Journal of Land Use Science

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/tlus20

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To cite this article: Kerstin Nolte, Kacana Sipangule & Niels Wendt (2022) Agricultural households in times of crisis. The COVID-19 pandemic, livelihoods and land-use decisions, Journal of Land Use Science, 17:1, 134-160, DOI: 10.1080/1747423X.2021.2020922

To link to this article: https://doi.org/10.1080/1747423X.2021.2020922

JOURNAL OF LAND USE SCIENCE
2022, VOL. 17, NO. 1, 134–160
https://doi.org/10.1080/1747423X.2021.2020922

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Agricultural households in times of crisis. The COVID-19 pandemic, livelihoods and land-use decisions

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ABSTRACT

The COVID-19 pandemic has profound impacts on agricultural households. We discuss how these impacts might affect the underlying drivers of land-use decisions. First, we conceptually extend models of (smallholder) land-use decision-making to assess how the pandemic affects the underlying drivers of land-use decisions. We then examine effects on agricultural households' livelihoods, by drawing on high-frequency phone surveys from eight African countries and a literature review. We find that the COVID-19 pandemic affects these households' livelihoods substantially, reflected for instance, by reductions in various income sources. We further find that households' coping capabilities are weakened, meaning vulnerable households have difficulties to cope with the impacts of the pandemic. Agriculture is likely to become even more important in the years to come for households with very limited resources. Accordingly, we expect more labour-intensive uses of agricultural land. However, context matters and thus impacts on land-use are likely to be very variable.

ARTICLE HISTORY
Received 31 July 2021
Accepted 15 December 2021

KEYWORDS
Land-use change; agricultural household; COVID-19; Africa

Introduction

Agriculture is a key driver of land-use and land-cover changes, and a main source of deforestation (Lambin & Meyfroidt, 2011). Especially in the tropics, where farmland is expanding into wetlands and forests, and where smallholders are active land-use decision-makers whose actions constantly modify the vegetation and land cover in their surroundings (Hettig et al., 2016; Malek et al., 2019). Individual land-use decisions are complex processes embedded in global and regional economic and environmental conditions and mediated by institutions (Lambin et al., 2001). Processes of globalization strongly shape the underlying factors of land-use changes, with particular attention being placed on shocks such as extreme weather events or trade conflicts (Chen et al., 2019; Lambin et al., 2001; Verburg et al., 2019). The ongoing COVID-19 pandemic is a shock that is likely to have profound impacts on agricultural households and in turn on their land-use decision-making, for instance, through disruptions to global supply chains (Guan et al., 2020) and reverse migration (Boillat & Zaehringer, 2020).

Pandemics and land-use change are closely related. Most research to date investigates how land-use drives infectious disease outbreaks (Gottdenker et al., 2014; Patz Jonathan et al., 2004). This has been shown for the Ebola virus (Rulli et al., 2017), as well as the Covid-19 pandemic (Plowright et al., 2021).

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However, our knowledge on how pandemics affect land-use change is limited. One of the few papers that investigates this link, is de la Fuente et al. (2020). They find that group labour restrictions to contain the Ebola epidemic in Liberia resulted in reductions in the area of rice planted, which in turn reduced yields. This lack of evidence is surprising, as disease outbreaks, including the COVID-19 pandemic, have profound impacts on agricultural households. In particular, measures taken to contain the spread of contagious diseases affect people's daily livelihood activities across the globe. We focus on the African continent which has a particularly high number of (vulnerable) family farms (Lowder et al., 2016).

This paper hence investigates the impact of the COVID-19 pandemic on the livelihoods of agricultural households in Africa and their land-use decisions. As land-use change is a longer-term process, it is difficult to determine the precise effects of the ongoing pandemic on land-use change. We therefore focus on the pandemic's impacts on some of the underlying drivers of land-use decisions and make inferences about how agricultural households' land-use decisions can potentially be affected by COVID-19. We base our work on the conceptual literature on land-use decision-making and extend existing frameworks to assess how COVID-19 affects the underlying drivers of land-use decisions. Drawing on a descriptive analysis of phone-survey data from eight African countries and a literature review on the impacts of the pandemic on agricultural households, we validate this framework. We then draw conclusions on potential land-use changes based on our results.

