Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Research Notes

COVID-19 and small enterprises in the food supply chain: Early impacts and implications for longer-term food system resilience in low- and middle-income countries

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ABSTRACT

Food and nutrition security play an essential role in weathering and overcoming the COVID-19 pandemic—and in achieving sustainable development. In most low- and middle-income countries, micro, small, and medium-sized enterprises (MSMEs) play an essential role in food supply chains and thus in ensuring food and nutrition security. However, limited attention has been paid to how these critical food system actors are being impacted by the pandemic and associated measures. This paper helps fill that gap through analysis of data from 367 agri-food MSMEs in 17 countries, collected in May 2020 and capturing early impacts of the pandemic on their operations. About 94.3% of respondents reported that their firm's operations had been impacted by the pandemic, primarily through decreased sales as well as lower access to inputs and financing amid limited financial reserves. Difficulty with staffing was also widely cited. Eighty-four percent of firms reported changing their production volume as a result of the pandemic; of these, about 13% reported stopping production and about 82% reported decreasing production. Approximately 54% had changed product prices as a result of the pandemic. The probability of being severely impacted was significantly higher for firms with <50,000 USD in annual turnover; a larger decrease in consumer mobility for grocery/pharmacy shopping also increased the probability of a severe impact. Surprisingly, the youngest firms and those with the fewest employees (controlling for turnover) were less likely to be severely impacted. Over 80% of firms had taken actions to mitigate the pandemic's impact on their operations and/or staff, and about 44% were considering exploring new business areas, with some seeing opportunities for growth. We conclude by discussing implications for policy responses to address immediate challenges as well as increase long-term food system resilience to support further progress towards sustainable development.

1. Introduction

Nutrition and food security play an essential role in immunity and resilience to disease (Chandra, 1997) as well as development, productivity, and wellbeing and are key for the achievement of the Sustainable Development Goals (Development Initiatives, 2017). However, about one in nine people worldwide was hungry, and many more were deficient in micronutrients (FAO et al., 2019; Ramakrishnan, 2002), even before the COVID-19 coronavirus pandemic began affecting lives and livelihoods worldwide. Projections for the impact of COVID-19 on nutrition suggest that it may result in an additional 6.7 million children with wasting (weight too low for their age) in 2020 compared with projections for 2020 without COVID-19 (Headey et al., 2020).

Ensuring food and nutrition security in low- and middle-income countries (LMICs) depends in part on the private sector. Even poor households in rural areas obtain large shares of their food from purchases, with over 50% of food consumed (by value) coming from purchases in most LMICs (GloPan, 2016; Tschirley et al., 2015). These purchased foods make important contributions to

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the diversity of diets: in rural Ethiopia, for example, it was found that purchased food contributed 5–6 food groups to the household dietary diversity score, whereas subsistence production only contributed about 2–3 food groups (Sibhatu & Qaim, 2017), with similar results seen in rural Malawi (Gelli et al., 2019).

Within the private sector, micro-, small-, and medium-sized enterprises (MSMEs) play critical roles in food systems worldwide, and particularly in LMICs (Demmler, 2020; Reardon, 2015). At the production stage, small- and medium-sized farms provide almost half of total calories worldwide, including over 85% of fruit and vegetables (by volume) and about 80% of animal-source foods (e.g., meat, dairy) in sub-Saharan Africa (Herrero et al., 2017). MSMEs are also highly active in the storage, distribution, wholesale, and processing sectors. For example, MSME meat processors are responsible for over 95% of meat processing in Ethiopia (Soethoudt et al., 2013). These mid-chain MSMEs are essential for ensuring food quality and safety and reducing post-harvest loss. MSMEs are also critical at the retail stage: for example, it is estimated than over 80% of several key foods in Kenya and Zambia are purchased through small, traditional outlets and 'mom and pop' stores, as opposed to supermarkets (Gómez & Ricketts, 2013; Wanyama et al., 2019).

Altogether, traditional food supply chains, made up primarily of MSMEs, dominate 50–80% of food economies in LMICs in Asia and Africa (Reardon, Bellemare, et al., 2020); for example, an estimated 72–83% of food consumed in India is handled by MSMEs (Reardon, Mishra, et al., 2020). Indeed, it has been argued that MSMEs play a critical role in promoting the consumption of nutrient-dense foods by the poor (Henson & Agnew, 2020)—and thereby in preventing malnutrition. Such firms are also important sources of employment, crucial for creating markets for farmers, and estimated to play a key role in LMIC food systems over the next 10–20 years (AGRA, 2019).

However, the role of MSMEs in food systems in LMICs has been largely hidden in discussions about responding to the impacts of the COVID-19 coronavirus pandemic on food and nutrition security—much as it has been in pre-pandemic policy debates and research (AGRA, 2019; Reardon et al., 2019). This paper aims to help fill that gap. Using data from a survey of 367 food MSMEs from 17 LMICs in Sub-Saharan Africa and Asia, we describe the ways in which the pandemic and associated control measures have affected and are affecting these firms' operations, highlighting characteristics that seem to make firms more or less resilient to this shock. We conclude by discussing the implications of the results for policymaking during the pandemic as well as for supporting a more resilient food system in a post-pandemic world.

