the broader agri-food value chain (Ceballos et al., 2020, 2021; Hailu, 2020; Kumar et al., 2020; Hirvonen et al. 2021; Mahajan and Tomar, 2020; Nchanji et al., 2021; Rawal et al., 2020; Van Hoyweghen et al., 2021). Second, we relate to the literature on the food security and nutrition effects of COVID-19 (Ceballos et al., 2020; Laborde et al., 2020; Ceballos et al., 2021; Diaz-Bonilla et al., 2021; Hirvonen et al., 2021). We add to both strands of the literature by presenting data from a panel of households over two consecutive years after the start of the pandemic and thus informing questions about the persistence of impacts on incomes from different sources, diet quality, and food security. Third, we contribute to a relatively scant literature on the effects of external shocks on migration. Overall, the literature predicts an ambiguous effect of COVID-19 on migration, with for instance Smith and Wesselbaum's (2020) theoretical framework highlighting food insecurity as a particularly important potential push factor to migrate, and

Sanchez and Achilli (2020) describing the increased obstacles to migrating from the imposed restrictions to movement in origin, destination, and transit countries.[3] Fourth, we relate to a small but growing literature on the impacts of compound COVID-19 and weather shocks (Kruczkiewicz et al., 2021; Mahul and Signer, 2020) on agriculture (Mishra et al., 2021) and food insecurity (Randell et al., 2021).

The remainder of the paper is organized as follows. Section 2 describes the data used for the analysis, including a description of the sampled households and the main outcome variables of interest. Section 3 outlines the methodological approach and potential issues that could affect our empirical findings. Section 4 presents and discusses the results regarding variations in food security and migration indicators and potential factors associated with these variations, including exposure to the tropical storms. Section 5 provides concluding remarks.

2. Data

The study's sample frame comprises commercial coffee and horticultural smallholder farmers with a cell phone that were initially interviewed for a broader impact evaluation of a value chain development program in the Western Highlands of Guatemala. This region is arguably the most vulnerable area in the country with poverty and chronic malnutrition rates of up to 81% and 63%, respectively (INE, 2015; MSPAS-INE-ICF, 2017). In terms of exposure to COVID-19, the region is relatively on par with the rest of the country, with an overall cumulative incidence (2,863 confirmed cases and 66 deaths per 100,000 inhabitants) slightly lower than that in other departments but also with a lower full-dose vaccination rate (34% for the Western Highlands

[3] Perhaps not directly related to our study but relevant in our context, Carletto et al. (2021) offer a historical perspective on the effects of the U.S. Great Depression on migrant households in rural Guatemala.

versus 45% in the rest of the country, as of June 2022). The sample frame includes 2,142 farmers living across 87 communities in the departments of Huehuetenango, Quiche, and San Marcos.[4]

We rely on a panel dataset comprising the baseline and two follow-up surveys. The baseline survey, conducted in November-December 2019, was administered through in-person interviews and covered an extensive range of topics, including demographic characteristics, agricultural production, assets and income sources, household expenditure, participation in social programs, food security, dietary diversity, anthropometry measurement for women and children, perceptions, and attitudes towards migration. The follow-up surveys were aimed at identifying the potential economic and nutritional effects of the lockdown and other COVID-19-related measures (i.e., the COVID-19 environment) and were conducted exclusively over the phone by the same team of female enumerators as in the baseline survey. The first follow-up survey was implemented in May-June 2020 and collected qualitative changes in income sources (including remittances) after the lockdown, coping mechanisms, food security indicators, a dietary diversity module, perceptions, and migration attitudes. The full findings from this initial follow-up survey are available in Ceballos et al. (2021). The second follow-up survey was fielded in May-June 2021 and included the same modules as the first follow-up survey, together with additional modules inquiring about changes in agricultural activity, permanent loss of job or business in the household, and exposure

[4] As discussed in Ceballos et al. (2021), these households reflect the broader population of commercial smallholder farmers in the region, with a subset of them being a randomly selected, representative sample of the total population of program beneficiaries and the remaining households belonging to non-beneficiary neighboring communities with similar characteristics to those within the program's reach. Nevertheless, it is not necessarily representative of all the rural population in the Western Highlands. See the above article for a deeper discussion around the comparability of the study sample with the average rural household in the region.

to climatic shocks considering the tropical storms ETA and IOTA that affected several areas of the country in late 2020.

The number of households located and interviewed during the first and second follow-up survey rounds were, respectively, 1,824 and 1,612. In both surveys, we attempted to reduce attrition by relying on local community leaders to locate households that were not answering repeated calls or had changed their phone number and by offering households a small airtime top-up (equivalent to 1.33 US dollars) for participating. Despite these efforts, the attrition rate from the first to the second survey wave was close to 15% (318 out of 2,142 households), and of almost 12% from the second to the third survey wave (212 out of 1,824 households).[5] Our study sample is the panel of 1,612 households interviewed during all three survey waves.

To understand whether attrition is related to a particular profile of households in the original sample, thus potentially affecting our analysis below, Table A.1 in the Appendix compares household characteristics between the baseline sample and our current working sample. Overall, both samples are quite comparable in terms of average household characteristics, with the only two exceptions of a slightly higher proportion of male-headed households and beneficiaries of the value chain program in the working sample. These differences are economically very small and to be expected under multiple hypothesis testing. Hence, we consider the working sample to be

[5] In the case of the 2021 round, about half of the attrition came from households refusing to conduct another interview, and the rest mostly from not being able to reach the household (with only 3 households, or 1.5% confirmed to have migrated out of the country). In the case of the 2020 round, unfortunately we did not collect detailed data on attrition, but most of the excluded households were those not able to be reached by phone after several attempts. In both survey rounds, we attempted to contact all unreached households in different days and different times of the day.

generally representative of the broader original sample interviewed in 2019 and conduct the analyses below without any adjustments.

The top panel of Table 1 shows average household characteristics for the set of 1,612 households included in our study sample. More than half of the households are located in the department of Huehuetenango, while about a third are in Quiche and the rest in San Marcos. About half of the households (46%) are beneficiaries of the value chains program and 80% grow coffee as one of their main crops. The average household has a middle-aged, male household head with incomplete elementary education, and does not speak Spanish as his main language. The dwelling typically has finished floors, unfinished ceiling, and is connected to electricity and to a water system but lacks connection to a drainage network. The average agricultural land size is 0.88 hectares, and the daily per capita household expenditure is 11.5 quetzales (equivalent to 1.53 US dollars). As the study sample mainly includes commercial but not subsistence smallholders, these socioeconomic characteristics resemble the representative household from the three departments covered in the study (including both urban and rural areas) but are somewhat better off than the characteristics for the average rural household in the area, according to the 2018 Population and Housing Census.[6]

The bottom panel of Table 1 shows that over 42% of the households report having been affected by tropical storms ETA and/or IOTA, while roughly nine out of every ten households are located in communities that restricted their access (i.e., self-confined) at some point during the 12 months prior to the 2021 follow-up survey, as reported by community leaders that were separately interviewed during fieldwork. Geographically, a higher fraction of the population was affected by

[6] https://www.censopoblacion.gt/ (accessed April 2022).

the storms in Quiche and Huehuetenango compared to San Marcos. Figure 1 maps the communities where sampled households are located and shows that communities that either closed their borders or remained opened are not concentrated at particular locations within each department, nor are systematically closer (or farther away) from the department's capital.

We conclude this section by describing the outcomes of interest that represent our main focus in the analyses ahead. First, we rely on answers to interviewed households about qualitative changes in income between 2019 and 2021 from three major sources: agricultural, non-agricultural, and remittances.[7] Second, we construct dichotomic indicators related to whether a household reported having a mild, moderate, or severe food insecurity experience during the 12 months prior to the interview, based on questions from the Food Insecurity Experience Scale (FIES, Ballard et al., 2013).[8] Third, we use a household dietary diversity score (HDDS), which is a measure widely used in the nutrition literature as a proxy for diet quality and comprises twelve possible food groups consumed by a reference household member (the interviewed individual) over the 24 hours before the interview.[9] Similarly, we analyze diversity in consumption of animal source foods (ASF score) and fruits and vegetables (F&V score).[10] Lastly, we focus on an indicator

[7] During the survey, households were asked to provide their answer to these questions by selecting one out of five categories: decreased a lot, decreased a little, remains the same, increased a little, and increased a lot. In some of the analyses below and for simplicity, we lump together the increased a little and increased a lot categories. In other analyses, we use a variable capturing whether a given household reported an unambiguous income decrease, defined as the household reporting a decrease in one or more of the three income sources but no increases.

[8] Mild food insecurity is defined as the household indicating that in at least one instance household members had eaten only a few kinds of foods because of a lack of money or other resources; moderate food insecurity as having eaten less than they thought they should; and severe food insecurity as having not eaten despite feeling hungry.

[9] The twelve food groups of the HDDS are: (1) cereals and grains; (2) roots and tubers; (3) vegetables; (4) fruits; (5) meats, poultry, and offal; (6) eggs; (7) fish and seafood; (8) legumes and nuts; (9) milk and milk products; (10) oil and fats; (11) sugar; and (12) miscellaneous foods. For additional information on the indicator see FAO (2010).

[10] The ASF score is based on seven food groups: (1) beef and pork meat; (2) poultry; (3) organ meat; (4) sausages; (5)

for intention to emigrate, based on a survey question that asks whether anyone in the household has the intention to migrate outside of the country to live or work over the following three years.

3. Methodology

The empirical analysis follows three different approaches. First, we perform before-after comparisons for several outcome variables of interest (Section 4.1). We focus on variations in outcomes between the pre-pandemic period (2019) and 2021, as the short-term changes during the initial months of the pandemic (2020 versus 2019) are extensively discussed in Ceballos et al. (2021). In the case of income, the comparisons are based on self-reported qualitative assessments on income changes (relative to the 2019 baseline period) elicited during the follow-up surveys. In the case of food insecurity experiences, dietary diversity measures, and intention to emigrate, we rely on direct quantitative comparisons between the rates or averages collected during each survey round.

Second, we rely on a multivariate regression framework to examine whether the food insecurity experiences, dietary diversity, and migration intentions reported before and after the start of the pandemic are correlated with certain household characteristics (Section 4.2). Given the longitudinal nature of our data and that household characteristics were only measured at baseline, we implement a panel data model with household random effects (i.e., assuming that unobserved, time-invariant households characteristics are independent of the control variables), while still controlling for fixed effects at the community level. We estimate the following generalized least squares (GLS) random effects model,

fish and seafood; (6) eggs; and (7) dairy products. The F&V score is based on five food groups: (1) fruits rich in vitamin A; (2) other fruits; (3) vegetables rich in vitamin A; (4) green leafy vegetables; and (5) other vegetables.

$$Y_{ijt} = \alpha_0 + \alpha_1 t_{20} + \alpha_2 t_{21} + X_{ij}\alpha_3 + \theta_i + c_j + u_{ijt} \quad (1)$$

where Y_{ijt} represents an outcome variables of interest (food insecurity experience, dietary diversity score, or intention to emigrate) reported by household *i* located in community *j* at period *t*; t_{20} and t_{21} are dummy variables for 2020 and 2021 survey rounds, respectively; X_{ij} is a vector of household characteristics measured at baseline (2019); θ_i is a household-specific component such that $E[\theta_i|X_{ij}] = 0$; c_j represents community dummies that control for the possible influence of factors common to all households in a given community (e.g., economic, social, cultural, and accessibility conditions) on the modeled outcomes; and u_{ijt} is an error term. The standard errors are clustered at the community level to account for likely within-community correlation in the reported outcomes.

