



# An Assessment of the Impact of COVID-19 on the Agri-Food System in Caribbean Small Island Developing States

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The COVID-19 pandemic impacts have arguable been more pronounced in the developing world, such as the Small Island States (SIDS) of the Caribbean, where a plethora of geophysical and socio-political factors have led to increased vulnerability, particularly in fragile sectors such as agriculture. The pandemic added another layer of complexity to the unstable agri-food systems of SIDS in the Caribbean. Measures to contain the unfolding crisis have tremendously disrupted food systems by threatening the production, distribution, and marketing of commodities which exposed the frailty of the region's food security. Caribbean SIDS are highly dependent on food imports and relies on international markets to secure food. Many are also dependent on agricultural exports and have a large portion of their population involved in agriculture making them particularly vulnerable to the rigors of the pandemic. Export restrictions on foodstuff and prohibitions due to lockdowns and border closures further exacerbated these challenges. Additionally, food and nutrition security in the region is also subjected to the effects of climate change and climate-related disasters. Dealing with the impacts of co-occurring disasters is, therefore, an ever-present threat. This study examines the impact of COVID-19 on the agri-food supply in the Caribbean. It also identified measures and initiatives adopted to cope with these disruptive consequences. The study involves the use of internet-based surveys and focus group discussions and internet-based surveys with stakeholders and online searches for related literature. A total of 96 farmers, 60 food distributors, 84 food service operators, and 237 consumers from the region participated in the online survey and 4 focus group discussions between January and November 2021. The results confirmed that the impacts of the COVID-19 pandemic were evident along the entire agri-food supply chain and numerous challenges and shocks were identified across all participating groups and countries. Some challenges and shocks such as loss of income and related challenges including lower sales and loss of markets affected all groups in the study but to varying degrees and based on socio-demographic factors. In general people of lower income status and smaller businesses were more susceptible to the negative impacts of the pandemic.

**Keywords:** agri-food system, Caribbean SIDS, food security, food system resilience, COVID-19 pandemic

## INTRODUCTION

The COVID-19 pandemic has significantly impacted and continues to impact all sectors of society globally. The impacts have been arguably more pronounced in the developing world, particularly in the Small Island Developing States (SIDS) including those of the Caribbean, where a plethora of geophysical and socio-political factors have led to increased vulnerability, of fragile sectors such as agriculture (Blazy et al., 2021). The pandemic added another layer of complexity to the traditionally unstable agri-food systems of SIDS in the Caribbean, further limiting local production and exposing the need to address crucial food security issues primarily linked to the high dependence on food imports (Blazy et al., 2021). Sudden shocks mainly from supply chain bottlenecks are becoming more and more evident and are now considered a serious threat to not only food and nutrition security, but also the general livelihoods of people to an unprecedented degree as impacts extend to other key socio-economic sectors across the region. Regional governments were forced to implement measures in response to the pandemic that have also contributed to the status of food insecurity in the region (Stephens et al., 2020). The restrictions on movement, border closures, and lockdowns, which all served as containment measures to curb the spread of the COVID-19 virus had and continue to have adverse impacts on the regional agricultural sector (Goswami et al., 2021). In many instances, the flow of inputs to farmers and their produce to markets have been disrupted leading to significant quantities of fresh fruits and vegetables being either dumped or left to decay in farmers' fields (Stephens et al., 2020; Torero, 2020). During the early stages of the pandemic, most countries in the region were able to adequately cope with the initial shocks and supply chain disruptions but as the pandemic ensued countries in the region are finding it increasingly difficult to manage, with many countries battling to supplement their food supplies and minimize food price inflation. The pandemic coupled with the geophysical and climate-related limitations, has placed Caribbean SIDS in a precarious position that needs urgent redress. According to Blazy et al., (2021), the pandemic led to a drop in income, production losses due to difficulties in marketing through conventional channels, but also difficulties in managing the farming systems due to reduced access to inputs and labor.

In February 2021 it was estimated that there were ~2.7 million food insecure people in the Caribbean compared to 1.7 million in April 2020 according to the Caribbean Community and Common Market (CARICOM) COVID-19 Food Security and Livelihoods Impact Survey conducted by the World Food Programme (WFP) in partnership with the CARICOM [Caribbean Community (CARICOM) et al., 2021]. This survey was conducted to rapidly gather data on the impacts on livelihoods, food security, and access to markets in CARICOM. Caribbean SIDS are net food importers, with at least seven of these countries importing more than 80–90% of all food consumed and only three Caribbean countries (Guyana, Belize, and Haiti) produce more than 50% of their own food [Caribbean Community (CARICOM) et al., 2021]. In fact, Caribbean food supply is heavily dependent on imports, primarily from the USA

where 15 CARICOM countries source up to 94% of their food imports from the USA market. The analysis of this survey showed that disruptions in transport routes resulted in many low-income countries having to devolve food distribution or seek alternative delivery routes which led to considerable food price inflation that consequently limited access to lower income sectors of society [Caribbean Community (CARICOM) et al., 2021].

The Caribbean region attempted to unite to reduce loss of life and further spread after the first confirmed case of the COVID-19 was reported on March 1st, 2020, in the Dominican Republic and on March 11th in Jamaica (Murphy et al., 2020). This came at a time when the region was preparing to roll out their annual disaster management plans (from June to November) for the 2020 Atlantic hurricane season (Marshall et al., 2021). A "COVID-19 Response Agri-Food Plan" was developed throughout the region to minimize the impact on food security, concentrating on adequate food access and production within the region (Marshall et al., 2021). National disaster and public health agencies in the region having to deal with managing these co-occurring hazards using generic policies shared by global public health agencies, therefore downplayed the urgency in dealing with place-based food security considerations (Marshall et al., 2021). Generic policies only provide general guidelines with limited consideration for the intrinsic geophysical and socio-cultural characteristics of Caribbean SIDS, and thus were ineffective (Marshall et al., 2021). On the consumer end, the demand for imported products is considerably high throughout the region, as large-scale external producers benefit from a competitive advantage that local producers are unable to match, in terms of quality, quantity, and price (Marshall et al., 2021). FAO (2021) data reports that 94% of all CARICOM imports of cereals, 90% of edible fruit and nut imports, and 90% of edible vegetables, as well as certain roots and tubers imports all come from the USA. Staple foods such as wheat and rice form the bulk of food imports to the region in addition to highly processed, sugary foods and beverages, which contribute to the high levels of obesity and other diet related lifestyle diseases and the triple burden of malnutrition (Fanzo et al., 2019; Saint Ville et al., 2019; Hickey and Unwin, 2020). According to Heck et al. (2020), wheat and rice prices compared to March 2019 have jumped by 8 and 25%, respectively. These trends highlight the complexity of addressing the food security dimensions of the COVID-19 pandemic, amidst climate shocks, loss of soil fertility, increasing pests and diseases, limited available land and the interplay of loss of incomes and availability and affordability of local and imported foods (Ganpat and Isaac, 2015; Beckford and Rhiney, 2016).

Globally, agri-food systems contribute an estimated 11 billion tons of food each year and significantly contribute to the GDP of many economies. Risk is inherent in agri-food systems and their vulnerability became a stark reality in 2020, when measures to contain the COVID-19 pandemic disrupted global and national supply chains and caused economic downturns in many countries due to loss of purchasing power, impacting food security and nutrition of vulnerable people, especially women and children in developing countries. The first 3 months of the pandemic disrupted connections

between supply and demand, even within well-established supply chains. Heck et al. (2020) described the pandemic as threatening the “software” and not the “material hardware” of food production, as other concurrent climatic and ecological crises do.

Having more resilient agri-food systems are critical to food and nutrition security, especially for vulnerable SIDS. The United Nations Common Guidance on Helping Build Resilient Societies defines agri-food systems’ resilience as “the capacity over time of agri-food systems, in the face of any disruption, to sustainably ensure availability and access to sufficient, safe and nutritious food for all, and sustain the livelihoods of agri-food systems’ actors” (United Nations, 2020). It calls for sustained efforts to merge tradition and modern agri-food systems by examining their three major components: (i) primary production; (ii) food distribution, linking production to consumption through food supply chains and transport networks; and (iii) household consumption, including intra-household food distribution. Key actors are farmers or producers; those providing input supply, post-harvest, storage, transport, and food processing services; food distributors, wholesalers, and retailers; food service operators and households and individuals as final consumers. Resilient agri-food systems must have a robust capacity to prevent, anticipate, absorb, adapt, and transform in the face of any disruption, with the functional goal of ensuring food security and nutrition for all and decent livelihoods and incomes for agri-food systems’ actors. Such resilience addresses all dimensions of food security but focuses specifically on the stability of access and sustainability, which ensure food security in both the short and the long term (FAO, 2021). This study explores the impact of the COVID-19 pandemic on agri-food systems in selected countries in the Caribbean. It also identifies some measures and alternative food initiatives that could be adopted to mitigate some of the negative impacts.

## METHODS

### Data Collection

Data collection involved the use of online surveys, and focus group discussions among farmers, food distributors, food service operators, and consumers. The surveys were done over the course of 11 months (January to November 2021) and involved nine Caribbean countries (Trinidad and Tobago, Barbados, Jamaica, Antigua and Barbuda, Dominica, Grenada, St. Kitts and Nevis, St. Lucia, and St. Vincent and the Grenadines). The surveys were publicized and distributed using various crowdsourcing approaches including direct emails and social media. Due to the limitations of the online survey, random selection was not possible. A total of 96 farmers, 60 food distributors, 84 food service operators and 237 consumers from the region participated in the online survey (Figure 1). All respondent group were asked to provide various socio-demographic information including gender, age, and nationality. To assess the impact of the COVID-19 pandemic on the agri-food supply chain in Small Island Developing States in the Caribbean, survey

participants were asked whether they experienced challenges and shocks, and if so, to identify the type of challenges and shocks and to describe coping strategies they may have employed. Respondents were also asked to rank the impact of the pandemic on a scale of 1–10, with 1 being very negative and 10 being very positive.