2. Methods

The data presented here come from a survey of owners and/or managers of MSMEs in the food system in 17 LMICs, including firms that directly produce, process, or sell nutritious foods as well as those providing supporting services (e.g., agricultural inputs, cold chain services). Eligible respondents were identified through three food MSME networks convened by the United Nations World Food Programme and the Global Alliance for Improved Nutrition.[1] An online survey questionnaire (in English, French, and Portuguese) was shared via email with about 1,120 firms on 29 April and was open for approximately three weeks, with the final responses collected on 23 May 2020. Follow-up via email and/or phone was used to encourage responses, but participation was fully voluntary. Through a series of closed- and open-ended questions, respondents were asked about how the COVID-19 coronavirus pandemic and any measures to control it (e.g., movement restrictions, border closings) were impacting their business, referencing the period since the pandemic began affecting their country (approximately 6 weeks prior to the survey, with some variation by country). In the interest of keeping the survey short and agile, we avoided questions that required quantifying impacts and instead used multiple-choice, categorical questions. All respondents provided written informed consent to participate. Data were cleaned and analysed using Stata SE15 (StataCorp, 2017). Illustrative examples taken from responses to open-ended survey questions are used throughout the paper to contextualise the quantitative data.

3. Results

3.1. Firm & country characteristics

In total, 367 eligible firms from 17 countries responded. About 59% of respondents were based in Africa and 41% in Asia, with the largest shares coming from Bangladesh, Kenya, and Nigeria. Table 1 displays key demographics and the main countries represented. The participating firms were generally small or micro-sized (i.e., with <10 or 11–50 employees),[2] with less than $100,000 USD in annual turnover. About 28% of responses were from women-owned businesses. Most firms were in the processing sector (58.9%), followed by distribution (37.6%), crop farming (23.7%), and retail (20.2%). The main food categories represented included grains (35.7%), vegetables (32.7%), fruit (25.1%), and fish (18.8%), with 12.5–17.4% for each of roots/tubers, dairy, eggs, meat, legumes, and nuts/seeds. Forty-nine percent of firms worked in more than one value-chain sector and 48% in more than one food category.

Table 2 provides information on the sample size (firms) per country and the key characteristics of the firms within the sample, by country. Across most countries, the largest share of responding firms have <10 employees or 11–50 employees (a 'micro' or 'small' firm); the exception to this is Myanmar, where a sizeable share of respondents are with medium-sized firms (up to 300 employees). About a third of firms are women-owned or -co-owned in most countries, with the outlier being Pakistan (0% female-owned firms). Main sectors of operations are largely similar across countries (with processing, distribution, and crop farming being the most common), but the firms' value chains show more variability, particularly for the dairy and meat/poultry value chains.

Table 2 also shows two key indicators of the severity of the pandemic at the approximate time of the survey. Reported COVID-19 cases per 100,000 people (WHO, 2020) vary widely from low levels in Malawi, Ethiopia, Burundi, Lao PDR, and Mozambique to much higher numbers in Pakistan and Bangladesh. Mobility data show somewhat similar patterns, with large reductions in movement for food shopping in Rwanda, Sri Lanka, Bangladesh, and Pakistan and smaller reductions in Zambia, Cambodia, and Tanzania. These data are taken from a Google dataset (Google LLC, 2020) showing how the number of visits to shops by users and the length of stay were different on May 1, 2020 versus the median for the same day during a baseline period in January–February 2020; the category in question includes grocery markets, food warehouses, farmers

[1] These include the Scaling Up Nutriton (SUN) Business Network, the Post-harvest Loss Alliance for Nutrition, and the Marketplace for Nutritious Foods.

[2] The International Finance Corporation (IFC) considers the following employment numbers to be indicative of MSMEs: Micro enterprise < 10, Small enterprise 10–49, Medium enterprise 50–300. However, different countries and agencies use different definitions (usually based on number of employees or annual turnover) for 'micro, small, and medium-sized enterprises' based on their national context; the threshold for 'large' tends to be higher in high-income countries than lower-income countries.

Table 1
Key firm characteristics.

	Percent/Mean	n/Std. dev.		Percent/Mean	n/Std. dev.
Age (mean, yr.)	7.62	7.1	**Value chain segment**		
Pct. <5 y. old	40.1%	147	Processing	58.9%	216
Pct. female-owned	28.4%	104	Distribution	37.6%	138
Turnover			Crop Farming	23.7%	87
Less than $50,000	52.9%	194	Retail	20.2%	74
$50 k to $100 k	14.2%	52	Livestock Farming	13.6%	50
$100 k to $500 k	13.6%	50	Business advisory services	9.5%	35
$500 k to $1M	4.4%	16	Aggregator	8.2%	30
$1M or more	9.4%	34	Input provider	6.0%	22
Don't know/Prefer not to say	5.7%	21	Other	8.4%	31
Number of employees			**Food category**		
10 or fewer	50.7%	186	Grains	35.7%	131
11–50	34.6%	127	Vegetables	32.7%	120
51–300	10.9%	40	Fruit	25.1%	92
Over 300	2.7%	10	Fish	18.8%	69
Unknown/prefer not to say	1.1%	4	Roots or tubers	17.4%	64
n	367		Dairy	15.5%	57
			Eggs	13.9%	51
			Meat	13.6%	50
			Legumes (beans, lentils, peas)	13.4%	49
			Nuts or seeds	12.5%	46
			Condiments, sweeteners, spices, and oils	7.4%	27
			Baked goods, other ready-to-eat foods	5.2%	19
			Beverages	3.3%	12
			Other	1.9%	9
			Not applicable	6.3%	23

markets, specialty food shops, drug stores, and pharmacies.[3] COVID-19 impacts thus varied across settings, but all countries were experiencing a non-trivial change in consumer behaviour at the time of the survey.