Parameter α_0 is the intercept that captures the unconditional mean of the modeled outcome variable, while parameters α_1 and α_2 capture the unconditional average change in the outcome variable in 2020 and 2021 with respect to 2019. The parameters of interest are contained in the vector of parameters α_3 that measure the corresponding partial correlations between the outcome variable and the set of household characteristics. We consider an extensive number of household variables that include age, gender, education, and language of household head, household size, participation in social programs, dwelling characteristics and access to services, per capita household expenditure, asset ownership, agricultural variables such as landholding size, irrigation system, main crops produced, and if at least one member of the household temporarily migrates internally within Guatemala for work.

Lastly, we assess whether observed changes in food insecurity experiences, dietary diversity, and migration intentions can be linked to specific factors or situations that the household experienced following the onset of COVID-19. We separately consider different factors triggered

by the pandemic experienced during the 12 months prior to the second follow-up survey (Section 4.3). These factors include: i) the degree of direct exposure to the virus at the community level (considering the community leader response to the number of COVID-19 cases in the community) and at the municipality level (according to the official rate of cases in each municipality);[11] ii) the degree of mobility restrictions in the community (i.e., the percentage of months that the community where the household is located imposed entry or exit restrictions, as reported by the community leader); iii) possible disruptions in the local food market (considering whether the median household in a community reported lower food availability or higher food prices in the local market); and iv) income shocks (capturing whether the household suffered a permanent job or business loss and/or a decrease in its sources of income). In addition, we consider exposure to extreme weather events, based on whether the household reported being affected by tropical storms ETA and/or IOTA in late 2020, which represented a major exogenous shock to many households (Section 4.4).

We accordingly extend the model described in Equation (1) as follows,

$$Y_{ijt} = \beta_0 + \beta_1 t_{20} + \beta_2 t_{21} + \beta_3 F_{ij} + \beta_4 t_{21} * F_{ij} + X_{ij}\beta_5 + \theta_i + c_j + u_{ijt} \quad (2)$$

where F_{ij} is an indicator variable capturing the presence of a given factor described above (i.e., direct exposure of the community or municipality to COVID-19, community-level mobility restrictions, community-level disruptions to local food markets, household-level income shocks, or the household's exposure to extreme weather events). The parameter of interest in Equation (2) is β_4, which measures the differential variation in the modeled outcome in 2021 (relative to the baseline period) between households that experienced each of these factors and households that

[11] The rates correspond to the number of cases reported by the Ministry of Health in Guatemala (MSPAS, 2021), per 10,000 people in the municipality according to the last population census (INE, 2020).

did not. Note that, due to the inclusion of the set of community-level dummies, parameter β_3 cannot be identified for indicator variables F_{ij} measured at the community or municipality level.

3.1 Endogeneity issues

Since the analyses above rely on before-after comparisons, it is worth discussing potential sources of endogeneity that could be affecting our results. First, as baseline data were collected towards the end of 2019 and follow-up data towards mid-2020 and 2021, the observed patterns could be influenced by seasonal trends in food availability, food access (income and prices), and dietary diversity. Yet, as documented in Ceballos et al. (2021), seasonal effects (if any) among our studied population and area (i.e., agricultural households in rural areas of the Western Highlands) would operate opposite to the estimated effects, which provides additional support to our empirical findings.

Second, despite relying on a wide set of (time-invariant) household control variables and location dummies to account for likely confounding effects on the modeled outcomes, we cannot rule out time-varying omitted variables such as demographic changes or migration flows influencing the results (although these were to some extent limited given the severe mobility restrictions in place during most of the time span of the study). In our working sample, about one third of the households reported a change in size or composition between 2019 and 2021, and our results are not sensitive to excluding these households from the analyses as detailed in the next section. In a similar vein, despite we do not find systematic differences in observable characteristics between households that remained in the sample and those that were lost along the

two follow-up survey rounds (as discussed earlier), we additionally checked that our main results hold when using the full unbalanced panel.[12]

Lastly, we recognize that some of the self-reported food security and migration indicators may be subject to measurement error due to a potential negative perception bias as a result of the pandemic (e.g., changes in income or consumption patterns) as well as misreporting (e.g., intention to emigrate). Yet, as long as the error is random or not correlated with other covariates, it would only imply a loss of efficiency in the estimations, which would still be unbiased.

4. Results

This section discusses the empirical results. First, we present before-after comparisons on several outcome variables of interest related to incomes, food security, dietary diversity, and migration attitudes. Second, we assess whether the reported food insecurity experiences, dietary diversity, and migration intentions are correlated with particular household characteristics. Finally, we evaluate whether the observed variations in these outcomes can be associated with different factors prompted by the pandemic or adverse weather events.

4.1 Before-after comparisons

We draw comparisons on multiple outcome variables of interest before and after the start of the pandemic. As indicated earlier, we pay special attention to medium-term variations (i.e., 2019 versus 2021), as short-term variations (i.e., 2019 versus 2020) of most measured outcomes are already discussed in Ceballos et al. (2021).

[12] The variation patterns in food insecure experiences, dietary diversity scores, and intentions to emigrate when using our full unbalanced panel are similar to our balanced panel. Further details are available upon request.

Figure 2 presents self-reported qualitative changes in household income by source between 2020 or 2021 and 2019. Overall, we observe a general recovery in incomes in 2021 compared to 2020, when the pandemic had just started and containment measures and mobilization restrictions were more stringent. In particular, a considerably smaller share of households report a decrease in incomes (from 2019 levels) during the 2021 survey than during the previous survey round. Importantly, the fraction of households indicating severe declines in their income during 2021 was about half that found in 2020 across all three income sources. In addition, the percentage of households in 2021 reporting a similar or higher income than in 2019 noticeably increased with respect to the previous survey round, with more than half reporting this for agricultural and non-agricultural incomes and around 45% for remittances (versus closer to a third of households doing so in 2020 for the first two sources and only a meagre 7% for remittances). The pattern of remittances, however, is not necessarily in line with the national official reports that point to a sustained increase in family remittances over the past two years.[13]

Still, an important subset of households are suffering income repercussions from the COVID-19 pandemic. In the case of income from agricultural activities, which constitute the main income source in our study sample, 49% report a decline with respect to 2019 (with 35% reporting a modest decline and 14% a large decline), while in the case of revenues from non-agricultural activities 36% report a decline (with 24% reporting a large decline).[14] All in all, roughly six out of

[13] According to the Central Bank of Guatemala, annual family remittances increased by 7.9% in 2020 and by 34.9% in 2021 (https://www.banguat.gob.gt/es/page/remesas-familiares-0, accessed on April 2022).

[14] When exploring income variations by department (Huehuetenango, Quiche, and San Marcos), we observe a larger prevalence of income decreases in San Marcos (84% for agricultural activities and 62% for non-agricultural activities). A similar pattern was found in 2020, which we argue could be explained by San Marcos being relatively more developed and connected to markets than the other two departments, such that the pandemic and containment measures could have had larger and long-lasting effects on multiple productive and economic activities in this department.

ten households in the working sample (946 households) report an unambiguous income decrease between 2019 and 2021 (i.e., report a decrease in one or more of their three income sources but no increases).

Appendix Figure A.1 shows how households have been coping with their income losses over the past two years. In 2021, about one third indicate either borrowing money or selling assets (basically livestock) to deal with income losses, while one fourth report using their own savings. The shift towards costlier mechanisms (i.e., borrowing) is somewhat worrisome, as opposed to 2020 where households mainly relied on savings, selling assets or no coping mechanism at all. The share of households relying on assistance from public or private institutions continues to be slightly over 20%, while an 8% report relying on help from a relative or friend (an increase from 2% during 2020).

Figure 3 illustrates, in turn, self-reported changes in food availability (Panel A) and prices (Panel B) for different food groups (dairy products, meats, F&V, roots and tubers, and grains and cereals) at the local market. More than eight out of ten households indicate that food availability across all five food groups remained the same or increased in 2021 with respect to 2019. This reveals a noticeable recovery in food availability compared to the responses in 2020 (not reported) where more than 90% of the households indicated an aggregate decrease in food availability, likely associated with the nationwide lockdown and stricter containment measures during the first months of the pandemic.[15] In contrast, households report food prices being still higher than in 2019, with a larger share of households reporting a price increase across every food group in 2021

[15] In 2020, we only asked for aggregate variations in food availability and not for variations by different food groups as in 2021.

compared to 2020, particularly for meats and dairy products. This upward trend in prices is aligned with the general price inflation since the onset of COVID-19.[16]

Panel A of Table 2 reports the prevalence of mild, moderate, and severe food insecure experiences over the three survey rounds and the results from a test for whether the post-pandemic rates are statistically different than the pre-pandemic ones. Aligned with the observed changes in incomes and food availability, we find an improvement in the prevalence of mild and moderate food insecure experiences in 2021 relative to 2020, but the levels that are still higher than in 2019. Roughly, eight out of ten households in 2021 report at least one episode where they only ate a few kinds of foods because of lack of resources (mild food insecurity), compared to 90% of households in 2020 and 57% in 2019. Similarly, around six out of ten households in 2021 report having eaten less than they thought they should (moderate food insecurity), compared to 87% of households in 2020 and 35% in 2019. However, the prevalence of severe food insecure experiences (i.e., not eating at some point despite feeling hungry) has remained over 20% since the onset of the pandemic versus 11% in 2019.

Turning to the household dietary diversity indicators, which serve as a proxy of diet quality, Panel B of Table 2 shows average scores across the three years under study. We observe a small recovery, relative to the pre-pandemic period, in overall dietary diversity between 2020 and 2021. We continue to observe a slightly lower HDDS for the reference household member, from an average score of 6.8 (out of twelve possible food groups) in 2019 to 6.6 in 2021, and the differences are statistically significant at conventional levels.[17] This decrease is mainly driven by a lower

[16] The average monthly price inflation in the country was 3.21% in 2020 and 4.26% in 2021 (Central Bank of Guatemala, https://banguat.gob.gt/es/page/inflacion, accessed on April 2022).

[17] This does not appear to be an artifact of relying on a comparison of means. Appendix Figure A.2 plots histograms with the HDDS distribution for 2019 (white bars) and 2021 (blue bars). The distribution for 2021 is slightly shifted to

diversity in the consumption of animal protein, from a score of 1.3 (out of seven possible ASF groups) in 2019 to 0.9 in 2021, revealing that more than one year after the start of the pandemic, household members were still consuming less than one animal protein group per day (mainly eggs). Similar to our 2020 findings, the lower diversity in the consumption of ASF is somewhat compensated by a higher diversity in the consumption of F&V, from a score of 2.1 (out of five possible F&V groups) in 2019 to 2.4 in 2021.

As noted in the previous section, these before-after variation patterns are not driven by potential seasonal effects, as multiple food products (including F&V and ASF) that fall into each food group are available and accessible year-round. Similarly, these variations do not seem to be driven by a change in household composition. While 37% of households report a change in composition between 2019 and 2021 (20% report an increase in size, 14% a decrease in size, and 3% a change in composition but not in size), the variations in HDDS, ASF, and F&V scores persist when excluding these households. Using the restricted sample with no changes in household composition (1,009 households), the HDDS changes from 6.8 in 2019 to 6.7 in 2021, the ASF score from 1.3 to 0.9, and the F&V score from 2.1 to 2.5.[18]

Appendix Figure A.3 offers additional insights on the variation of consumption of animal protein and F&V. The figure reports the share of households that consumed each of the seven ASF groups (Panel A) and five F&V groups (Panel B) over the three survey rounds. As in 2020, we still observe lower consumption of all seven animal protein groups in 2021 relative to 2019 (with a

the left compared to 2019, with a lower share of households consuming nine through eleven food groups and a higher share consuming five through seven food groups. A similar shift was observed in 2020.