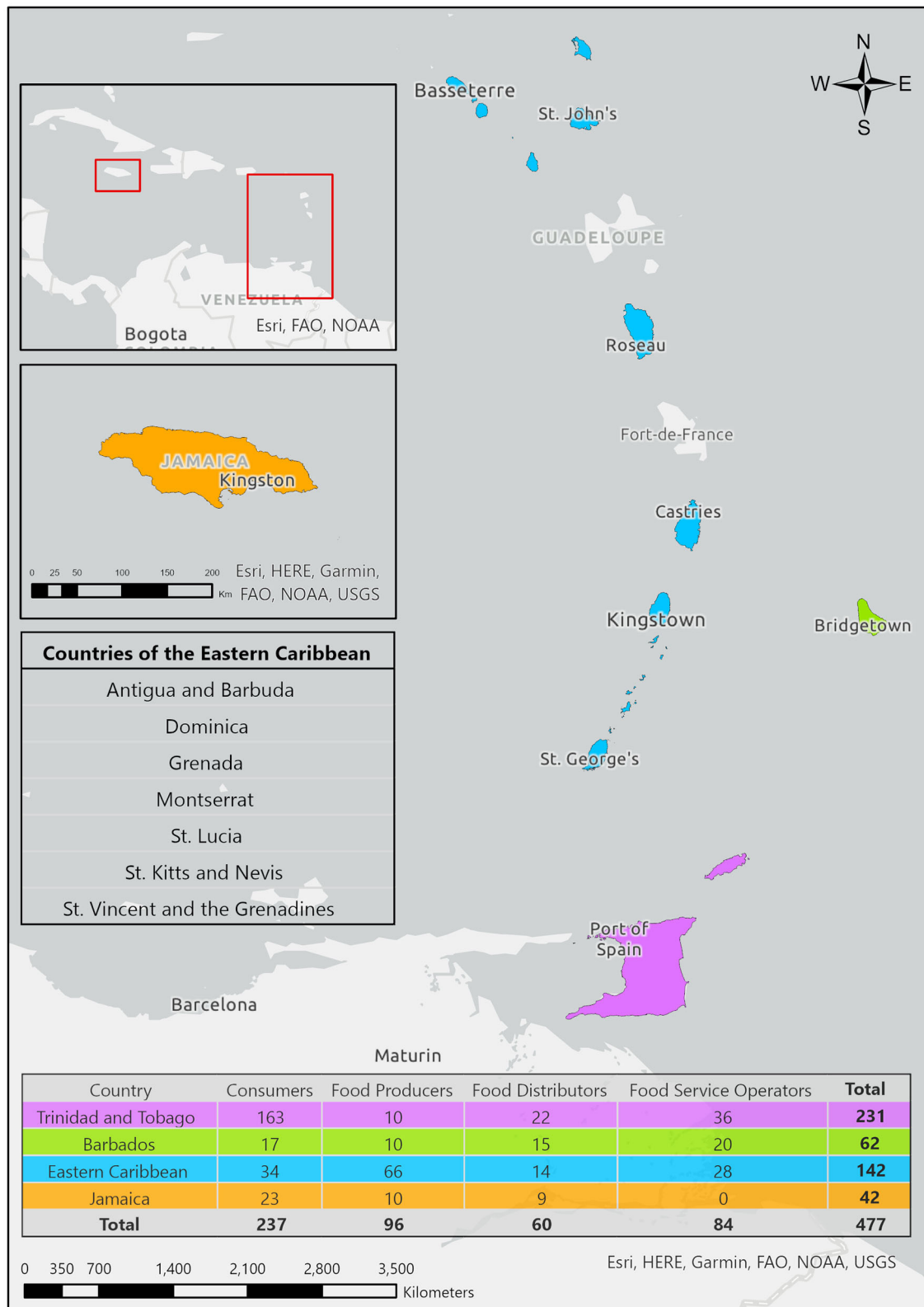
### Focus Group Discussions (FGD)

A focus group is a small group discussion on issues relevant to a topic and is frequently used to collect qualitative data (Krueger, 1994). This methodology was used to develop an understanding of the impact on lives and livelihoods across the region because of the COVID-19 pandemic. Focus groups discussions have been successfully used in numerous food security studies to obtain information regarding food choices and diets within the context of lived experiences as stated by Raibee (2004). In this study, four (4) focus groups discussion were conducted using informal face to face focus group sessions in Farmers’ markets in Trinidad (vendors, farmers, and consumers). For face-to-face discussion, COVID-19 safety protocols had to be observed so no more than 2 people were questioned at a time, which limited the number of respondents. Each focus group took between 10 and 15 min and all responses were documented. Discussions were guided by ten open ended core questions which were as follows:

1. What are the main sectors affected by COVID-19 in your community?
2. What are some of the main challenges faced?
3. How have these challenges been overcome?
4. Any new opportunity because of the challenges encountered?
5. Were new markets accessible?
6. Was money accessible?
7. Do you have better access to markets now compared to the start of the COVID-19 pandemic?
8. Were there changes in the cost of food items/raw materials compared to the same period during the past 4 years?
9. Could you mention some food items for which prices have increased or decreased?
10. Were you the recipient of any support from the Government/private sector or NGO?

### Coding and Data Analysis

Data obtained from the online surveys were numerically coded and statistically analyzed using the Statistical Package for Social Sciences (SPSS v. 28). Coded data were then subjected to both descriptive and inferential statistical analysis (frequencies, and cross-tabulation). Chi-square tests of association were performed to examine significant associations between qualitative variables and socio-demographic factors. Similarly, one-way analysis of variance (ANOVA) tests with the associated *post-hoc* test (Tukey’s b) was performed to examine significant differences among means of impact scores with the socio-demographic factors as independent variables.



**FIGURE 1 |** Map of the Caribbean highlighting countries and different groups in the agri-food system involved in the survey.

**TABLE 1 |** Socio-demographic characteristics of the COVID-19 pandemic survey participants from the Caribbean.

Categories and description	Proportion of respondents %			
	Farmers	Food distributors	Food service operators	Consumers
	(N = 96)	(N = 60)	(N = 84)	(N = 237)
<b>Gender</b>				
Male	66.7	53.3	50.0	31.2
Female	33.3	46.7	50.0	68.8
<b>Age (years)</b>				
<25	4.2	18.3	16.7	21.2
25–44	56.3	51.7	42.9	51.8
45–64	39.6	23.3	35.7	25.9
≥65	0.0	6.7	4.8	1.2
<b>Level of education</b>				
Primary school	10.4	13.3	4.8	0.6
Secondary school	16.7	40.0	35.7	12.4
Vocational/technical training	6.3	3.3	7.1	5.9
Tertiary	66.7	43.3	52.4	81.2
No formal education	0.0	0.0	0.0	0.0
<b>Country</b>				
Trinidad and Tobago	10.4	36.7	42.9	68.2
Barbados	10.4	25.0	23.8	8.2
Eastern Caribbean	68.8	23.3	33.3	14.1
Jamaica	10.4	15.0	0.0	9.4
<b>Rurality</b>				
Rural	62.5	60.0	57.1	42.4
Urban	37.5	40.0	42.9	57.6
<b>Household size (members)</b>				
1–3	47.9	33.3	44.0	42.9
4–6	41.7	63.3	53.6	51.8
≥7	10.4	3.3	2.4	5.3
<b>Monthly household income (USD<sup>†</sup>)</b>				
<500	16.7	20.0	14.3	8.2
500–1,999	29.2	20.0	14.3	30.0
2,000–3,999	29.2	43.3	20.2	32.4
4,000–5,999	16.7	13.3	15.5	14.1
6,000–7,999	2.1	0.0	16.7	6.5
≥8,000	6.3	3.3	19.0	8.8
<b>Employment status</b>				
Government employed	n/a*	n/a	n/a	20.6
Privately employed	n/a	n/a	n/a	28.8
Self employed	n/a	n/a	n/a	19.4
Unemployed	n/a	n/a	n/a	25.3
Student	n/a	n/a	n/a	4.1
Retiree/Pensioner	n/a	n/a	n/a	1.8
<b>Land ownership status</b>				
Rent or leased state land	25.0	n/a	n/a	n/a
Rent or leased private land	16.7	n/a	n/a	n/a

(Continued)

**TABLE 1 |** Continued

Categories and description	Proportion of respondents %			
	Farmers	Food distributors	Food service operators	Consumers
	(N = 96)	(N = 60)	(N = 84)	(N = 237)
Full ownership	16.7	n/a	n/a	n/a
Family-owned land	41.7	n/a	n/a	n/a
<b>Time in operation (years)</b>				
<2	12.5	30.0	17.5	n/a
2–5	18.8	23.3	20.0	n/a
6–10	31.3	10.0	23.8	n/a
11–15	18.8	6.7	11.3	n/a
>15	18.8	30.0	27.5	n/a
<b>Business type</b>				
Sole proprietorship	n/a	63.3	61.9	n/a
Partnership	n/a	20.0	20.2	n/a
Limited liability company	n/a	16.7	17.9	n/a
<b>Business registration</b>				
Registered	n/a	53.3	76.2	n/a
Unregistered	n/a	46.7	23.8	n/a
<b>Type of food service</b>				
Dine in restaurant	n/a	n/a	25.0	n/a
Fast-food restaurant	n/a	n/a	23.8	n/a
Street food stall/ shop	n/a	n/a	34.5	n/a
Catering service	n/a	n/a	16.7	n/a