3.2. Impacts

About 94.3% of respondents reported that their firm's operations had been impacted by the pandemic and associated control measures. By far the most common impact cited was decreased sales (81.5% of respondents). Firms also noted difficulty accessing inputs (48.8%), financing (40.2%), or equipment and services (30.1%); limited financial reserves (42.5%); difficulty paying staff (43.9%), inadequate staff (20.2%), or difficulty with staff getting to work (37.0%); closed retail or sales outlets (39.0%); and lost contracts (34.1%). As an illustrative example, a potato-farming group in Nigeria noted that lockdown had prevented farmers from going to their fields as usual, that input prices were rising, and that markets were harder to access due to lockdown. A producer of fortified drinks, soy products, and moringa in Kenya noted that they were unable to pick up their packaging materials in Nairobi due to that city being locked down—which also prevented them from delivering their products to the main urban market. Indeed, inter-regional movement restrictions were a common cause of firms' troubles. As a Kenyan producer of roots/tubers, legumes, and vegetables noted:

> "My farm is in a different county... from where I live (Nairobi). My main market is also in another county... Movement from Nairobi to [home county] is restricted, and the people who man the roadblocks keep on shifting goals on the permits required to allow movement of fresh produce or do not allow me to go to the farm. As a result, I have lost two acres of tomatoes and am unable to plant other crops."

The closure of retail outlets and institutional clients (e.g., schools) was also a common complaint of firms, leading to decreased sales. A Pakistani firm that works with contract farmers to supply produce to restaurants and retail shops explained that the shutdown of those outlets had led to large increases in food loss and waste (due to unsold products). An egg producer in Mozambique noted:

> "Coronavirus has lowered our egg production, and even though we produce locally we are unable to sell them because purchasing power has decreased. Thus, we transport egg to [other districts] every fortnight. If the circulation restrictions become more strict, we will be severely affected, with a risk of closing the company. With eight permanent workers, five seasonal workers and a production of 6000 eggs per day, the coronavirus is bringing down our company's dream to open more egg and chicken production lines."

Respondents were asked to rate the severity of these impacts, taken jointly, on their firm's operations. Of the 346 impacted firms, 38% reported the impact being moderate but manageable, whereas 43% described it as considerable, from which it would be difficult to recover; 16% reported that the impact was severe and likely to cause business closure. Only 3% considered the impact to be only minor.

As shown in Fig. 1, 83.8% of firms reported changing their production volume as a result of the pandemic; of these 290 firms, about 13% reported stopping production, 46% reported a considerable (>30%) decrease, 26.9% a moderate decrease (15–30%), 9.0% a slight decrease (<15%), and 5.5% an increase in production. Considering the firm's product's sales price, approximately 54% of respondents had changed their product's price as a result of the pandemic; of these changes, about 27.1% represented a considerable (>30%) decrease, 28.6% a moderate decrease (15–30%), 9.6% a slight decrease (<15%), 18.6% a slight increase, and 16% a moderate or larger increase.

Looking to the next six months, 84.5% of firms expected impacts of the pandemic on their supply chains. The main anticipated impacts cited were shortages of supplies (60.3%) and transportation and distribution disruptions (49.0%); about 27.7% of firms

[3] As the data come primarily from use of smartphone apps and are based on a sample of Google users, they likely do not perfectly represent the behaviour of the wider population, particularly lower-income and older individuals. For four countries (Burundi, Ethiopia, Malawi, and Madagascar, representing 8% of the observations), no data were available; in the regression model, the mean value across the other included countries was used, instead.

Table 2
Country-level firm characteristics and impacts of COVID-19.