[18] The time-variation patterns in food insecure experiences and intention to emigrate, which are the other two main outcomes of interest, are also very similar between the restricted and full working sample. Further details are available upon request.

minor recovery for beef and pork meat and poultry relative to 2020). Likewise, we observe higher consumption between 2019 and 2021 across all F&V groups except for vegetables rich in vitamin A, though less pronounced than what was observed in 2020. Despite the lower nutrient bioavailability in F&V compared to ASF, we cannot conclude whether this sustained substitution away from ASF diversity towards F&V diversity since the start of the pandemic has resulted in an overall lower nutrient intake, as more detailed consumption data, such as quantities consumed, were not collected (Allen and Gillespie, 2001; Murphy and Allen, 2003; Arimond and Ruel, 2004).

Panel B of Table 2 also reports dietary diversity indicators for a selected woman 15-49 years old (WDDS) and child 6-23 months old (DDS) in the household. [19] Similar to the reference member for the HDDS, the same woman (in 1,345 households) was followed up over the three survey rounds. In the case of children, a child 6-23 months was selected in each round due to the narrow age range to construct the dietary indicator and the wide time span between surveys that would otherwise further limit the number of observations for analysis; the number of households with children are 280 in 2019, 206 in 2020 and 213 in 2021. We find that the average dietary diversity score for women has remained relatively stable around 4.5 (out of nine possible food groups) over the three years, whereas the post-pandemic increase in the dietary diversity score for children persists, from 3.3 (out of seven possible food groups) in 2019 to 3.5 in 2021, although the

[19] The WDDS measures the number of nine different food groups that the woman in the household consumed over the previous 24 hours to the survey. The nine food groups comprise: (1) cereals, grains, roots, and tubers; (2) dark green vegetables; (3) other fruits and vegetables rich in vitamin A; (4) other fruits and vegetables; (5) organ meats; (6) meat, poultry, and fish; (7) eggs; (8) legumes, nuts, and seeds; and (9) milk and milk products. The children DDS measures the number of seven different food groups that the child consumed over the previous 24 hours to the survey. The seven food groups comprise: (1) cereals, grains, roots, and tubers; (2) legumes and nuts; (3) dairy products (milk, yogurt, cheese); (4) flesh foods (meat, fish, poultry, and liver/organ meats); (5) eggs; (6) vitamin A rich fruits and vegetables; and (7) other fruits and vegetables.

change is marginally significant and lower than in 2020. This continued apparent prioritization of young children in the household is aligned with the type of intra-household reallocation of foods observed among vulnerable rural populations facing an external shock or adverse event (Block et al., 2004; Skoufias and Vinha, 2012).

Lastly, Panel C of Table 2 presents the share of households reporting whether someone in the household has an intention to emigrate over the next three years. As opposed to 2020, where the share of households revealing an intention to emigrate had decreased by about one percentage point relative to the pre-pandemic period (from 3.3% in 2019 to 2.1% in 2020), in 2021 we observe a significant increase in the intention to emigrate, at 9.6% of households. This recent increase could be due to less stringent mobility restrictions and reduced uncertainties compared to the beginning of the pandemic that initially precluded people from leaving their home or to improved employment opportunities abroad with a relative normalization of conditions into 2021.[20] These figures are somewhat striking considering the sensitivity of migration questions, which are potentially prone to underreporting.

4.2 Relationship between outcomes and household characteristics

Next, we assess whether the reported food insecurity experiences, dietary diversity, and migration intentions are correlated with certain household characteristics. We rely on the regression framework described in Equation (1) to derive partial correlations between the modeled outcomes across all three survey rounds and household socioeconomic characteristics measured at baseline, in addition to indicator variables for each survey round.

[20] By department, we find a much higher increase in San Marcos (from 2% in 2019 to 21.7% in 2021) than in Quiche (from 1.8% to 12.9%) and Huehuetenango (from 4.5% to 5%). As indicated above, San Marcos is the department that was likely most affected by the pandemic and where we observe a larger prevalence of reported income decreases.

Table 3 presents the estimation results for five outcomes of interest: if households experienced moderate or severe food insecure episodes in column (1); HDSS, ASF, and F&V scores in columns (2) through (4); and if someone in the household intends to emigrate in column (5). The coefficient for the survey round dummies reported at the top of the table reflect the unconditional changes in the modeled outcomes with respect to the baseline period (2019), already discussed in the previous section, and show a higher prevalence of food insecure experiences (especially in 2020), lower HDDS and ASF scores, higher F&V scores, and an increased intention to emigrate in 2021.

Regarding the correlations with household characteristics, we find several interesting patterns that permit to characterize the type of households associated with more food insecurity, less favorable diets, or that indicate having an intention to emigrate. Households reporting a moderate or severe food insecure episode are more likely to be smaller landholders that produce corn as one of their main crops, not own a vehicle, lack connection to electricity, have more precarious dwellings, and speak a language different than Spanish as their main language, characteristics generally associated with more isolated populations. Households exhibiting a lower dietary diversity, including ASF and F&V, tend to be households with an older head, lower per capita expenditures, and with less finished dwellings that lack electricity or water connection, reflecting the lower accessibility of poorer households to a wider range of foods. In addition, a lower HDDS and ASF score is associated with smaller landholders that do not own assets and have a less educated household head who does not necessarily speak Spanish. Households of larger size are, in turn, more likely to report a higher F&V score. Corn producers exhibit a lower overall dietary diversity while cardamom producers show more diversity in the consumption of animal proteins combined with less diversity in F&V. Interestingly, beneficiaries of a social school

program report a more diverse consumption behavior. Finally, emigration intentions do not seem to be much associated with observable household characteristics. Larger households with a younger head and poorer cooking methods are more likely to report that someone in the household has an intention to emigrate.

In Appendix Figure A.4, we further explore the association between dietary diversity indicators, before and after COVID-19, and household income. We report local polynomial curves for HDDS, ASF, and F&V scores in 2019 (gray line) and 2021 (blue line) against the natural logarithm of per capita household expenditures measured at baseline. The shaded areas represent 95% confidence bands. We observe that the curves for both HDDS and ASF scores (upper and middle panel) are upward sloping during both periods, corroborating that richer households in the sample maintained more diverse overall and animal protein diets before and after the pandemic. However, when drawing comparisons between periods, richer households show a score decrease after the onset of COVID-19 that is also more pronounced for ASF as opposed to HDDS, while there are no major (clear) changes among poorer households. Hence, in the context of our sample relatively richer households –that had broader access to and consumed a wider variety of animal proteins (e.g., eggs, poultry, beef and pork meat, dairy products) prior to the pandemic– have adjusted to a greater extent their consumption of these foods than relatively poorer ones. In contrast, in the case of the F&V score (lower panel) we find an increase among lower-to-middle income households, bringing them closer to relatively richer households in terms of their F&V dietary diversity and thereby flattening the pre-pandemic curve.

4.3 Potential factors triggered by the pandemic associated with changes in outcomes

We now turn to examine whether the variations in food insecurity experiences, dietary diversity, and intentions to emigrate are associated to specific factors that were prompted by the pandemic. An implicit assumption of our empirical approach that relies on before-after comparisons is that COVID-19, as a global shock, affected all households. Yet, there are potential factors or channels through which the pandemic could have further exacerbated (or attenuated) the observed changes in the outcomes of interest. Among these factors, we separately consider the degree of direct exposure to the virus, the extent of local mobility restrictions, disruptions in local food markets, and income shocks. The analysis below relies on the regression framework defined in Equation (2), focusing on medium-term variations (2019 versus 2021) while controlling for short-term trends (2019 versus 2020).

A first potential driver of the reported variations in the outcomes of interest is the degree of direct exposure to the virus. A higher prevalence of the virus and its effects among neighboring households could have resulted in added fears, disruptions, and increased uncertainty that aggravate the food insecurity, nutritional intake, or migration preferences of households. We consider intensity indicators both at the community and municipality level. For the former indicator, we use the number of COVID-19 cases reported by the community leader over the 12 months prior to the 2021 follow-up survey, normalized by the number of people in the community, which ranges from 0% to 13% across the communities in our sample. For the latter indicator, we use the official number of cases per 10,000 people in the municipality, recorded between July 2020 and June 2021, assuming that all households in a municipality where exposed to the virus in the same degree. The rate of infections across the municipalities in our sample ranges from 12.2 to 644.9 infections (per 10,000 people).

Table 4 presents the estimation results using the share of reported cases at the community level in Panel A and using the rate of infections at the municipality level in Panel B. From Panel A, we only find a negative association between the share of COVID-19 cases in the community and household overall dietary diversity. A one percentage point increase in the share of cases is correlated with an additional 0.06 points decrease in HDDS (on a scale 0-12).[21] When considering the rate of cases at the municipality level (Panel B), we find that one more infection per 10,000 people in the municipality where the household resides is correlated with a lower increase in the diversity of F&V consumed (0.11 lower points on a scale 0-5). We also observe, however, that the prevalence of households reporting moderate or severe food insecure experiences increased to a lower extent among municipalities with higher infection rates. Hence, while more direct exposure to the virus could have worsen dietary diversity, it does not appear to have aggravated food insecure episodes but the opposite. A possible explanation for these apparent contrasting results could be related to the higher level of aid focalized in areas (municipalities) where the virus spread more widely that at least helped to attenuate food insecure experiences.[22]

A second potential driver of the observed outcome variations could be the extent of mobility restrictions faced by households. As indicated earlier, in addition to the national containment measures established by the central government during the pandemic, several communities in the study sample were more stringent in restricting access to help prevent the spread of the virus in their community. The leaders from 74 (out of 87) communities in the study sample reported closing their borders at some point during the 12 months prior to the 2021 follow-

[21] We also considered using a binary variable for whether the leader reported at least one COVID-19 case in the community and we do not find any statistically significant results.

[22] We find that among municipalities with a higher rate of COVID-19 cases there is similarly a larger share of households in our sample reporting receiving some form of public or private aid.

up survey. The number of months for which access was restricted, however, varied widely from 1 to 12. As such, it is worth exploring whether a higher degree of mobility restrictions contributed to the observed changes in food insecure episodes, dietary diversity, and migration intentions.

Table 5 reports the estimation results using the percentage of months the community was closed. We generally do not find differentiated variations among households in communities that voluntarily closed their borders for larger versus shorter periods of time. Only for F&V we observe statistically significant differences, but the magnitude of the differences is very small: one percentage point increase in the percentage of months that the community closed is associated with an additional 0.01 points increase in the F&V score. It follows from these results that the closing of community borders for longer periods of time does not seem to have been directly associated with food supply shortages.

A third possible channel of the reported outcome variations are local supply disruptions as well as household income shocks. In the absence of (ideal) local market data, we rely on household self-reports as a proxy for potential disruptions in local food markets. As noted earlier, we inquired households about changes (with respect to 2019) in local food availability and prices across five food groups (dairy products, meats, F&V, roots and tubers, and grains and cereals) during the 12 months prior to the 2021 survey. Based on each household's answers, we construct an availability index and a price index indicating for how many of the food groups (from 0 to 5) availability decreased or prices increased, respectively. Since the value of each index may differ across households within a community, we consider the index value of the median household. In the case of income shocks, we consider whether the household experienced an unambiguous decrease in income in 2021 relative to 2019 (58.7% of households) or whether someone in the household

permanently lost their job or closed their business over the 12 months preceding the 2021 survey (5.5% of households).