We proceed as follows: first, we give an overview of the COVID-19 pandemic on the African continent. We then conceptualize the ways in which the pandemic may affect the underlying drivers of households' land-use decisions. Then we present our material and methods. The results section depicts and discusses the way the pandemic affects agricultural households' livelihoods by drawing on survey data from eight African countries and a literature review. Finally, we discuss how these changes may affect smallholders' land-use choices and draw conclusions.

The COVID-19 pandemic in Africa

The first COVID-19 cases on the African continent were recorded in mid-February 2020. Generally, the share of confirmed cases in Africa, particularly in the first wave has been low compared to other continents (Salyer et al., 2021). However, these cases have to be taken with caution, as limited testing capacities, poor health systems and under-reporting may have resulted in the fewer infections being reported. The lower infection rates have also been attributed to the adoption of early containment measures and existing infection control and tracing systems from previous contagious disease outbreaks like Ebola, and the low risk of virus importation from COVID-19 hotspots due to limited mobility (Chitungo et al., 2020).

Figure 1 shows the daily infections per million inhabitants for the period between 1 March 2020 and 30 November 2021 for the eight African countries that we focus on in this paper. The severity of the different COVID-19 waves across the eight countries is quite clear and has increased over time. This is particularly the case for Zambia, Uganda and Malawi, which experienced a third wave in July to September 2021.

Lockdown measures on the African continent started shortly after the first case of COVID-19 was reported (Salyer et al., 2021). We provide an overview of the severity of the lockdown measures and their timing across the eight African countries, using the stringency index developed by the Blavatnik School of Government at the University of Oxford. The index is scaled between 0 and 100, with higher values indicating stricter lockdown measures such as travel bans as well as school and workplace closures (Hale et al., 2021). Figure 2 displays the daily stringency index calculated for the eight countries between March 1, 2020 and November 30, 2021. As can be seen, lockdown measures were first implemented in March and quickly became stricter over time. Figure 2 also shows the duration of the measures, with Chad and Ethiopia maintaining strict measures for most of 2020, while Malawi and Zambia had less stringent and shorter lockdowns. For all countries, the peak of lockdown measures can be observed around April and May of 2020. Several countries tightened lockdown measures again during 2021, most notably Uganda.

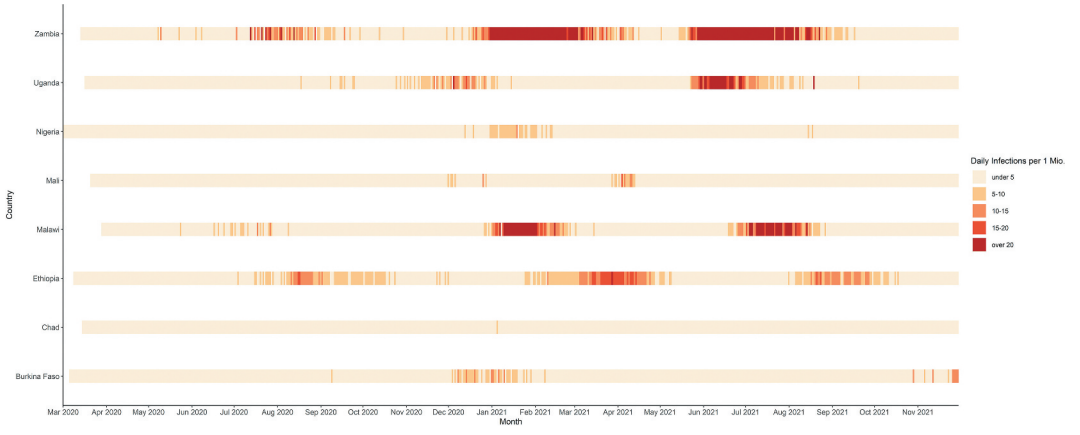

Figure 1. Daily infections per million inhabitants between March 2020 and November 2021. *Source: own display based on data from Our World in Data (*Ritchie et al., 2020).

