Local food system and household responses to external shocks: the case of sustainable coffee farmers and their cooperatives in Western Honduras during COVID-19

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Introduction: The COVID-19 pandemic lockdowns (people confined to home, with movement restrictions) presented an external shock to livelihoods and food systems worldwide, most severely affecting vulnerable households in low-income countries. While evidence is available regarding how COVID-19 generally affected low-income countries, the specific dynamics of local food-system responses and sustainably-certified coffee farm households has not been examined, despite them being usually deemed to be more resilient to shocks. This research examines how local food systems in Honduras changed during lockdowns, how certified coffee households coped with the shock, especially food insecurity, and the potential role of coffee cooperatives in increasing households' resilience under future shocks and stressors.

Methods: We applied a mixed-methods approach that combined a structured household survey with semi-structured qualitative interviews with 91 households, 6 cooperative representatives, and 18 food-system representatives.

Results: We found that coffee-income-dependent households experienced greater food insecurity during lockdown than coffee households with diversified incomes. Before lockdown the local food system was highly dependent on external fresh food from outside the state. Food suppliers changed altered fresh-food procurement strategies, mostly to maintain fresh-food availability at the beginning of the pandemic. However, more than half the interviewed households lacked confidence regarding food security, amid rising food prices and local shortages. Certified coffee cooperatives supported their members by providing food assistance, cash transfers, and credit.

Discussion: Some of these strategies are difficult to maintain where crises are recurrent and that may render households more vulnerable to future extreme events. Rather, coffee cooperatives could diversify and support their members in growing and marketing additional food crops. This could be a key approach for boosting local food security and strengthening the local food system.

KEYWORDS

food security, local food systems, resilience capacity, farming households, certified
farmers

1 Introduction

COVID-19 was the first pandemic over the last century necessitating extreme governmental measures worldwide to reduce its spread. The World Health Organization (WHO) recommended mobility restrictions to reduce the spread of infection during the first wave of COVID-19. These mobility restrictions were introduced in low income countries without any preparation, disrupting food systems, reducing income and employment, and further weakening economies across the world (Swinnen and Vos, 2021).

Evidence regarding how COVID-19 affected food security during and after the lockdown period is growing (Béné, 2020) and is portraying the deficiencies of the current food systems in many countries (Gliessman, 2020). For instance, households in low income countries experienced shocks during the lockdown due to less labor demand and increasing food costs (Béné, 2020). This led to declining household incomes, which affected households' capacity to access food (Erokhin and Gao, 2020; Laborde et al., 2021). Other examples include studies reporting reductions in rural households' access to food (fruit and animal-based foods), and reductions in prices, sales, and incomes for farmers (Harris et al., 2020). Changes in food costs also affected the quality of vegetable consumption from Europe, Asia, Africa, Latin America, and the Caribbean (Jordan et al., 2021). In addition, evidence has emerged regarding supply-chain responses to confront lockdowns. For example, shortening food supply chains between production and consumers was a Central America's strategy to maintain food supply in local communities (Lopez-Ridaura et al., 2021; Tittonell et al., 2021).

Limited attention has been paid to how coffee farming households were affected during the first wave of COVID-19 and responded to this extreme event. In Peru for instance, coffee farmers used financial strategies such as savings and accessed loans to cover household expenses in response to the COVID-19 crisis (Vargas et al., 2021). Reports of negative impacts of COVID-19 on the national coffee sector for Honduras, i.e., small-coffee farmers had low coffee yields for 2020/21 due to lack of labor during lockdown to fertilize coffee plants after coffee harvest March and April 2020, local coffee-traders and exporters (issues related to exporting logistics) (Rios et al., 2022), also exist in Central America, including Honduras (Fromm, 2022). Likewise, Lara-Arévalo et al. (2023) provides a general overview related to food supply chains disruptions and its impacts on food availability and accessible from COVID-19 lockdowns in Honduras based on secondary information, but without specific focus on coffee grower, the local food system and their changes food security status.

Many factors likely shaped coffee household responses to the pandemic and its impacts. Foremost, being primary producers tended to lessen impacts in most of Mesoamerica due to their own food production and their ability to engage in local markets (Lopez-Ridaura et al., 2021). Households whose incomes relied more heavily on off-farm sources, such as temporary work in construction or on commercial farms, faced more difficulties during the lockdown (Lopez-Ridaura et al., 2021). In general, more diversified farms are more resilient against market and price volatilities than less diversified ones (Anderzén et al., 2020). Also the level of specialization of coffee farmers to access high quality or certified coffee markets can in some instances reduce available household labor for other activities like own food production (Vellema et al., 2015). On the other hand, certified coffee farmers (e.g., Fairtrade or organic) are probably in a stronger position to face external shocks because of their better access to credit as well as benefitting from transparent internal accounting procedures, technical assistance, and capacity-building initiatives compared to non-certified coffee farmers (Beuchelt and Zeller, 2011, 2013). Moreover, Bacon et al. (2014) and Bacon (2015) found that members of certified coffee cooperatives in Nicaragua had access to marketing services for various food crops, including fruits, vegetables, beans, and maize, stressing the link between the certification (here Fairtrade) and improved food security and food sovereignty for coffee farmers. Thus, farmers households' income dependency probably played a key role in terms of their level of vulnerability during the lockdowns.

However, the benefits of certification on well-being of coffee farmers in Central America are not always clear-cut. For instance, Jena et al. (2017) and Estrella et al. (2022) did not find significant differences in total households' incomes from certified (Fairtrade and other certification schemes) and non-certified coffee farms in Nicaragua and Honduras. One possible reason for these discrepancies is that the total amount of certified coffee sold by coffee farmers in Mesoamerica is relatively low due to limited market demand (Méndez et al., 2010; Panhuysen and Pierrot, 2020).

Central America in the past has been repeatedly affected by food insecurity (Alpízar et al., 2020), more recently intensified by seasonal weather fluctuations (inter-annual events) and extreme events such as droughts and storms affect the planting season for beans, maize and vegetables in the region (Harvey et al., 2018). As a consequence, the overall food availability and access decrease, particularly impacting the more vulnerable households in the area (Harvey et al., 2018; FEWSNET, 2023). To better respond to these weather challenges, farmers with certification programs started to adapt and incorporate different agroecological practices such as shade trees and improved soil management for better water retention (Pico-Mendoza et al., 2020; Koutouleas et al., 2022). Agrobiodiversity as a strategy gives shade in the coffee farms for example and, maybe contributes to food security of coffee households (Fernandez and Méndez, 2019). Within this complex landscape, a particular point of interest lies in comprehending the situation of certified coffee farmers and their food security during the COVID-19 lockdowns.

This research seeks to understand for cooperatively organized, coffee producers (a) how the local food system, in which the coffee farmers interact, has changed under COVID-19 mobility restrictions, (b) how this change affected the coffee farming households and their food security situation, (c) what strategies did farmers implement to maintain their food security, and (d) the role coffee cooperatives played in supporting households to increase their food security resilience. Our study specifically concentrated on two certified cooperatives in Western Honduras.

1.1 Conceptual framework

We used a food system approach to better understand the effect of mobility restrictions on household food security. Figure 1 describes the different stepwise activities of the food system (i.e., production, processing, sale, and consumption) and the various actors involved in each step, as defined by the UN Food and Agriculture Organization's (FAO) High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security (CFS) (Ericksen, 2008; HLPE, 2014, 2017; Béné et al., 2016, 2023). The food

system outcomes contributing to food security dimensions such as food access and availability (Ericksen, 2008; Ingram, 2011), and are affected by shocks and stressors (socioeconomic drivers), such as changes in demography or income.