Table 6 presents the corresponding results using proxies of local market disruptions in Panel A and household income shocks in Panel B.[23] We find that households in communities where the median household reported a larger extent of decrease in local food availability were less prone to report increases in the prevalence of moderate or severe food insecure experiences in 2021 (relative to 2019) and are associated with a lower decrease in the diversity of ASF consumed; lower availability in one additional food group (out of five possible food groups) is correlated with an 8 percentage points lower increase in the likelihood of reporting a moderate or severe food insecure episode, and with 0.06 points lower decrease in the ASF score (on a scale 0-7). Similarly, households in communities where the median household reported a larger extent of increase in local food prices are associated with a lower decrease in their overall dietary diversity; a price increase in an additional food group (out of five possible food groups) is correlated with 0.16 points lower decrease in HDDS. Hence, among localities where households self-reported a larger degree of local food market interruptions, we do not find more food insecure episodes or a lower dietary diversity but the opposite. These findings could be related to these localities being relatively more developed and thus connected to dynamic markets (affected to a greater extent by the pandemic), while at the same time having wealthier households that are more protected and could have better coped with the crisis.[24] Interestingly, localities with sharper food price surges

[23] We also considered a joint model with both supply and demand factors and find qualitatively similar results.

[24] We find a clear positive correlation between communities reporting a larger extent of increase in local food prices and average daily per capita household expenditures, while in the case of communities reporting a larger extent of decrease in local food availability the correlation with household expenditures is only marginally positive.

are associated with an increase in the intention to emigrate: a price increase in an additional food group is associated with a 2 percentage points increase in the intention to emigrate.

Turning to income shocks, we observe that households reporting an unambiguous income decrease in 2021 (compared to 2019) were more likely to exhibit larger reductions in their dietary diversity than households that did not experience an income decrease. For households reporting an income decrease, their F&V score increased by 0.47 points less while their HDDS and ASF scores decreased by 0.2 and 0.08 points more, respectively. Similarly, households where a member permanently lost their job or closed their business show a lower increase in the F&V score (of 0.42 percentage points). Lastly, an unambiguous income decrease is correlated with a substantial 5 percentage points increase in the intention to emigrate. In sum, household income shocks appear to have played some role in the observed variations in dietary diversity and migration intentions.

4.4 Exposure to extreme weather events and variation in outcomes

In addition to the major shock brought about by the COVID-19 pandemic, more than four out of ten households in our study reported being affected by tropical storms ETA and/or IOTA in November 2020. These storms represented a large adverse climatic event that negatively impacted crops and assets, particularly among households in Quiche and Huehuetenango where the storms caused more damage. It is thus relevant to assess whether this exposure to extreme weather events, representing a compound shock for households who were already undergoing the consequences of the COVID-19 pandemic, contributed to the reported variations in food insecure situations, dietary diversity, and migration intentions.

Table 7 shows the estimation results when including, in the context of Equation (2), an indicator variable for whether a household reported having been affected by ETA and/or IOTA.

Interestingly, we find that, compared to households who were exposed to the COVID-19 pandemic shock alone, those that were additionally exposed to an extreme weather event were substantially more prone to show larger increases in the prevalence of moderate or severe food insecure episodes in 2021 (compared to 2019) and a larger decrease in their overall dietary diversity. A household affected by ETA and/or IOTA exhibits a 23.1 percentage points higher increase in the likelihood of reporting a food insecure experience relative to a household that was not affected by the storms. In addition, households exposed to the storms are associated with a larger decrease in HDDS (0.18 points lower) and ASF diversity (0.13 points lower), and a slightly higher intention to migrate (even though this is not statistically significant at conventional levels).

These findings point to the risks posed by compound shocks among vulnerable households in the aftermath of COVID-19 and to the importance of climate adaptation and resilience strategies to cope with the increasing exposure to climate extremes. The region of study is prone to adverse events and, besides ETA and IOTA, 69% of the study sample indicate having been affected by an extreme weather event over the past five years.

5. Concluding Remarks

The COVID-19 pandemic and the strict measures to contain it has represented a major global shock and posed multiple economic and food security risks, especially for vulnerable populations in complex rural settings. This paper assesses the continuing effects of the COVID-19 environment and exposure to extreme weather on incomes, food security, dietary diversity, and migration attitudes in the Western Highlands of Guatemala. This region is the most vulnerable area in the country with poverty and chronic malnutrition rates of over 80% and 60%, respectively. We rely

on an extensive panel household survey of agricultural smallholders collected over three survey rounds in 2019, 2020, and 2021.

The results show improvements in incomes, food security, and dietary diversity in 2021 relative to 2020, but at levels that are still below the pre-pandemic ones recorded in 2019. We find that more than half of the households still report an overall income decrease relative to 2019, combined with a worrisome shift towards borrowing as a coping strategy. Similarly, the majority of households indicate a substantial recovery in local food availability across a range of food groups, though accompanied by persistently higher prices. In terms of food security, the prevalence of mild and moderate food insecure episodes have decreased compared to 2020, but that of severe episodes has slightly increased. As for dietary diversity, we continue to observe a general decrease in the household dietary diversity index, with a shift away from the consumption of ASF groups towards consumption of more F&V groups. In contrast, the dietary diversity scores for women and young children have remained unchanged or increased, respectively, after the start of the pandemic. We also find a three-fold increase in the intention to emigrate in 2021, which was not observed during the previous survey round in 2020. More detailed analyses suggest that household income shocks played some role in the variations in dietary diversity and migration intentions, as opposed to direct exposure to the virus, local mobility restrictions, or food market disruptions, which show mixed results. Finally, households that were in addition affected by ETA and/or IOTA tropical storms that hit the country in late 2020 were substantially more prone to show larger increases in the prevalence of moderate or severe food insecurity experiences and a larger decrease in their diet diversity.

The study provides important insights for economic and recovery policies in the aftermath of a global shock across vulnerable households in complex rural settings. Despite the positive

finding of a recovery in incomes, food security, and dietary diversity in 2021 with respect to 2020, the observed shift towards more costly mechanisms, i.e., borrowing, to cope with the pandemic deserves a closer look, particularly under the potential of lending sources not being necessarily formal. In this sense, temporal soft loans with lenient terms could be helpful in this regard, perhaps through public-private partnerships with high rural penetration such as Banrural. Our findings regarding the pernicious effects of compound shocks on vulnerable households, such as those resulting from the exposure to both the COVID-19 environment and ETA and IOTA tropical storms, also remark the importance of expanding formal financial mechanisms to improve rural households' resilience and promoting climate adaptation strategies to cope with exposure to extreme weather events, a long-lasting problem in the Western Highlands. The significant increase in the intention to emigrate further points to the exacerbation of ongoing push factors at the household and/or local levels during the pandemic, despite the ongoing recovery measures and efforts.

Lastly, while the study is based on a rich pre- and post-pandemic panel dataset of smallholder farmers collected over three years, we certainly cannot fully discard time-varying unobserved factors affecting the results as we still rely on before-after comparisons. We also cannot rule out potential measurement errors due to a general negative perception bias (due to the crisis) or misreporting of certain (sensitive) indicators. An additional follow-up survey would permit to assess longer term variations or reversals to pre-pandemic levels on incomes, food security, dietary diversity, and migration attitudes in the region, considering the recent conflict in Eastern Europe and its implications on input and food availability and accessibility worldwide.

References

Allen, L.H., Gillespie, S., 2001. What works? A review of the efficacy and effectiveness of nutrition interventions. Asian Development Bank.

Arimond, M., Ruel, M.T., 2004. Dietary diversity is associated with child nutritional status: Evidence from 11 demographic and health surveys. The Journal of Nutrition 134(10): 2579-2585

Ballard, T.J., Kepple, A.W., Cafiero, C., 2013. The Food Insecurity Experience Scale: Development of global standard for monitoring hunger worldwide. FAO Technical Paper Version 1.1, October

Block, S.A., Kiess, L., Webb, P., Kosen, S., Moench-Pfanner, R., Bloem, M.W., Timmer, C.P., 2004. Macro shocks and micro outcomes: Child nutrition during Indonesia's crisis. Economics & Human Biology 2(1): 21-44.

Ceballos, F., Hernandez, M.A., Paz, C., 2021. Short-term impacts of COVID-19 on food security and nutrition in rural Guatemala: Phone-based farm household survey evidence. *Agricultural Economics* 52(3): 477-494.

Ceballos, F., Kannan, S., Kramer, B., 2020. Impacts of a national lockdown on smallholder farmers' income and food security: Empirical evidence from two states in India. *World Development* 136: 105069.

Ceballos, F., Kannan, S., Kramer, B., 2021. Crop prices, farm incomes, and food security during the COVID-19 pandemic in India: Phone-based producer survey evidence from Haryana State. *Agricultural Economics* 52(3): 525-542.

Carletto, C., Maluccio, J.A., Shrestha, S.M. and Stewart, M.F., 2021. Migration, economic crisis and child growth in rural Guatemala: Insights from the Great Recession. *Food Policy* 104: p.102145.

Diaz-Bonilla, E., Flores, L., Paz, F., Piñeiro, V., Zandstra, T., 2021. Guatemala: The impact of COVID-19 and policy implications: Second report (Vol. 21). International Food Policy Research Institute, Washington, DC.

FAO, 2010. Guidelines for measuring household and individual dietary diversity. Food and Agriculture Organization, Rome. http://www.fao.org/3/a-i1983e.pdf.

Hailu, G., 2020. Economic thoughts on COVID-19 for Canadian food processors. *Canadian Journal of Agricultural Economics* 68(2): 163-169.

Hale, T., Angrist, N., Goldszmidt, R., Kira, B., Petherick, A., Phillips, T., Webster, S., Cameron-Blake, E., Hallas, L., Majumdar, S., Tatlow, H., 2021. A global panel database of pandemic policies (Oxford COVID-19 Government Response Tracker). *Nature Human Behavior* 5: 529–538.

Hirvonen, K., De Brauw, A., Abate, G.T., 2021. Food consumption and food security during the COVID-19 pandemic in Addis Ababa. *American Journal of Agricultural Economics* 103(3): 772-789.

Hirvonen, K., Minten, B., Mohammed, B., Tamru, S., 2021. Food prices and marketing margins during the COVID-19 pandemic: Evidence from vegetable value chains in Ethiopia. *Agricultural Economics* 52(3): 407-421.

IFRC, 2021. 6-months Operation Updated, Central America: Hurricanes Eta & Iota. Situation Report, International Federation of Red Cross and Red Crescent Societies, https://reliefweb.int/report/guatemala/central-america-hurricanes-eta-iota-6-months-operation-update-mdr43007.

INE, 2020. XII Censo Nacional de Población y VII de Vivienda: Resultados del Censo 2018. Instituto Nacional de Estadistica (INE). Guatemala: Ciudad de Guatemala, https://www.censopoblacion.gt/ [In Spanish].

INE, 2015. Republica de Guatemala: Encuesta Nacional de Condiciones de Vida 2014, Principales Resultados. Guatemala: Ciudad de Guatemala [In Spanish].

Kruczkiewicz, A., Klopp, J., Fisher, J., Mason, S., McClain, S., Sheekh, N.M., Moss, R., Parks, R.M., Braneon, C., 2021. Opinion: Compound risks and complex emergencies require new approaches to preparedness. *Proceedings of the National Academy of Sciences* 118(19).

Kumar, A., Padhee, A.K., Kumar, S., 2020. How Indian agriculture should change after COVID-19. *Food Security* 12(4): 837-840.

Laborde, D., Martin, W., Swinnen, J., Vos, R., 2020. COVID-19 risks to global food security. *Science* 369(6503): 500-502.

Mahajan, K., Tomar, S., 2021. COVID-19 and supply chain disruption: Evidence from food markets in India. *American Journal of Agricultural Economics* 103(1): 35-52.

Mahul, O., Signer, B., 2020. The perfect storm: How to prepare against climate risk and disaster shocks in the time of COVID-19. *One Earth* 2(6): 500-502.

Mishra, A., Bruno, E., Zilberman, D., 2021. Compound natural and human disasters: Managing drought and COVID-19 to sustain global agriculture and food sectors. *Science of the Total Environment* 754: p.142210.