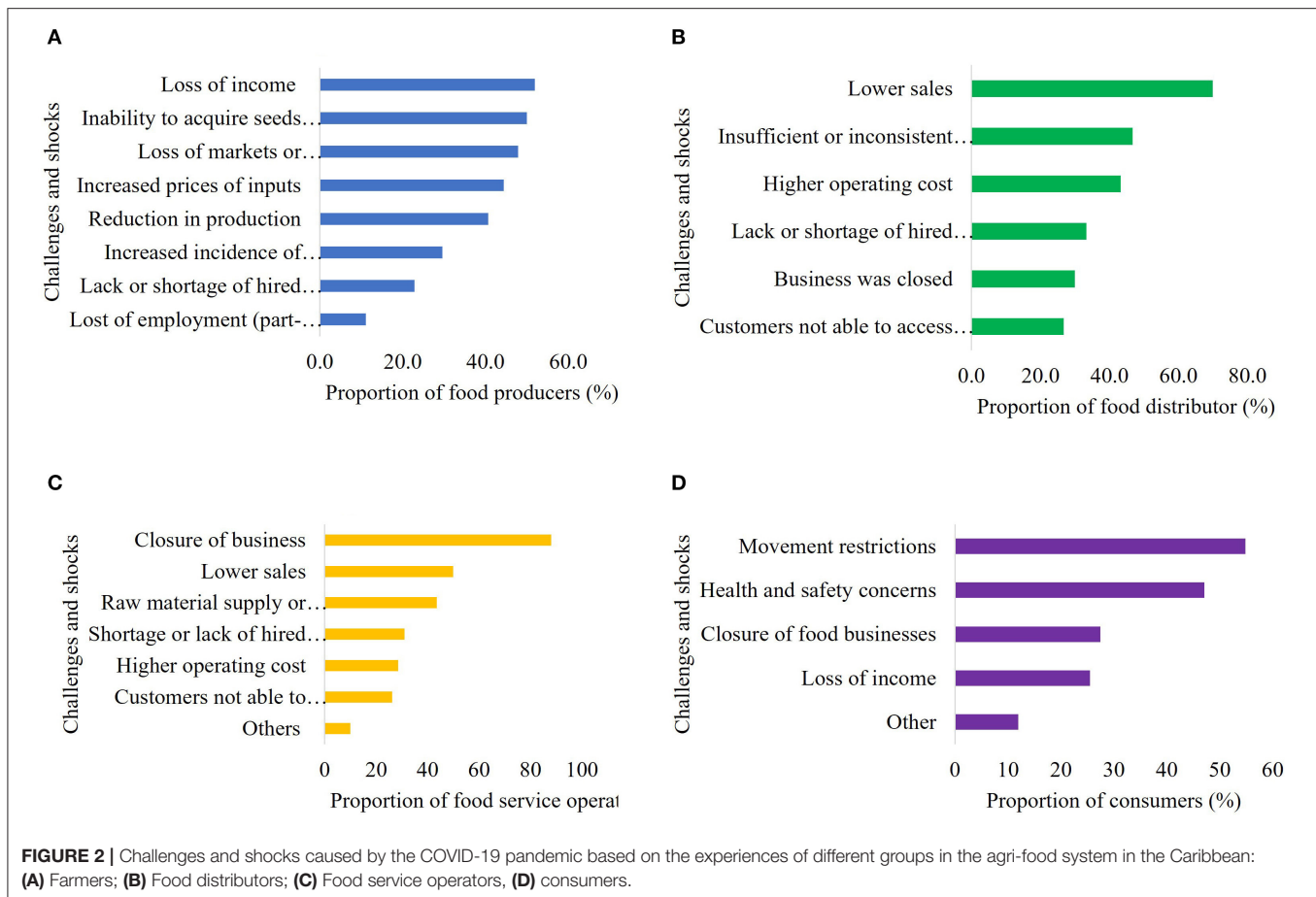
\*n/a, not assessed.

<sup>†</sup>USD, United States Dollar.

## RESULTS

### Characteristics of Respondents

The socio-demographic characteristics of respondents are presented in **Table 1**. Of the 96 farmers, 66.7% were male and 56.3% were between 25 and 44 years, 39.6% were 45–64 years old, and 4.2% were <25 years old. Most farmers (68.8%) in the study were from the Eastern Caribbean, with 10.4% each from Trinidad and Tobago, Barbados, and Jamaica. In terms of land ownership, some 41.7% of farmers produced food on family-owned land, 25% rented or leased state land while rent or leased private land and full ownership both separately accounted for 16.7%. Most food distributors were male (53.3%), with the age category 25–44 years accounting for a majority (51.7%), followed by 45–64 years (23.3%), <25 years (18.3%) and 65 years and older” (6.7%). Some 36.5% of food distributors in the study came from Trinidad and Tobago, 25% from Barbados, 23.3% from the Eastern Caribbean and 15% from Jamaica. Food distributors from rural areas comprised 60% of the sample and the remaining 40% from urban areas. Equal proportions (50%) of male and female food service operators participated in this study. Some 42.9% was in the age category 25–44 years old, 35.7% 45–64 years old, 16.7% was <25 years old and 4.8% was 65 years or older. Some 42.9% operated in Trinidad and Tobago, 33.3% operated in the Eastern



Caribbean, and 23.8% operated in Barbados. Most (57.1%) food service operator were from rural areas and 42.9% in urban areas. The highest number of consumer respondents were female (68.8%) and 51.8% of the sample was 25–44 years, 25.9% was 45–64 years, 21.2% was <25 years and 1.2% was 65 years or older. Most consumers lived in urban areas (57.6%), while the remaining 42.4% lived in rural areas. Finally, 51.8% of consumers reported that their household size was between 4–6 members, 42.9% 1–3 members, and 5.3% of households had 7 or members.

## Impact of the COVID-19 Pandemic Farmers

Most farmers (52.1%) reported that they faced challenges and shocks which were directly related to the COVID-19 pandemic. Some 37.5% did not face any challenges and shock while 10.4% were unsure. Some respondents from Trinidad and Tobago reported a boost to their production because of Migrant workers from Venezuela with one interviewee explaining that it was migrant labor that saved the production of vegetables on his farm. Chi-square test of association showed no statistically significant association between experiencing challenges and shocks and any of the socio-demographic factors evaluated. However, several challenges and shocks were reported based on multiple responses, which included loss of income (51.9%), inability to acquire seeds

and planting materials (50%), loss of markets or difficulties selling produce (47.9%), increased prices of inputs (44.4%), reduction in production (40.4%), increased incidence of pest and diseases (29.6%), lack or shortage of hired labor (22.9%), and loss of employment among part-time farmers (11.1%) (Figure 2). Focus group discussions in Trinidad and Tobago revealed that farmers were also impacted by employee absenteeism either because of sickness or quarantine orders and 75% of all respondents reported a decrease in direct income because of loss of market or loss of employment. Apart from being affected by lower incomes, smallholder farmers also faced food security challenges in their households. Another finding highlighted by focus group discussions in Trinidad and Tobago was praedial larceny with several farmers reporting increased theft of farm produce, livestock, and agricultural inputs during the pandemic. Among those farmers that experienced difficulties to access seeds and planting materials, 65.4% attributed their experience to markets or stores being closed, 42.3% cited movement restrictions imposed by the country, 42.2% believe there was a scarcity or inadequate supplies, 23.1% cited loss of income, 15.4% cited health or safety concerns and 11.5% attributed it to lack of transportation. Further analysis showed that difficulties to access seeds and planting materials was significantly associated with time in operation ( $\chi^2 = 18.95$ ,  $df = 8$ ,  $p \leq 0.018$ ) with those

**TABLE 2 |** ANOVA model on the socio-demographic variables for respondent ranking of the impact of the COVID-19 pandemic in the Caribbean.

Categories and description	Respondent impact ranking (Mean ± SEM)		
	Farmers	Food distributors	Food service operators
<b>Gender</b>			
Male	5.88 ± 0.263	5.00 ± 0.336	3.62 ± 0.337a <sup>#</sup>
Female	5.81 ± 0.372	5.07 ± 0.359	2.67 ± 0.337b
P-value <sup>†</sup>	0.891	0.885	0.049
<b>Age (years)</b>			
<25	6.50 ± 1.053	4.27 ± 0.542ab	4.71 ± 0.547a
25–44	5.70 ± 0.287	5.39 ± 0.323a	3.50 ± 0.341ab
45–64	6.00 ± 0.342	5.43 ± 0.480a	2.13 ± 0.374b
≥65	0.00	3.00 ± 0.899b	2.00 ± 1.024b
P-value	0.660	0.039	0.001
<b>Level of education</b>			
Primary school	4.20 ± 0.642b	4.25 ± 0.667	3.50 ± 1.118
Secondary school	6.00 ± 0.508ab	4.83 ± 0.385	2.93 ± 0.408
Vocational/ technical	7.00 ± 0.829a	5.00 ± 1.334	4.33 ± 0.913
Tertiary	5.97 ± 0.254ab	5.46 ± 0.370	3.09 ± 0.337
P-value	0.037	0.401	0.557
<b>Country</b>			
Trinidad and Tobago	5.60 ± 0.651	5.41 ± 0.399	3.89 ± 0.353a
Barbados	7.20 ± 0.651	5.40 ± 0.483	2.00 ± 0.474b
Eastern Caribbean	5.61 ± 0.253	4.29 ± 0.500	3.00 ± 0.400ab
Jamaica	6.40 ± 0.651	4.67 ± 0.623	0.00
P-value	0.115	0.268	0.007
<b>Rurality</b>			
Rural	5.87 ± 0.272	5.22 ± 0.315	2.88 ± 0.320
Urban	5.83 ± 0.351	4.75 ± 0.385	3.50 ± 0.369
P-value	0.940	0.346	0.204
<b>Household size (members)</b>			
1–3	5.78 ± 0.311	5.10 ± 0.429	3.41 ± 0.364
4–6	5.85 ± 0.334	5.00 ± 0.311	3.02 ± 0.330
≥7	6.20 ± 0.668	5.00 ± 1.357	1.00 ± 1.567
P-value	0.852	0.982	0.289
<b>Monthly household income (USD<sup>‡</sup>)</b>			
<500	4.25 ± 0.451	5.00 ± 0.478bc	2.75 ± 0.618
500–1,999	6.21 ± 0.341	6.12 ± 0.478ab	2.58 ± 0.618
2,000–3,999	5.36 ± 0.341	4.85 ± 0.324bc	2.41 ± 0.520
4,000–5,999	6.25 ± 0.451	3.25 ± 0.585c	3.46 ± 0.594
6,000–7,999	8.00 ± 1.276	0	2.86 ± 0.573
≥8,000	9.00 ± 0.737	8.00 ± 1.170a	4.63 ± 0.536
P-value	0.001	0.001	0.055
<b>Land ownership status</b>			
Rent or leased state land	5.75 ± 0.418	n/a*	n/a
Rent or leased private land	4.75 ± 0.512	n/a	n/a
Full ownership	6.63 ± 0.512	n/a	n/a
Family-owned land	6.05 ± 0.324	n/a	n/a
P-value	0.050		

(Continued)

**TABLE 2 |** Continued

Categories and description	Respondent impact ranking (Mean ± SEM)		
	Farmers	Food distributors	Food service operators
<b>Time since operating (years)</b>			
<2	6.00 ± 0.596	5.11 ± 0.369bc	3.14 ± 0.605
2–5	6.56 ± 0.486	3.57 ± 0.418c	3.94 ± 0.566
6–10	5.60 ± 0.377	7.67 ± 0.639a	3.42 ± 0.519
11–15	6.33 ± 0.486	6.00 ± 0.782ab	2.44 ± 0.754
>15	5.00 ± 0.486	5.00 ± 0.369bc	2.73 ± 0.482
P-value	0.116	0.001	0.434
<b>Type of business</b>			
Sole proprietorship	n/a	5.21 ± 0.306	3.48 ± 0.306
Partnership	n/a	4.43 ± 0.505	2.65 ± 0.535
Limited Liability Company	n/a	5.25 ± 0.668	2.53 ± 0.570
P-value		0.397	0.206
<b>Business registration</b>			
Registered	n/a	5.63 ± 0.317	3.16 ± 0.280
Unregistered	n/a	4.36 ± 0.338	3.10 ± 0.500
P-value		0.008	0.922
<b>Type of food service</b>			
Dine in restaurant	n/a	n/a	3.48 ± 0.490
Fast-food restaurant	n/a	n/a	3.00 ± 0.503
Street food stall/ shop	n/a	n/a	2.86 ± 0.417
Catering service	n/a	n/a	3.43 ± 0.601
P-value			0.748
<b>Overall mean</b>	5.85 ± 0.214	5.03 ± 0.244	3.14 ± 0.243

\*n/a, not assessed.