Our definition of food security follows that of the FAO (2006), "*Food security exists when all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.*" We focused on food supply, including local food production, household reserves, and local food markets (availability and access to food). In addition, we included the food insecurity experiences of coffee households to understand the access to food changes before and during the COVID-19 lockdown. The decision to exclude the dimension of food use and stability from our research was influenced by two factors. First, the mobility restriction imposed during the lockdowns limited our ability to explore how households prepared daily meals. Second, the duration of our fieldwork was relatively short, making it challenging to capture the stability of all food security dimensions adequately.
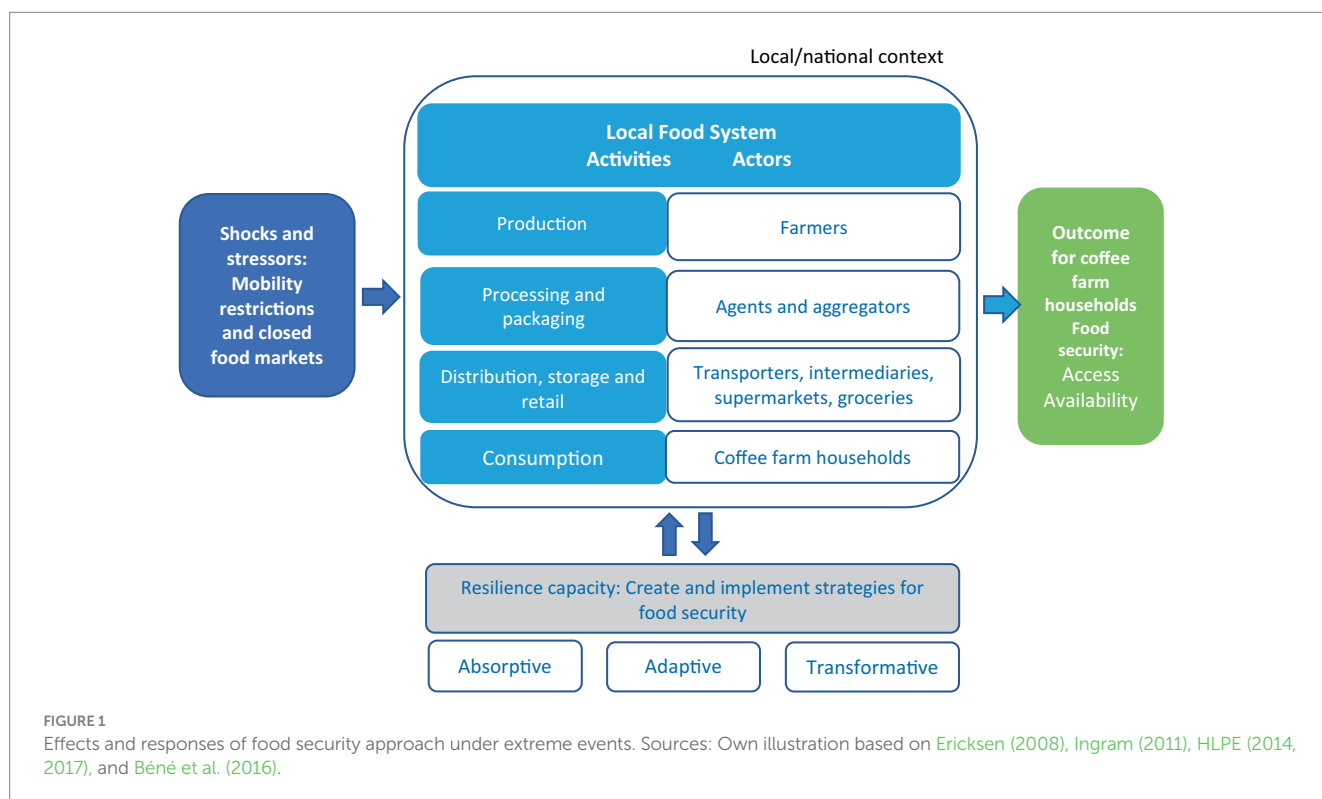
Food systems' resilience capacity refers to their capability to react and implement strategies to increase food security (Béné et al., 2016). The concept of resilience is based on a set of actions and strategies of individuals, households, a community, or a system to confront shocks and stressors. According to the intensity of shocks and stressors, the responses or strategies can be classified as absorptive, adaptive, or transformative (Béné et al., 2012). *Absorptive* capacity refers to individuals, households, and systems that can absorb the negative impacts of mild shocks without compromising livelihoods, positions, or basic needs (Béné et al., 2012; Ansah et al., 2019). *Adaptive* capacity complements absorptive capacity, meaning that individuals and households can increase changes and adaptations through diversification of households' livelihood activities or access to credit when shocks are moderate (Béné et al., 2012). *Transformative* capacity refers to circumstances in which individuals, households, or systems are impacted by stressors and shocks of a catastrophic and permanent nature (Béné et al., 2012). If absorptive and adaptive strategies are insufficient, individuals or households must make substantial lifestyle and livelihood changes to survive under severe shocks or stressors. Therefore, resilience refers to capacity, rather than outcome (Béné et al., 2016).

2 Materials and methods

2.1 Study area

Honduras has a population of nearly 10 million inhabitants of which 48% live below the national poverty line with less than USD 6.85 per person/day in 2019 and 14.6% of the population suffers moderate or severe food insecurity (World Bank, 2020). Our study area was located in Western Honduras, specifically the department of Ocotepeque (Figure 2) with a population of 175,001 inhabitants in 2023 (INE, 2023). The study region has a wide range of elevations, stretching from 800 meters above sea level (m.a.s.l) to 2,400 m.a.s.l. The highlands in the region are part of the Guisayote Forest Reserve, which converges with farmers' vegetable plots and coffee farms. The dry season is between December and February. The dry corridor, is a region with over for dry months per year (i.e., precipitation below 50 mm) (CIAT, 2018). Livelihoods in this region depend on the cultivation of beans, coffee, maize, vegetables, livestock, off-farm labor, and remittances (FEWSNET, 2014). The local economy is highly reliant on coffee, given the concentrated focus of critical services such

FIGURE 1
Effects and responses of food security approach under extreme events. Sources: Own illustration based on Ericksen (2008), Ingram (2011), HLPE (2014, 2017), and Béné et al. (2016).

as input provision, technical assistance, transportation, and banking specifically tailored to coffee cropping (CIAT, 2018). In our study we specifically targeted households engaged in coffee farming, recognizing coffee as the primary livelihood source within this regional context. Notably, the region is characterized by the presence of numerous coffee farms, organized into cooperatives. The central hub for commercial activities, including supermarkets, a diverse array of shops, and the sole public food market, is situated in the city of San Marcos. In contrast, villages generally feature smaller grocery stores, illustrating a nuanced economic landscape.

The two coffee cooperatives in our study are termed Cooperative A (Coop A) and Cooperative B (Coop B), have requested that we maintain their anonymity for this research. Coop A was established in 2000 and operates in a village within the La Labor municipality, while Coop B was founded in 1999 and is situated in a village near the Mercedes municipality. Both cooperatives acquire the coffee cherry produced by their members. Subsequently, they process the coffee cherries, which involves pulping, selecting, and drying the coffee beans. Following this processing phase, the cooperatives sell the dried parchment coffee to coffee roasters in North America and Europe, facilitated by national exporters. Because both cooperatives hold a Fairtrade certification, they offer specific services to their members such as access to credit, capacity building on agronomic practices and the regulated purchase and sale of coffee. Both farmers' cooperatives have the same organizational structure, constituted by a General Assembly, which is composed of all members, a president elected by the General Assembly, and a management team that represents each administrative area (financial/accounting, technical assistance, operations, and support). According to cooperative representatives, Coop A has 63 members and Coop has 61 members, and all of them hold a Fairtrade and/or organic certification.

The studied coffee households are primarily located in a village 11 km from the town of La Labor and in Mercedes, 18 km from the town of San Marcos. The coffee farms are situated between 900 and 1,800 m.a.s.l. and produce a similar coffee quality.

2.2 Selection of stakeholders and data collection

This research uses a mixed-methods approach, combining a structured household survey with semi-structured, qualitative stakeholder interviews with households, representatives of cooperatives, and other food-system actors, and photograph recording and observation. Data collection took place between May and July 2020. The main national curfew was imposed during March 15–31, 2020, and mobility restrictions within municipalities and between municipalities and states were implemented from April 1 to September 2020 (see Figure 3).

Structured household surveys were conducted in two selected cooperatives that agreed to participate in the research despite the circumstances of COVID-19. Ninety-one households were surveyed, including 40 households from Coop A and 51 households from Coop B. The survey was conducted in two parts. First, a more extensive household survey that was conducted in 2019, pre-COVID-19, and a second survey (in 2020) with the two cooperatives and households selected for the survey in 2020 represented a subsampled of 91 households of those surveyed in 2019. Focusing on the same coffee households enabled us to compare the households' food insecurity both pre and during the COVID-19 outbreak.

