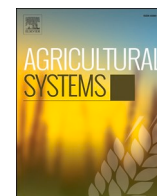




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Perceived effects of COVID-19 restrictions on smallholder farmers: Evidence from seven lower- and middle-income countries

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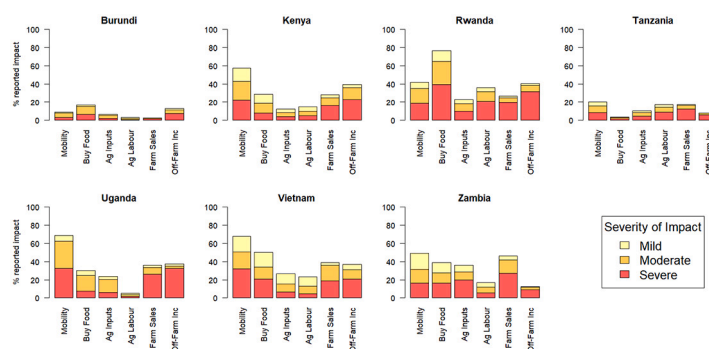
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HIGHLIGHTS

- We report on 9201 interviews with smallholder farmers on the effects of COVID-19 and associated restrictions during 2020.
- Effects attributed to restrictions were widespread and severe, off-farm and farm-based incomes were reduced.
- More stringent national containment measures were associated with worse economic and food security outcomes.
- Depending on location and study timing up to 80% of respondents reduced food consumption and up to 50% suffered income loss.
- As the pandemic rumbles on it is vital to support rural peoples and their agricultural work to avoid a secondary crisis.

GRAPHICAL ABSTRACT



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ABSTRACT

CONTEXT: The COVID-19 pandemic caused unprecedented global disruption and continues to wreak havoc. Dire predictions were made about the risks to smallholder farmers in lower- and middle- income, but hard data have been lacking. We present the results from 9201 interviews with smallholder farmers from seven countries.

OBJECTIVE: The objectives are to describe: i) how farmers perceive the key effects of the COVID-19 pandemic and containment measures on livelihoods and food security; ii) the effects on agricultural activities; iii) the coping strategies households deployed.

METHODS: Household surveys were conducted as part of ongoing monitoring programs during the latter half of 2020. Sites in seven countries were covered: Burundi; Kenya; Rwanda; Tanzania; Uganda; Zambia; and Vietnam. Findings are representative of smallholder farmers across multiple districts per country.

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RESULTS AND CONCLUSIONS: The effects of the COVID-19 containment measures were widespread and often perceived to be severe. Food purchase, off-farm income, sale of farm produce, and access to crop inputs were all affected. In locations under more stringent restrictions during the time of the survey, up to 80% of households had to reduce food consumption and/or variety. Almost all households with off-farm incomes reported reductions, by half on average. A half to three-quarters of households (depending on the location) with income from farm sales reported losses compared to the pre-pandemic situation. In locations with more relaxed containment measures in place during the time of the survey, less frequent and less severe economic and food security outcomes were perceived by the respondent, with around 20% of households reporting negative outcomes. Mobility restrictions, reduced market access, crashes in sale price for agricultural goods, and soaring prices for food purchase were key factors. Sale prices generally dropped for all agricultural products in any given location, and affected not only high-value perishable products, but also staple crops such as maize and cassava. Depending on the location, between 30% and 90% of the households applied coping strategies in response to the pandemic during 2020. There was an almost complete absence of official aid amongst households interviewed. **SIGNIFICANCE:** Our results raise the thorny issue of how best to balance containment of disease against the wellbeing of the vulnerable rural population in lower- and middle-income countries. There is a risk that the buffering capacity of rural people will become exhausted. Possible policy measures to limit negative outcomes include i) tiered mobility restrictions with travel allowed for economic reasons; ii) short-term price guarantee schemes to stabilise the food system; iii) direct aid; iv) the timely re-installation of distribution channels for agricultural inputs.

1. Introduction

The SARS-CoV-2 or coronavirus disease (COVID-19) continues to spread around the world since its discovery in 2019 and is recognised as a global pandemic by the World Health Organization (WHO). The pandemic has resulted in direct human health issues across the world, while containment measures such as travel restrictions, curfews and closures of public places are having severe economic consequences as well as social costs (World Bank 2020a and 2020b; WFP, 2020). Food systems across the world are directly affected by these measures, leading to disruptions in food production and the whole food supply chain, with direct effects on both producers and consumers (Stephens et al., 2020; Torero, 2020; UN, 2020).

Smallholders are an important part of the food system, contributing the majority of food production in many low-income and middle-income countries. Small farms (≤ 20 ha) produce more than 75% of most food commodities in Sub-Saharan Africa, Southeast Asia, South Asia, and China (Herrero et al., 2017). They are also the most vulnerable to food insecurity and poverty (Sibhatu and Qaim, 2018; Fanzo et al., 2018), with households suffering from both lack of available nutritious foods and low purchasing power even when food is available. As stated by Béné et al. (2021) 'Access to food – whether through own production or using income from cash cropping or nonfarm sources – was already poor and may have gotten worse due to the COVID-19 pandemic and policies adopted to slow the spread of the disease'. The World Bank estimated that by the end of 2020 an additional 88 to 115 million people were pushed into extreme poverty by the COVID-19 pandemic (World Bank, 2020a).

This study was conceptualised in May of 2020, when precious little was known about the COVID-19 virus, the health implications, and the impacts of containment measures. Our intention was to collect information on the general trends relating to smallholders' livelihoods, agriculture, and food security, for as broad a geographic area as we could access. Considering the widespread lack of knowledge, we prioritised a broad and shallow research strategy over a deep and narrow study. In the intervening time, a literature assessing the effects upon smallholder farmers' food security and livelihoods has emerged. According to a recent systematic review looking at food security outcomes, 35 papers have been published to date (Picchioni et al., 2021). Another recent review from a micro-economic perspective found eight papers worth consideration (Bloem and Farris, 2021). Two papers report on multi-national survey datasets, which can claim nation-level representation (the RECOVR dataset – Egger et al., 2021; and the LSMS-ISA dataset – Josephson et al., 2021). Two more papers report on nationally representative datasets for single countries (Adjognon et al., 2021;

Amare et al., 2021), and the remainder report on subnational regions generally, but not entirely, within a single nation. The majority of those studies use panel datasets with pre-pandemic rounds, and make use of validated indicators of self-reported food security status to compare against the pre-pandemic counterfactual (e.g. the Food Insecurity Experiences Scale, see Ballard et al., 2013). In this study we did not have access to a robust counterfactual dataset and therefore asked respondents to identify disruptions they believed were caused by the pandemic and associated restrictions, and then to self-assess the severity of effects of those disruptions on their livelihoods and food security (food access). Despite this sub-optimal approach, we note that this study would meet the inclusion criteria set out in the systematic review by Picchioni et al. (2021).