				Characteristics of sampled MSMEs			
Country	n	COVID-19 Cases (per 100,000 people)	Decrease in mobility to food stores & pharmacies	Employees	Pct. female owned	Main sectors (% of firms)	Main value chains (% of firms)
Bangladesh	54	47.02	−53%	<10 (52%), 11–50 (31%)	37%	Distribution (72%), Processing (52%), retail (38%), crop farming (31%)	Grains (48%), inputs (39%), fruit (37%), eggs (30%)
Kenya	54	7.30	−31%	<10 (63%), 11–50 (31%)	26%	Processing (67%), crop farming (28), livestock farming (19%), aggregation (19%)	Vegetables (31%), grains (30%), dairy (22%), roots/tubers (20%)
Nigeria	51	7.62	−45%	<10 (39%), 11–50 (49%)	33%	Processing (67%), distribution (39%), crop farming (33%)	Vegetables (45%), grains (43%), roots/tubers (29%)
Indonesia	36	37.39	−23%	>10 (75%), 11–50 (22%)	19%	Distribution (53%), processing (25%), crop farming (14%)	Fish (78%), vegetables (17%), grains (8%)
Sri Lanka	33	29.77	−83%	<10 (45%), 11–50 (30%)	39%	Processing (79%), distribution (39%), retail (24%)	Fruit (33%), grains (27%), vegetables (24%), nuts/seeds (21%)
Rwanda	29	17.82	−63%	<10 (48%), 11–50 (38%)	24%	Processing (41%), crop farming (34%), livestock farming (21%)	Grains (34%), vegetables (34%), fruit (31%), eggs (24%)
Mozambique	22	2.50	−39%	<10 (59%), 11–50 (32%)	23%	Distribution (45%), livestock farming (41%), processing (32%)	Eggs (41%), meat/poultry (36%), vegetables (27%), legumes (23%), fish (23%)
Tanzania	20	8.28	−23%	<10 (70%), 11–50 (25%)	26%	Processing (80%), distribution (25%); crop farming, aggregation, and advisory services (each 20%)	Grains (60%), roots/tubers (35%), vegetables (20%), fruit (20%)
Madagascar	11	4.75	NA	<10 (45%), 11–50 (36%)	36%	Processing (91%), retail (36%), distribution (27%)	Grains, nuts/seeds, fruit (each 27%); legumes, fish, vegetables (each 18%)
Myanmar	11	2.78	−41%	11–50 (36.4%), 51–300 (55%)	18%	Processing (73%), distribution (36%), retail (36%)	Grains (27%); roots/tubers, nuts/seeds, dairy, fruit, beverages, ready-to-eat foods (each 18%)
Pakistan	11	74.42	−48%	<10 (27%); 11–50 (64%)	0%	Processing (64%); distribution, retail, and advisory services (each 27%)	Fruit (63%), grains (45%), meat/poultry (36%), vegetables (36%)
Zambia	11	5.43	−10%	<10 (54%), 11–50 (36%)	36%	Processing (64%), distribution (27%)	Grains (64%), legumes (54%); roots/tubers, nuts/seeds, vegetables (each 27%)
Malawi	10	1.93	NA	<10 (50%), 11–50 (30%)	30%	Processing (80%), crop farming (30%), livestock farming (30%)	Grains (50%), fruit (50%), roots/tubers (40%), meat/poultry (40%)
Ethiopia	4	1.16	NA				
Lao PDR	4	2.65	−29%				
Burundi	3	1.30	NA				
Cambodia	3	7.40	−18%				

Note: due to small sample size, information on employees, sector and value chains is not included for Ethiopia, Lao PDR, Burundi, and Cambodia. Firms can be active in more than one sector and more than one value chain. Mobility data comes from (Google LLC, 2020); case data from (WHO, 2020), refers to cases reported through 30 April 2020. NA = not available.

anticipated a possible suspension or stoppage of production, and 24.8% anticipated suppliers closing down. About 22.3% of firms anticipated diversifying their supply chain, 22.3% of firms expected to shift to a more localised supply chain, and 17.4% anticipated reducing product lines and/or ingredients used. As an example, a processor and distributor of bean-based products in Rwanda reported expected impacts on the cost of dry beans (their main raw material) and also that restrictions on the travel of engineers would limit them from installing new processing machines. However, <20% of firms anticipated a change of their production focus (e.g., toward production of hand sanitiser or similar) or moving their operating premises. As one processor and distributor of grains, legumes, and vegetables in Burundi noted, "It is difficult to anticipate a contingency plan without the funds [to carry it out]."

3.3. Which MSMEs appear to be most resilient?

Analysis of data by subgroup via Pearson's Chi-squared tests (Table 3) reveals that impacts cut across all sectors: at least 45% of respondents in each food category and each business category reported a considerable or severe impact of the pandemic on their business, with similar results (albeit at a lower level) seen for reports of stable or increased production/business volume. However, firms in business services and distribution were significantly more likely to report stable or increased production/business volume as a result of the pandemic ($p = 0.001$ and 0.047, respectively), whereas those in the fish sector were less likely to do so ($p = 0.009$). Reporting an overall severe impact on the business was significantly more common for crop farmers ($p = 0.023$), and food service/catering was the hardest hit sector, with all 10 firms in this sector reporting severe or considerable impacts of the pandemic ($p = 0.005$). There were fewer clear differences by value chain, but reporting an overall severe impact on the business was marginally significantly more common for firms working with dairy, vegetables, or legumes ($p = 0.081$, $p = 0.053$, $p = 0.089$). Female-owned firms were more likely to report a 30% or greater decrease in production, with 67% of women-owned firms reporting this ($p = 0.067$), but there were no differences in overall reported business impact by gender of firm owner.