The survey of 2019 was a randomized household survey including two cooperatives from Honduras and 91 farm households. The two
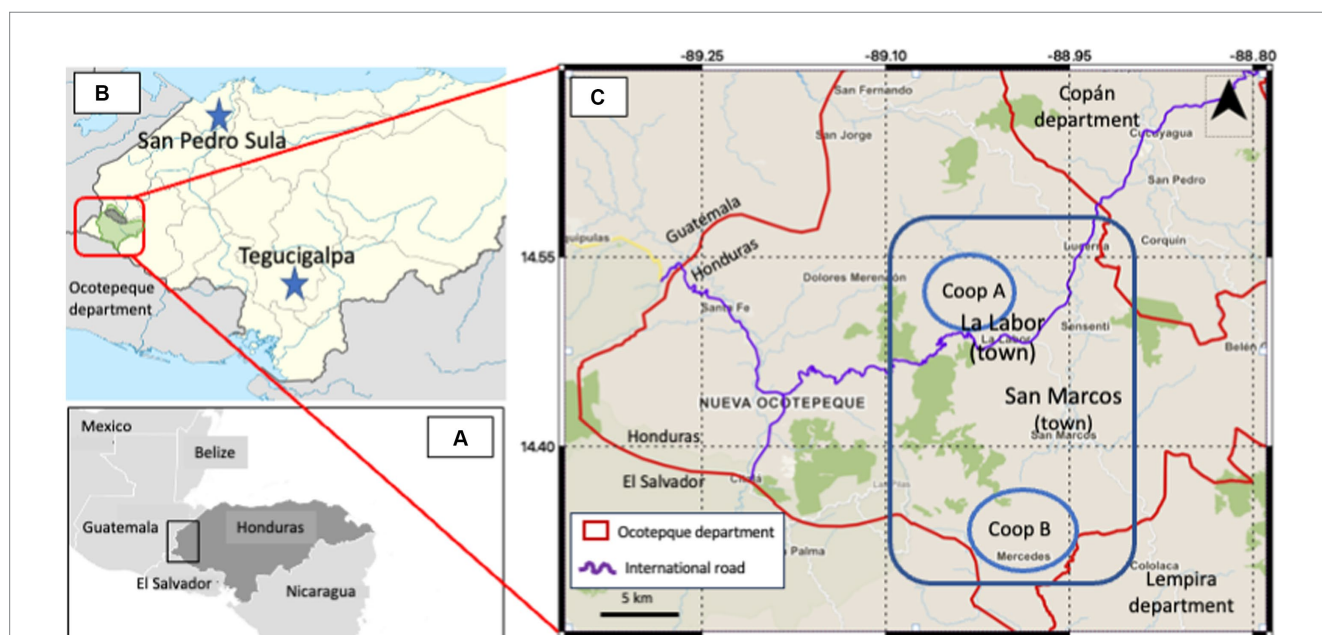
FIGURE 2
Study area in Honduras. **(A)** Location of Honduras in Central America; the black square highlighting the western part of Honduras; **(B)** Area in green represents the current coffee cultivation area in Ocotepeque department, and grey represents low elevation areas (<1,000 m.a.s.l.); **(C)** The area with the blue square is the study area, green areas within the blue square represent the Guisayote Forest Reserve; blue circles the location of interviewed coffee cooperatives and coffee farming households. Next to the blue circles represent La Labor (at the top) and Mercedes (in the button), these are the capital cities of the municipalities that share the same name.

cooperatives were selected based on their interest and scope (geographic and certification). The households were sampled by drawing a first list of potential household respondents based on individual membership lists provided by each cooperative. This list was further revised with the support of cooperative leaders and technical assistants, to ensure that only active members of the cooperatives were interviewed. We then applied a simple random sampling method with 90% confidence level and 5% precision level, stratified per elevation (two strata: under 1,200 m.a.s.l., and between 1,200 and 1,800 m.a.s.l.). In the survey we collected data on coffee farmers' livelihoods, poverty through The Poverty Probability Index® (PPI), food security access dimension (Food Insecurity Experience Scale; FIES), and household income diversification (incomes by coffee, crops, animals, forestry, labor off-farm and external incomes), which was conducted in the same study area between September and October 2019. The survey was supported by a technical assistant from each cooperative, who coordinated the appointments with respondents, using a list of cooperative members.

For the 2020 survey, additional criteria to select sub-samples of coffee farmers and cooperatives were: (a) coffee households with previous food insecurity data collected, and (b) agreed to join to the research, and (c) agreed to follow all health security measures from the national government during the research.

Cooperative leaders and coffee households helped us to identify the main suppliers of fresh food (vegetables, fruits and staple foods) for farmers, such as grocery shops, supermarkets, (in)formal vendors, and food marketplaces where farmers get the basic food basket. The cooperative leaders scheduled interviews with food suppliers based on the trustworthiness they enjoy among the population. Vendors from the open food market in San Marcos were not included due to availability (i.e., open market closure due to COVID-19 restrictions).

By ethical reason, all participants of these research, coffee households, cooperatives, and local food system actors were anonymized. All surveyed and interviewed stakeholders were included in this study on a voluntary basis. The structured household survey (in 2020) addressed (1) food insecurity (access and availability), (2) food systems (actors and factors) from households perspective, (3) changes in local food systems (the origin of fresh and staple foods) and a list of them before and during lockdown, and (4) coffee farmers' strategies in response to household food insecurity during the lockdown. To estimate coffee households' food insecurity and their prevalence, we used the Food Insecurity Experience Scale – FIES developed by FAO as part of the evolution of the lasted version from the Food Insecurity Access Scale – HFIAS and Latino-America and the Caribbean Food Security Scale – ELCSA (Ballard et al., 2013). The FIES captures the dimensions of households' food access through eight questions that were integrated into the structured household surveys in 2019 and 2020, which range from being worried about food security, changes in dietary diversity to skipping meals or without eating for a whole day (Ballard et al., 2013). The severity level of households' or individuals' food insecurity is an unobservable trait. The experiences associated with household respondents' food insecurity are associated with the FIES question set; thus, the more severe a household's experienced food insecurity, the higher the probability of reporting associated experiences. The survey results are triangulated with the semi-structured interviews applied to households and food system actors regarding food access and availability. The leaders of Coop A agreed to meet with all coffee households that participated in the survey in 2019. The Coop B supported the study with two technical assistants who helped collecting the information (survey). We did a pre-test of the survey with staff of both cooperatives to identify gaps of information, and misleading vocabulary. We conducted the survey in person, utilizing paper forms, and following the cooperatives leaders' recommendation designed it to take no longer than 15 min per

FIGURE 3
Timeline of mobility restrictions and interviews from February to September 2020.
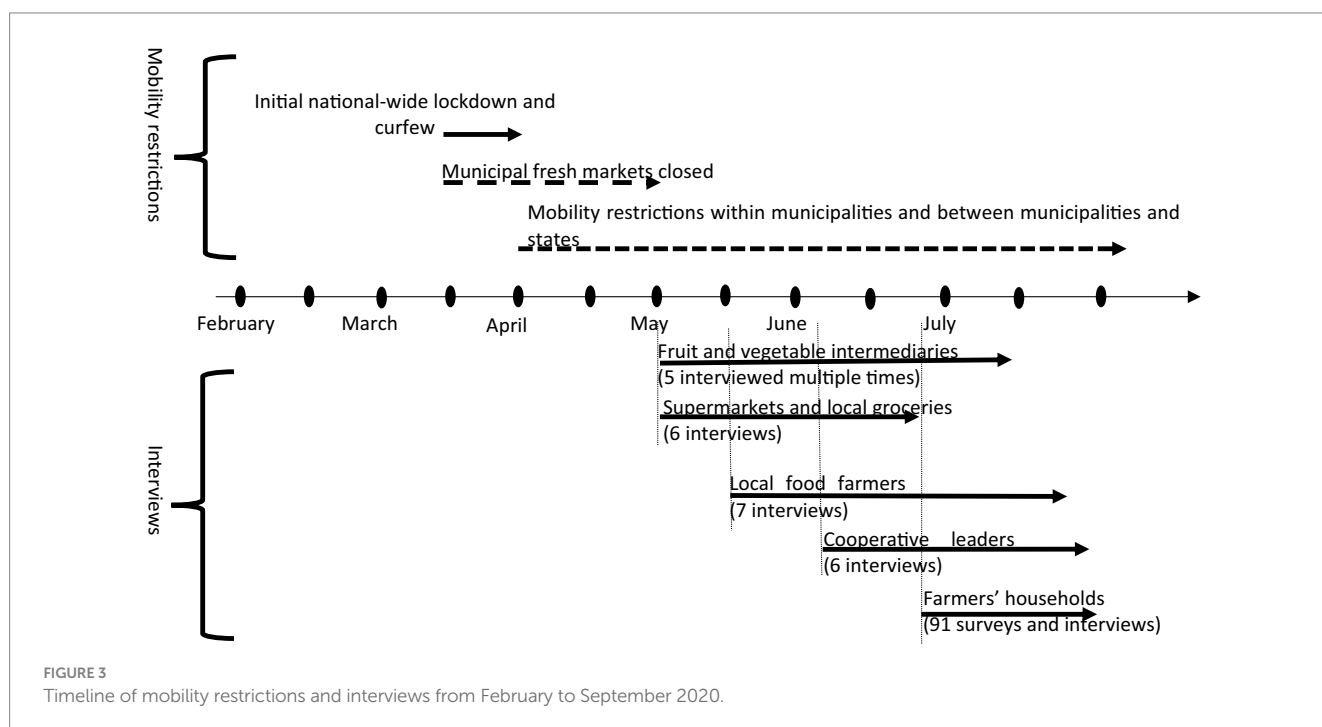
interview. In total, the survey comprised 28 questions, including 15 with multiple-choice options and 13 with yes/no responses.

Due to the time constraint, unfortunately, we had to exclude important variables such as households' poverty (PPI) during the lockdown. This limited the scope of the analysis of the present study.

The semi-structured interviews were conducted with various local food-system actors (i.e., representatives of food suppliers, such as supermarkets, intermediaries, coffee households, food producers, local groceries, and cooperative leaders; Figure 3). For all interviews and surveys, we followed the national health care measurement such as social distancing, mask wearing, conducting interviews only in open areas, cleaning with alcohol our hands before and after each survey interview and avoiding any physical contact.

We interviewed key informants such as leaders of the two cooperatives to identify the most popular fruits and vegetables in the region. We photographed fresh food and food vendors from the food marketplace in San Marcos in 2019. For 2020, we took photos of informal fresh food vendors (intermediaries, vendors in the international road and pick-ups vendors), grocery stores, and supermarkets along the C4 transnational road in the municipalities of Mercedes, La Labor and the village of Rosario. The first author of this paper logged field observations between 2019 and 2020 and recorded day by day events in a logbook.