The geographical scope of studies to date has been limited (Bloem and Farris, 2021). We present results from seven countries, representative of smallholder farmers within multiple sub-national regions per country. For three of those countries, there is no published information on the effects of the COVID-19 pandemic on smallholder farmers (Vietnam, Burundi, Tanzania). For one country – Zambia – there is only one other published study (comprising of 40 interviews; Mathew et al., 2020). Two of the countries – Kenya and Rwanda – are covered in the nationally representative RECOVR datasets (see Egger et al., 2021), and there is also one more focused study in Kenya (Nechifor et al., 2021). Uganda is covered by the long-term LSMS-ISA dataset (Josephson et al., 2021) and also one study of smallholders in the Western province has been published (Mahmud and Riley, 2021). This manuscript therefore adds to the geographic scope of the academic literature, and provide opportunity for corroboration or otherwise for existing datasets and results. Furthermore, there has been little research on the coping strategies that rural households applied to deal with the negative effects of the pandemic, which is an important element to be able to assess the resilience of these vulnerable households to recover from the current shock.

This study aims to address these knowledge gaps via the results from cross-sectional surveys carried out during the latter part of 2020 and early 2021 with smallholder farmers from seven countries. In total 9201 interviews were conducted. The objectives of this study are i) to describe the disruptions as perceived by smallholder farmers due to the COVID-19 pandemic and associated containment measures, related to livelihoods and food security; ii) to describe the perceived effects these measures have had on agricultural activities; iii) to delineate the coping strategies households employed to deal with these perils. We explore possible reasons for differing results across the study locations, considering the stringency of national policy responses and the timing of the surveys, and draw lessons for possible policy responses.

2. Methodology

2.1. Data collection

Throughout the second half of 2020 a series of household surveys were implemented in sites in seven countries: Burundi, Kenya, Rwanda, Tanzania, Uganda, Vietnam and Zambia (Table 1, Fig. 1). The data presented in this study are all based on single cross-sectional survey applications, and site selection was opportunistic, whereby ongoing activities pivoted to gather information on COVID-19. The programs which were able to collect this information were already running, and were working with smallholder farmers at the poorer end of the spectrum in each country – typically land holdings were 1 ha or less and incomes were rarely above the international poverty line of \$1.90 per person per day (except for a sub-sample in South West Uganda - see Hammond et al., 2021). Table 1 gives key information regarding sample size, survey timing and locations; as well as contextual information: national peaks in COVID-19 infections, and stringency of official containment measures in place at the time of the surveys (Hale et al., 2021), and an indication of the overall state of development in each nation using the Human Development Indicator (UNDP, 2020). The number of households interviewed differed between the countries, and were based on statistical analyses determining the size of representative samples of smallholder farmers who were, or could be, engaged in the ongoing research activities in each site. Whilst this is not representative of the overall population, in each case it gives a thorough representation of the smallholder farmers within the study sites, and may be indicative of smallholders’ experiences elsewhere. The sites were generally identified at district level and have been summarised in Table 1 as sub-national regions. Households were chosen for interview randomly from lists of both the general population and lists of participants in the ongoing project activities within each site. Throughout this manuscript we refer to the country when discussing the survey findings in relation to national policies regarding COVID-19 containment measures or national-level development indicators, but it is important to note that surveys are only representative for smallholders in the areas listed in Table 1, and not for the countries as a whole. In total 9201 households were interviewed.

2.2. National response to COVID-19 and survey timing

The seven countries studied illustrate a diversity of official response to COVID-19 (see also Table 1). During the time of data collection in Tanzania, the government policy was that there was no COVID-19 in Tanzania, and that everything should continue as normal. In Burundi, the government frankly stated that the nation was too poor to risk shutting down their economy. The official response in Zambia was a

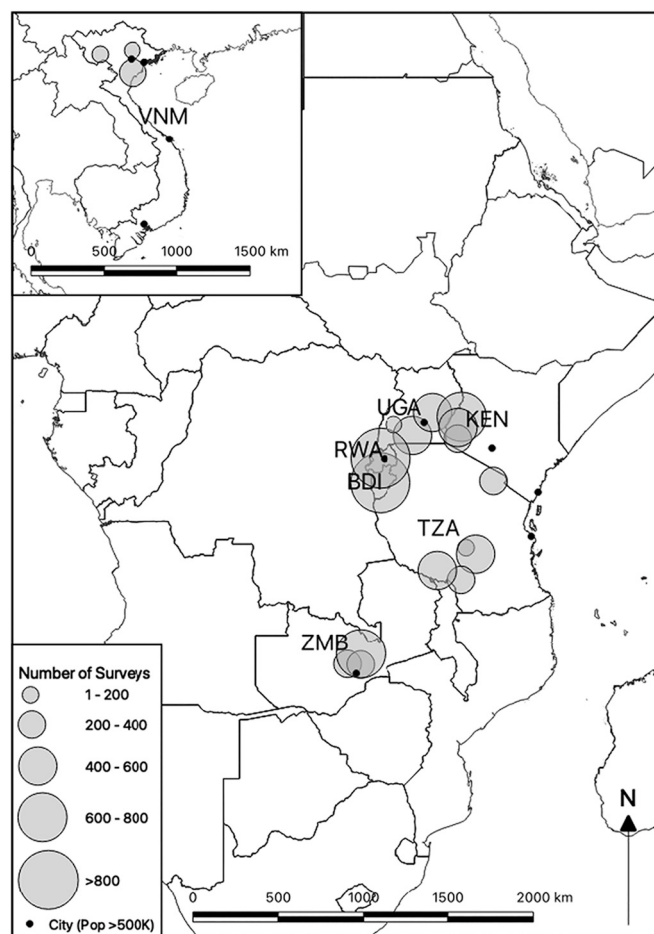


Fig. 1. Study locations.

little firmer, with the closure of universities, schools, entertainment and large gatherings, but without any curfew or enforced mobility restrictions. Uganda and Kenya both opted for enforced curfews and travel restrictions. Vietnam and Rwanda both implemented very well organised and stringent containment measures, including curfews, contact tracing, and strict social distancing regulations; operating a “go hard and go fast” approach which has been widely praised in both popular and academic literature (e.g. Karim et al., 2021; Van Tan, 2021; Cahán, 2020).

The timing in which the surveys were conducted in relation to the

Table 1

Sample sizes, locations, and timing. National peaks in COVID-19 infections (WHO, 2021), stringency of COVID-19 restrictions during the period of the survey (Hale et al., 2021) and the national human development score (UNDP, 2020).