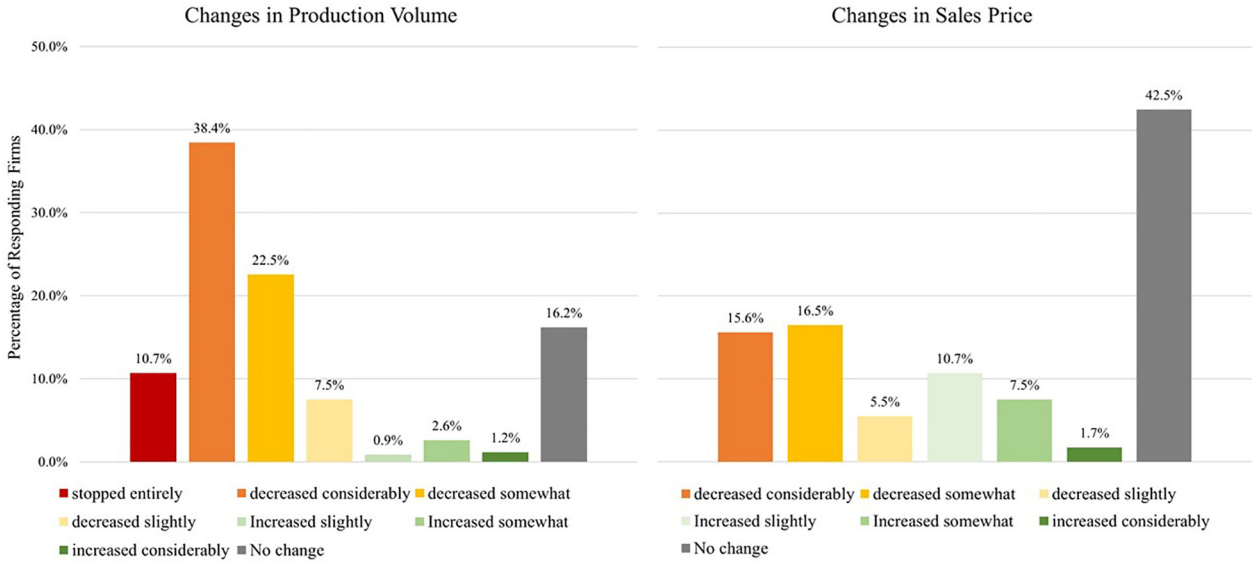

Fig. 1. Reported changes in food production volume (left) and sales price (right). Note: includes only those firms that report being impacted by the pandemic.

Table 3
Differences in severity of COVID-19 impact, by sector and value chain.

	Firms reporting considerable or severe impact on firm operations		Firms reporting stable or increased production	
	Percentage	P	Percentage	P
All Firms	56.1%		25.3%	
By sector				
Processing	**60.2%**	**0.061**	52.7%	0.162
Crop farming	**66.7%**	**0.023**	18.3%	0.154
Livestock farming	54.0%	0.744	9.7%	0.199
Retail	**65.9%**	**0.090**	22.6%	0.501
Distribution	55.8%	0.920	**46.2%**	**0.047**
Business advisory services	45.7%	0.192	**18.3%**	**0.001**
Input provider	59.1%	0.773	5.4%	0.771
Aggregator	50.0%	0.480	10.8%	0.294
Wholesale, trading, export/import	66.7%	0.519	2.2%	0.828
Catering and food service	**100.0%**	**0.005**	2.2%	0.694
By value chain				
Grains	55.7%	0.907	38.7%	0.482
Roots & Tubers	64.1%	0.159	20.4%	0.379
Nuts & seeds	54.4%	0.794	**18.3%**	**0.053**
Legumes	**67.4%**	**0.089**	17.2%	0.206
Meat & poultry	60.0%	0.553	15.1%	0.642
Fish	47.8%	0.123	**9.7%**	**0.009**
Dairy	**66.7%**	**0.081**	19.4%	0.239
Eggs	64.7%	0.184	16.1%	0.471
Vegetables	**63.3%**	**0.053**	34.4%	0.684
Fruit	55.4%	0.876	28.0%	0.457
Condiments, sweeteners, spices & oils	59.3%	0.734	8.6%	0.594
Beverages	50.0%	0.663	5.4%	0.186
Animal feed	50.0%	0.861	0.0%	0.409
Baked goods & other ready-to-eat foods	63.2%	0.526	6.5%	0.521

Note: p-value refers to the Pearson Chi-squared test statistic; values in bold have $p < 0.10$

To examine factors influencing firm resilience to the effects of the pandemic in more detail, we estimated a logit model predicting the likelihood of a firm reporting being severely impacted by the pandemic based on various firm characteristics. Independent variables were selected based on expectations of characteristics that might make a firm more or less vulnerable to the effects of pandemic-related control measures and included binary variables for being a female-led firm, being one year old or less, being ten years old or older, selling highly perishable foods (i.e., meat, fish, dairy, egg, fruit, or vegetables), selling shelf-stable staple foods (i.e., grains or legumes), having <10 employees, having <50,000 USD or >500,000 USD in annual turnover, being engaged in farming, being in the retail or food service sectors, and being diversified (i.e., working across more than one food category or business area). We also included a variable capturing the average percentage change in mobility compared to before the pandemic for groceries, food markets, and pharmacies, as described in Section 3.1 (Google LLC, 2020). Country-level dummy variables were included for the countries with sufficiently large sample sizes to make this feasible, with standard errors adjusted for clustering at the country level.

As shown in Table 4, the probability of reporting being severely impacted by pandemic-associated control measures was

Table 4
Results of regression predicting likelihood of being severely impacted by the pandemic.