MSPAS, 2021. "Situación de COVID-19 en Guatemala." Ministerio de Salud Pública y Asistencia Social (MSPAS). Guatemala: Ciudad de Guatemala, https://tablerocovid.mspas.gob.gt/ [In Spanish].

MSPAS-INE-ICF, 2017. Encuesta Nacional de Salud Materno Infantil 2014-2015: Informe Final. Ministerio de Salud Publica y Asistencia Social (MSPAS), Instituto Nacional de Estadistica (INE), and ICF International. Guatemala: Ciudad de Guatemala [In Spanish].

Murphy, S.P., Allen, L.H., 2003. Nutritional importance of animal source foods. The Journal of Nutrition 133(11): 3932S-3935S.

Nchanji, E.B., Lutomia, C.K., Chirwa, R., Templer, N., Rubyogo, J. C., Onyango, P., 2021. Immediate impacts of COVID-19 pandemic on bean value chain in selected countries in sub-Saharan Africa. *Agricultural Systems* 188 (2021): 103034.

Randell, H., Jiang, C., Liang, X.Z., Murtugudde, R., Sapkota, A., 2021. Food insecurity and compound environmental shocks in Nepal: Implications for a changing climate. *World Development* 145: p.105511.

Rawal, V., Kumar, M., Verma, A., Pais, J., 2020. COVID-19 lockdown: Impact on agriculture and rural economy. *Society for Social and Economic Research* 13(2): 34.

Sanchez, G., Achilli, L., 2020. Stranded: the impacts of COVID-19 on irregular migration and migrant smuggling. Policy Briefs 2020/20, Migration Policy Centre.

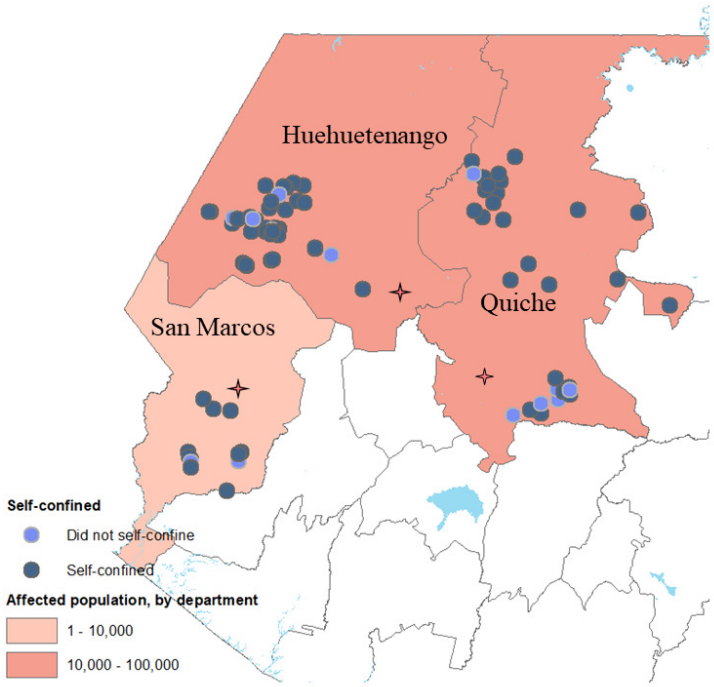
Skoufias, E., Vinha, K., 2012. Climate variability and child height in rural Mexico. Economics & Human Biology 10(1): 54-73.

Smith, M.D., Wesselbaum, D., 2020. COVID-19, Food Insecurity, and Migration. *The Journal of Nutrition* 150(11): 2855–2858.

Van Hoyweghen, K., Fabry, A., Feyaerts, Wade, I., Maertens, M., 2021. Resilience of global and local value chains to the Covid-19 pandemic: Survey evidence from vegetable value chains in Senegal. *Agricultural Economics* 52(3): 423-440

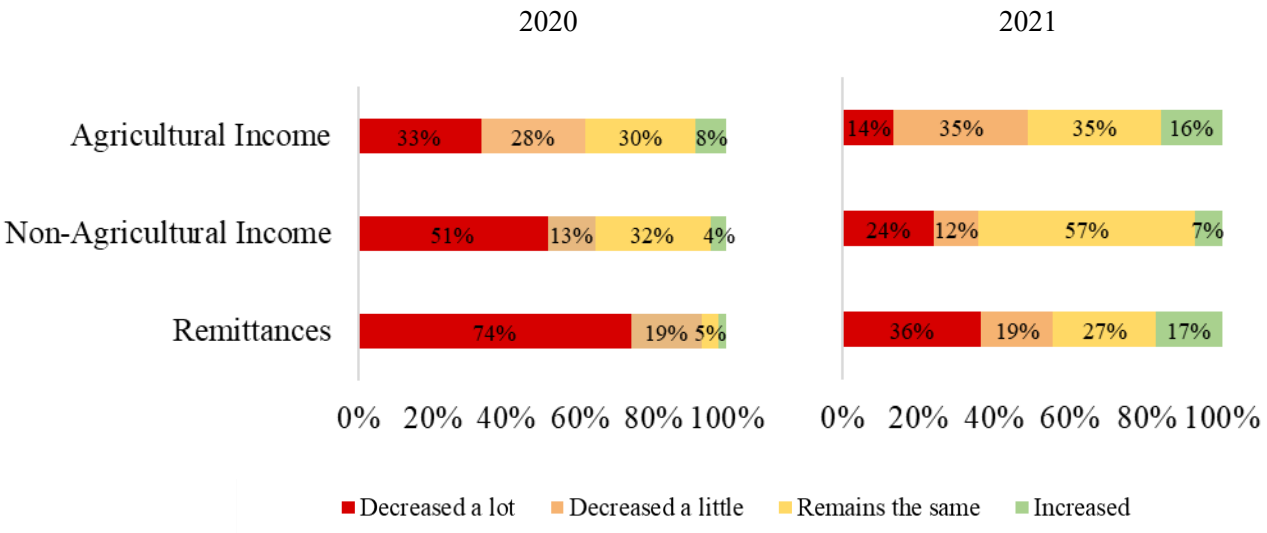
Figures and Tables

Figure 1. Location of sampled communities and exposure to tropical storms



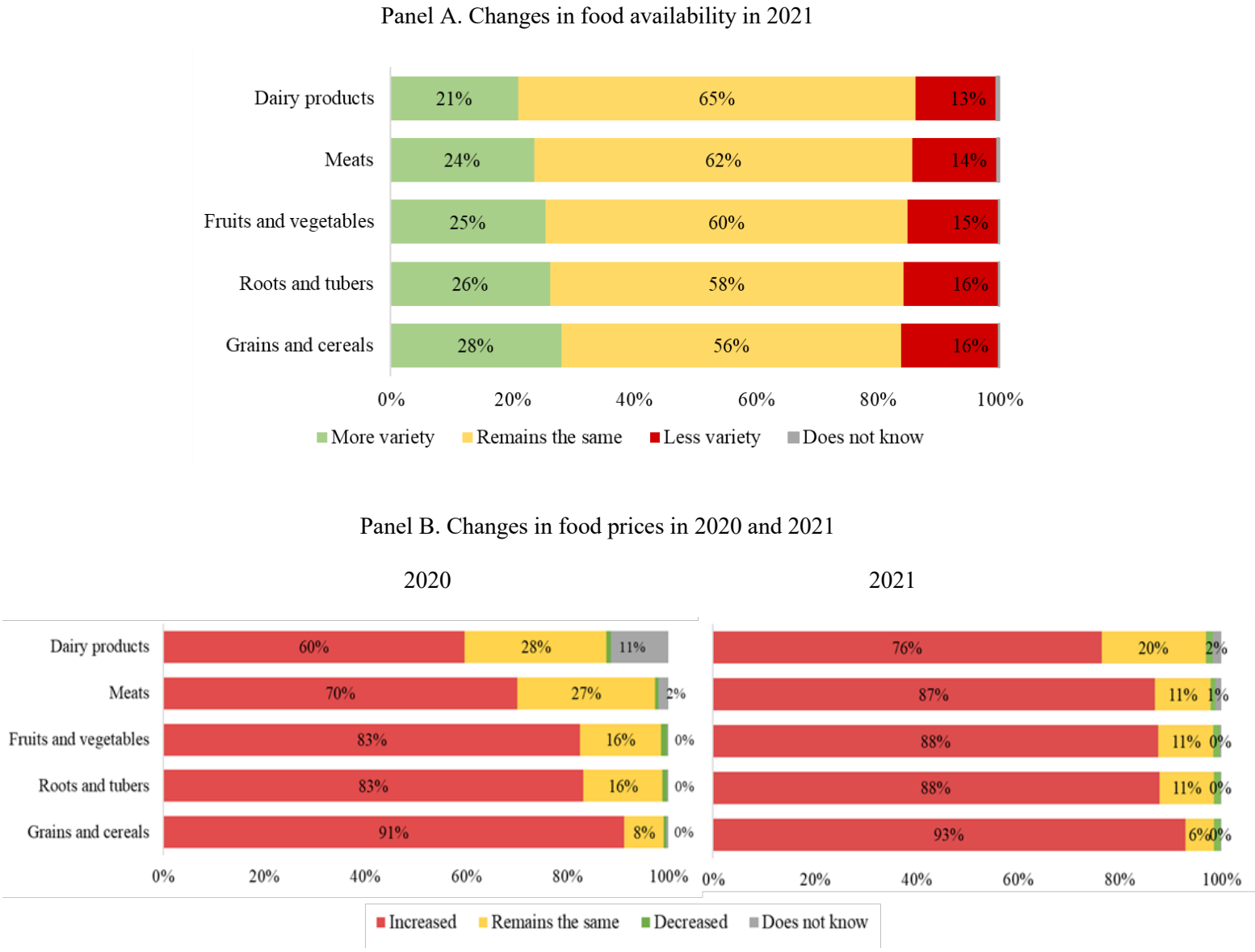
Note: This figure maps the average georeferenced point (circle) of all interviewed households within each sampled community in the panel survey. Communities are distinguished between those that restricted and did not restrict their access at some point during the 12 months prior to the 2021 follow-up survey, as reported by the community leader. The stars are the corresponding department's capital. The color intensity of the departments is based on the extent of the population in each department that was affected by tropical storms ETA and/or IOTA, according to Reliefweb. https://reliefweb.int/map/honduras/central-america-hurricanes-eta-and-iota-honduras-and-guatemala-affected-population (accessed on April 2022).

Figure 2. Reported changes in income sources (relative to 2019)



Note: This figure shows the percentage of interviewed households that reported changes by income source in 2020 and 2021 with respect to 2019. The total number of observations is 1,612 households for agricultural and non-agricultural income and 508 and 454 households, respectively, in 2020 and 2021, for income from remittances. Answer categories in the questionnaire were symmetric, with households being able to declare that their income had increased either a lot or a little; however, these are lumped together into a single "Increased" category for clarity of exposition.

Figure 3. Reported changes in food availability and prices (relative to 2019)



Note: Panel A shows the percentage of households that reported changes in food availability by group at their local market in 2021 (relative to 2019). Panel B shows the percentage of households that reported increases in food prices by group at their local market in 2020 and 2021 (relative to 2019). Answer categories in the questionnaires were: increased, decreased, remains the same, or doesn't know; the figure only shows the "Increased" category for clarity of exposition. The values in both panels are based on the sample of 1,612 households.