Country	Number of interviews	Sub-national regions	Months of data collection	Stringency of COVID-19 restrictions	National COVID-19 peaks	Human Development Indicator (0–1)
Burundi	842	Muramvya, Gitega, Ngozi.	Aug – Sep 2020	11.11	No significant peaks	0.433
Kenya	1711	Western, Rift, Nyanza, Central.	Jun – Nov 2020	73.60	July 2020, Nov 2020	0.601
Rwanda	1151	East, West, South, South West.	Dec 2020 – Jan 2021	59.72	Aug 2020, Jan 2021	0.543
Tanzania	2590	Mbeya, Arusha, Iringa, Kilolo south, Iringa, Songwe, Njombe.	Nov – Dec 2020	14.31	No significant peaks	0.529
Uganda	859	Central, Eastern, Western.	Sept 2020 – Jan 2021	50.15	Sep 2020, Dec-Jan 2021	0.544
Vietnam	489	Son La, Thai Nguyen.	Aug – Nov 2020	62.71	Mar-Apr, Jul-Aug 2020	0.704
Zambia	1433	Chibombo, Kapiri, Chisamba.	Aug – Sep 2020	49.61	July 2020, Feb 2021	0.584

national situation is also relevant. Official containment measures waxed and waned in accordance with national needs. The survey in Rwanda was carried out after a particularly stringent lock-down, which was later relaxed having succeeded in reducing the community transmission rates and in recognition of the negative economic effects. In Vietnam the survey was conducted during a second wave of containment measures, which were later relaxed. In Kenya, the data collection spanned a period of strict containment measures, and the relaxation of those measures. In Uganda, data collection was during a period of more relaxed measures following seven months of more stringent restrictions. Considering these dynamics, the differing outcomes reported for the different countries are as much due to survey timing as to national policy responses.

2.3. Survey content

In each case, the COVID-19 household survey was applied as part of a longer survey related to ongoing activities in the study locations. The COVID-19 survey began by asking if the respondent was aware of any suspected cases of COVID-19 within the local community or within their extended networks. The second part asked about their experience of any disruptions within the last month which had been caused by the COVID-19 pandemic compared to their “usual” situation. The potential disruptions covered were: reduced mobility, reduced market access for food or agricultural inputs; agricultural labour, non-farm work; and sales of farm produce. If respondents reported a disruption to one of these categories, they were asked to rate the severity of the disruption, choosing from “mild”, “moderate”, and “severe”. In the case of income reductions respondents were asked to estimate the proportion of income lost (choosing from “little”, “one quarter”, “half”, “three quarters”, or “all”). Income loss of half or more was coded as “severe”, loss of one quarter was coded as “moderate”, and loss of a little income was coded as “mild”. This was followed by a section asking if any coping strategies had been applied during the last month to deal with food shortages or income loss; and then questions relating to access to aid, and if they intended to make any changes should COVID-19 continue for another year. In two of the survey implementations (North West Vietnam and Central Uganda) 992 respondents were also asked if they perceived any positive effects of COVID-19, where the answer was a free text entry and coded during data cleaning.

2.4. Pre-pandemic data

We did not have the benefit of pre-pandemic data in six of the seven countries studied (the Vietnam sites were the exception). In order to contextualise the findings we therefore drew upon data from surveys of smallholder farmers conducted in similar projects, carried out in the same or neighbouring regions of each country. The data used was collected using the RHoMIS tool (Hammond et al., 2017, van Wijk et al., 2020), is available open access (RHoMIS, 2021), and has been favourably assessed for data quality compared to other large-scale surveys such as LSMS-ISA (Fraval et al., 2019a). Surveys conducted between 2017 and 2019 were selected, except for the dataset covering Arusha (Tanzania) which was from 2015. Despite our efforts to select data from locations with similar geographical and farm system characteristics, and with similar sample frames, the pre-pandemic data are not strictly comparable to the post-pandemic survey reported here and the comparative findings should be considered indicative rather than exact.

2.5. Data analysis

Survey data was collected using the ODK software system on smartphones and tablets (Hartung et al., 2010) and digitally stored. Data were harmonised between each survey implementation and compiled. Analysis was conducted in the R software environment (R Core Team, 2021). Where correlations have been calculated, these used Spearman’s rank correlation coefficient.

3. Results

3.1. Presence of COVID-19 in the rural communities

In each of the locations, few respondents reported knowledge of any suspected cases of COVID-19 (Fig. 2). In the Rwandan and Kenyan study sites around 20% of respondents knew of a suspected case; in the Ugandan sites about 10%; and in other locations it was less than 5%. This finding is subject to a number of important caveats: the question was phrased to relate to *potential* or *suspected* cases, rather than tested and confirmed cases, and identification of any individuals who may have been infected was deliberately avoided. Nevertheless, taboos related to admitting infections could have prevented individuals from reporting suspected cases, and the lack of systematic national testing schemes for COVID-19 infections (especially in rural areas) may have led to lower awareness of disease incidence (especially asymptomatic infections). Notably, Rwanda had better capacity to test for COVID-19 compared to other countries reported here, and in Rwanda more suspected cases were reported. Nevertheless, in most cases the surveys were conducted after notable national peaks in COVID-19 infections, when relatively large numbers of people were clinically diagnosed, and awareness of the disease and symptoms was high in national media (see Table 1). It is therefore surprising that so few respondents were aware of anybody with suspected cases of COVID-19. We interpret this as weak evidence that COVID-19 infections were relatively low in the rural areas studied in these surveys.

3.2. Experience of COVID-19 containment measures

In most of the sites where we conducted the surveys, the majority of farmers experienced disruptions from the COVID-19 containment measures in place (Fig. 3). The Burundi and Tanzania sites were exceptions to this. Disruptions to mobility were mentioned most often by the interviewees, with likely knock-on effects on the ability of farmers to purchase food and sell farm produce. In Burundi and Tanzania, where few restrictions were in place, there was little disruption to food purchase reported. In the other five countries, anywhere between 30 and 80% of the households reported that food purchases were disrupted. This large range may be due to the restrictions in force at the time of the survey; but even at the lower end of the scale, if 30% of respondents experience additional challenges in already food insecure locations, that is an issue to be taken seriously. At the upper end of the scale, it could

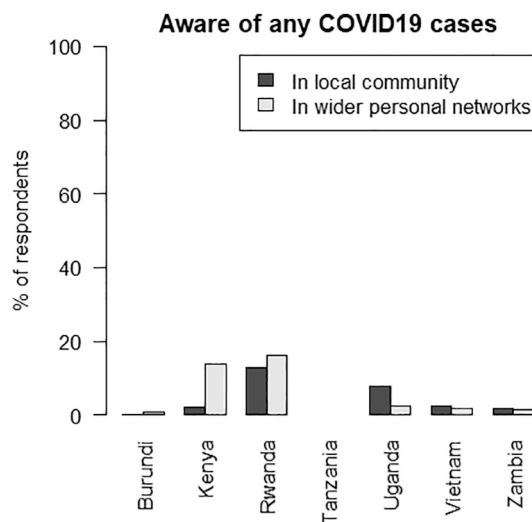


Fig. 2. Respondents’ knowledge of confirmed or suspected cases of COVID-19 within either their local community or their extended networks. Note that awareness of COVID-19 questions were not allowed to be asked in Tanzania.