Variable	Marginal Effect	p	
Female-led firm	0.028	0.469	
One year old or less	−0.103	0.000	***
Ten years old or older	−0.061	0.387	
Highly perishable food	−0.033	0.462	
Shelf-stable staple food	−0.041	0.404	
<10 employees	−0.057	0.045	**
Under 50 k in annual turnover	0.128	0.000	***
Over 500 k in annual turnover	0.105	0.111	
Crop or livestock farmer	0.054	0.151	
Retail or food service	0.043	0.306	
Diversified	−0.021	0.546	
Decrease in grocery mobility	0.005	0.000	***

Note: for all binary variables, the marginal effect is for a discrete change of the binary variable from 0 to 1. Variables found to be significant are marked with ** and *** for $p < 0.05$ and $p < 0.01$, respectively.

significantly higher for firms with <50,000 USD in annual turnover. Younger firms (those in operation for less than one year) were less likely to be severely impacted, as were those with the smallest number of employees. A larger decrease in consumer mobility for grocery shopping within the country also significantly increased the probability of a severe impact on firms. Interestingly, food category had no significant impact on likelihood of severe impact, nor did diversification across foods or business areas, underlining the universal nature of the pandemic's impacts. The country-level variables indicated significantly higher likelihood of severe impact in Bangladesh, Kenya, Nigeria, and Tanzania but lower likelihood in Sri Lanka.

3.4. Actions

Approximately 80.7% and 83.9% of firms reported taking actions to mitigate the impact of the pandemic on their business operations and to protect their employees, respectively. Considering the former category, main actions included adapting the supply chain (47.6%) and increases in communication: with clients and customers (48.0%), via social media (33.8%), and internally (33.1%). As examples, one Lao PDR food processor, retailer, and caterer reported creating a new service of set-menu meal deliveries for self-isolating families and businesses, and an Indonesian vegetable producer that usually sold to hotels and restaurants had started catering and targeting sales to religious holiday celebrations. While these are generally positive adaptations, there were also some more negative adaptations: a Nigerian egg producer noted selling off laying birds to reduce the cost of feeding in response to lower sales amid the lockdown.

About one third of respondents (31.4%, n = 93) reported downsizing their workforce in order to reduce operational costs. Considering employee support, main actions included providing personal protective equipment (76.6%), providing information on prevention of COVID-19 transmission (74.7%), and cleaning work areas more frequently (70.1%). About one third each reported adjusting staff working hours (e.g., using rotations) and allowing employees to work from home. Only 8.8% of firms, however, reported offering paid sick leave and <2% offered transport or childcare to employees. About 7.5% had closed the business completely.

Not all impacts, however, were negative. About 43.6% of respondents noted wanting to explore new business areas as a result of the pandemic. Those most commonly named included various models for online sales and delivery, including use of smartphone apps; production of medical supplies and protective equipment; focusing more on processing and creating shelf-stable products via drying, UHT processing, and/or canning; expanding exports; producing food supplements and therapeutic foods, especially for use in relief projects; and producing clean, safe, or 'immunity-bo osting' foods. Indeed, some respondents saw the pandemic as creating business opportunities specifically for firms producing 'healthy' and safe foods, due to renewed attention to issues such as health and hygiene. As noted by a processor and retailer of grains and condiments in Indonesia:

> "The coronavirus pandemic has raised the awareness of health in Indonesia. This gives a really good awareness of the healthy food and beverage industry... in our opinion, this could give a really good impact on health[-related] businesses and open new business opportunities, and we think we could adapt to this condition, though we need some time for that."

Others noted finding motivation in being among the 'essential' businesses keeping their community going during the pandemic. As one Tanzanian respondent explained, 'Being in the food industry means we are the main service providers at the moment. The nation depends on us for provision of food.' A crop aggregator in Nigeria similarly noted that, "[the] pandemic has served as an eye opener not only for me but I thought it is for everyone... most people see farming as [an] occupation for poor households; it is now known global[ly] that for everything one possess[es] on earth, importance of food to every household cannot be overlooked. This has actually encouraged my organisation members that farming is a good business."

4. Limitations

The use of an online survey of existing MSME networks enabled rapid analysis to address an evolving issue while working within pandemic-imposed constraints on movement and personal contact. However, it did introduce certain potential biases. First, there was some potential for misinterpretation of questions, as the online survey mechanism did not allow for explanation or elaboration on meaning, as possible in a face-to-face survey. Second, certain countries are over-represented in the responses, due to the greater presence of the surveyed networks in those countries, and certain regions (e.g., Latin America) are not covered. The networks themselves also have some biases. Two of the networks are comprised of firms from all segments of the agri-food value chain and nearly all foods; however, due to an emphasis on supporting the production and sale of 'nutritious foods', they underrepresent firms producing fast food, highly processed snacks and drinks, sweeteners, non-nutritious condiments, and dessert products. The sample thus underrepresents impacts on firms producing these foods, many of which have longer shelf-lives. It does, however, include firms in the value chains for main staples, legumes, fruits, vegetables, nuts, dairy, meat, poultry, egg, and fish, in both raw and processed forms, as well as composite products. The third network, the Post-harvest Loss Alliance for Nutrition, exists in only three countries and has a narrower focus, on the prevention of post-harvest loss across the value chains of specific foods (fish in Indonesia and tomatoes in Ethiopia and Nigeria). Its membership is thus less representative of the agri-food sector and, within these three countries, over-represents firms focussed on these commodities (as shown in Table 2 for fish in Indonesia). However, only 12.5% of responding firms belonged uniquely to this network.