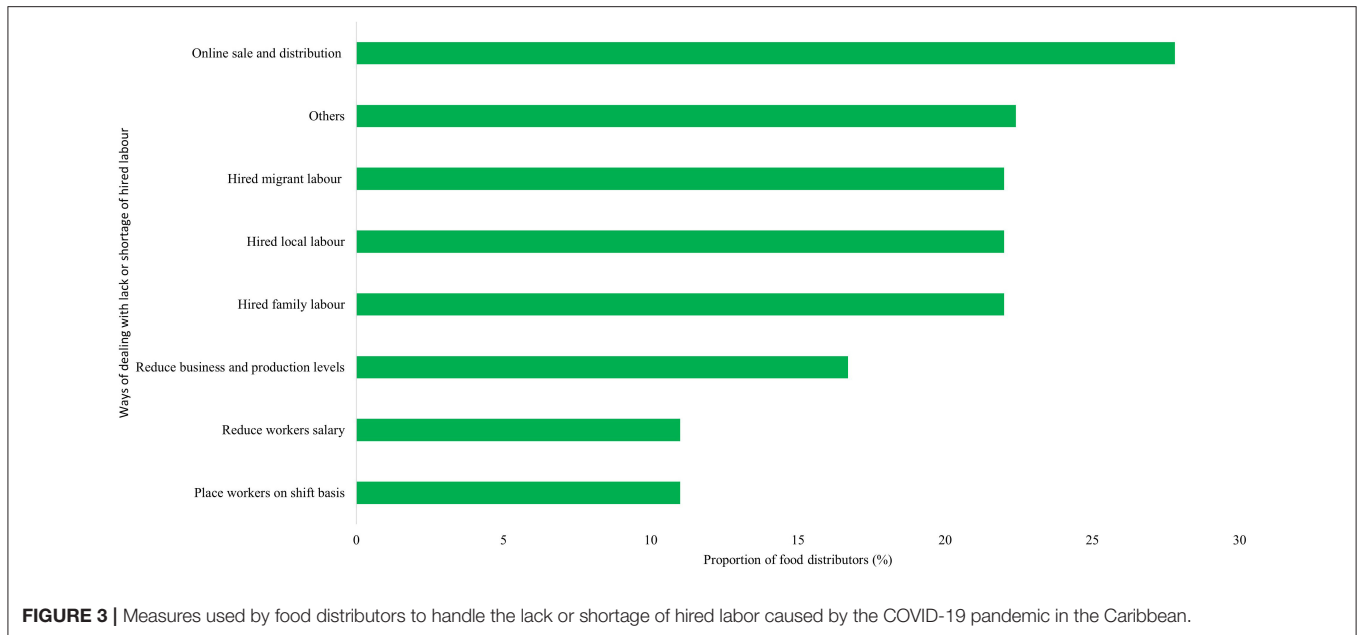
<sup>#</sup>Means within a category, for each group of respondents, that do not share a common letter is significantly different at the p-value stated.

<sup>†</sup>P-value from one-way ANOVA.

<sup>‡</sup>USD, United States Dollar.

farmers that have been operating for 2–5 years and more than 15 years being more likely to experience shocks or difficulties compared to other categories.

Most of those farmers who experienced loss of market or difficulties with selling produce (52.1%) were forced to give away or destroy part of their production due to the lack of marketing and storage capacity. This action was significantly associated with the level of education of farmers ( $\chi^2 = 27.51$ ,  $df = 6$ ,  $p \leq 0.001$ ). Farmers who achieved primary school and secondary school education were more likely to giveaway or destroy their produce than those that achieved vocational/technical training and tertiary training. Among those farmers that experienced a lack or shortage of hired labor, a combined 56.5% resorted to hiring alternate labor for their businesses while 37.5% did nothing and 6.1% had no need. The hiring of alternate labor included family members (18.8%), new local labor (18.8%) and migrant labor (18.8%). There was no significant association between experiencing lack or shortage of hired labor and any of the socio-demographic factors evaluated.



Most farmers (58.3%) did not implement any biosecurity measure on their farm or production areas, but 35.4% did and 6.3% were unsure of what to do. This was significantly associated with gender ( $\chi^2 = 6.753$ ,  $df = 2$ ,  $p \leq 0.034$ ) and education ( $\chi^2 = 20.326$ ,  $df = 6$ ,  $p \leq 0.002$ ). Male farmers were more likely to implement biosecurity measures than their female counterparts. Furthermore, farmers with vocational or technical training were less likely to implement biosecurity measures than those of other education categories.

Finally, the overall mean impact score for farmers ranking of the impact of the COVID-19 pandemic on their food production or business operation was 5.85 (SEM  $\pm$  0.214). Mean impact scores were significantly different based on level of education ( $F = 2.943$ ,  $p \leq 0.05$ ), monthly household income ( $F = 7.541$ ,  $p \leq 0.001$ ) and land ownership status ( $F = 2.543$ ,  $p \leq 0.037$ ) (Table 2). Among education categories, farmers with vocational or technical level training had the highest mean score of 7.00 (SEM  $\pm$  0.829), which was significantly higher than the mean score for those with primary school education (4.20, SEM  $\pm$  0.642) (Table 2). Farmers who had a monthly household income of  $\geq 8,000$  USD were very optimistic about the impact of the COVID-19 pandemic with a mean score of 9 (SEM  $\pm$  0.737), which was significantly higher than households with 2000–3999 USD (5.4 SEM  $\pm$  0.341), and households with  $\leq 500$  USD (4.3 SEM  $\pm$  0.451) (Table 2). Full ownership of their land made farmers more optimistic about the impact of the COVID-19 pandemic with mean a score of 6.6 (SEM  $\pm$  0.512) and significantly higher than those that rented or leased private land (4.8 SEM  $\pm$  0.512) (Table 2).

### Food Distributors

Most food distributors (73.3%) experienced challenges because of the COVID-19 pandemic but 23.4% indicated that they experienced increased sales and 3.3% felt that sales were normal.

Based on focus group discussion in Trinidad and Tobago, when asked about new opportunities because of challenges encountered, some respondents indicated that they had more flexibility in working from home, others indicated that there were more opportunities through the burgeoning online markets and delivery services. Experiencing challenges and shocks among food distributors, was significantly associated with business type ( $\chi^2 = 11.267$ ,  $df = 2$ ,  $p \leq 0.004$ ), business registration ( $\chi^2 = 4.115$ ,  $df = 1$ ,  $p \leq 0.042$ ), rurality ( $\chi^2 = 4.602$ ,  $df = 1$ ,  $p \leq 0.001$ ), level of education ( $\chi^2 = 17.583$ ,  $df = 3$ ,  $p \leq 0.001$ ), and monthly household income ( $\chi^2 = 20.533$ ,  $df = 4$ ,  $p \leq 0.001$ ). A significantly higher proportion of food distributors that operated sole proprietorship and partnership businesses experienced challenges compared to those that operated limited liability companies. Furthermore, unregistered businesses were affected by the COVID-19 pandemic in higher proportions than registered businesses. The data also showed that a significantly higher proportion of businesses that operated in rural areas were negatively impacted by the COVID-19 pandemic compared to those operating in urban areas. In terms of education, food distributors with primary and secondary school education were more likely to be affected by the COVID-19 pandemic than those that achieved tertiary training and vocational and technical training. The data also showed that food distributors from households with monthly income of  $\leq 500$  USD were more likely to be affected by the COVID-19 pandemic than all other monthly household income categories. In terms of the challenges experienced, 70% of food distributors attributed it to lower sales, 46.7% experienced difficulties with accessing raw materials, 43.3% believed that it was due to higher operating cost, while 26.7% felt it was because customers were not able to access the business and 20% indicated that it was because their businesses were closed (Figure 2). Food distributors gave various responses for how the COVID-19 pandemic affected



the supply of agricultural raw materials used in their operation. Most (53.3%) reported that the supplies of raw materials were inconsistent, 36.7% received insufficient quantity of raw materials, and 16.7% indicated that there was a reduction in the quality of raw material received. On the other hand, 30% felt no impact, 23.3% experienced an increase in the quantity of raw materials received. Lack or shortage of hired labor were significantly associated with businesses registration status ( $\chi^2 = 6.562$ ,  $df = 1$ ,  $p \leq 0.010$ ), and level of education ( $\chi^2 = 11.769$ ,  $df = 3$ ,  $p \leq 0.008$ ). Unregistered businesses were likely to experience higher levels of labor shortages compared to registered businesses. Food distributors with only secondary school education were more likely to experience lack or shortage of labor in their businesses compared to those with primary school education and tertiary education. Various measures were used by food distributors to deal with shortage or lack of hired labor including online sales and distribution (27.8%), hiring family members (22%), hiring migrant workers (22%), hiring local labor (22%) and reducing business and production levels (16.7%), placing workers on shift (11%) and reducing workers salary (11%) (Figure 3).