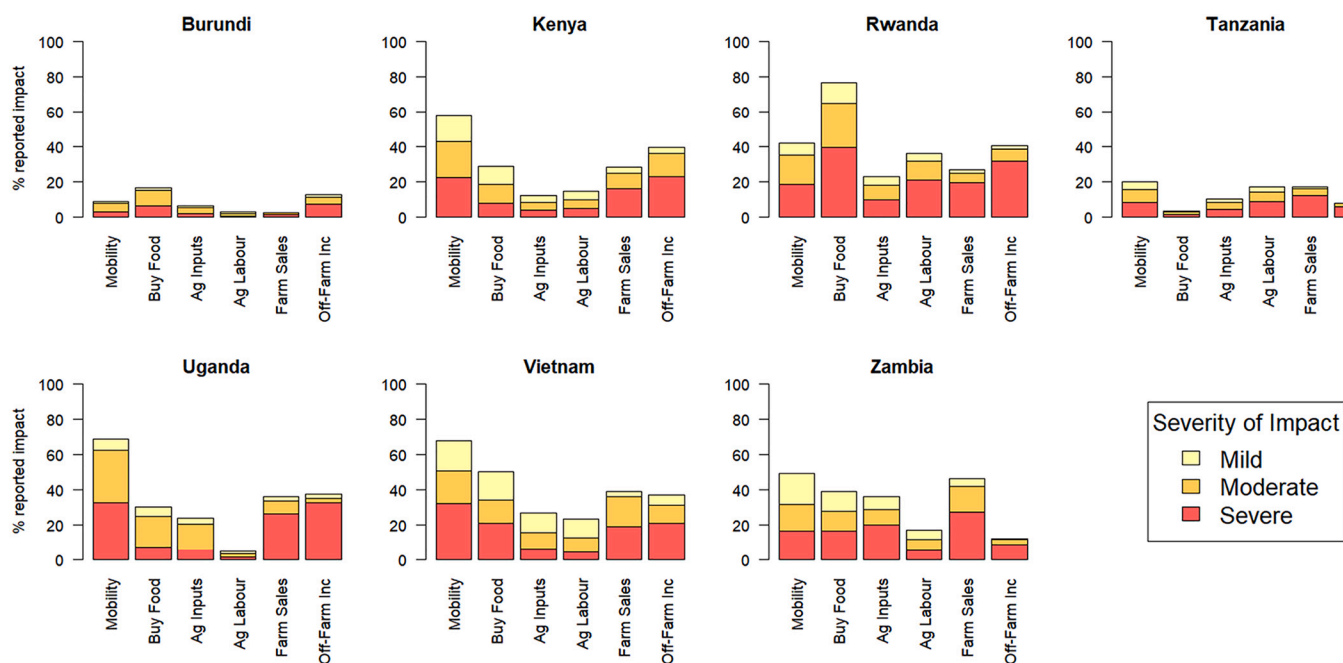


Fig. 3. Graphical representation of the disruptions which smallholder farmers perceived to be caused by the COVID-19 pandemic and associated restrictions, in each of the study sites. The height of the bars represents the proportion of respondents in each study location who reported each disruption, and the shading of the bars represents the degree of perceived severity.

indicate a critical impact on food security, especially if the situation were to continue for prolonged periods. The ability to generate off-farm income was also affected, but showed a large variation between countries. In the Rwanda and Uganda sites, around 35% of all households reported severe effects of COVID-19 measures on their off-farm income. Given that normally in surveys of similar smallholder households around 40–50% of the households report that they have off-farm income sources (e.g. Frelat et al., 2016), this means that most of the households with off-farm incomes reported losses (see also Tables 2 and 3). These results therefore suggest that for the large majority of households who usually earned off-farm incomes, their livelihoods were severely affected. This was most marked in the Kenyan, Rwandan, Ugandan, and Vietnamese study sites. Few households reported severe disruptions to the availability of agricultural labour, probably due to increased family time available for labour, and because of the low usage of hired labour in smallholder households compared to larger agricultural businesses.

3.3. Income losses

Respondents estimated income reductions from farm and off-farm

Table 2

Comparison of pre-pandemic incomes from farm and off-farm sources, and the post-pandemic income losses, as estimated by survey respondents. Values are mean averages with standard error in parentheses.

Country	Pre-Pandemic Farm Income \$PPP per person per day	Post-Pandemic Average % Farm Income Loss	Pre-Pandemic Off-Farm Income \$PPP per person per day	Post-Pandemic Average % Off-Farm Income Loss
Burundi	0.33 (0.03)	1 (0)	0.06 (0.01)	6 (1)
Kenya	0.81 (0.04)	12 (1)	0.28 (0.03)	18 (1)
Rwanda	0.24 (0.01)	14 (1)	0.06 (0.01)	22 (1)
Tanzania	1.02 (0.07)	9 (0)	0.25 (0.04)	4 (0)
Uganda	0.68 (0.05)	20 (1)	0.34 (0.04)	24 (1)
Vietnam	2.06 (0.07)	16 (1)	0.68 (0.05)	17 (1)
Zambia	0.30 (0.03)	22 (1)	0.08 (0.01)	7 (1)

sources over the previous month, which they considered were due to the COVID-19 pandemic and related containment measures, compared to their “usual” situation. The average income reductions for the study populations ranged from a few percent up to 20%, depending on the location (and timing in relation to restrictions; Table 2). However, according to the pre-pandemic data about a third of households (depending on location) did not have farm-based incomes, and between one- and two-thirds did not have off-farm incomes (Table 3). Almost all the respondents with off-farm incomes reported losses, and slightly under half of the respondents with farm-based incomes reported losses (Table 3). For those respondents who reported losses, the average proportion lost was around 50%, with remarkably little variation between the study locations (Table 3). In accordance with the results presented in Fig. 3, the income reductions were much less in Burundi and Tanzania compared to the other study locations.