We documented the origin of all staple food, vegetables and fruits mentioned during the households' survey and cross-referenced this information with the photographic data on fresh food items sales by local food market before and during the lockdown. Finally, we followed the linkages from the coffee households' preferences to the origin of fresh food by asking food system actors. This allowed us to map and better understand which food items originated from outside the local food system as well as describing the local food system for both periods.

2.3 Data analysis

We performed two types of analysis: (1) a descriptive analysis of the households' socioeconomic characteristics, poverty, and food insecurity levels; and (2) an analysis of resilience strategies of the coffee household farmers, and farmers' cooperatives to assure food security, and actors within the local food system strategies aimed at keeping the local food system flowing to sure food availability in the study area. For (1) we used the household survey data from 2019 for socioeconomic characteristics, poverty, and food insecurity measures, and from the 2020 survey data we used the food insecurity measure. For the analysis of food insecurity, we used the data from the eight questions FIES applied: (a) You were worried you would not have enough food to eat? (b) You were unable to eat healthy and nutritious food? (c) You ate only a few kinds of foods? (d) you had to skip a meal? (e) You ate less than you thought you should? (f) Your household ran out of food? (g) You were hungry but did not eat? (h) You went without eating for a whole day?. Quantitative categorical types of data were analyzed using percentages, frequency distributions, and cross-tabulation. While quantitative continuous data were analyzed using means, and standard deviations. ANOVA and t-Test were used to see whether there were significant differences among different groups like cooperatives A and B and three grouped by coffee income dependency.

The Kruskal–Wallis and Wilcoxon non-parametric tests were utilized to investigate potential differences in FIES among cooperatives and income groups over the years and within them, respectively. For non-normally distributed variables, the Mann–Whitney test and Dunn Bonferroni test were used by pairwise comparison among cooperatives and coffee income dependency groups.

The FIES analysis methodology utilizes Item Response Theory (IRT) to examine responses to survey or test questions. Within IRT, the Rasch model, employed for analyzing FIES data, aims to enhance measurement accuracy and reliability by systematically assessing response data. This IRT measurement model, known as the Rasch model, not only offers a theoretical foundation but also provides a set of statistical tools (Nord, 2014). We ran a probabilistic model linking unobservable traits with respondents' experiences is the Rasch Model, following by a procedure jointly developed by the FAO and Cafiero et al. (2018) for a prevalence of food insecurity. This was applied to each cooperative for both periods (i.e., 2019 and 2020). Finally, we classified the food (in)security of households by year, following the four FAO groupings and thresholds, i.e., (i) food secure, (ii) marginally food insecure, (iii) moderately food insecure, and (iv) severe food insecure (Ballard et al., 2013). We then analyzed differences in the FIES scores between years across cooperatives and income groups using boxplots. In these latter analyses, significance in the differences was assessed using a Kruskal-Wallis non-parametric test, with pairwise comparisons assessed using Wilcoxon's rank-sum test.

For the resilience analysis we used the survey data from 2020 and the food-system actor interviews and observations.

The descriptive analysis focused on describing households' demographic and socioeconomic characteristics for farmers cooperatives, and for three households' coffee income dependency groups. Our research focused exclusively on coffee farmers, meaning that all households had a level of dependence on incomes from coffee. We determined these groups according to the income distribution of households' coffee, other crops, animals, forestry, off-farm labor (e.g., construction, commerce, and commercial farms) and external incomes (e.g., remittances, aid assistance). A group with coffee incomes below 50% of total households is here termed "diversified," those with coffee incomes between 50 and 75% "coffee specialized," and households with coffee incomes above 75% "coffee-dependent."

All qualitative interviews were transcribed and analyzed using Atlas.ti software and coded them thematically such as impacts of lockdowns to formal and informal food vendors, households' responses and strategies to keep food security, changes of food suppliers, cooperatives strategies to maintain food security members, barriers of coffee cooperatives to linked food production and local food demands.

3 Results

Our study showed that (i) that local food-system changed under mobility restrictions, (ii) that the status of coffee farming households and their food insecurity differed before and during the pandemic and illustrated (iii) describes the resilience capacity of coffee households' and (iv) cooperatives' and their strategies to address pandemic-induced food insecurity. These results are explained in more detail in the following subsections.

3.1 Changes of the local food system under mobility restrictions

In this section, we will delineate the transformations within the local food system both before and during the COVID-19 triggered lockdown, presenting our analysis in two sections.

3.1.1 The local food system prior to the pandemic

Prior to the pandemic, the local food system in Ocotepeque state in Western Honduras consisted of farmers growing vegetables, fruit, and staple foods (beans and maize); intermediaries; public markets; supermarkets, and grocery shops. Intermediaries can be split in two groups, including vegetable and fruit sellers with a fixed business location, using wheelbarrows or tents along the international road called CA4. These vendors buy fruit and vegetables from international transporters and local farmers, and some source directly from Guatemala or El Salvador. They sold products to residents in the surrounding villages and lorry drivers and tourists who use the international road. The intermediaries in the second group have a vehicle (pickup truck) and bring fruit and vegetables to open markets, villages, local restaurants, supermarkets, and groceries. Like the first group of intermediaries, they procure products from local farmers and international transporters.

The main municipal marketplace in the region is in San Marcos, 12 km away from La Labor (Figure 2). There are four local supermarkets based in the main towns of La Labor and San Marcos. There are also smaller grocery shops in these towns and nearby villages. A grocery shop in the region refers to a small shop that most often sells processed food with a long shelf life and staple food, and some sell a smaller quantity of fresh vegetables, such as tomatoes and onions.

Maize and beans were physically accessible from three sources regards to vendors and coffee farmers interviewed: local farmers, including coffee growers; open markets, and supermarkets. 37% of the coffee farmers located in La Labor and Mercedes buy beans after the coffee season in December and January, keeping them for consumption during the next 3–6 months. Other coffee farmers (46%) plant beans and maize between March and April and harvest them between June and August. If the coffee harvest is good, beans and maize for consumption usually last 3–6 months according to coffee farmers and cooperative leaders interviewed. All other coffee farmers buy these staples from the open marketplace, supermarkets, and grocery shops. The money for these expenses comes from either coffee sales or from off-farm labor such as fixed jobs as staff of the cooperatives, owner of small businesses and/or from temporary labor on construction sites or temporary labor on commercial farms such as large landowners selling monocultures to specialized supermarkets on capitals of main cities of Honduras.

Interviews with staple food sellers in the study area suggest that the government regulates beans and maize prices through two national institutions that buy, stock, and sell grain. During scarcity periods, these institutions release their grain stocks to avoid extreme market prices and high prices variability. This also reduces the capacity of intermediaries to establish higher market prices. The two governmental institutions are: The Honduran Institute of Agriculture Marketing (Instituto Hondureño de Mercado Agrícola; IHMA) and the National Basic Supplies Bank (Suplidora Nacional de Productos Básicos; Banasupro). According to the interviewees, IHMA has two functions: (a) buying beans and maize in regions

where the crops are grown and stock the produce in collection centers; and (b) selling beans and maize to intermediaries or Banasupro. Banasupro operates in the retail market through its own shops and alliances with supermarkets and grocery shops in each municipality. Through this scheme, the government tries to establish market prices and guarantee the availability of beans and maize for the local population.

According to the food system actors interviewed and households survey, 60% of the fruit sold comes from outside the Ocotepeque municipality, including Guatemala, Mexico, Salvador, and the United States (see Figure 4). International fruit transporters move cargo from Guatemala or El Salvador to supermarkets and open markets in Honduras. Before reaching their destination, transporters sell a portion of their freight to the intermediaries located along the international road, who then sell the fruit to local customers. In addition, some intermediaries located in La Labor independently transport fruit (grapes, apples, mangoes, and pears) directly from Guatemala to Honduras. The most planted vegetables in the study area, like broccoli, cabbage, carrots, onions, peppers, potatoes, and tomatoes, come from specialized vegetable farmers around the Guisayote Forest Reserve in Ocotepeque department and Guatemala (see Figure 4) according to local food system stakeholders. However, almost all farms have contract arrangements with large supermarkets in the main cities of Honduras, Tegucigalpa, and San Pedro Sula, where they deliver the highest quality ("class extras" and "class I" according to FAO's Codex Alimentarius) products. The secondary quality ("class II") harvest is supplied to town marketplaces, such as San Marcos, Ocotepeque, and Santa Rosa, Copán. The remaining harvest is sold to intermediaries who sell it to further villages and small towns.

Households in villages located far from urban areas access fruit and vegetables through open marketplaces in nearby towns. Thus, these households must frequently travel from their villages to open marketplaces in urban areas to access food.