Table 1. Household characteristics

Variable	Mean	Standard Deviation	Min	Max
Panel A: Baseline characteristics (2019)				
Household head is male	0.841	0.366	0.000	1.000
Household head age	47.928	13.995	16.000	94.000
Household head has no education	0.362	0.481	0.000	1.000
Household head did not complete elementary education	0.307	0.461	0.000	1.000
Household head completed elementary education or above	0.331	0.471	0.000	1.000
household head's main spoken language is Spanish	0.301	0.459	0.000	1.000
Household size	5.788	2.670	1.000	18.000
Household is beneficiary of social school program	0.275	0.447	0.000	1.000
Dwelling has finished walls	0.465	0.499	0.000	1.000
Dwelling has finished ceiling	0.137	0.344	0.000	1.000
Dwelling has finished floors	0.546	0.498	0.000	1.000
Dwelling is connected to electricity	0.849	0.359	0.000	1.000
Dwelling is connected to water system	0.850	0.357	0.000	1.000
Dwelling is connected to drainage network	0.300	0.458	0.000	1.000
Cooking fuel of household is electricity or gas	0.033	0.178	0.000	1.000
Daily per capita expenditures (in quetzales)	11.523	12.829	0.167	108.972
Household owns a TV or radio	0.732	0.443	0.000	1.000
Household owns a vehicle	0.242	0.428	0.000	1.000
Household owns livestock	0.574	0.495	0.000	1.000
Agricultural land size (in hectares)	0.883	1.392	0.003	21.840
Agricultural land has irrigation system	0.146	0.354	0.000	1.000
Coffee is among main crops produced	0.804	0.397	0.000	1.000
Cardamom is among main crops produced	0.120	0.325	0.000	1.000
Corn is among main crops produced	0.464	0.499	0.000	1.000
Beans is among main crops produced	0.171	0.377	0.000	1.000
Household had an internal migrant in the last 3 years	0.040	0.195	0.000	1.000
Household is beneficiary of Value Chains Project	0.460	0.499	0.000	1.000
Household is located in Huehuetenango	0.566	0.496	0.000	1.000
Household is located in Quiche	0.308	0.462	0.000	1.000
Household is located in San Marcos	0.126	0.332	0.000	1.000
Panel B: Exposure to weather shocks and community closure				
Household was affected by tropical storms Eta/Iota	0.423	0.494	0.000	1.000
Community closed in past 12 months (as reported by leader)	0.896	0.306	0.000	1.000
Observations				1,612

Note: The table shows summary statistics for different household characteristics collected during the baseline survey in 2019 in Panel A, and for indicator variables for whether the household was affected by tropical storms ETA and/or IOTA in November 2020 and for whether the community where the household is located closed (as reported by the leader) during the 12 months prior to the 2021 follow-up survey for Panel B.

Table 2. Mean indicators of food insecurity experiences, dietary diversity indicators, and intention to emigrate

Indicator	(1) 2019	(2) 2020	(3) 2021	(4) Difference 2020-2019 p-value	(5) Difference 2021-2019 p-value
Panel A: Food insecurity experiences					
Mild insecurity	0.569	0.901	0.821	0.000	0.000
	(0.495)	(0.298)	(0.383)		
Moderate insecurity	0.350	0.867	0.573	0.000	0.000
	(0.477)	(0.340)	(0.495)		
Severe insecurity	0.105	0.205	0.225	0.000	0.000
	(0.307)	(0.404)	(0.418)		
Panel B: Dietary diversity indicators					
Dietary Diversity Score (HDDS), scale 0-12	6.817	6.444	6.649	0.000	0.005
	(1.854)	(1.583)	(1.567)		
Animal Source Food (ASF) score, scale 0-7	1.260	0.816	0.855	0.000	0.000
	(1.001)	(0.781)	(0.836)		
Fruits and Vegetables (F&V) score, scale 0-5	2.143	2.517	2.440	0.000	0.000
	(1.455)	(1.339)	(1.417)		
Women Dietary Diversity Score (WDDS), scale 0-9	4.516	4.478	4.571	0.462	0.289
	(1.414)	(1.253)	(1.271)		
Children Dietary Diversity Score (DDS), scale 0-7	3.268	3.893	3.521	0.000	0.074
	(1.636)	(1.217)	(1.494)		
Panel C: Intention to emigrate					
Intention to emigrate over next three years	0.033	0.021	0.096	0.031	0.000
	(0.180)	(0.144)	(0.294)		

Note: This table reports the average and standard deviation (in parentheses) of different outcome variables of interest over the three survey rounds (columns (1) through (3)). Columns (4) and (5) report the p-value from a t-test for equality of means (assuming unequal variances) between the average values reported at baseline (2019) versus 2020 and 2021, respectively. The food insecure experiences reported in Panel A correspond to situations experienced over the months prior to the survey and are part of the eight Food Insecurity Experience Scale (FIES) items proposed by Ballard et al. (2013). The HDDS, ASF, and F&V scores reported in Panel B measure the number of food groups that a reference household member consumed over the previous 24 hours to the interview. The WDDS and children DDS measure the number of food groups that a selected woman 15-49 years old and a child 6-23 months old in the household consumed over the previous 24 hours to the survey. See the main text for the food groups comprised in each score. Panel C reports whether a household member has the intention to emigrate over the next three years. All reported indicators are based on the 1,612 households surveyed in the three rounds, except for WDDS and children DDS. The number of surveyed households with women are based on 1,345 for the three rounds; the number of households with children equals 280 in 2019, 206 in 2020, and 213 in 2021.

Table 3. Food insecure experiences, dietary diversity indicators, and intention to emigrate and household characteristics

Coefficient	(1)	(2)	(3)	(4)	(5)
	Dependent variable:				
	Moderate or severe food insecurity	HDDS (scale 0-12)	ASF score (scale 0-7)	F&V score (scale 0-5)	Intention to emigrate
2020 survey round	0.511***	-0.373***	-0.444***	0.374***	-0.012
	(0.028)	(0.117)	(0.060)	(0.091)	(0.008)
2021 survey round	0.215***	-0.168*	-0.405***	0.297***	0.062***
	(0.052)	(0.093)	(0.053)	(0.105)	(0.017)
Household head is male	-0.012	0.010	0.034	-0.025	0.002
	(0.016)	(0.063)	(0.030)	(0.056)	(0.010)
Household head age	0.000	-0.008***	-0.004***	-0.004**	-0.001***
	(0.001)	(0.003)	(0.001)	(0.002)	(0.000)
Household head did not complete elementary education	-0.002	0.110**	0.035	0.079	-0.001
	(0.014)	(0.051)	(0.027)	(0.049)	(0.009)
Household head completed elementary education or above	0.013	0.137**	0.064**	0.099	0.014
	(0.016)	(0.062)	(0.032)	(0.067)	(0.011)
Household head's main spoken language is Spanish	-0.046*	0.386**	0.266***	0.004	-0.021
	(0.025)	(0.155)	(0.072)	(0.110)	(0.017)
Household size	0.001	-0.006	-0.004	0.013*	0.005***
	(0.003)	(0.011)	(0.006)	(0.008)	(0.002)
Household is beneficiary of social school program	0.011	0.133**	0.029	0.053	-0.003
	(0.014)	(0.065)	(0.030)	(0.058)	(0.008)
Dwelling has finished walls	-0.023	0.093	0.095***	-0.014	0.006
	(0.016)	(0.062)	(0.031)	(0.051)	(0.009)
Dwelling has finished ceiling	-0.047***	-0.072	0.045	0.036	-0.011
	(0.018)	(0.074)	(0.036)	(0.071)	(0.012)
Dwelling has finished floors	-0.029**	0.083	0.028	-0.025	0.007
	(0.013)	(0.065)	(0.028)	(0.053)	(0.010)
Dwelling is connected to electricity	-0.035*	0.192**	0.042	-0.018	-0.013
	(0.021)	(0.086)	(0.052)	(0.073)	(0.009)
Dwelling is connected to water system	0.029	-0.006	-0.023	0.146*	0.007
	(0.024)	(0.077)	(0.041)	(0.081)	(0.013)
Dwelling is connected to drainage network	-0.007	-0.008	0.037	0.022	0.011
	(0.017)	(0.066)	(0.036)	(0.059)	(0.012)
Cooking fuel of household is electricity or gas	-0.082***	0.065	0.096	0.037	-0.032**
	(0.028)	(0.136)	(0.080)	(0.100)	(0.016)
Tertile 2 of per capita household expenditure	-0.012	0.168**	0.100***	0.069	0.005
	(0.017)	(0.065)	(0.037)	(0.052)	(0.009)
Tertile 3 of per capita household expenditure	-0.028	0.328***	0.190***	0.132**	0.014
	(0.021)	(0.082)	(0.041)	(0.066)	(0.010)

(Cont.)

Coefficient	(1)	(2)	(3)	(4)	(5)
	Dependent variable:				
	Moderate or severe food insecurity	HDDS (scale 0-12)	ASF score (scale 0-7)	F&V score (scale 0-5)	Intention to emigrate
Household owns a TV or radio	-0.002	0.123**	0.073**	0.035	0.010
	(0.015)	(0.058)	(0.030)	(0.045)	(0.009)
Household owns a vehicle	-0.037**	0.216***	0.132***	0.077	-0.007
	(0.018)	(0.071)	(0.030)	(0.065)	(0.010)
Household owns livestock	0.004	0.040	0.004	-0.002	-0.006
	(0.016)	(0.059)	(0.033)	(0.052)	(0.009)
Agricultural land size (in logs)	-0.018***	0.081***	0.036**	0.039	0.000
	(0.007)	(0.031)	(0.015)	(0.026)	(0.004)
Agricultural land has irrigation system	-0.010	0.136	0.043	0.075	0.014
	(0.020)	(0.084)	(0.041)	(0.059)	(0.011)
Coffee is among main crops produced	0.005	0.128	0.051	-0.005	-0.008
	(0.034)	(0.116)	(0.048)	(0.089)	(0.016)
Cardamom is among main crops produced	-0.030	0.037	0.068*	-0.158**	0.013
	(0.019)	(0.079)	(0.037)	(0.074)	(0.012)
Corn is among main crops produced	0.039***	-0.149**	-0.029	-0.086	0.003
	(0.015)	(0.068)	(0.032)	(0.058)	(0.008)
Beans is among main crops produced	0.005	0.012	-0.030	-0.022	0.004
	(0.020)	(0.062)	(0.032)	(0.065)	(0.009)
Household had an internal migrant in the last 3 years	0.004	0.038	0.017	0.026	0.002
	(0.028)	(0.104)	(0.049)	(0.094)	(0.016)
Constant	0.174***	7.847***	1.489***	2.471***	0.014
	(0.065)	(0.248)	(0.129)	(0.207)	(0.031)
Community fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	4,836	4,836	4,836	4,836	4,836
Overall R-squared	0.305	0.236	0.320	0.111	0.069

Note: The table reports generalized least squared (GLS) random effects estimations for each dependent variable against a set of household characteristics. See the main text for a detailed description of dependent (outcome) variable modeled in each column. The household characteristics are measured at baseline (2019) and all regressions include community fixed effects. The excluded (base) category for education is No education. Robust standard errors, clustered by community, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4. Changes in food insecure experiences, dietary diversity indicators, and intention to emigrate and direct exposure to COVID-19