3.4. Disruptions experienced and their causes

The reported causes of income losses and the causes of reduced food purchases are shown in Fig. 4, disaggregated by country. The most important cause of decreased farm-based income was low sale prices for agricultural produce, reported by 20–60% of respondents, depending on location. Access to markets (either transportation of goods or through intermediate buyers) was reported to lesser extent, by roughly 20% of the households depending on the location. For off-farm income the main cause was a lack of opportunities to work, and a lack of transport opportunities to access work. Also, a substantial percentage of households reported decreased remittances coming from family members living in the cities and/or working away from the farm.

The most important causes of disruption to food purchases were high market prices to buy food, a lack of cash to purchase foods, followed by access challenges due to either closed markets or lack of transport options. The contradictory reports of low sale prices for agricultural goods and high purchase prices for foodstuffs was widely observed; and may perhaps indicate market failures and traders attempting to buffer their own risks during a time of uncertainty. It appeared that reduced transportation – for travel to markets or for visiting buyers – was a greater

Table 3

Comparison of the proportion of households who earned incomes from farm and off-farm activities pre-pandemic, against the proportion of households who reported losing incomes from farm and off-farm activities post-pandemic. The vast majority of households with off-farm incomes reported losses, and a little under half the households with farm-based incomes reported losses, although this varied more by study site. The average incomes reductions are presented for only those households who lost income. These values are considerably higher than the population averages, and demonstrate the unequal effect distributed across the populations.

Country	Pre-Pandemic	Post-Pandemic	Post-Pandemic	Pre-Pandemic	Post-Pandemic	Post-Pandemic
	% with farm-based income	% reported farm income loss	% farm income reduced for only those who reported losses	% with off-farm income	% reported off-farm income loss	% off-farm income reduced for only those who reported losses
Burundi	65	3	50 (5)	19	13	46 (2)
Kenya	78	29	43 (1)	40	40	46 (1)
Rwanda	68	28	50 (1)	35	41	55 (1)
Tanzania	73	18	52 (1)	27	8	52 (2)
Uganda	88	43	51 (1)	59	43	62 (1)
Vietnam	64	39	40 (1)	41	37	46 (2)
Zambia	61	47	47 (1)	26	13	54 (2)

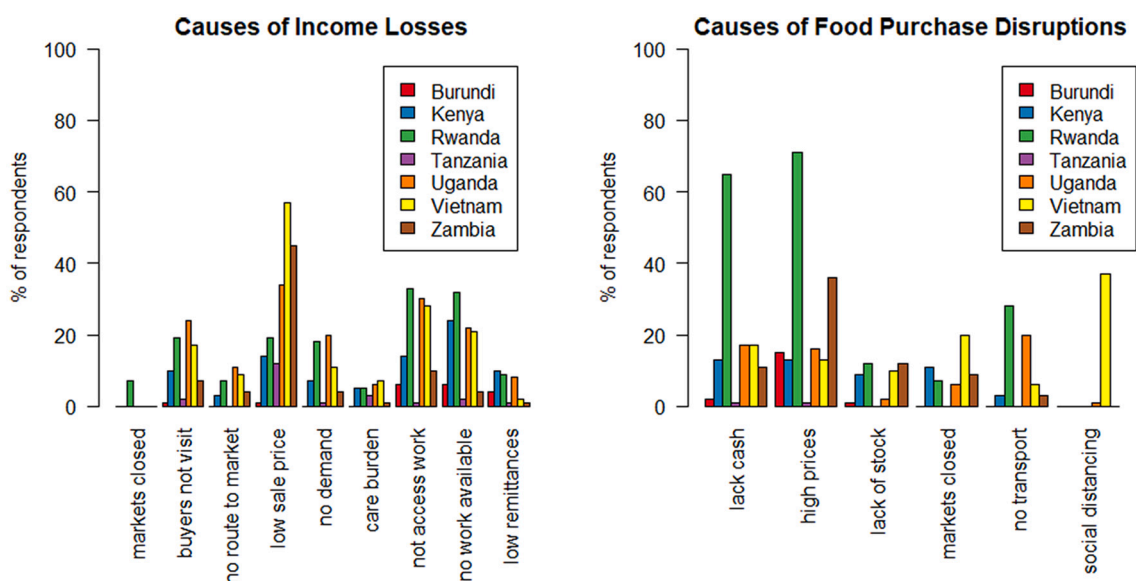


Fig. 4. Causes of disrupted incomes (left panel) and disrupted food purchases (right panel).

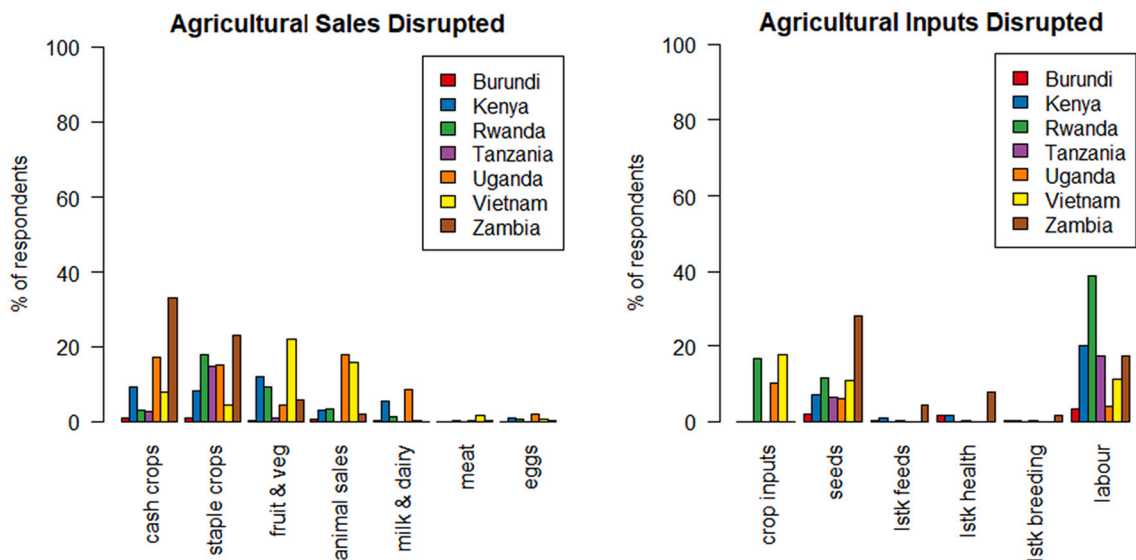


Fig. 5. The agricultural products for which sales were disrupted (right panel); and the agricultural inputs which were disrupted (left panel). “Lstk” is a contraction of “livestock” and “veg” a contraction of vegetables.

obstacle to making sales or purchases than closures of physical marketplaces.