3.1.2 The local food system during the lockdown

As an observer into the study area, at the beginning of the nation-wide lockdown (March 15–31, 2020), supermarkets, public markets, and grocery stores were closed following government-imposed regulations. In the subsequent lockdown (from April 1 to September 2020), there was more flexibility in urban and peri-urban areas, such as Tegucigalpa and San Pedro Sula, where the food chain and strategic sectors, such as health and transportation, were allowed to reopen. However, the situation in rural areas was different. In the study area, the main market was closed for more than 45 days; hence, local vegetable producers (one of the sources of fresh vegetables) could not transport vegetables to the markets each week and were compelled to discard produce. Mobility restrictions between municipalities and department presented further barriers to moving fresh products from growing regions to markets. As a result of international border closures, the availability of imported vegetables and fruits were severely reduced, according to local sellers (see Figure 4).

Consequently, most vegetable farmers reduced their agricultural activities between March and May 2020 to avoid another loss of harvest as shown in the interviews with local food farmers and intermediaries. During this time, intermediaries with vehicles (pickup trucks) purchased vegetables from vegetable producers (who still had
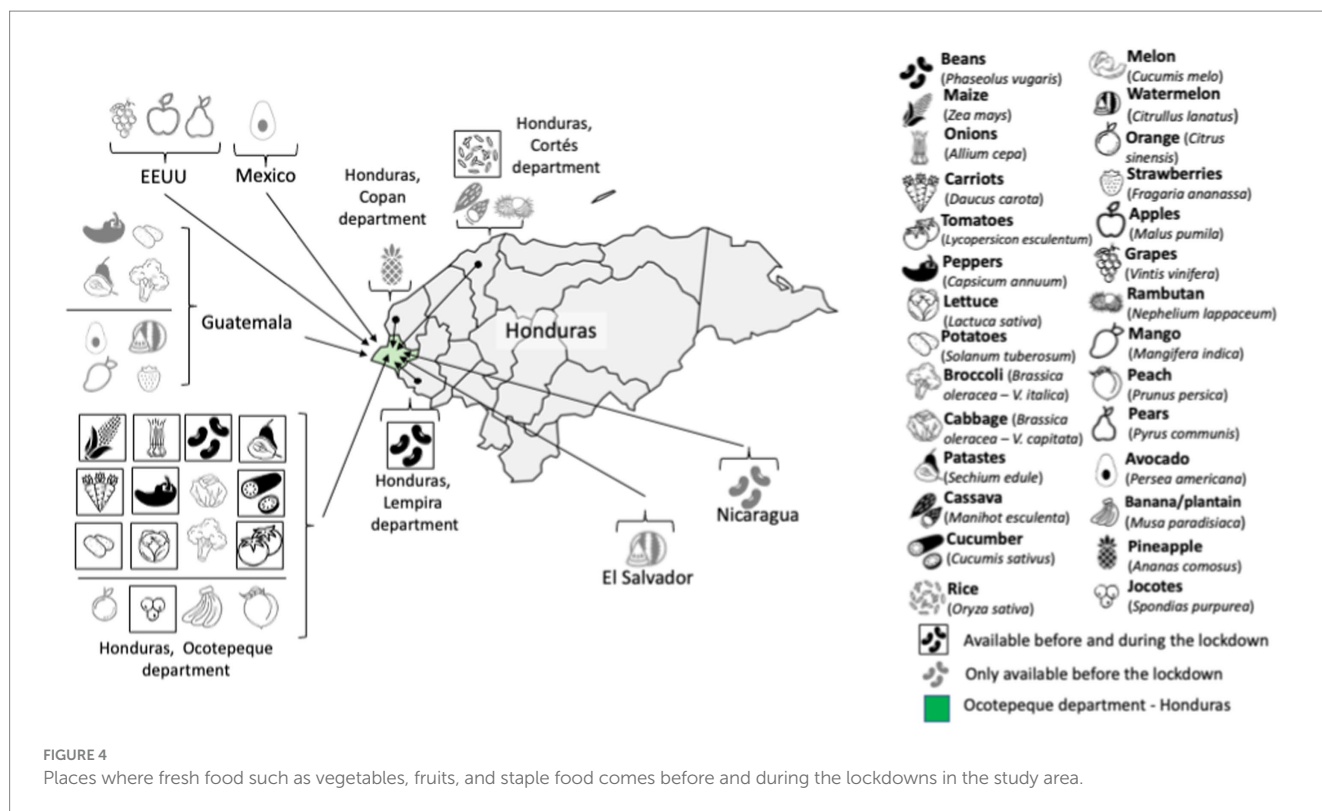
FIGURE 4
Places where fresh food such as vegetables, fruits, and staple food comes before and during the lockdowns in the study area.

some vegetables) around the Guisayote Forest Reserve area and transported them to the municipality of La Labor and villages for sale in the study area. Week by week, the local vegetable supply became scarcer, and prices began to increase. By June 2020, 77% of coffee households surveyed reported that could no longer afford vegetables due to higher prices according to informal discussions with coffee households. With a fall in demand because of higher prices, intermediaries stated that they had to reduce the fresh food supply to these small cities and villages.

According to interviews with supermarket owners and intermediaries, when households ran out of stock at the end of April, the population began to demand more beans. Bean prices in the study area increased from 13 Lempiras/500 grams (US$ 0.50) in April 2020 to 25 Lempiras/500 grams (US$ 1.00) at the end of June 2020. The intermediaries, usually selling vegetables, began offering small amounts of beans and maize in their tents and vehicles between May and June, as the high prices of beans and maize guaranteed superior profits. The intermediaries obtained the beans and maize from local stocks, their own production or other intermediaries who transported them undeclared from Nicaragua and Guatemala. In the first week of July, the local harvest of beans began, and prices returned to 13 Lempiras/500 grams by the last week of July 2020. One of the supermarkets' owners, who is a major supplier for grocery shops around neighboring villages (including where Coop A is located), reported high demand for snacks like potato- or tortilla chips and sugary drinks like regular soda or fruit drinks, due to their lower prices (affordable) in comparison to fresh food available during the lockdowns.

In the interviews and surveys, none of the participants noted that governmental agencies Banasupro or IHMA supported either the availability of beans and maize or controlled prices. In the interviews

and surveys, none of the participants noted that governmental agencies Banasupro or IHMA supported either the availability of beans and maize or controlled prices. Following the initial lockdown, Banasupro reopened shops in Tegucigalpa and San Pedro Sula, including temporary stores at many points in these cities; however, in the rest of Honduras, especially in the Ocotepeque department, Banasupro shops were open only in the capital of this department at a fixed point (more than 30–70 km away from these households), limiting rural households' access to Banasupro services.

3.2 Coffee-farming households and their food insecurity before and during the lockdown

The pre-pandemic 2019 survey revealed the demographic, socioeconomic, and income distribution of coffee households (Table 1).

The survey results show that the households from Coop A have a higher probability of being under the national poverty line than those from Coop B according to the PPI index collected in 2019, which could be explained by different income-diversification strategies, where coffee households with diversified income accounted for 59% in cooperative A and 26% in cooperative B (see Table 1). Among these groups, the primary source of income was off-farm labor, constituting 45 and 41% for cooperatives A and B, respectively. Additionally, income from coffee contributed 36 and 37% for cooperatives A and B, respectively. According to cooperatives' representatives and staff, they are all also coffee-household members who had been granted off-farm labor such as technical assistants or administrative staff, with stable incomes.

The coffee households with more dependence on coffee income (Specialized and Dependent group) are more likely to be poor than the coffee households of the diversified income group (see Table 2).

Nearly all interviewed households, (97% of the coffee households) have Fairtrade and/or the Organic certification. The remaining coffee households had been in a pre-certification process with the certifier or had not been clear about the current status of their farm certification during the survey conducted in 2019.

Notably, there were considerable local differences in access to food, and especially vegetables, experienced by coffee farmers organized in the two coffee cooperatives. Based on the data from the households' survey in 2020, coffee farmers from Coop A had limited access to vegetables and fruit due to mobility restrictions, as most

fresh food consumed by households in Coop A consume comes from outside of the municipality. In contrast, households surveyed from Coop B accessed fruits and vegetables through a local grocery shop (in Mercedes) and intermediaries between April and June. This food availability was facilitated by a local grocery shop that began buying fresh food (primarily vegetables) from local farmers and surrounding villages in the Mercedes municipality. Additionally, new intermediaries began to sell some fruits and vegetables in the small town where Coop B is located. These intermediaries and food producers were from neighboring villages that had sold fresh produce in the San Marcos market prior to the lockdown. This supply of fresh food guaranteed food availability for the households in Coop B (Table 3). For both cooperatives, coffee households did not report a shortage of beans, as

TABLE 1 Demographic, socioeconomic, and income distribution variables of coffee households by cooperative – 2019.