Coefficient	(1)	(2)	(3)	(4)	(5)
	Dependent variable:				
	Moderate or severe food insecurity	HDDS (scale 0-12)	ASF score (scale 0-7)	F&V score (scale 0-5)	Intention to emigrate
	Panel A: Percentage of COVID-19 infections at community level				
2020 survey round	0.511***	-0.373***	-0.444***	0.374***	-0.012
	(0.028)	(0.117)	(0.060)	(0.091)	(0.008)
2021 survey round	0.207***	-0.146	-0.390***	0.314***	0.060***
	(0.058)	(0.098)	(0.056)	(0.114)	(0.018)
2021 round x % COVID-19 infections	0.020	-0.058*	-0.040	-0.047	0.005
	(0.033)	(0.035)	(0.029)	(0.088)	(0.014)
Overall R-squared	0.306	0.236	0.321	0.111	0.069
	Panel B: Rate of COVID-19 infections at municipality level				
2020 survey round	0.511***	-0.373***	-0.444***	0.374***	-0.012
	(0.028)	(0.117)	(0.060)	(0.091)	(0.008)
2021 survey round	0.300***	-0.212**	-0.413***	0.439***	0.055**
	(0.062)	(0.103)	(0.053)	(0.129)	(0.021)
2021 round x Rate of COVID-19 infections	-0.064**	0.033	0.006	-0.107**	0.005
	(0.026)	(0.029)	(0.018)	(0.044)	(0.009)
Overall R-squared	0.308	0.236	0.320	0.111	0.069
Household characteristics	Yes	Yes	Yes	Yes	Yes
Community fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	4,836	4,836	4,836	4,836	4,836

Note: The table reports generalized least squared (GLS) random effects estimations for each dependent variable against different indicator measures of direct exposure to COVID-19 and a set of household characteristics. See the main text for a detailed description of the dependent (outcome) variable modeled in each column. The percentage of COVID-19 infections at the community level reported in Panel A correspond to the number of cases over the 12 months prior to the 2021 follow-up survey reported by the community leader, divided by the number of people in the community. The rate of COVID-19 infections at the municipality level reported in Panel B corresponds to the official total number cases and deaths between July 2020 and June 2021 reported by the Ministry of Health in Guatemala (MSPAS, 2021), normalized by the number of people in the municipality according to the last Population Census of 2018 (INE, 2020). The household characteristics are measured at baseline (2019) and all regressions include community fixed effects. Robust standard errors, clustered by community, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 5. Changes in food insecure experiences, dietary diversity indicators, and intention to emigrate and degree of local mobility restrictions

Coefficient	(1)	(2)	(3)	(4)	(5)
	Dependent variable:				
	Moderate or severe food insecurity	HDDS (scale 0-12)	ASF score (scale 0-7)	F&V score (scale 0-5)	Intention to emigrate
2020 survey round	0.511***	-0.373***	-0.444***	0.374***	-0.012
	(0.028)	(0.117)	(0.060)	(0.091)	(0.008)
2021 survey round	0.305***	-0.164	-0.454***	0.086	0.035*
	(0.072)	(0.115)	(0.065)	(0.123)	(0.021)
2021 round x % Months community closed	-0.003	-0.000	0.002	0.007**	0.001
	(0.002)	(0.003)	(0.001)	(0.003)	(0.001)
Household characteristics	Yes	Yes	Yes	Yes	Yes
Community fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	4,836	4,836	4,836	4,836	4,836
Overall R-squared	0.310	0.236	0.321	0.114	0.071

Note: The table reports generalized least squared (GLS) random effects estimations for each dependent variable against an indicator variable for the degree of mobility restrictions and a set of household characteristics. See the main text for a detailed description of the dependent (outcome) variable modeled in each column. The percentage of months the community closed is based on the number of months reported by the community leader over the 12 months prior to the 2021 follow-up survey. The household characteristics are measured at baseline (2019) and all regressions include community fixed effects. Robust standard errors, clustered by community, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 6. Changes in food insecure experiences, dietary diversity indicators, and intention to emigrate and supply disruptions or income shocks

Coefficient	(1)	(2)	(3)	(4)	(5)
	Dependent variable:				
	Moderate or severe food insecurity	HDDS (scale 0-12)	ASF score (scale 0-7)	F&V score (scale 0-5)	Intention to emigrate
	Panel A: Disruptions in local food markets				
2020 survey round	0.511***	-0.373***	-0.444***	0.374***	-0.012
	(0.028)	(0.117)	(0.060)	(0.091)	(0.008)
2021 survey round	0.184	-0.930**	-0.529***	-0.293	-0.051
	(0.138)	(0.375)	(0.132)	(0.421)	(0.039)
2021 round x Decrease in food availability (index 0-5)	-0.083**	0.061	0.056*	0.053	0.008
	(0.042)	(0.086)	(0.033)	(0.058)	(0.011)
2021 round x Increase in food prices (index 0-5)	0.012	0.155*	0.022	0.119	0.023**
	(0.035)	(0.080)	(0.031)	(0.095)	(0.011)
Overall R-squared	0.313	0.237	0.321	0.112	0.070
	Panel B: Demand shocks				
2020 survey round	0.511***	-0.373***	-0.444***	0.374***	-0.012
	(0.028)	(0.117)	(0.060)	(0.091)	(0.008)
2021 survey round	0.237***	-0.052	-0.361***	0.597***	0.032*
	(0.061)	(0.111)	(0.061)	(0.111)	(0.018)
Unambiguous decrease in total income	0.021	-0.020	-0.009	0.102	-0.011
	(0.019)	(0.060)	(0.031)	(0.064)	(0.008)
Household member lost job permanently	0.030	-0.058	-0.051	-0.008	0.048*
	(0.038)	(0.150)	(0.056)	(0.094)	(0.027)
2021 round x Unambiguous decrease in total income	-0.037	-0.196*	-0.084*	-0.473***	0.049***
	(0.044)	(0.101)	(0.043)	(0.109)	(0.017)
2021 round x Household member lost job permanently	-0.002	-0.027	0.083	-0.415***	0.017
	(0.101)	(0.167)	(0.073)	(0.158)	(0.054)
Overall R-squared	0.306	0.237	0.321	0.119	0.074
Household characteristics	Yes	Yes	Yes	Yes	Yes
Community fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	4,836	4,836	4,836	4,836	4,836

Note: The table reports generalized least squared (GLS) random effects estimations for each dependent variable against different indicator variables for supply disruptions and income shocks and a set of household characteristics. See the main text for a detailed description of the dependent (outcome) variable modeled in each column. In panel A, the decrease in food availability and increase in food prices indexes are the corresponding indexes for the median household in each community; the indexes range from 0-5 as each household is asked to report if there was a decrease in availability or price increase across five food groups (dairy products, meats, F&V, roots and tubers, and grains and cereals) over the 12 months prior to the 2021 follow-up survey. In panel B, the indicator variable for an unambiguous decrease in income identifies those households that reported a decrease in one or more of their three main income sources but no increases in 2021 (relative to 2019), while the indicator for a permanent job loss identifies those households where at least one member lost their job or closed their business permanently during the 12 months prior to the 2021 follow-up survey. The household characteristics are measured at baseline (2019) and all regressions include community fixed effects. Robust standard errors, clustered by community, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

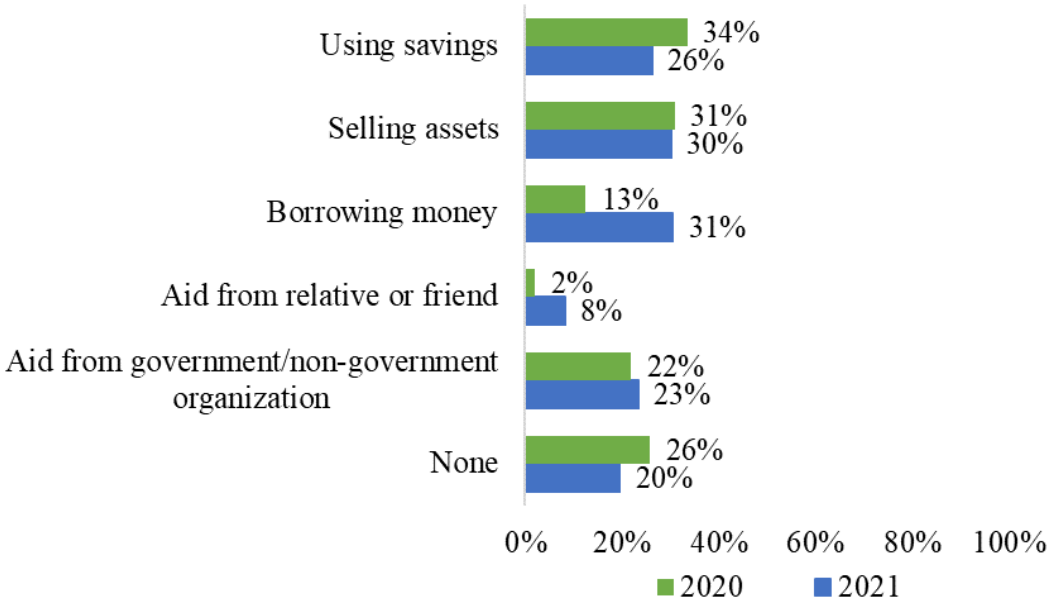
Table 7. Changes in food insecure experiences, dietary diversity indicators, and intention to emigrate and exposure to extreme weather

Coefficient	(1)	(2)	(3)	(4)	(5)
	Dependent variable:				
	Moderate or severe food insecurity	HDDS (scale 0-12)	ASF score (scale 0-7)	F&V score (scale 0-5)	Intention to emigrate
2020 survey round	0.511***	-0.373***	-0.444***	0.374***	-0.012
	(0.028)	(0.117)	(0.060)	(0.091)	(0.008)
2021 survey round	0.117*	-0.093	-0.351***	0.351***	0.048***
	(0.065)	(0.088)	(0.061)	(0.100)	(0.018)
Affected by tropical storms	-0.021	0.039	0.035	0.070	-0.012
	(0.022)	(0.070)	(0.034)	(0.062)	(0.008)
2021 round x Affected by tropical storms	0.231***	-0.178*	-0.128**	-0.129	0.034
	(0.056)	(0.108)	(0.054)	(0.132)	(0.023)
Household characteristics	Yes	Yes	Yes	Yes	Yes
Community fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	4,836	4,836	4,836	4,836	4,836
Overall R-squared	0.319	0.236	0.321	0.111	0.070

Note: The table reports generalized least squared (GLS) random effects estimations for each dependent variable against an indicator variable for exposure to tropical storms and a set of household characteristics. See the main text for a detailed description of the dependent (outcome) variable modeled in each column. The indicator variable for affected by tropical storms identifies those household that reported being affected by ETA and/or IOTA in November 2020. The household characteristics are measured at baseline (2019) and all regressions include community fixed effects. Robust standard errors, clustered by community, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

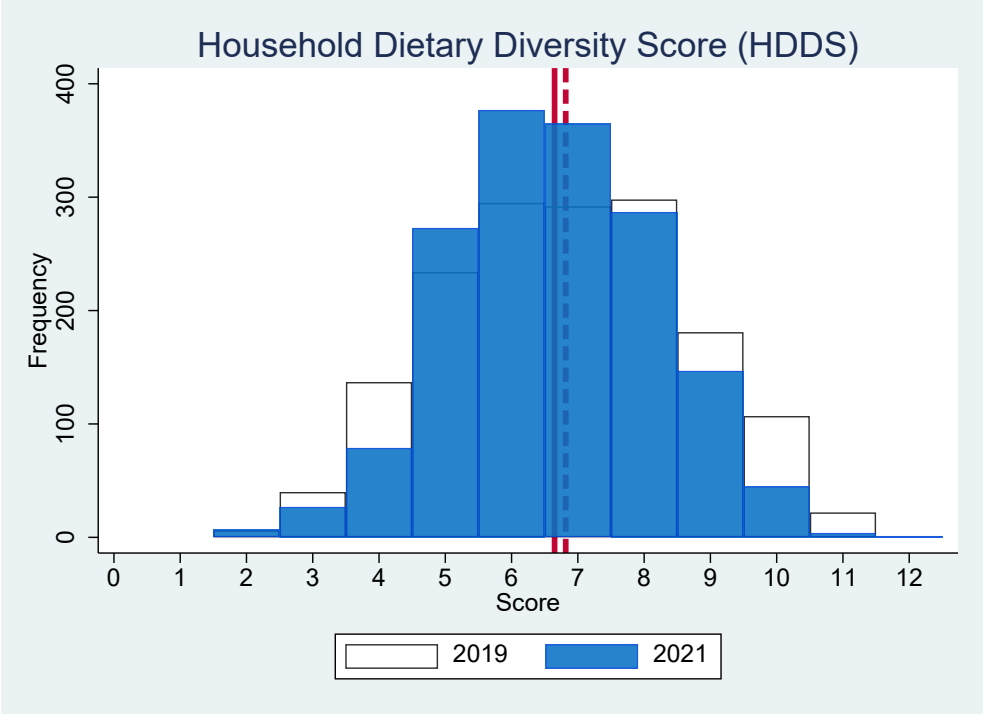
Appendix. Supplementary Figures and Tables

Figure A.1. Coping mechanisms for income losses



Note: This figure shows the percentage of households that reported using different coping mechanisms (multiple choice answers) due to a decrease in their total household income. The values are based on the sample of 1,118 and 946 households that reported an unambiguous decrease in total income in 2020 and 2021, respectively.