The agricultural commodities for which respondents received low prices are shown in Fig. 5, alongside the agricultural inputs for which access was disrupted. The commodities most commonly produced within a specific region, were generally the ones affected by price crashes and value chain disruptions. It was not only perishables but all agricultural products which were disrupted. Crop inputs such as seeds and fertilisers were disrupted for approximately 20% of households depending on the location. Labour disruptions (including households' own supply of labour) was reported more widely than crop input disruptions. Livestock inputs were rarely mentioned.

3.5. Coping strategies

Respondents were asked about measures they had taken due to reduced incomes or reduced availability of food. These were termed "coping strategies", and are presented in Table 4. The total number of coping strategies used per household, and the proportion of households who deployed coping strategies, were highest in sites in Rwanda and Vietnam; followed by Kenya and Uganda; and lowest in the Burundi, Tanzania, and Zambia sites. This is in accordance with the severity of disruptions experienced (see Fig. 3), and with the stringency of official efforts to curtail transmission of the virus at the time of the survey (the surveys in Vietnam and Rwanda were conducted in the midst of major efforts to contain COVID-19; the other surveys were not). The reduction of food consumption – both in terms of quantity consumed and the diversity of foods consumed – was a common coping strategy (Fig. 6). It was particularly common in the Rwanda and Vietnam studies, where the major causes were high purchase prices and a lack of cash (Rwanda), and the need for strict social distancing (Vietnam – see Fig. 4). Other common coping strategies were to sell livestock, to use savings, to sell crops which had been stored for consumption, to eat crops which were intended for sale, or to take out loans which would be difficult to repay. All of these strategies reduce the buffering capacity of households to deal with future shocks. Direct aid or donations were very rarely received. The more extreme coping strategies such as sale of large livestock (Fig. 7), assets, taking children out of education, or reducing healthcare were not widely observed, which implies that at the time of the surveys (late 2020) some buffering capacity remained.

3.6. Positive effects of COVID-19

Respondents in the Vietnamese surveys and those in Central Uganda were asked if they perceived any positive effects due to the COVID-19 pandemic (Table 5). Most households said there were no positive effects. Seventy-seven percent of the Vietnamese respondents perceived no benefits, compared to 43% of the Ugandan respondents, which may

be related to the (slightly lower) severity of the disruptions experienced. Where positive effects were reported, in Uganda this was mainly due to increased time spent on the farm, and a small proportion of households reported more time spent with their families, and increased incomes due to favourable prices or support schemes. In Vietnam a small proportion of household reported increased incomes or more family time as positive outcomes.

3.7. Correlation of household outcomes and national-level factors

Three of the outcomes reported were correlated against the stringency of official COVID-19 containment measures (using the system devised by Hale et al., 2021), and against the overall development status of each country (using the Human Development Indicator, UNDP, 2020). The outcomes assessed were the reported reduction in food quantity and diversity consumed, the proportion by which household income was reduced, and the number of coping strategies a household deployed. Positive correlations were found in all cases, significant at the $p < 0.001$ level (Table 6). This indicates that with more stringent official restrictions, the greater was the negative effect on smallholder farmers' food security and livelihood. It also indicates that the more developed the nation, the harsher was the effects on smallholders. This seems counter-intuitive, but is explained by the fact that the lower income countries tended to apply less stringent measures. The more stringent measures were generally not supplanted with official aid or income support measures, and so led to greater negative impacts on the rural populations.

4. Discussion

Based on the survey results presented here, the undesirable effects of the COVID-19 containment measures were widespread and often perceived to be severe (Figs. 3-6), whilst the incidence of COVID-19 was perceived by smallholder farmers in our study locations to be very low (Fig. 2). Although this study did not objectively quantify impacts and was based on perceptions of occurrence and severity, the farmers' perceptions were remarkably similar to studies which followed a more econometric approach (e.g. Bloem and Farris, 2021; Egger et al., 2021; Josephson et al., 2021;). Our studies spanned a variety of locations and the timing of the surveys in relation to stringent restrictions varied. Except for the locations where restrictions were mild (Tanzania and Burundi; see also Hirvonen et al., 2021), mobility constraints were widespread, as were market access issues, price fluctuations, and income reductions. Almost all households who usually relied upon off-farm incomes reported reductions, on average by a half. Farm-based incomes were reduced for about half to three-quarters of the households who usually obtained them; with the income reduced by approximately 50%. Similar findings have been reported in multiple locations in sub-Saharan

Table 4
Coping applied by households.

	Burundi	Kenya	Rwanda	Tanzania	Uganda	Vietnam	Zambia
Mean number of coping strategies applied (s.e.)	0.6 (0.03)	1.7 (0.05)	4.1 (0.07)	0.5 (0.01)	1.8 (0.07)	3.2 (0.10)	0.9 (0.03)
% who applied any coping strategy	30	59	88	39	59	91	44
% reduced food quantity	11	20	79	1	18	34	10
% reduce food diversity	9	21	76	1	24	50	8
% eat extra crops	3	18	0	0	13	24	14
% sell extra crops	5	13	25	21	8	7	10
% harvested early	6	14	42	0	8	6	11
% collect wildfoods	0	1	19	0	1	20	1
% eat livestock	0	5	4	1	1	38	1
% sell livestock	2	23	45	14	22	41	16
% use savings	8	19	44	1	38	45	2
% sell assets	1	4	5	1	2	0	3
% incur risky debt	4	14	27	4	20	17	9
% receive aid or donations	0	4	8	0	6	4	2
% reduce education or healthcare	1	2	5	0	1	0	2

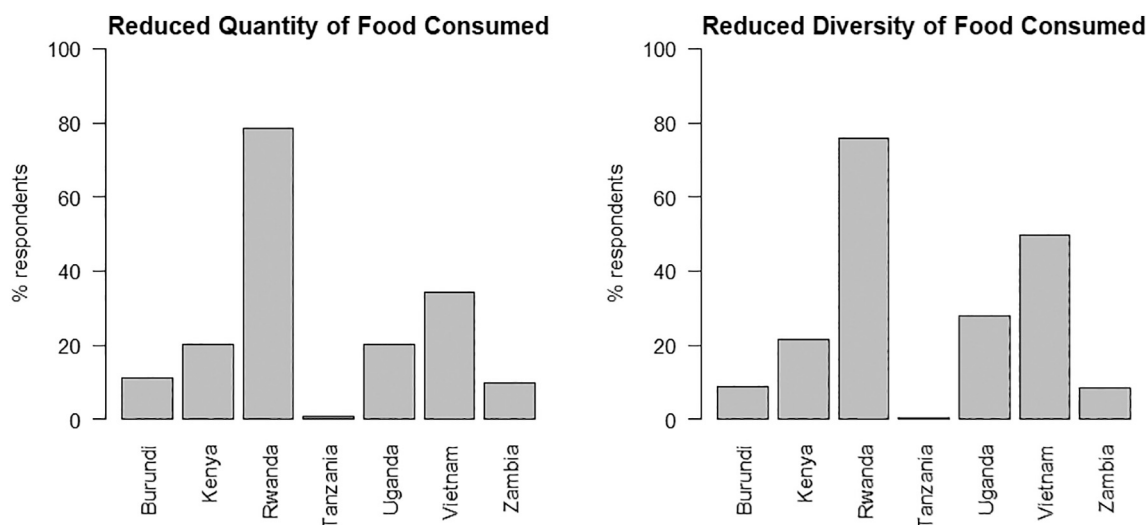


Fig. 6. The proportion of respondents who reported having to reduce the quantity food consumed (left) and variety of food consumed (right) due to the effects of COVID-19 restrictions.