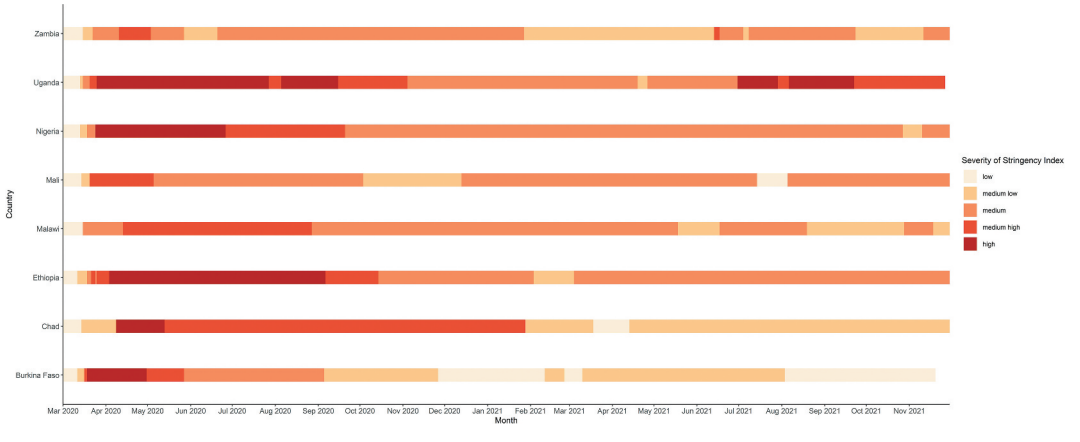

Figure 2. Stringency index showing the severity of lockdown measures between March and November 2021. *Source: own display, based on the Stringency Index by the Blavatnik School of Government at the University of Oxford (*Hale et al., 2021).

Conceptual framework: *Understanding the impact of COVID-19 on the drivers of land-use change*

While first insights from other regions suggest that the pandemic has increased pressure on land (e.g. in the Greater Mekong subregion (Waibel et al., 2020)) and damaged forests (e.g. in Sulawesi Golar et al. (2020)), as of now, little is known about the impacts in Africa. It remains unclear whether an increase or a decrease in the expansion of agricultural land is to be expected, as well as what the longevity of this COVID-19 effect will be.

In this section, we therefore extend conceptual models of (smallholder) land-use decision-making. There is a vast literature on (smallholder) land-use decision-making with contributions from various disciplines, including (but not limited to) economics, anthropology, psychology, and life sciences, and interdisciplinary approaches (Ojima et al., 1994; Singh et al., 2016) including contributions from land system sciences (Brown et al., 2004; Malek et al., 2019; Van Vliet et al., 2015). Generally, these disciplines distinguish between internal factors, such as ability and motivation, and external factors that shape land-use decisions such as policies (Malek et al., 2019). Our focus is on these external factors, specifically the underlying drivers of land-use decision-making (Geist & Lambin, 2002;