Variables	Coops			
	A (n = 40)	A Standard deviation	B (n = 51)	B Standard deviation
PPI – Probability of being below of the national poverty line – (%) †	38%*	0.19	29%*	0.17
Number of households members – (Mean) ‡	4.3	1.53	3.9	1.63
Age of household head – (Mean) ‡	46	12.70	46	13.00
Size of farm (Ha) – (Mean) †	2.2*	3.78	2.6*	2.02
HDDS - Households dietary diversified score – (Mean) †	9.4	1.78	9.3	1.44
Farm elevation (MASL) – (Mean) †	1288*	132.79	1330*	95.91
Household head male – (%)	90%		88%	
Access to clean water (public system) – (%)	100%		88%	
The education of the head of household – (%)				
No studies	8%		4%	
Elementary	75%		67%	
Middle	15%		24%	
Higher	3%		6%	
Income distribution – (%)				
HHs incomes with >75% of coffee (Coffee dependent)	35%	6.30	33%	2.42
HHs incomes with <75% > 50% (Coffee specialized)	39%	7.04	8%	7.07
HHs incomes with <50% (Diversified)	26%	14.28	59%	13.93

* Indicate a significant difference between two groups. Symbol ‡ indicates normally distributed variables. Symbol † indicates non-normally distributed variables. t-Test was used to test for statistical differences for normally distribute variables. Mann–Whitney $post\ hoc$ test was used for non-normally distributes variables.

TABLE 2 Demographic, and socioeconomic variables by income distribution groups (2019).

Variables	Income distribution		
	Diversified (n = 40)	Specialized (n = 20)	Dependent (n = 31)
PPI – Probability of being below the national poverty line – (%) †	26%[a]	43%[a]	36%[a]
Number of households members – (Mean) †	3.9	4.9[a]	3.7[a]
Age of household head – (Mean) ‡	43	45	50*
Size of farm (Ha) – (Mean) †	3.0	1.8	2.0
HDDS – Households dietary diversified score – (Mean) †	9.5	9.8[a]	8.8[a]
Farm elevation (MASL) – (Mean) ‡	1.324	1.298	1.307
Household head male – (%)	90%	90%	90%

Symbol ‡ indicates normally distributed variables. Symbol † indicates non-normally distributed variables. ANOVA test was used to test for statistical differences for normally distribute variables *** $p > 0.01$; **$p < 0.05$; *$p < 0.1$ indicates a significant difference, then we used a Turkey test for pairwise comparison. Kruskal–Wallis tests were used to test for statistical differences, letter (a) indicate a significant difference between groups, followed by pairwise comparisons based on the Dunn-Bonferroni test post hoc test was used for non-normally distributes variables.

TABLE 3 Changes in households' access to vegetable, fruit, and staple food suppliers before and during mobility restrictions.

Food suppliers	Fruit and vegetables		Staple food (beans and maize)	
	Before mobility restrictions (*n* = 91)	During mobility restrictions (*n* = 91)	Before mobility restrictions (*n* = 91)	During mobility restrictions (*n* = 91)
Local grocery shop (pulpería)	16.5%	33.0%	15.4%	20.9%
Grocery shop	0.0%	0.0%	0.0%	0.0%
Supermarket main town	3.3%	2.2%	16.5%	17.6%
Local seller	4.4%	6.6%	5.5%	2.2%
Local farmer	4.4%	8.8%	17.6%	7.7%
Intermediary	36.3%	41.8%	9.9%	11.0%
Food self-production	34.1%	18.7%	46.2%	29.7%
Marketplace in San Marcos	55%	7.7%	19.8%	5.5%
Supermarket in San Marcos	2%	1.1%	0.0%	0.0%
Staple food storage	0%	0.0%	0.0%	37.4%
Other/no answer	1.1%	0.0%	5.5%	3,3%

these had already been stored before the COVID-19 crisis. For example, 37% of the households interviewed started to buy beans from intermediaries and/or harvested them from their farms between February and April to store them for the upcoming months (as usually practiced).

Table 3 reveals an increase in food purchases from local grocery shops, while access to the traditional fresh food suppliers in the marketplace fell sharply. On-farm production of staple foods and vegetables decreased by one-third, due to shortages of inputs, such as seeds, fertilizers, and technical assistance, according to the farmers surveyed.

Food insecurity increased among coffee producing households during the lockdown. According to first question of the survey of FIES, around 50% of the households did not report food insecurity in 2019, whereas only 15% of the households did not report food insecurity in 2020. The Rasch model, used to analyze the other FIES questions, revealed that the prevalence of moderate and severe cases of food insecurity in households increased from 6% in 2019 to 19% during the lockdown. It means that households reduced the quality of nutritious food and quantity. The situation is confirmed by households surveyed, one respondent expressed, "We could not find all kinds of food that we used to buy due to shortages of fruits and vegetables" (The head of a coffee household, personal interview, 2020). Another said, "Our situation is bad because we do not have enough money to procure food" (The head of a coffee household, personal interview, 2020). Furthermore, a participant remarked, "We are buying fewer vegetables because they are very expensive." (The head of coffee household, personal interview, 2020). These voices illustrate the impact of the lockdown on the food security of coffee households, reinforcing the quantitative data.

Figure 5 reveals the changes in households food security before and during lockdowns in the study area. Figure 5A shows that Coop A moved from being food secure in 2019 (mean value "0"), to eating only a few kinds of foods (mean value "3") during the lockdowns, while for Coop B households, the mean changed from 'worried about not having enough food' (mean of "1") to 'unable to procure healthy and nutritious food' (mean of "2"). The mean of the specialized group
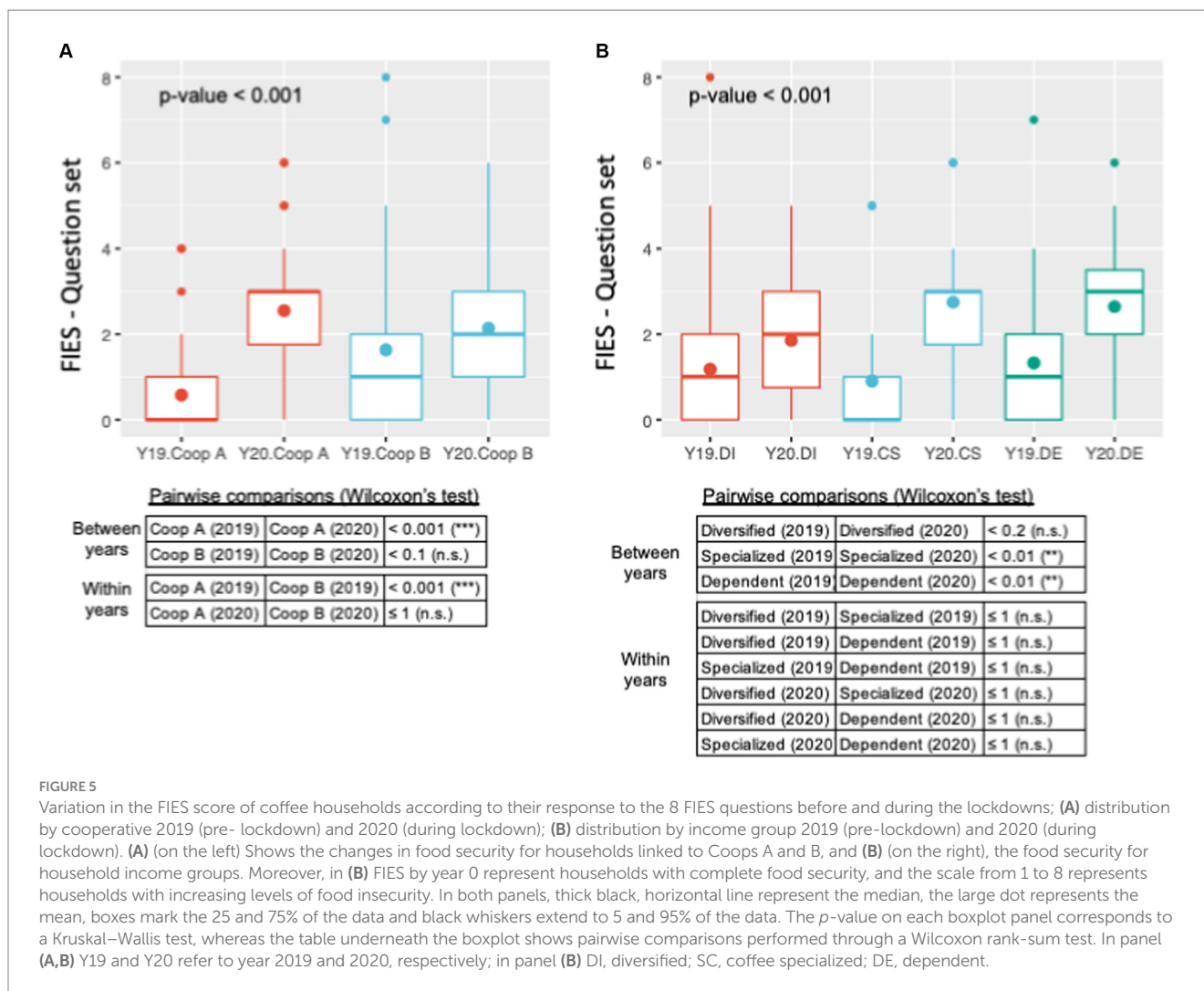
indicated that they are food secure (0), and the mean of the dependent and diversified groups represented a 'worried about not having enough food' (1 of 8). During the lockdowns, food insecurity is more severe for specialized and dependent groups (3 of 8) than for the diversified group (2 of 8). In general, where households' food insecurity is higher (Coop A) and for specialized and dependent groups, two varaibles are recurrent in both cases, (a) high rates of poverty, and (b) high dependence on coffee incomes (see also Tables 1, 2).