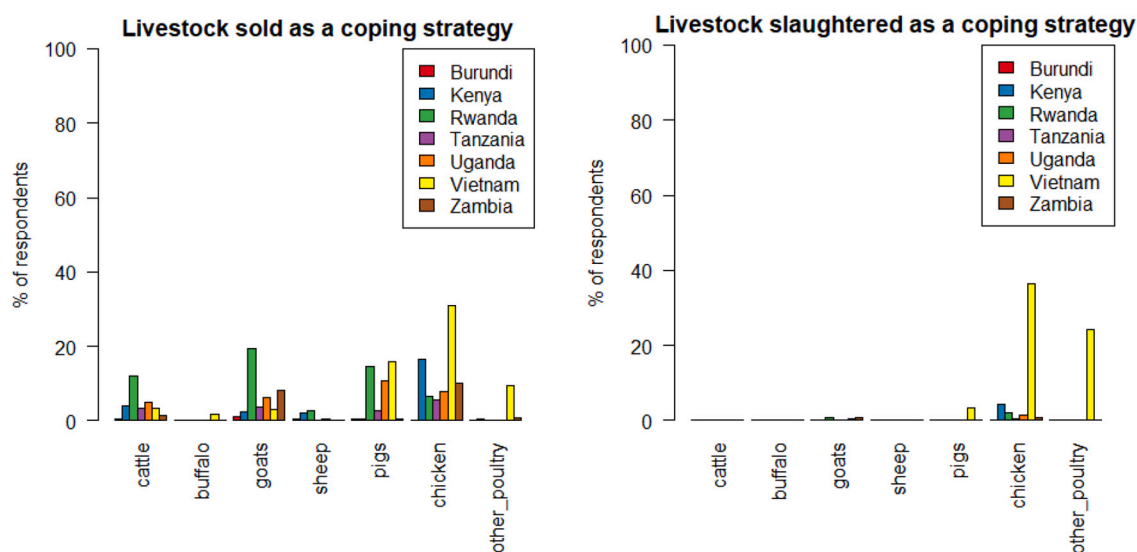


Fig. 7. The use of livestock to buffer negative effects of COVID-19 restrictions: for sale (left panel) and for slaughter (right panel).

Table 5
Positive effects of COVID-19, as perceived by respondents.

	Uganda (%)	Vietnam (%)
None	43	77
Focus on farm	39	2
Family & homelife	14	7
Increased income or savings	9	12
Improved hygiene	1	2

Africa (Adjognon et al., 2021; Egger et al., 2021; Mahmud and Riley, 2021; Josephson et al., 2021), and the disruption of off-farm income observed as a general and important factor in negative food security outcomes (Picchioni et al., 2021). During the midst of more stringent restrictions, up to 80% of the household surveyed reduced food intake or variety (Fig. 6), exacerbating current food insecurity levels (e.g. Fraval et al., 2019b). Although we do not know the duration of these effects, they indicate concerning trends. The main causes reported were high purchase prices, a lack of money, or an inability to physically access markets (not market closures). The impact on food access rather than

Table 6
Correlations between the outcomes experienced by households, the stringency of the national response to COVID-19, and the general state of national development. Correlations were assessed using Spearman’s Rho; all were significant at the $p < 0.001$ level. Food consumption relates to both quantity and diversity of food consumed. Income loss was measured using proportional estimates by respondents. Stringency of COVID-19 restrictions was measured using the Oxford COVID-19 government response tracker (Hale et al., 2021), where a higher number indicates more stringent measures. National development status was measured using the Human Development Index (UNDP, 2020), where a higher number indicates a more developed nation.

Outcome type	Stringency of COVID-19 restrictions	Increased national development
Food consumption reduced	+0.23	+0.29
Proportion of income lost	+0.31	+0.29
Coping strategies used	+0.39	+0.26

availability is aligned with a recent review of the global food security impacts due to COVID-19 (Béné et al., 2021). Our empirical findings support the modelling work (Laborde et al., 2021), which predicted an increase in the number of people in lower- and middle-income countries who could not afford a healthy diet. The effects of undernutrition caused by COVID-19 during 2020–2022 have been valued at US\$29.7 billion (Osendarp et al., 2021), and food security impacts are predicted to become deeper and slower to recover following subsequent rounds of restrictions (Nechifor et al., 2021).

There was an almost complete absence of direct aid or government support in every location studied. Such support programs have been shown to greatly ameliorate the negative impacts (Abay et al., 2020; Arndt et al., 2020). A negative cycle was suggested, entailing reduced mobility, reduced availability of (or access to) paid work, reduced sale prices for agricultural products, and increased purchase prices for foodstuffs; all related to the stringency of restrictions imposed to curtail the spread of COVID-19. This led households to deploy coping strategies such as sale of livestock, unplanned crop sales, use of savings, and the taking out of risky loans. The incomes generated through these coping strategies were seen as less than usual (due to low sale prices) and the money obtained did not go as far as usual (due to increased food purchase prices). The link between more stringent restrictions, food insecurity, and off-farm income reduction has also been established using a robust statistical analysis to compare areas of Nigeria which experienced differential restrictions (Amare et al., 2021). In a comparison between two Indian states, it was established that market price stabilisation limited the food security impacts on smallholder farmers, and reduced panic selling of commodities and assets, thus preventing further price de-stabilisation. Through systematic review, the timing, duration, and stringency of COVID-19 restriction measures, as well as the appropriate policies to mitigate their adverse impacts, were identified as the main factors contributing to food system disruptions (Picchioni et al., 2021).