Comparing data on firm size, age, and gender of firm owner from the World Bank Group's Enterprise Surveys (World Bank Group, 2020) to our sample for seven countries that comprise about 75% of our sample suggests that, compared to MSMEs in the agri-food sector as a whole, firms surveyed here are representative in terms of female ownership but slightly smaller (in terms

of number of employees) than the sector overall and significantly younger; the latter two differences might be expected to make them more vulnerable to shocks such as the pandemic, but the results of the regression suggest the opposite.

Finally, the survey response rate, 33%, is in line with typical rates for online surveys (Deutskens et al., 2004; Nulty, 2008) but low compared to an in-person survey. The firms responding may thus not be fully representative of the firms in their networks. In particular, the responding firms may have been harder hit by the pandemic than the average firm (and thus more motivated to opine on the topic); in contrast, representatives of firms that were the hardest hit (e.g., closed, risking closure) may have been less able or willing to take the time to respond to the survey, given other pressures. Overall lower response rates in countries that were less impacted by the virus (e.g., Laos, Cambodia) support the former hypothesis while comparison of results for severity of impact between countries with relatively high response rates and those with relatively low response rates supports the latter hypothesis. While rates of mobile network penetration in these settings are generally high, firms in more remote areas may have been less likely to complete the survey, as it required a computer or smartphone (however, in all of these countries, most MSMEs are concentrated in less-remote areas). The sample may also under-represent those firms with less internet-savvy owners/managers, which may also be firms less able to pivot to online platforms and other adaptations. Finally, the survey was available in English, French, and Portuguese, covering main languages of business in all countries, but not in local languages such as Kiswahili and Bangla, which may have dissuaded some business owners from participating.

5. Discussion

The COVID-19 pandemic has been noted as having significant effects on food systems worldwide, through both the fragilities it has revealed within food supply chains (Torero, 2020) and its effects on food demand and consumer purchasing power (Barrett, 2020). With the abovementioned caveats in mind, this paper has added new evidence on how actors within LMIC food systems are coping with the pandemic through a survey of 367 food system MSMEs in 17 countries in Asia and Africa conducted early in the pandemic. Overall, we found that the overwhelming majority of firms had been impacted by the pandemic, with the vast majority of these impacts being negative—primarily in the form of decreased sales (and revenues) and difficulty accessing inputs, equipment, and services. Nearly 80% of firms had decreased their production volume due to the pandemic.

The results largely align to those found in a study of impacts of the COVID-19 epidemic on Chinese SMEs in February 2020 (Dai et al., 2020), which found severe impacts on firm operations. They also align to the early hypotheses of Reardon and colleagues (Reardon, Bellemare, et al., 2020), who emphasised that the pandemic could result in considerable impacts being felt post-farm and in mid- and down-stream segments. Those hypotheses were largely confirmed in rapid studies of impacts on agriculture in Bangladesh (FAO, 2020), vegetable supply chains in Ethiopia (Tamru et al., 2020) and India (Harris et al., 2020), and agricultural commodity traders in Myanmar (Goeb et al., 2020; MSU & IFPRI, 2020), which found generally negative impacts on loss levels, production or trading volumes, and/or sales, in line with the results of this study.

Specifically, decreased sales was the major complaint reported here by firms. In addition to direct closures of retail outlets and lower consumer purchasing power, this likely arose due to changes in consumer behaviour: a decrease in consumer mobility for grocery shopping was significantly associated with an increased likelihood of severe negative impacts for firms. While unsurprising, this emphasises the importance of consumer actions for the bottom line of firms: one of the most important ways to support food system firms during the pandemic is to enable consumers to shop safely. This may be achievable partly through online platforms: numerous firms surveyed here, even small ones in LMIC settings, reported experimenting with such approaches or interest in doing so. However, such approaches are likely to leave behind some firms and consumers and thus need to be accompanied by policies and processes that facilitate in-person retail, including for the small shops and informal markets that are critical to food supply in many LMICs and sell the products of many MSMEs (Demmler, 2020; Resnick, 2020). Policy responses in the early days of the pandemic included actions that both facilitated food retail (e.g., credit or loan moratorium programmes for small-scale retailers in India and Nigeria) and hindered it (e.g., banning street vendors in Malawi and Ethiopia), offering lessons for improvement (Kennedy & Resnick, 2020). Targeted interventions to bolster consumer demand (e.g., unemployment insurance and other social safety nets) may also be needed.