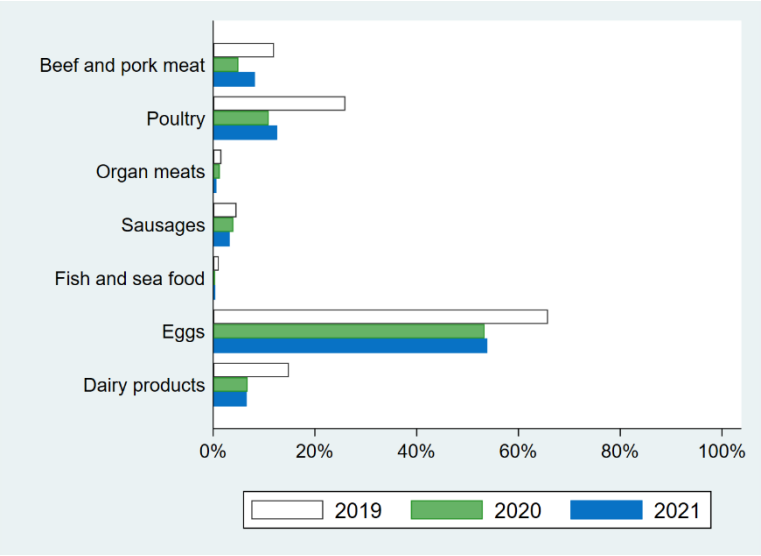
Figure A.2. Distribution of household dietary diversity score



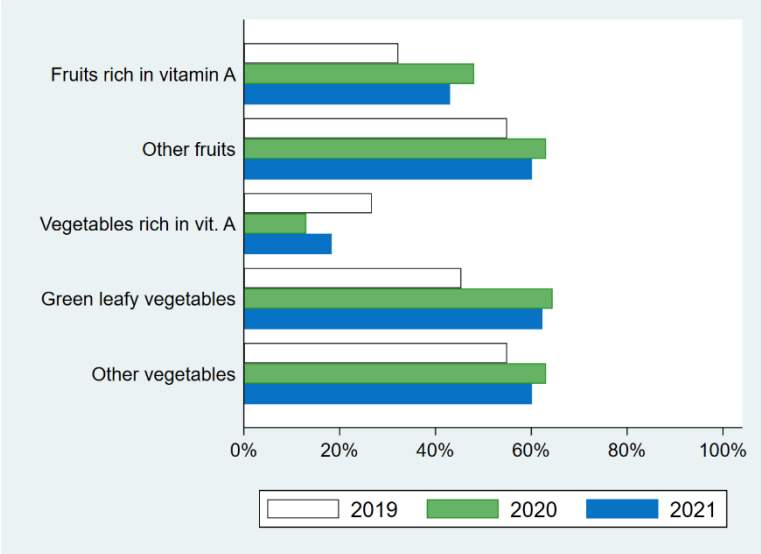
Note: This figure shows the distribution of the HDDS in 2019 and 2021 for the 1,612 surveyed households. The white histogram bars correspond to 2019 and the blue bars to 2021. The vertical dotted red line on the figure indicates the average score in 2019 while the solid red line indicates the average score in 2021. This dietary diversity score measures the number of food groups (up to twelve) that a reference member of the household consumed over the previous 24 hours in each survey. See the main text for the groups comprised in the score.

Figure A.3. Household consumption of animal source foods and fruits & vegetables

Panel A: Animal Source Food (ASF) consumption

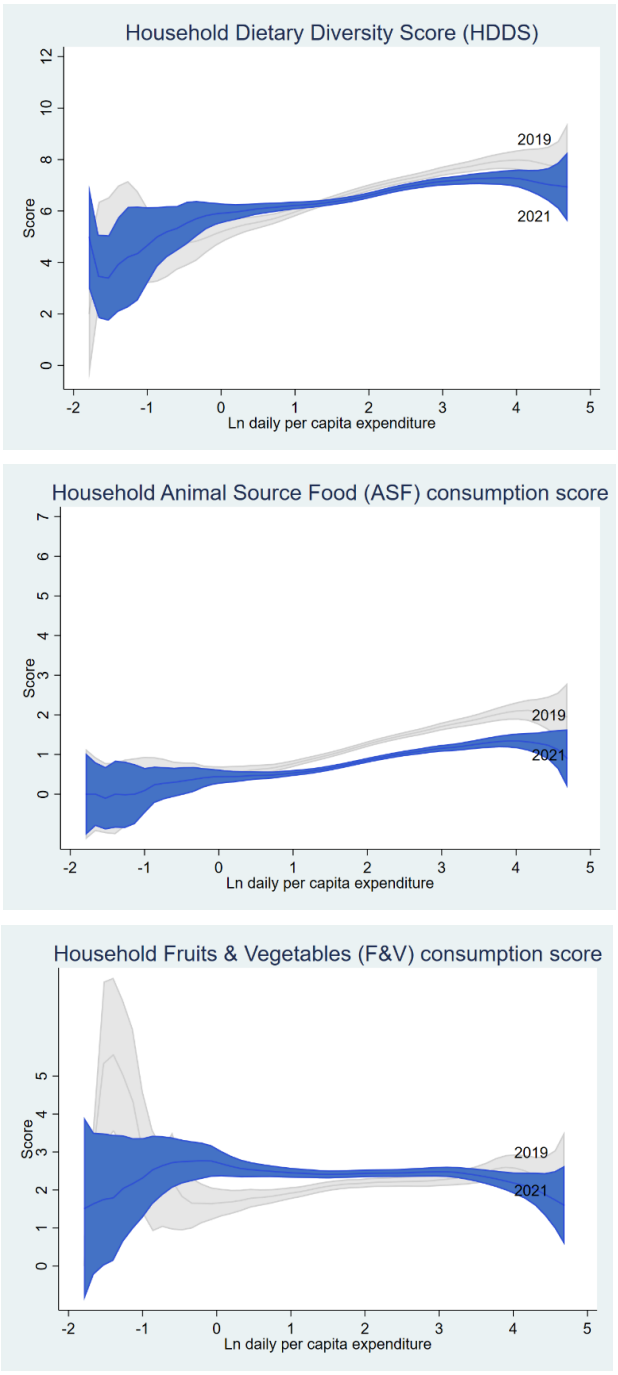


Panel B: Fruits & Vegetables (F&V) consumption



Note: This figure shows the percentage of households reporting having consumed the corresponding animal source food (ASF) groups in Panel A and fruits and vegetables (F&V) groups in Panel B over the previous 24 hours of each survey. The white bars correspond to 2019, the green bars to 2020, and the blue bars to 2021. The values in both panels are based on the sample of 1,612 households.

Figure A.4. Local polynomial plots of household dietary diversity indicators by income level, 2019 versus 2021



Note: This figure shows local polynomial plots between the HDDS, ASF, and V&F scores and the natural logarithm of per capita daily expenditures (measured at baseline) for 2019 and 2021 across the 1,612 surveyed households. The local polynomial plots are derived using an Epanechnikov kernel, standard rule-of-thumb bandwidth, and assume a polynomial of degree two. The shaded areas represent the 95% confidence bands. These dietary diversity scores measure the number of food groups that a reference member of the household consumed over the previous 24 hours for each survey. See the main text for the groups comprised in each of the scores.

Table A.1. Orthogonality tests between households in the baseline and working samples

Characteristics at baseline (2019)	Households surveyed at baseline	Households surveyed across the three years	p-value
Household head is male	0.830	0.841	0.032
	(0.013)	(0.013)	
Household head age	47.591	47.928	0.215
	(0.892)	(0.935)	
Household head has no education	0.357	0.362	0.521
	(0.031)	(0.030)	
Household head did not complete elementary education	0.312	0.307	0.505
	(0.030)	(0.031)	
Household head completed elementary education or above	0.331	0.331	0.958
	(0.028)	(0.029)	
Household head main language spoken is Spanish	0.303	0.301	0.868
	(0.071)	(0.072)	
Household size	5.772	5.788	0.623
	(0.158)	(0.161)	
Household is beneficiary of social school program	0.275	0.275	0.934
	(0.032)	(0.038)	
Dwelling has finished walls	0.467	0.465	0.864
	(0.046)	(0.047)	
Dwelling has finished ceiling	0.141	0.137	0.573
	(0.021)	(0.022)	
Dwelling has finished floors	0.546	0.546	0.984
	(0.044)	(0.045)	
Dwelling is connected to electricity	0.831	0.849	0.426
	(0.055)	(0.039)	
Dwelling is connected to water system	0.852	0.850	0.670
	(0.034)	(0.036)	
Dwelling is connected to drainage network	0.302	0.300	0.859
	(0.050)	(0.050)	
Cooking fuel of household is electricity or gas	0.033	0.033	0.937
	(0.007)	(0.007)	
Daily per capita expenditures (in quetzales)	11.594	11.523	0.758
	(1.075)	(1.207)	
Household owns a TV or radio	0.741	0.732	0.185
	(0.036)	(0.040)	
Household owns a vehicle	0.238	0.242	0.621
	(0.035)	(0.040)	
Household owns livestock	0.568	0.574	0.389
	(0.044)	(0.042)	
Agricultural land size (in hectares)	0.943	0.883	0.117
	(0.153)	(0.133)	
Agricultural land has irrigation system	0.141	0.146	0.256
	(0.031)	(0.032)	

(Cont.)

Characteristics at baseline (2019)	Households surveyed at baseline	Households surveyed across the three years	p-value
Coffee among main crop produced	0.780	0.804	0.218
	(0.079)	(0.067)	
Cardamom among main crop produced	0.141	0.120	0.373
	(0.083)	(0.073)	
Corn among main crop produced	0.479	0.464	0.285
	(0.064)	(0.061)	
Beans among main crop produced	0.177	0.171	0.442
	(0.042)	(0.037)	
Household had an internal migrant in the last 3 years	0.038	0.040	0.344
	(0.010)	(0.011)	
Household is beneficiary of Value Chains Project	0.423	0.460	0.022
	(0.152)	(0.159)	
Observations	2,142	1,612	

Note: This table reports the results of the orthogonality (balance) test of baseline characteristics between households included in the baseline sample (2,142 households interviewed in 2019) and households included in our working sample (1,612 households interviewed in 2019, 2020, and 2021). The first two columns report the corresponding averages and standard errors clustered by community in parentheses. The p-value reported in the third column results from the orthogonality test between the two household groups.

ALL IFPRI DISCUSSION PAPERS

All discussion papers are available **here**

They can be downloaded free of charge

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
www.ifpri.org

IFPRI HEADQUARTERS
1201 Eye Street, NW
Washington, DC 20005 USA
Tel.: +1-202-862-5600
Fax: +1-202-862-5606
Email: ifpri@cgiar.org