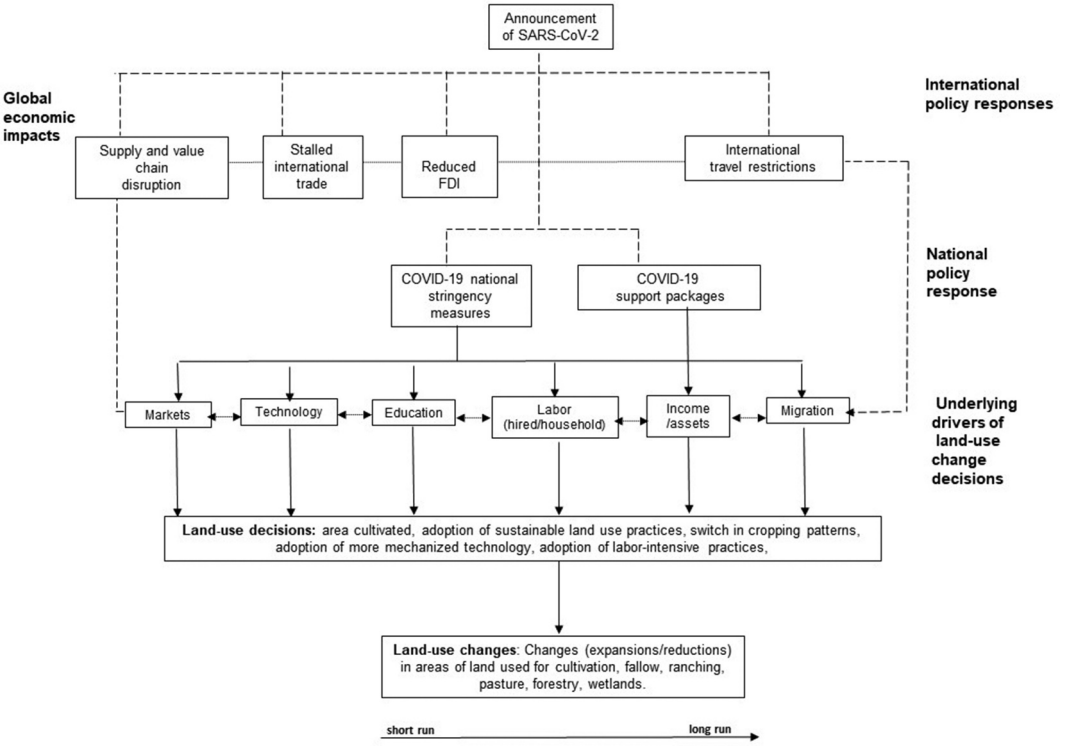

Figure 3. COVID-19 and Agricultural Households Land-Use Decisions.

Hersperger & Bürgi, 2009; Van Vliet et al., 2015). These underlying drivers can be distinguished into factors which agricultural households have no control over, such as political, social, global and macroeconomic developments, as well as immediate causes that are directly and locally influenced by households (Angelsen & Kaimowitz, 1999; Hettig et al., 2016).

Malek et al. (2019) show that land-use decision-making is highly context-sensitive and may differ according to the development stages and profiles of smallholders. For instance, Kubitza et al. (2018) demonstrate the importance of context-sensitivity by showing how land policies shape land-use decisions. They find that Indonesian farmers who hold formal land titles invest more in their already cultivated land, and are hence less likely to deforest. However, formal land titles are rare in forest margins.

Figure 3 provides an overview of our model of smallholder land-use decision-making in the context of the COVID-19 pandemic. Our model has three layers: (1) the global, regional and national level, which presents the impacts of COVID-19 and associated policy responses, (2) the underlying drivers of land-use decisions as derived from the literature, and (3) the subsequent implications of the pandemic on agricultural households' land-use decisions.

The Global, Regional and National level

The COVID-19 pandemic has affected all regions of the world and Africa has not been spared from the ensuing global economic slowdown. In a bid to delay the spread of the SARS-CoV-2 virus responsible for COVID-19 and in awareness of the shortcomings of their health systems, many African countries imposed international travel restrictions and closed their international borders after the announcement of the disease outbreak (Amewu et al., 2020). These travel restrictions and containment policies, such as the banning of in person commerce at a global scale, had disruptive

effects on revenue from tourism and remittances, global prices and exchange rates, as well as on capital markets in Africa (Amewu et al., 2020; Bisong et al., 2020). Furthermore, global value chains are being disrupted, international trade is stalling and foreign direct investments are declining across the continent.

In addition to imposing international travel restrictions, many African governments responded to the rising COVID-19 incidences domestically by declaring state of emergencies, limiting social gatherings and issuing stay at home orders (Josephson et al., 2021). While there was variation in the type and duration of COVID-19 containment measures adopted across countries as discussed above, many of them included some features such as the closure of non-essential businesses, schools and higher education facilities, and the limitation of public transportation. In addition to the containment strategies, a number of African countries also launched COVID-19 support packages (Lastunen et al., 2021; Miller et al., 2020) to cushion the effects of the pandemic on households' livelihoods.

The underlying drivers of smallholders' land-use decisions

Altogether, these global and national strategies were effective in curbing the spread of COVID-19 and supporting households in the first waves of the pandemic, but came at huge economic costs (African Development Bank, 2021) with impacts on the underlying drivers of smallholder land-use decisions. Among the immediate determinants of land-use decisions, the literature identifies markets, (agricultural) technology, demographic factors, such as household composition and migration, and economic factors such as income and asset holdings (Angelsen & Kaimowitz, 1999; Hettig et al., 2016; Malek et al., 2019).