Disruptions in access to inputs, equipment, and services were all widespread, and most firms (85%) expected continued disruptions to supply chains, particularly with regard to input and transport. Indeed, the domestic limitations on movement across regions or into/out of cities emerged as a clear cause of firms' difficulties (including accessing their facilities, moving products, or sourcing inputs, equipment, and technicians), underlining the importance of, to the extent possible, keeping borders open to support food systems during the pandemic—a point which has been made strongly for international borders (Bouët & Laborde Debucquet, 2020; Glauber et al., 2020) but less so for *intra*national ones. Comments from surveyed firms highlight how exceptions to movement restrictions for essential goods or industries like agri-food may be insufficient if not consistently enforced or not encompassing the movement of workers, inputs to packaging and processing (in addition to production), and essential equipment and the technicians needed to install and maintain it. Innovative policy approaches to facilitate transport of food (such as a new app for farmers, traders, and transporters in India and special intra-state transport permits for seed in Nigeria (Kennedy & Resnick, 2020)) have emerged since this data was collected and could be considered for scale-up to other countries if needed to mitigate movement restrictions in the future.

While this survey was fielded only about 6 weeks after the pandemic began impacting the countries concerned, nearly one third of firms reported already having laid off workers. For each of the 93 firms surveyed here that reported laying off staff, there will be ripple effects as those staff need to seek alternative employment or make do with less or no income. Given the difficulty of starting a business in many LMICs (World Bank, 2020), firms that fail are unlikely to be quickly replaced, and the negative effects on employment may be long-lasting. This underlines the potential benefits, in terms of protecting consumer incomes and preventing poverty and hunger, of providing interim financial support to MSMEs to enable them to continue operating and paying wages (and thereby continuing to fulfil their important role in employment (ILO, 2019)). Such approaches stand in contrast to policies adopted by several LMICs (including three studied here) that required firms to continue paying wages during the pandemic—even if they were unable to operate (Rosenbach & Resnick, 2020).

Finally, the vulnerability of the firms with the lowest level of turnover likely arises due to lower reserves and/or profits, shrinking the financial buffer available to provide resilience to adverse shocks to revenues. This emphasises the need to ensure that policy responses, such as those providing grants and loans to MSMEs (Rosenbach & Resnick, 2020), do not only seek out the largest firms

in terms of production or employment but consider firm vulnerability, as well. In the long term, it will be essential to address the systemic issues that make access to finance a particularly acute challenge for MSMEs in the agri-food sector of LMICs (Nordhagen et al., 2019). Controlling for turnover levels, however, the likelihood of severe impacts was lower for the youngest firms and those with the fewest employees. This may relate to greater adaptability and agility (due to being smaller and less established), to having less to lose, or to using more tech-enabled business models (which may be more likely among younger, start-up firms). While the results of this study offer only an initial snapshot, a key aspect of the longer-term post-COVID research agenda on food systems should be to examine the factors that increase agri-food firm resilience and how to foster them more broadly.

This study has also provided reasons for optimism. Firms had adopted numerous positive coping mechanisms (e.g., increased communication, improved workplace sanitation) and nearly half were hoping to or already had explored new business areas as a result of the pandemic. Some of the areas named offer high-potential avenues for making food systems more resilient in the long term, as well as more supportive of nutrition and sustainable development. For example, a greater focus on processing for improved storage life would help to address the major problem of food waste (FAO, 2019) and could increase food safety, palatability, convenience, and nutrient content as well as shelf-life (Dwyer et al., 2012), thereby helping increase nutrition security. This may be particularly important in settings and during times (such as a pandemic) with less regular access to markets for fresh, perishable products. Similarly, efforts to improve hygiene as part of the immediate response to the pandemic could be leveraged to increase food safety (a major cause of disease in many LMICs (Kirk et al., 2015)). As noted by some survey respondents, COVID-19 also offers a potential opportunity in that it has led many people to place increased value on health and highlighted the importance of nutrition in wellbeing, as several diet-related non-communicable diseases (e.g., diabetes) are among the risk factors for serious COVID-19 complications (Wu et al., 2020). For businesses that produce safe, nutritious foods, this newfound interest in health could be an occasion to expand their consumer base and product line while improving population nutrition—an ambition cogently expressed here by a survey respondent from Indonesia.

6. Conclusion

MSMEs are critical producers of food in LMICs (Demmler, 2020), and a key entry point for mitigating the risks that COVID-19 poses to global food security (Laborde et al., 2020). A food system that integrates a diverse set of MSMEs and larger firms is likely to be more resilient to shocks than one reliant on only a few producers or processors, as shown by the mass culls of livestock that took place in the United States amid the closure of meatpacking plants due to COVID-19 within a highly concentrated industry (Azzam, 1998; Gallagher & Kirkland, 2020). Decreased production and potential business failure of MSMEs during the pandemic, as documented here, could result in decreased availability or affordability of safe, nutritious food, eventually resulting in decreased diet quality and increases in malnutrition (Cornelsen et al., 2015; Headey & Ruel, 2020; Rozelle et al., 2020). Through both direct effects on food supply chains and indirect effects via incomes, it has been estimated that the pandemic could double the number of food insecure people globally (WFP, 2020); an increase in wasting prevalence due to pandemic-related reduced food access (combined with decreased access to health/nutrition services) is projected to result in about 120,000 additional child deaths in 2020 (Headey et al., 2020). Among other policy actions, supporting MSMEs throughout food value chains in LMICs is a critical step to ensure these dire scenarios do not come to pass.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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