Most food distributors (96.7%) were able to adopt biosecurity measures which became standard practices throughout the COVID-19 pandemic. There was no significant association in biosecurity measures adoption rate among any of the demographic categories evaluated. Food distributors ranked the impact of the COVID-19 pandemic on their distribution business with an overall mean of 5.03 (SEM  $\pm$  0.244). Mean impact scores were significantly different based on age ( $F = 2.988$ ,  $p \leq 0.039$ ), business registration status ( $F = 7.488$ ,  $p \leq 0.008$ ) and monthly household income ( $F = 5.423$ ,  $p \leq 0.001$ ) (Table 2). Mean scores for food distributors in the age categories 45–64 (5.43 SEM  $\pm$  0.480) and 25–44 (5.39 SEM  $\pm$  0.323) were significantly higher than those 65 years and older (3.00 SEM  $\pm$  0.899) (Table 2). Registered food distribution companies had a more positive outlook on the COVID-19 pandemic with a mean score of 5.6 (SEM  $\pm$  0.317) compared to operators of unregistered businesses 4.4 (SEM  $\pm$  0.338) (Table 2). Food distributors who had a monthly household income of  $\geq$ 8,000 USD were very optimistic about the impact of the COVID-19 pandemic with a mean score of 8 (SEM  $\pm$  1.170), which was significantly higher than households with 4,000–5,999 USD (3.3 SEM  $\pm$  0.585), 2,000–3,999 USD (4.8 SEM  $\pm$  0.324) and  $\leq$ 500 USD (5.0 SEM  $\pm$  0.478) (Table 2).

### Food Service Operators

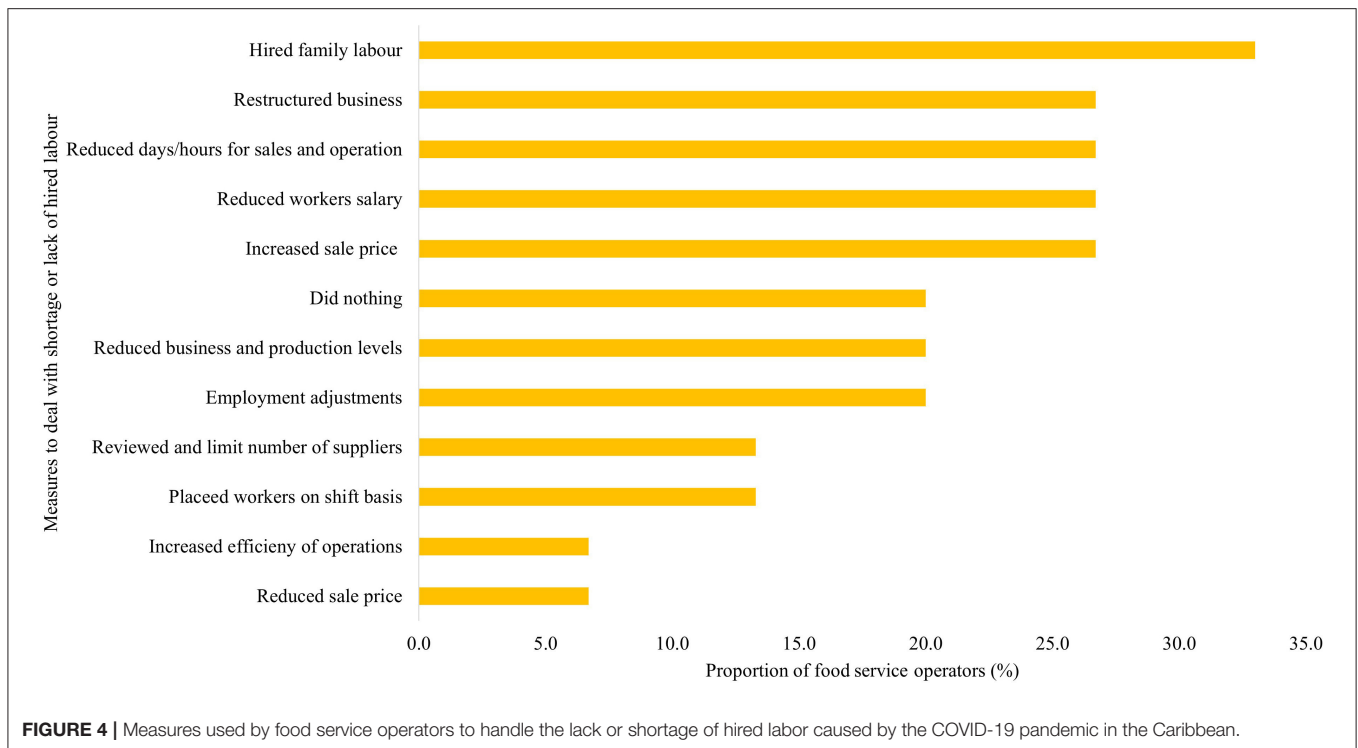
All food service operators (100%) in this study experienced challenges during the COVID-19 pandemic. The challenges experienced included closure of businesses (88.1%), lower sales (50%), raw materials supply or quality (43.6%), shortage or lack of hired labor (31%), higher operating cost (28.6%), customers not able to access the business (26.2%) and other (10%) (Figure 2). Some 35.7% of food service businesses were closed for 6–10 weeks, 28.6% closed for 2–5 weeks, 23.8% closed for 10 or more weeks and 11.9% closed for <2 weeks. Food service operators had various experiences regarding access and supply of agricultural raw materials. Some 43.6% experienced insufficient supply, 33.3%

experienced inconsistent supply and 12.8% suggested that there was a reduction in the quality of raw materials supplied. However, 23.1% indicated that they did not experience any noticeable impact on the supply of raw materials. Lack or shortage of hired labor was significantly associated with business registration status ( $\chi^2 = 10.364$ ,  $df = 1$ ,  $p \leq 0.001$ ), country ( $\chi^2 = 11.259$ ,  $df = 2$ ,  $p \leq 0.004$ ), and monthly household income ( $\chi^2 = 17.124$ ,  $df = 5$ ,  $p \leq 0.004$ ). Unregistered businesses were more likely to suffer from a lack or shortage of hired labor compared to registered businesses. Furthermore, shortage or lack of hired labor was more prevalent in Trinidad and Tobago and Barbados than in the Eastern Caribbean countries. Finally, food service operators with a monthly household income of  $\leq$ 500 USD experienced more labor shortages than those with higher monthly household incomes. Various measures were used to deal with shortage or lack of hired labor. Some 33% resorted to hiring family labor, 26.7% each, increased sale price, reduced workers salary, reduced days/hours for sales and operation and business restructuring. Some 20% each, carried out employment adjustments and reduced business and production levels while 20% did nothing (Figure 4).

Food service operators ranked the impact of the COVID-19 pandemic as negative with an overall mean of 3.14 (SEM  $\pm$  0.243). Mean impact scores were significantly different based on gender ( $F = 3.992$ ,  $p \leq 0.049$ ), age ( $F = 5.961$ ,  $p \leq 0.001$ ), and country ( $F = 5.206$ ,  $p \leq 0.007$ ) (Table 2). Male food service operators (3.62 SEM  $\pm$  0.337) were more optimistic about the impact of the COVID-19 pandemic compared to their female counterpart (2.67 SEM  $\pm$  0.337) (Table 2). Similarly, food service operators <25 years old (4.71 SEM  $\pm$  0.547) were more optimistic than those 45–64 (2.13 SEM  $\pm$  0.374) and 65 years and older (2.00 SEM  $\pm$  1.024) (Table 2). Finally, food service operators from Trinidad and Tobago were more optimistic about the overall impact of the COVID-19 pandemic than those from Barbados (Table 2).

### Consumers

Most consumers (67.1%) indicated that they experienced difficulties in accessing food throughout the pandemic and this was significantly associated with country ( $\chi^2 = 14.245$ ,  $df = 6$ ,  $p \leq 0.027$ ). Although consumers from all countries in the study experienced difficulties in accessing food, it appears that significantly higher proportion in Barbados and Jamaica compared to Trinidad and Tobago and the Eastern Caribbean. In terms of the factors that contributed to the difficulties in accessing food, majority of consumers (54.9%) attributed it to movement restrictions such as curfew and lockdowns, 47.1% experienced difficulties because of their health and safety concerns, 27.5% attributed it to closure of food businesses and 25.5% reported that loss of income and increased food prices caused difficulties for them to access and obtain food (Figure 2). Consumers from the focus group discussion in Trinidad and Tobago when asked to identify the food items for which prices increased or decreased all reported an overall increase in almost all food. Most consumers (79.4%) changed their shopping behavior because of the COVID-19 pandemic. Change in shopping behavior was significantly associated with household size ( $\chi^2 = 7.055$ ,  $df = 2$ ,  $p \leq 0.029$ )