3.3 Resilience capacity

3.3.1 Coffee households' strategies to address pandemic-derived food insecurity

Coffee-farming households' strategies to address food insecurity can be divided into two categories (absorptive and adaptive). The first involves coping strategies used during lockdown to respond to food insecurity, and the second comprises strategies that households implemented over the medium-term to mitigate lockdown-effects on food security in the upcoming months.

The most common coping strategy used by households to address food insecurity was tapping into savings from coffee sales, with 57% adopting this approach. Additionally, 18% of households resorted to seeking credit from coffee cooperatives. Some coffee farmers expressed their concern about the situation: "Coffee incomes could not cover coffee debts and now we requested a credit to procure food, I am worried" (Coffee farmer, personal interview, 2022). Households in Coop B accessed much higher credit levels than those of Coop A because this cooperative had greater cash flow (available budget to offer credit) than Coop A, according to the representatives of each cooperative. Subsequently, the households of Coop A reported to having eaten food and sought assistance from relatives and friends to cope with food insecurity. Selling goods, animals, or land was not a strategy for any of these households. Table 4 summarizes the household strategies used to cope with food shortages during household lockdown.

FIGURE 5
Variation in the FIES score of coffee households according to their response to the 8 FIES questions before and during the lockdowns; **(A)** distribution by cooperative 2019 (pre- lockdown) and 2020 (during lockdown); **(B)** distribution by income group 2019 (pre-lockdown) and 2020 (during lockdown). **(A)** (on the left) Shows the changes in food security for households linked to Coops A and B, and **(B)** (on the right), the food security for household income groups. Moreover, in **(B)** FIES by year 0 represent households with complete food security, and the scale from 1 to 8 represents households with increasing levels of food insecurity. In both panels, thick black, horizontal line represent the median, the large dot represents the mean, boxes mark the 25 and 75% of the data and black whiskers extend to 5 and 95% of the data. The *p*-value on each boxplot panel corresponds to a Kruskal–Wallis test, whereas the table underneath the boxplot shows pairwise comparisons performed through a Wilcoxon rank-sum test. In panel **(A,B)** Y19 and Y20 refer to year 2019 and 2020, respectively; in panel **(B)** DI, diversified; SC, coffee specialized; DE, dependent.

Asked between June and July of 2020 what households would do to counter the effects of the lockdown in the coming months (i.e., moving toward adaptive strategies), 30% of households in Coop A indicated that they could not do anything to mitigate food insecurity in the coming months, and 24% of Coop B households responded the same. For 40% of all households shared that they were desperate, fearing that their current strategies would not work to reduce their food insecurity in the coming months, but they perceived no other option other than to wait. The coffee households said: "We have no idea what to do to eat in the next months, but we know that God will save us" (The head of a household, personal interview, 2020). "I could do nothing, just wait to see what will happen." (The head of a household, personal interview, 2020).

In contrast, the other 60% of households highlighted two strategies. First, producing food on their farms by growing crops like beans, maize, and other vegetables, with 18 and 41% of households from Coop A and B listing this strategy, respectively. The second strategy was better management of household resources by taking measures such as a budget planning to determine where household expenses could be reduced. This strategy was reported by 10 and 21% from households Coop A and B, respectively.

3.3.2 Cooperatives' strategies to address members' food security

The interviews with cooperatives' leaders and members revealed that the cooperatives supported coffee households with food provisions. Cooperative A gave one bag of food provisions to each household member and provided loans to acquire food and other items between May and June. The bag contained beans, flour, maize, oil, pasta, salt, and sugar, to make tortillas, i.e., enough food for 15 days for a family with four members according to the interviews. The cooperative struck a deal with Fairtrade to use funds from its meeting budget for direct cash transfers to the member households; thus, a sum proportional to the amount of coffee sold by each household to the cooperative was transferred to members' accounts. Additionally, cassava cuttings and plantain seeds were distributed to members to promote independent food production.

Cooperative B delivered three bags of food provisions to each household between May and June (one bag each 15 days). One of them was sponsored by the cooperative and the other two were donated by a coffee importer and a coffee roaster that were traditional customers of the cooperative. The donation from these customers was in cash, so the cooperative arranged logistics to make bags with essential foods

TABLE 4 Strategies to confront food insecurity at the household level during mobility restrictions.

		Coop A	Coop B
		(n = 40)	(n = 51)
Sold	Sold some goods	0%	0%
	Sold/ate some livestock	0%	0%
	Sold some land	0%	4%
Access to credits	Loan from a financial institution	0%	6%
	Loan from an informal lender	8%	2%
	Loan from the coop	8%	25%
Less food	Reduced the number of meals per day	5%	2%
	Ate less food	23%	12%
Sought help from friends or relatives		25%	8%
Worked longer than usual to reduce costs of coffee production		5%	4%
Some family members who previously did not work had to work		0%	0%
Used savings		48%	65%
Signed up for a government aid program		3%	4%
A family member moved to a new place		0%	0%
Nothing		30%	24%

available for members. The bags of food provisions contained rice, beans, maize, oil, pasta, salt, sugar, and flour to make tortillas. In addition to this, the cooperative gave 4,000 lempiras (US$ 160) to their members at the beginning of the lockdown to address rising food costs.

One potential avenue to improve households' food security involves the active participation of cooperatives in marketing food crops. When questioned about the feasibility of such an initiative, cooperative representatives responded that the current cooperative some barriers, the current cooperative statutes only permit engagement in marketing for coffee and not for food crops, skills to market fresh food and a defined marked. The representatives of Coop A explicitly stated, "We cannot market fresh food due to restrictions in the statutes. Also, we need steady food production and a defined market, lacking the necessary skills to do so… the bottleneck is the market, we had experiences with food garden projects before, but they failed without a market connection" (President of Coop A, personal interview, 2020). Similarly, the representatives of Coop B acknowledged the constraint, stating, "We need to explore options with all members through a full assembly, but the existing statutes do not allow us to market crops other than coffee, our business is the coffee" (President of Coop B, personal interview, 2020). Then, questioned about options without changing statutes, the representatives responded that they could offer technical assistant to management beans and maize, access to credits to procure inputs such as fertilizer for other crops and seeds. "We could offer technical assistant for other crops and access to credits for inputs such as pests and diseases management and fertilizers" (President of Coop A, personal interview, 2020) "Now, we are offering beans and maize seeds and credits" (President of Coop B, personal interview, 2020).

However, the interviews with the local coffee system actors indicated evidence of a potential demand side in case cooperatives and farmers would engage in local vegetable production. The local supermarket and local groceries located in La Labor said that they were ready and able to procure and offer vegetables from local production if these vegetables met the local demand. A supermarket owner explained:

"Customers want vegetables, they are growing them in our region, but we do not have anyone to supply them to us. We would like to offer small boxes of fresh food according to demand; for instance, a box with avocado, carrots, onions, patastes (*Sechium edule*), peppers, and tomatoes for 200 lempiras (US$ 8) for a family. I am sure that it would sell easily and quickly" (Supermarket owner, personal interview, 2020). This is confirmed by two grocery shop owners (personal interviews, 2020) who stated that:

"People demand ayote (*Cucurbita argyrosperma*), broccoli, carrots, onions, patastes, peppers, onions, and tomatoes but the suppliers are not consistent in bringing vegetables. We need around 50 kg of vegetables per week." (Grocery shop owner, personal interview, 2020).

This evidence demonstrates that local markets need specific kinds and quantities of vegetables each week. Therefore, a local demand for fresh food exists. Bottlenecks are the low local food production and a lack of links between food production and the local markets. For example, one intermediary stated that "main vegetables could grow here but the producers do not have transport to bring vegetables from farms to the market" (Intermediary, personal interview, 2020). In addition to that, a grocery show owner emphasizes the need for further support of local farmers to grow vegetables: "Local producers need technical assistance and credit. Without those, it is not possible to produce with consistency, quantity, and quality of fresh food" (Grocery shop owner, personal interview, 2020). However, currently the cooperatives do not support their farmers in income diversification and linking them to alternative markets despite the existing market demand.

4 Discussion and conclusion

4.1 Impacts on coffee households and the local food system

The vulnerability of local food system already existed before the COVID-19 crisis. Our evidence suggests that coffee households in the study area suffered food insecurity before the pandemic, although beans, maize and some vegetables were grown around them. This could be explained by the lower purchasing power of the more vulnerable coffee households due to their poverty level in the study area. This phenomenon has been termed the food-system paradox by Béné and Devereux (2023), where a region or country shows a growing malnutrition or food insecurity status. However, this same region could produces food for domestic demand, with the issue being that the produced food moves to neighboring states, following the laws of supply and demand, seeking who can afford to pay for it.