Drops in sale prices were observed for practically all agricultural products commonly sold in any given location, and affected not only the high-value and often perishable products, but also staple crops such as maize and cassava. This suggests general disruption to the agricultural system including labour, inputs, markets, as well as farmer desperation (as described using beans as a case study by Nchanji et al., 2021); rather than breakdown of specific value chains for high-value produce (Alam and Khatun, 2021). The increasing disparity between the sale prices for agricultural goods and purchase prices for foodstuffs and inputs (see also Narayanan and Saha, 2021; Adewopo et al., 2021; de Boef et al., 2021) is concerning and ought not to be allowed to spiral out of control.

About 20% of the households interviewed reported challenges acquiring seeds or fertilisers, and with securing sufficient labour on their farms. The majority of households said they would seriously consider changing their farming practices if the COVID-19 situation continued for another year (data not presented), but the implications of this were unclear. A mixture of more subsistence-oriented strategies and more commercial strategies were suggested by respondents in each site. It is clear, however, that the timing of agricultural input supplies and other impediments is very important in determining the food production outcomes (Ayanlade and Radeny, 2020). The surveys reported here were conducted in the latter half of 2020, after the main planting season, so outcomes of the agricultural disruption will become more evident in the harvests of 2021 and 2022. In Asia, the greatest vulnerability to COVID-19 related disruptions was found to be in high-input production systems with long supply chains (Dixon et al., 2021). It may well be that in small-scale African farming, the more intensified systems stand to lose more in terms of production and income compared to the less intensified farms. The more intensified farmers, who are reliant on off-farm incomes to co-fund the intensification, are usually the most shock resilient group of rural households (Karanja et al., 2016). The fact that they appear now to be vulnerable (also observed by Mahmud and Riley, 2021) illustrates that the unexpected consequences of COVID-19 extend to the rural environment in ways not anticipated. It is also important to note that the

work published to date is based on data from the first full year of the pandemic (2020), and as the pandemic rages on different disruptions may come to the fore. For example food availability (supply) may become an issue if agricultural production is disrupted during key times; or if rural households' buffering capacity is exhausted. It would be unwise to assume linear progression of the impacts based on data from 2020 only.

The data and results reported in this study are subject to a number of caveats, which limit the certainty of the findings and the potential for scaling the findings to national level. Firstly, the data are based on self-reported perceptions and not on objective measures or validated questionnaire-indicators for self-reported assessments. Secondly, the assessments are based on crude distinctions and categories, and thus would not be expected to capture fine-scale variations (a strategy also used by Egger et al., 2021). For example, mobility restrictions were not decomposed into distances, purposes of travel, access to classes of vehicle and so on. Thirdly, the samples were drawn from pre-defined project areas, which were not intended to be nationally or even sub-nationally representative. However, they are representative of smallholder farmers within numerous districts and are very likely to be representative of smallholder farmers within the sub-national regions listed in Table 1. Fourthly, the timing of the surveys in relation to peaks of COVID-19 infections and associated restrictions greatly influences the interpretation of the findings. It is not possible to attribute the observed outcomes to national policy response or to pre-existing national factors such as economy, infrastructure, or farming systems. Rather the results should be interpreted as relating to the general effects of COVID-19 restrictions on smallholder farmers. Comparison to the emerging literature shows that in most cases, the outcomes identified are remarkably similar in most lower- and middle-income locations studied to date (see Aggarwal et al., 2020 for an interesting counter-example).

During 2021, following the data reported in this article, a second and then a third wave of infections, with associated containment measures, occurred in Africa (Salyer et al., 2021). In Vietnam a fourth wave has occurred. Even in the public health literature, calls have been made to moderate the containment measures in order to protect livelihoods, food security, and wellbeing (Adams et al., 2021; Meyerowitz-Katz et al., 2021). For example, Rwanda and Vietnam have been rightly praised for exemplary containment of COVID-19 (Karim et al., 2021; Van Tan, 2021), but during the periods of stringent restrictions, we observed severe food insecurity outcomes. Media analysis from five African countries has shown that popular narratives often framed the situation as a balance between containment of the COVID-19 virus and food security; and that this was a hot topic in all five of the locations studied (Birner et al., 2021). Policy responses often relaxed after complaints of food insecurity or economic hardship were received, and some measures were taken by governments which have not been captured by the data presented in this survey. For example, in late 2020 the Zambian government provided more subsidies for seeds and fertilisers compared to usual, which reduced costs for farmers. Throughout the pandemic Rwanda treated agriculture as an essential service and thus operations continued exempt from many restrictions, and containment measures were adapted to ease food insecurity outcomes.

5. Conclusions

There has been high-level recognition that the COVID-19 crisis will continue to cause widespread and deep economic disruption, and that development gains in lower- and middle-income countries may be lost (HLPE, 2020; World Bank, 2020a; OECD, 2020), potentially throwing hundreds of millions of people into poverty (Sumner et al., 2020). Warnings have been raised about negative effects on food security and nutrition for large swathes of people in lower- and middle-income countries (Laborde et al., 2021). Based on surveys of 9201 rural households in seven countries we find these concerns to be well-founded, and extremely worrying.

The surveys which were conducted during more stringent phases of restrictions to contain COVID-19 reported more severe socio-economic impacts for rural smallholders. The policy choice between minimising the direct health risks and minimising the negative effects to food security and incomes is very difficult, and decisions were necessarily taken with little information. Due to a general lack of thorough COVID-19 testing in the countries discussed in this manuscript, it is not possible to know the degree of incidence of the disease, or the potential for spread had the containment measures not been implemented. Based on the surveys reported here (conducted in the latter half of 2020) and various literature reporting other studies based on data from 2020, negative food security and economic outcomes were clearly evident amongst rural households, and many households dug into their reserves to buffer against income losses and food shortages. Media analysis (Birner et al., 2021) shows that popular narratives in five African countries commonly framed a choice between exacerbating poverty and containing COVID-19, and that often the governments relaxed containment measures in acknowledgement of the economic hardships caused (Rwanda was an example of this). Going forward, we conclude that the careful monitoring of economic and food security implications of non-pharmaceutical interventions is needed in order to minimise undesirable outcomes for human welfare and development.

Further waves of infections and containment measures have occurred throughout 2021, will likely continue for years to come. We contend that two critical tipping points in the food system must be guarded against: the exhaustion of buffering capacity amongst the rural population; and the severe disruption of essential agricultural production activities such as planting and harvesting. In order to protect against these, we make the following recommendations (which have also been evidenced elsewhere): more nuanced mobility restrictions with travel allowed for economic reasons (e.g. Amare et al., 2021), the provision of direct aid or income support to rural households (e.g. Abay et al., 2020; Arndt et al., 2020), a government-sponsored minimum sale price for agricultural goods (e.g. Dixon et al., 2021), and stabilised purchase prices for foodstuffs (e.g. Ceballos et al., 2020).

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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