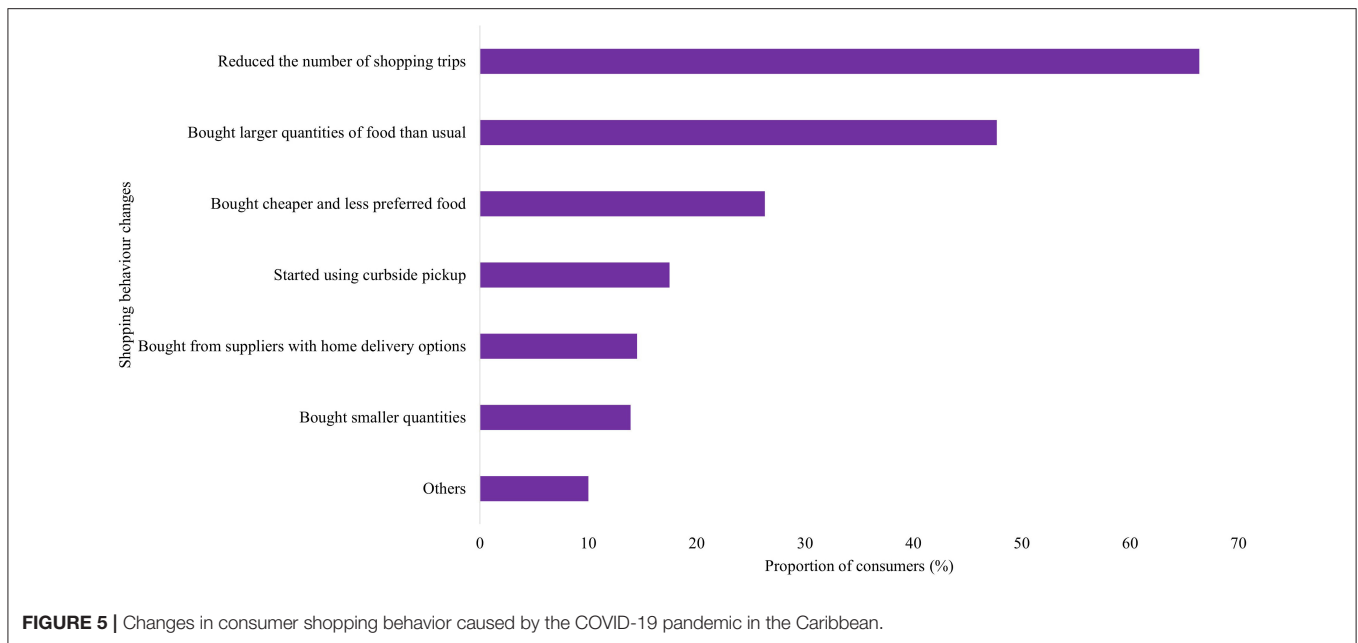


with higher proportions of household having 4–6 members changing their shopping behavior. There were multiple ways in which consumers' shopping behavior changed. Most consumers (66.4%) reduced the number of shopping trips, 47.7% bought larger quantities of food than usual, 26.3% bought cheaper and less preferred food, 17.5% started using curbside pickup, 14.5% bought from suppliers with home delivery options and 13.9% bought smaller quantities (Figure 5). Most consumers (63.9%) indicated that they adopted a healthier diet since the COVID-19 pandemic. The adoption of a healthier diet was significantly associated age ( $\chi^2 = 10.329$ ,  $df = 3$ ,  $p \leq 0.016$ ) and gender ( $\chi^2 = 6.692$ ,  $df = 1$ ,  $p \leq 0.008$ ). A significantly higher proportion of consumers between the ages of 45–64 adopted healthier diets compared to other age categories. The data also showed that a significantly higher proportion of female consumers adopted a healthier diet compared to males. Among those consumers that adopted a healthier diet, 58.8% did so because they felt eating a healthier diet would boost their immunity to infection, 19.1% attributed eating a healthier diet to the fear of contracting the virus, 15.5% reported that healthier options became available and 6.6% reported that limited transport affected their access to fast food restaurants and food outlets. These consumers used different means to adopt healthier diets. Most (75.5%) of those consumers adopting a healthier diet indicated that they did so by choosing to consume more home-cooked meals, 36% indicated they used more locally produced food and food ingredients, and 35.1% felt that growing their own food or home gardening contributed to them having a healthier diet. Majority of consumers (65.1%) indicated that they have eaten or used more locally produced food and food ingredients since

the COVID-19 pandemic. This was also significantly associated with country ( $\chi^2 = 8.474$ ,  $df = 3$ ,  $p \leq 0.037$ ), rurality ( $\chi^2 = 6.784$ ,  $df = 1$ ,  $p \leq 0.009$ ) and household size ( $\chi^2 = 5.914$ ,  $df = 2$ ,  $p \leq 0.050$ ). A significantly higher proportion of Trinidad and Tobago consumers believed they consumed or used more locally produced food and food ingredients since the COVID-19 pandemic compared to other countries in the study. Furthermore, a significantly higher proportion of consumers from rural areas have consumed or used more locally produced food and food ingredients compared to those from urban areas. Finally, a significantly higher proportion of consumers from households with 4–6 members consumed or used more locally produced food and food ingredients compared to consumers from other household size categories.

## DISCUSSION

The results indicated that the impacts of the COVID-19 pandemic were felt along the entire agri-food supply chain and numerous challenges and shocks were identified across all participating groups and countries. Some challenges and shocks such as loss of income and related challenges including lower sales and loss of markets affected all groups in the study but to varying degrees. The level of challenges and shocks experienced by each group were also based on various socio-demographic factors. For example, the results indicated that business type, business registration, rurality, level of education and monthly household income were important factors that influenced how food distributors responded to shocks or challenges. Nevertheless, there were also some



opportunities that arose due to the COVID-19 pandemic. For example, online sale and delivery services of agricultural produce increased tremendously in Trinidad and Tobago, since people were advised to limit crowd interaction to minimize the spread of the disease. This opportunity, while not new, provided a lifeline for food producers and other operators in a hurting agri-food service industry. The pandemic disruptions sparked technological and organizational innovations that will likely prove permanent. What was notable from respondents in Trinidad and Tobago was the increase in value-added commodities from local foods, such as cassava and sweet potato flour, packaging of a range of other commodities from herbs to vegetables and food crops. Institutions such as the Caribbean Research and Development Institute (CARDI) and the Inter-American Institute for Cooperation in Agriculture (IICA) located throughout CARICOM have been providing training to farmers throughout the region promoting the use and consumption of local foods in agro-processing, good manufacturing processes and health and safety. These interventions will be complemented by the deployment of ICT enabled data collection and analytical tools. With respect to consumers, significant association was observed with country, as higher proportion of consumers in Jamaica and Barbados experienced challenges and shocks compared to Trinidad and Tobago and Eastern Caribbean countries. On the other hand, no significant association was detected among any socio-demographic factors for farmers and food service operators in this study which was an indication that challenges, and shocks experienced by these groups were equally felt across all socio-demographic categories. All food service operator in this study reported challenges and shocks and this was the most affected category of respondents. This is linked to the fact that most countries in the survey, instituted complete closure or restricted opening hours of food service businesses

during the pandemic. Challenges and shocks associated with COVID-19 are widely reported globally and several studies have highlighted the impact of COVID-19 on actors in the agri-food supply chain in specific countries. Iese et al. (2021) reported that in the Pacific Islands, namely Fiji and Solomon Islands the impacts on national economies and agricultural production, markets, food systems and socio-cultural processes have been experienced at the household level, increasing poverty and hardship. Xie et al. (2021) reported that the COVID-19 pandemic has adversely impacted the agricultural supply chain, export of agricultural products, and overall food security in China. Another study done in North America pointed out that the COVID-19 pandemic and the near-total temporary loss of the foodservice distribution channel, exposed the vulnerability of agri-food supply chain in the early stages of the pandemic in that region (Weersink et al., 2021). Furthermore, Coluccia et al. (2021) suggested that the negative trend of agri-food exports in Italy was a clear consequence of the pandemic and demand shocks highlighted food supply chain vulnerability.

The results indicated that 51.9% of farmers experienced loss of income, 70 and 50% of food distributors and food service operators, respectively, experienced lower sales and 25.5% of consumers experienced loss of income. This is another clear example of the impact of the COVID-19 containment measures affected livelihood. For example, in Trinidad and Tobago, between March to June 2020, on-farm activities were severely impacted and the movement restrictions during this period affected the most time-critical activities which were labor dependent, especially for general crop management and harvesting. Loss of income and increased poverty during COVID-19 was a speculative reason for the increase in theft in Trinidad and Tobago. The World Bank (2020) projected that loss of income caused by COVID-19 containment measures would be

one of the many channels through which poverty would expand globally (Mahler et al., 2020). Further projections indicated that 71 and 100 million people will return to the extreme poverty condition (living on a per capita monthly income <US \$ 1.90 PPP a day). In the present study, poorer families and smaller businesses were more susceptible to loss of income which is similar to findings from other regions. Gu and Wang (2020) reported that in China, farmers' incomes generally declined due to the COVID-19 pandemic, and traditional small-scale farmers have suffered more losses. Income inequality among countries also affected ability to respond to the COVID-19 pandemic with low- and middle-income countries, including those in this study facing greater challenges to cope. A study using data on income streams under lockdown in developing countries, suggested that an additional 9.1% of the population in sub-Saharan Africa have immediately fallen into extreme poverty because of COVID-19, with about 65% of this increase resulting from loss of income due to lockdowns (Teachout and Zipfel, 2020). The hiring of migrant labor is posited as one way to bolster and develop resilience in the agri-food system. Alvarado (2021) reported that many of the Venezuelan migrants who are in Trinidad and Tobago are highly trained University graduates in agriculture and could offer a lot more to develop the sector.

Loss of income was directly linked to stay-at-home orders and business closure which had a ripple effect throughout economies because consumers could not access goods and services, and the businesses were unable to earn income. Eventually, this led to some businesses laying off employees or forcing them to accept reduced or no salary for the period. All groups involved in this study indicated that they experienced challenges and shocks because of the stay-at-home and business closure order. The ILO (2020) estimated that the COVID-19 crisis could throw millions of workers into unemployment with an estimated rise in unemployment of between 5.3 and 24.7 million people, from a base of 188 million unemployed in 2019. The resulting increase in unemployment or underemployment will have severe consequences on livelihood and has already been reported with greatest impact on the poor and vulnerable (Economic Commission for Latin America the Caribbean, 2020).

Some 47.9% of farmers indicated that they experienced difficulties in acquiring agro-inputs throughout the COVID-19 pandemic, while 45.8% did not experience any difficulty and 6.3% was not sure. In several African countries Nchanji and Lutomia (2021) and Middendorf et al. (2021) reported similar findings where farmers faced difficulties in accessing farm inputs, access to seed, and to extension services. The opposite was observed in Europe where there was limited impact on food production and transportation as well as agricultural products (Meuwissen et al., 2021). Most countries in the Caribbean however provided support, encouraging home-gardening by distributing seeds, seedlings and other inputs to householders, smallholder farmers and vulnerable families for growing basic products—such as corn, beans, vegetables, and tubers—in their own homes and even initiating home garden competitions while some countries even made state lands available for cultivation. The findings of other studies support home gardening initiatives because of the benefits that may be achieved including enhanced food availability at

the household and community levels (Lal, 2020) and supporting diverse diets when on-farm production is low, or market access is limited (Connors et al., 2021). Another study showed that higher frequency of garden usage during the COVID-19 lockdown was associated with better self-rated physical health (Corley et al., 2021). Therefore, home gardening may be an important tool to help achieve food security and support mental well-being. Some governments in the Caribbean provided food to quarantined communities and public-private partnership agreements were established to control domestic prices of the basic food basket. A similar mitigation strategy was reported in Fiji and Solomon Islands where Iese et al. (2021) explained that early actions by most Pacific Island governments included increased access to farms, increased production of root crops, vegetables, and seasonal fruits. A shift to traditional barter systems, land and resource sharing between households enabled households to cope with challenges and shocks (Iese et al., 2021).