During the lockdowns, those households that were more dependent on coffee income experienced greater food insecurity than the households with diversified incomes such as off-farm labor (e.g., personnel staff of coffee cooperatives who are also coffee farmers and

coop members). This is partially explained by their poverty status and their high dependency on coffee, making them more vulnerable to external shocks such as climate hazards and variability of international coffee prices. Similar evidence from Guatemala reveals that households with coffee income dependence have less access to food and less agricultural income than households with coffee and food intercrops (Lopez-Ridaura et al., 2019; van Asselt and Useche, 2022). Bacon et al. (2021), reported that diversified and better incomes for farmers' households has a positive correlation with their food security in Nicaragua. In addition, coffee farmers with intercropping such as beans and maize, livestock and home-gardens had less months of food insecurity from south of Mexico, despite of high volatile of coffee prices and low availability of food in the local food system (Fernandez and Méndez, 2019). Thus, there is mounting evidence that income diversified households enjoy greater food security than households with a high dependence on coffee as their main income.

Food availability was disrupted at the beginning of quarantine because some fresh food, such as fruits and vegetables come from beyond state and country borders. Also, beans stored by households began to become scarce due to mobility restrictions. This finding is similar to Lopez-Ridaura et al. (2021), who reported that high dependencies on food imports in Central America, such as vegetables and fruit, impacted the food system via supply disruptions during the COVID-19 lockdown. Our finding is in contrast to Harris et al. (2020) and Workie et al. (2020) who reported that food availability disruptions in developing countries occurred due to reductions in fresh food production by vegetable farmers. These latter were unable to deliver their produce to the market, also reporting a reduction in food production due to market interruptions in developing countries.

Informal actors, such as local intermediaries with vehicles (pick-ups) and some local small food producers had an important role in linking local vegetable production and local consumers (transport and distribution) in villages. Without the fresh food shortages would have started already in the beginning of the lockdown. The creation of new food supply channels between local food producers and consumers was also evidenced in South and Central America (Tittonell et al., 2021) and India (Harris et al., 2020). This flexibility of formal and informal actors of food systems was crucial to maintaining sales and reducing food insecurity at the height of the COVID-19 crisis (Reardon and Swinnen, 2020). This study offers new evidence to add to the discussion on resilience strategies in developing countries in specific and informal contexts.

4.2 Household responses

Coffee farming households demonstrated limited resilience to cope with negative impacts of mobility restrictions on food security due to high dependency of coffee incomes and poverty status. Indeed, they lacked resilience capacity to keep food security before the COVID-19 crisis. Some coffee farmers were able to maintain access to food through savings, reduced expenses, and assistance from friends and relatives (absorptive capacities), and other measures such as access to credit (adaptive capacities). Evidence from India reveals a similar pattern among farming households, including reductions in household expenses and increased borrowing during periods of mobility restrictions (Harris et al., 2020). Lopez-Ridaura et al. (2021) reported the same pattern for farm households in Central America

and Mexico during the first wave of COVID-19. In Perú, Vargas et al. (2021) reported that coffee household farmers used savings and accessed loans to cover household expenses such as food and changed their food consumption behavior (i.e., ate more staple food crops) than animal products. Coffee households' strategies, such as reducing expenses and taking on financial debt are unsustainable when facing increasingly frequent extreme events (IPCC, 2012). Small-scale coffee farmers in some countries in Latin America are poor and vulnerable, and continuous accumulation of debt without improved incomes could make them poorer and more vulnerable to new extreme events in the long term.

We found little evidence related to adaptive strategies, though more may have evolved after the field research ended. Despite the absorptive strategy of loans between farmers and cooperatives to access and store staple food for the months following the dates of the lockdown, we note that was already a common practice before the pandemic due to the seasonal nature of agriculture and sale markets. Regarding strategies related to transformative capacity, it was too early to capture and discuss any evidence due to the short period of fieldwork during the first months of the pandemic.

4.3 Role of cooperatives

The third aspect of the results addressed the role of coffee cooperatives in supporting households' management of food insecurity. Farmers cooperatives' resilience-building strategies, such as food assistance and financial support, can mitigate the impact of extreme events on households' food access in the short-term. The collective actions implemented during mobility restrictions had an important role across the food system. Existing networks between local and national institutions from civil society, such as community based farmers organizations; government; NGOs, and related organizations, are essential for improving food system sustainability of during crises (Tittonell et al., 2021).

The mandate (legal statutes) of the cooperatives in this study is exclusively focused on coffee production, while their members have much more diverse farming systems. Farmer cooperatives often have different orientations; for instance, community orientation (e.g., to enhance food security), or market orientation (e.g., marketing services for coffee), or both (Bijman and Wijers, 2019). Inclusive business could be a means for meeting to farmers' basic needs beyond profit from a cash crop only (Hahn, 2012), thereby reducing poverty though development of inclusive food systems (food value chains) (Vos and Cattaneo, 2021). As Bacon et al. (2014) reported, coffee cooperatives in Nicaragua could be useful in coping with food insecurity through the development of local food system approaches that increase access to beans and maize. A case study conducted in Nicaragua, as reported by Putnam et al. (2016), highlights that the promotion of an agroecological approach by farmer cooperatives through a project serves as a crucial strategy to enhance food security in coffee communities. This approach plays a key role in fostering food sovereignty and building resilience against economic and weather-related extreme events. In such cases, national institutions and NGOs could promote cooperative members' active inclusion to support local food production and food security within the main goals of the cooperatives and business models. Coffee cooperatives' roles could be extended to partially or comprehensively offer market access services and technical training for growing fresh

foods such as vegetables, beans, and maize, facilitating the link between farmers' households and local markets.

The evidence of this research contributes to the debate regarding the importance of local food production to achieve and maintain food security in developing countries (Erokhin and Gao, 2020), which also authors using a food sovereignty perspective have emphasized (Gliessman et al., 2019; Gliessman and Ferguson, 2021). In this study case, we found a potential opportunity for the coffee sector to promote food security and access to healthy and diversified diets for more vulnerable coffee households through a strategy that integrates coffee cooperatives and their members within the local food system according to their priorities. The link between a higher crop diversity in coffee farming systems and a better dietary diversity was also confirmed by Bacon et al. (2023). Notably, coffee farming system diversification appears as a crucial strategy that gives farmers the ability to cope and adapt to shocks such as from the COVID-19 pandemic. This would also follow the transformative potential of the COVID-19 crisis to rebuild the resilience capacity of local food systems, reintroducing diversification and linkages between food production, distribution, and consumers (Gliessman, 2020).

5 Conclusion

This work offers valuable insights into local food systems and coffee value chain actors' resilience (e.g., farmers and farmers' cooperatives) under the COVID-19 lockdowns. The certified coffee households were already food insecure before the COVID-19 crisis. Our study also showed that the most vulnerable households, the ones that experience higher levels of food insecurity, are those that depend more on coffee as main source of income. Despite fresh food production in the study area, many coffee farmers did not have access to fresh food from the local food system. This is partially attributed to the fact that the main target market for local food production is the supermarkets in the departmental capitals. Additionally, the purchasing power of these coffee households is impacted by the levels of poverty This deteriorated during the COVID-19 crisis. Food insecurity further increased among the certified coffee households as markets closed, staple crops and vegetable produce became expensive, and fruits were hardly unavailable.

Our findings contribute to the debate on cash crops versus the integration of food production under the umbrella of local food systems to achieve and maintain food security in developing countries. It also helps identify opportunities for transforming food systems, strengthening food security, and improving access to healthy and diversified diets, especially identifying where cooperatives can contribute to these outcomes. This includes several aspects. First, adaptive strategies to face extreme events such as a lockdown need to ensure that the local food production is linked with local food markets and consumption patterns to ensure the continuous availability of food during extreme events. This should be part of adaptive strategies. Second, coffee cooperatives supported by committed buyers and coffee certification should prioritize and adopt transformative strategies aimed at enhancing the food security of coffee households. This endeavor may necessitate amendments to existing statutes, underlining the need for an inclusive approach in aligning cooperative structures with the evolving challenges in the food security landscape of their members. Thirdly, it is essential to emphasize the significance of crop diversity within coffee farms, a promotion facilitated by cooperatives. This involves actively involving local food

market actors, including both formal and informal vendors, contributing to strengthening the resilience of local food systems, especially in the face of extreme events. The coffee sector, especially cooperatives and their partners, should explore innovative strategies that address household needs for food security and strengthen farmers' resilience practices on the farm, such as intercropping with beans, maize, vegetables, and fruits. These approaches should complement certifications, emphasizing the necessity for a comprehensive and collaborative approach in designing and implementing new initiatives within the coffee sector.

Lastly, we underscore that more research is needed to extend both the geographic (in terms of areas covered in and outside Honduras) and temporal (in terms of long-term implications) of the COVID-19 pandemic and other shocks. Future studies should further study the long-term implications of COVID-19 and other recurrent crises over larger geographic areas, as this would help build a robust evidence base to inform adaptation and resilience policy and action.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

FR-C: Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization, Writing – original draft. ML: Writing – review & editing, Supervision, Investigation, Funding acquisition. CB: Writing – review & editing, Supervision. JR-V: Writing – review & editing, Formal analysis. TB: Writing – review & editing, Supervision, Investigation.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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