More established, farmers, over 15 years seemed to have had more access to supplies of agro-inputs than relatively newer establishments between 2 and 5 years. Respondents cited the closure of outlets, movement restrictions, loss of income, health or safety concerns and lack of transportation as being the major reasons affecting raw materials supply. This could be attributed to distribution constraints experienced during the pandemic. The difficulty of importing inputs has been exacerbated by the extreme shortage of foreign exchange necessary to purchase animal health products, agrochemicals and even farm equipment. Only the largest agro-input suppliers usually have their own sources of foreign exchange, while small, and medium-sized agro-input suppliers which usually service farmers almost never have their own sources of foreign exchange and usually relies on credit. It is worthwhile to note that the demand for agro-inputs increased as many persons got involved in home gardening (Marshall et al., 2021). Although the exact demand caused by home-gardening throughout the pandemic has not been quantified it may have contributed to supply shortage of agro-inputs in some areas that were already stressed to meet existing demands.

The enabling environment for agro-input suppliers affect farmers that rely on timely and reliable availability of critical inputs for their production. Agro-Input suppliers operating throughout the Caribbean reported that the COVID-19 crisis has hindered the enabling environment for agro-input systems in the following ways: First, the availability of imported inputs was constrained due to logistical barriers, manufacturer challenges, and domestic firm access to foreign exchange. Second, farmer demand for inputs declined due to initial restrictions and the uncertainty associated with the general economic slowdown and then after a sudden increased demand with relaxed restrictions. Thirdly, the restrictions on mobility and social distancing requirements have limited agro-input marketing, distribution, and embedded services for farmers. In general, the negative impacts of COVID-19 on smaller firms were more severe than on larger firms, demonstrating that smaller firms were more vulnerable than larger firms during the pandemic.

Just under 50% of farmers in this study indicated that they experienced challenges with selling or marketing their

produce during the pandemic and some had to give away or leave their produce in the field. Interestingly, food distributors, food service operators and consumers had challenges with accessing food or fresh agricultural produce which shows the disruptions experienced were also linked to communication and logistical challenges. Inconsistencies with transportation and limited economic activities posed numerous threats to food distributors. Food distributors and food service operators experienced delays in the supply of raw materials, and the quantity and quality of raw material received, however, food distributors had a positive outlook toward the COVID-19 pandemic compared to food service operators. This positive outlook of food distributors in some countries was probably due to the shift in new market opportunities. Domestic markets for food production and distribution channels have to some extent become more diversified through improved technological services and innovations. In many Islands, these systems have become more coordinated and adapted to changing patterns in demand and have taken advantage of new business opportunities, in processing and online shopping, which were some of the ways that food distributors in this study cope with the challenges and shocks. During the COVID-19 pandemic, agricultural, Business to Business (B2B) and Business to Consumer (B2C), e-commerce platforms have significantly increased and begun to facilitate access to perishable products. From the consumer side, increased support toward healthy food and local markets was also strengthened which includes increased uptake of domestically sourced fruit and vegetables and some animal products and the ability of local and regional supply chains to meet these needs. In the United States, Ahuja et al. (2021) reported that market opportunity doubled during the COVID-19 with an historical 8% growth rate. In fact, this expanding ecosystem of farm-to-consumer marketing schemes have grown just as consumers have sharply expanded use of online grocery purchases, food delivery, and home gardens (Guo et al., 2020). The food industry which was providing hotels (many of which have been closed in the region) is redistributing fresh food in support of the most vulnerable through Governmental support programmes. In Trinidad and Tobago for example, small farmers and small and medium business enterprises have access to adapted finance so they can continue to produce, increasing supply patterns. Many agri-food suppliers had some business opportunities for online food delivery systems and online digital payments by scaling up online ordering systems, while supermarkets have enabled groceries to be ordered through WhatsApp and even email. Restaurants and other food service providers also participated in school-feeding programmes which are important contributors to food security.

The impact of the COVID-19 pandemic caused a shift in which 67.1% of consumers in this study indicated that they experienced difficulties in accessing food with 54.9% attributing the issues to movement restrictions such as curfew and lockdowns, loss of income, stay-at-home orders, and market disruptions, all to help curb the spread of the virus. Although the results indicated that a significantly higher proportion of consumers in Jamaica and Barbados were affected compared to Trinidad and Tobago and the Eastern Caribbean, the issues

were common throughout the region. Besides the direct impact of the measures taken, there were other local socioeconomic factors not identified in this study that may have contributed to the differences among countries. In Jamaica for example, the lockdown and stay-at-home order provided opportunities for the Government to institute other measures to fight crime creating a very complex social dynamic (Crawford et al., 2021). Several studies from different parts of the world also reported issues with food access, food security and related social issues because of the COVID-19 pandemic. The Central Bank of Trinidad and Tobago (CBTT) reported an increase in food prices which they attributed to a surge in international commodity prices and inclement weather (Central Bank of Trinidad and Tobago 2021). Furthermore, food inflation (year-on-year) rose from 3.2 in January to 4.9% in July 2021 with the largest increases recorded for vegetables, fruits, milk, cheese, and eggs (Central Bank of Trinidad Tobago., 2022). Wang et al. (2020) reported that over 20 million school students in the United States of America, experienced food access problems because schools were closed. The World Food Programme (2020) estimated an increase of 130 million people facing acute food insecurity because of the COVID-19 pandemic (World Food Programme, 2020).

A positive effect of the widespread lockdowns and restrictions is that consumers used more locally produced food and food ingredient (36%) and 35.1% grew their own food which helped to reduce household expenditure since public measures were put in place for people to stay at home thus reducing their household income similar to the findings of Blazy et al. (2021). The stay-at-home order forced some households to prepare more home-cooked meals, which caused a change in eating behavior (Kartari et al., 2021). However, with this change, households were consuming foods with an extended shelf-life compared to fresh fruits and vegetables (Janssen et al., 2021). The switch in eating behaviors can be associated to changes in socioeconomic status, employment, and psychological traits (Vidal et al., 2021).

## CONCLUSIONS, RECOMMENDATIONS AND LIMITATIONS

It is necessary to examine the impact of the COVID-19 pandemic on agri-food systems in the Caribbean and to identify mechanisms employed to cope. An understanding of the impacts and effective coping strategies employed will inform effective data-driven decision making and highlight best practices as these countries continue to navigate the perils of the pandemic. This study found that challenges and shocks related to the COVID-19 pandemic were experienced along the entire agri-food supply chain in the Caribbean. Some of these challenges and shocks were common to all actors while others were more specific and showed significant associations with socio-demographic variables. In general people of lower income status and smaller businesses were more susceptible to the negative impacts of the pandemic. The findings also suggest that to overcome the challenges and shocks related to the COVID-19 pandemic some existing businesses used creative means or capitalized on opportunities such as online marketing. In some cases, new businesses were

created because of the opportunities that arose. Some consumers reported developing healthier eating habits and consuming more locally produced food. This is important because the Caribbean is generally considered one of the unhealthiest regions and the high dependence on food importation makes it very food insecure.

Based on the findings of this study the following recommendations are made. Food security policies should be designed and implemented to protect the most vulnerable populations such as the poor, uneducated, small businesses, and rural areas inhabitants. These policies should focus on the entire agri-food supply chain with specific intervention measures depending on vulnerabilities. Governments across the Caribbean should create an enabling environment to stimulate increased local production and foster behavioral change in consumer choices. These two factors are interdependent and must be collectively addressed to help countries across the region to become more food secure. The findings of this study also support the views that Governments, private sector, and all stakeholders must all work together to build a more resilient agri-food system that can withstand the challenges and shocks associated with pandemics but also those caused by natural disasters. To develop a more resilient, sustainable, and efficient local agri-food system, climate-smart agricultural practice must be encouraged and incentivized. This will enhance local production capacity and efficiency and reduce foreign input requirements. It is also necessary that intra-regional trade is promoted which will ensure easier access to markets and minimize the socio-economic impacts of external shocks.

The present study has some limitations. Firstly, because of the restriction put in place for the COVID-19 pandemic, it was difficult to get information from a larger number of participants from more countries in the region. The online surveys were completed only by individuals who have access to online resources which were non-representative and convenient samples. Therefore, these findings represent the populations in these countries who had access to the various online resources. Future studies should focus on a capturing data from more

participants and other methodologies can be considered for assessing and increasing the reliability of the data obtained.

## DATA AVAILABILITY STATEMENT

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

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by The University of The West Indies. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

## AUTHOR CONTRIBUTIONS

OD, WA-I, and AJ conceived the study. OD, WA-I, AJ, and KF conducted the surveys and interviews. OD and RR performed quantitative analysis. All authors contributed to the development of survey instruments. All authors contributed to the article and approved the submitted version.

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## REFERENCES

- Ahuja, K., Chandra, V., Lord, V., and Peens, C. (2021). *Ordering In: The Rapid Evolution of Food Delivery*. Available online at: <https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/ordering-in-the-rapid-evolution-of-food-delivery> (accessed March 20, 2022).
- Alvarado, G. (2021). *Venezuelan Expert to Trinidad and Tobago: 'Take Advantage of Land to Recover Post-Pandemic'*. *Newsday Newspaper*. Thursday July 1, 2021. Available online at: <https://archives.newsday.co.tt/?s=Thursday%20July%201,%202021%20alvarado#> (accessed January 20, 2022).
- Beckford, C. L., and Rhiney, K. (2016). *Globalization, Agriculture and Food in the Caribbean*. Climate change, Gender and Geography. London: Macmillan Publishers Ltd.
- Blazy, J. M., Causeret, F., and Guyader, S. (2021). Immediate impacts of COVID-19 crisis on agricultural and food systems in the Caribbean. *Agric. Syst.* 190:103106. doi: 10.1016/j.agsy.2021.103106
- Caribbean Community (CARICOM), Caribbean Disaster Emergency Management Agency (CDEMA), World Food Programme (WFP), and Food and Agriculture Organization (FAO) (2021). *Caribbean COVID-19 Food Security and Livelihoods Impact Survey – Regional Summary Report 2021*. Christchurch, Barbados, United Nations World Food Programme (WFP).
- Central Bank of Trinidad and Tobago. (2022). *CBTT Economic Bulletin January 2022, Volume XXIV, No.1*. Port of Spain, Trinidad and Tobago: CBTT.
- Coluccia, B., Agnusdei, G. P., Miglietta, P. P., and De Leo, F. (2021). Effects of COVID-19 on the Italian agri-food supply and value chains. *Food Control* 123, 107839. doi: 10.1016/j.foodcont.2020.107839
- Connors, K., Jaacks, L. M., Prabhakaran, P., Veluguri, D., Ramanjaneyulu, G. V., and Roy, A. (2021). Impact of crop diversity on dietary diversity among farmers in India during the COVID-19 pandemic. *Front. Sustain. Food Syst.* 5:695347. doi: 10.3389/fsufs.2021.695347
- Corley, J., Okely, J. A., Taylor, A. M., Page, D., Welstead, M., Skarabela, B., et al. (2021). Home garden use during COVID-19: associations with physical and mental wellbeing in older adults. *J. Environ. Psychol.* 73:101545. doi: 10.1016/j.jenvp.2020.101545
- Crawford, T. V., Parchment, K. F., and Robinson, S. S. (2021). Impact of COVID-19 pandemic restrictions on major crimes and sexual offences in Jamaica: A comparative analysis of crimes reported by the Jamaica Constabulary Force (2014–2020). *Int. J. Soc. Sci. and Humanit. Res.* 9, 162–172.

- Economic Commission for Latin America and the Caribbean (2020). *ECLAC Latin America and the Caribbean and the COVID-19 Pandemic: Economic and Social Effects*. Santiago: ECLAC.
- Fanzo, J. C., Hawkes, E., Udomkesmalee, A., Afshin, L., Allemandi, O., Assery, P., et al. (2019). "2018 Global Nutrition Report-Shining a Light to Spur Action on Nutrition." Bristol: Development Initiatives Poverty Research Ltd.
- FAO (2021). *The State of Food and Agriculture 2021. Making Agrifood Systems More Resilient to Shocks and Stresses*. Rome: FAO. doi: 10.4060/cb4476en
- Ganpat, W. G., and Isaac, W. P. (2015). *Impacts of Climate Change on Food Security in Small Island Developing States*. IGI Global Publishers.
- Goswami, P., Roy, K., Dutta, S., Ray, K., Sarkar, S., Brahmachari, K., et al. (2021). Multi-faceted impact and outcome of COVID-19 on smallholder agricultural systems: integrating qualitative research and fuzzy cognitive mapping to explore resilient strategies. *Agric. Syst.* 189:103051. doi: 10.1016/j.agsy.2021.103051
- Gu, H., and Wang, C. (2020). Impacts of the COVID-19 pandemic on vegetable production and countermeasures from an agricultural insurance perspective. *J. Integr. Agric.* 19, 2866–2876. doi: 10.1016/S2095-3119(20)63429-3
- Guo, H., Liu, Y., Shi, X., and Chen, K. Z. (2020). The role of e-commerce in the urban food system under COVID-19: lessons from China. *China Agric. Econ. Rev.* 13, 436–455. doi: 10.1108/CAER-06-2020-0146
- Heck, S., Campos, H., Barker, I., Okello, J. J., Boy, E., Brown, L., et al. (2020). Resilient agri-food systems for nutrition amidst COVID-19: evidence and lessons from food-based approaches to overcome micronutrient deficiency and rebuild livelihoods after crises. *Food Secur.* 12, 823–830. doi: 10.1007/s12571-020-01067-2
- Hickey, G. M., and Unwin, N. (2020). Addressing the triple burden of malnutrition in the time of COVID-19 and climate change in Small Island Developing States: what role for improved local food production? *Food Secur.* 12, 831–835. doi: 10.1007/s12571-020-01066-3
- Iese, V., Wairiu, M., Hickey, G. M., Ugalde, D., Salili, D. H., Walenenea, J., et al. (2021). Impacts of COVID-19 on agriculture and food systems in Pacific Island countries (PICs): Evidence from communities in Fiji and Solomon Islands. *Agric. Syst.* 190:103099. doi: 10.1016/j.agsy.2021.103099
- ILO (International Labour Organization) (2020). *COVID-19 and the World of Work: Impact and Policy Responses*. Available online at: [https://www.ilo.org/wcmsp5/groups/public/-/-dgreports/-/-dcomm/documents/briefingnote/wcms\\_738753.pdf](https://www.ilo.org/wcmsp5/groups/public/-/-dgreports/-/-dcomm/documents/briefingnote/wcms_738753.pdf) (accessed March 18, 2020).
- Janssen, M., Chang, B. P. I., Hristov, H., Pravst, I., Profeta, A., and Millard, J. (2021). Changes in food consumption during the COVID-19 pandemic: analysis of consumer survey data from the first lockdown period in Denmark, Germany, and Slovenia. *Front. Nutr.* 8:635859. doi: 10.3389/tnut.2021.635859
- Kartari, A., Özen, A. E., Correia, A., Wen J, and Kozak, M. (2021). Impacts of COVID-19 on changing patterns of household food consumption: an intercultural study of three countries. *Int. J. Gastron. Food Sci.* 26:100420. doi: 10.1016/j.ijgfs.2021.100420
- Krueger, R. A. (1994). *Focus Groups. A Practical Guide for Applied Research*. 2nd Edn. Thousand Oaks: Sage.
- Lal, R. (2020). Home gardening and urban agriculture for advancing food and nutritional security in response to the COVID-19 pandemic. *Food Secur.* 12, 871–876. doi: 10.1007/s12571-020-01058-3
- Mahler, D. G., Lakner, C., Castaneda, R. A. A., and Wu, H. (2020). *Updated Estimates of the Impact of COVID-19 on Global Poverty*. World Bank Blog. Available online at: <https://blogs.worldbank.org/opendata/updated-estimates-impact-covid-19-global-poverty>
- Marshall, T., Saint Ville, A., Fletcher-Paul, L., and Isaac, W. P. (2021). "COVID-19: the impact of a complex disaster on household food security in Caribbean SIDS," in Campbell Y, Connell J, editors. *COVID in the Islands: A Comparative Perspective on the Caribbean and the Pacific*. Singapore: Palgrave Macmillan.
- Meuwissen, M., Feindt, P. H., Slijper, T., Spiegel, A., Finger, R., de Mey, Y., et al. (2021). Impact of Covid-19 on farming systems in Europe through the lens of resilience thinking. *Agric. Syst.* 191:103152. doi: 10.1016/j.agsy.2021.103152
- Middendorf, B. J., Faye, A., Middendorf, G., Stewart, Z. P., Jha, P. K., and Prasad, P. V. V. (2021). Smallholder farmer perceptions about the impact of COVID-19 on agriculture and livelihoods in Senegal. *Agric. Syst.* 190:103108. doi: 10.1016/j.agsy.2021.103108
- Murphy, M. M., Jeyaseelan, S. M., Howitt, C., Greaves, N., Harewood, H., Quimby, K. R., et al. (2020). COVID-19 containment in the Caribbean: the experience of Small Island Developing States. *Res. Global.* 2, 1–9. doi: 10.1016/j.resglo.2020.100019
- Nchanji, E. B., and Lutomia, C. K. (2021). Regional impact of COVID-19 on the production and food security of common bean smallholder farmers in Sub-Saharan Africa: implication for SDG's. *Global Food Secur.* 29:100524. doi: 10.1016/j.gfs.2021.100524
- Raibee, F. (2004). Focus-group interview and data analysis. *Proc. Nutr. Soc.* 63, 655–660. doi: 10.1079/PNS2004399
- Saint Ville, A., Po, J. Y. T., Sen, A., Bui, A., and Melgar-Quinonez, H. (2019). Food security and the Food Insecurity Experience Scale (FIES): ensuring progress by 2030. *Food Secur.* 11, 483–491. doi: 10.1007/s12571-019-00936-9
- Stephens, E. C., Martin, G., van Wijk, M., Timsina, J., and Snow, V. (2020). Editorial: Impacts of COVID-19 on agricultural and food systems worldwide and on progress to the sustainable development goals. *Agric. Syst.* 183, 102873. doi: 10.1016/j.agsy.2020.102873
- Teachout, M., and Zipfel, C. (2020). *The Economic Impact of COVID-19 Lockdowns in Sub-Saharan Africa*. London: International Growth Centre.
- The World Bank (2020). *Poverty and Shared Prosperity 2020 - Reversal of Fortune*. Available online at: <https://www.worldbank.org/en/publication/poverty-and-shared-prosperity> (accessed January 20, 2022).
- Torero, M. (2020). Without food, there can be no exit from the pandemic. *Nature* 580, 588–589. doi: 10.1038/d41586-020-01181-3
- United Nations (2020). *UN Executive Summary: United Nations Common Guidance on Helping Build Resilient Societies*. New York, NY: UN.
- Vidal, L., Brunet, G., Curutchet, M. R., Girona, A., Pardiñas, V., Guerra, D., et al. (2021). Is COVID-19 a threat or an opportunity for healthy eating? An exploration of the factors that moderate the impact of the pandemic on eating habits in Uruguay. *Appetite*. 167:105651. doi: 10.1016/j.appet.2021.105651
- Wang, Q., Liu, C., Zhao, Y., Kitsos, A., Cannella, M., Wang, S., et al. (2020). Impacts of the COVID-19 pandemic on the dairy industry: Lessons from China and the United States and policy implications. *J. Integr. Agric.* 19, 2903–2915. doi: 10.1016/S2095-3119(20)63443-8
- Weersink, A., von Massow, M., Bannon, N., Ifft, J., Maples, J., McEwan, K., et al. (2021). COVID-19 and the agri-food system in the United States and Canada. *Agric. Syst.* 188:103039. doi: 10.1016/j.agsy.2020.103039
- World Food Programme (2020). *WFP Hunger Map*. Available online at: <https://hungermap.wfp.org/> Available online at: <https://hungermap.wfp.org/> (accession January 20, 2022).
- Xie, Y., Sarkar, A., Hossain, M. S., Hasan, A. K., and Xia, X. (2021). Determinants of farmers' confidence in agricultural production recovery during the early phases of the COVID-19 pandemic in China. *Agriculture* 11, 1075. doi: 10.3390/agriculture11111075

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