These determinants are interlinked and affect one another. For instance, agricultural technology is affected by market access and at the same time has feedback loops on income levels (Angelsen & Kaimowitz, 2001; Geist & Lambin, 2002; Hettig et al., 2016). Moreover, trade-offs between ecological and socio-economic goals are explored in agent-based models explore ecological and socio-economic trade-offs (An, 2012; Dislich et al., 2018; Rindfuss et al., 2007). Clough et al. (2016) find that profitability is more important for land-use choices than ecological functions in Indonesia.

How changes in the underlying factors may affect land-use?

Malek et al. (2019) stress the importance of contexts and development stages for land-use decisions. Accordingly, an important context factor is household vulnerability and ability to cope with shocks. In this section, we discuss how changes in the underlying drivers may affect smallholders' subsequent land-use decisions in the long and short run. In particular, how such decisions result in changes in agricultural land use; e.g. changes in the area used for certain agricultural purposes (e.g. expansion or reduction of cultivated area) as well as changes in the way land is being used (e.g. agricultural intensification or extensification). Put differently, we investigate how agricultural households cope with or, if thinking in the longer-term, adapt to the COVID-19 shock. Singh et al. (2016) conceptualize such decisions as a response continuum from no response, to (short-term) coping, and (long-term) adaptation.

First, one crucial factor is access to **markets**. Changing market accessibility is found to have a strong impact on household's land-use decisions. Constraints on output markets are thought to hinder agricultural expansions, while imperfections in input markets may have ambiguous effects. On the one hand, they may also constrain expansions; on the other hand, imperfections in such markets may lead to agricultural expansions as smallholders try to substitute other inputs with land (Hettig et al., 2016).

Second, **agricultural technologies**, which include techniques and practices that affect the growth and quantity of agricultural output, are vital for smallholder agriculture (Mwangi & Kariuki, 2015). Common technologies adopted by smallholders include new crop varieties, soil-, fertility-,

pest-, weed and water management practices. Adoption of these technologies is strongly influenced by the flow of information, for instance, through extension services and government programs (Cafer & Rikoon, 2018; Dobler-Morales et al., 2020; Junquera & Grêt-Regamey, 2019; Keys & Roy Chowdhury, 2006). Whether agricultural technologies are available and being adopted, depends on the characteristics of the technology and interlinkages with market conditions. Some technologies are found to be land-saving, while others are found to expand agricultural areas (Angelsen & Kaimowitz, 1999; Hettig et al., 2016).

Third, systematic reviews report that economic factors are some of the key driving forces behind smallholder land-use decisions (Hettig et al., 2016; Malek et al., 2019). **Income**, in particular, has been associated with the decisions to deforest, intensify or expand land for agricultural purposes. There seems to be a persistent 'myth' that poverty drives deforestation (Lambin et al., 2001). However, the relationship between poverty and deforestation is more nuanced and complex; poverty is not the sole and often not the major underlying driver of forest change (Chomitz, 2007; Lambin et al., 2001). In a similar vein, the effects of changes in income on household's land-use decisions are ambiguous. Typically, one would expect that a reduction in income leads to a reduction in agricultural areas (Godoy et al., 2009; Hettig et al., 2016). Households may also leave land fallow or rent it out to raise additional income. However, increases in off-farm income are found to decrease deforestation by providing alternative income opportunities (Geoghegan et al., 2001; Hettig et al., 2016; Kaminski & Thomas, 2011).

Fourth, the level of **education** can also influence household's land-use decisions; albeit the effects of education reflect a combination of different transmission channels, e.g. also affecting values and norms (Hettig et al., 2016). High levels of education are typically associated with more intensive agricultural practices (Amare & Shiferaw, 2017; VanWey et al., 2013). In the short term, closure of education facilities and losses of off-farm job opportunities lead to increases in household labour for agriculture, in particular, the share of young working-age household members increases. The literature on land-use change shows that the composition of households across lifecycles affects land-use decisions, with households composed of young working-age members engaging most in labour-intensive agriculture (De Sherbinin et al., 2008; VanWey et al., 2007).

Finally, demographic changes caused by **migration** also affect the available household labour for agriculture. Moreover, any changes in migration patterns impact the amount of remittances received in rural areas. Broadly speaking, the literature expects a negative relationship between remittances and deforestation. However, this relationship is highly contingent on the migrants and the agricultural systems, and empirical evidence is thus ambiguous (Lambin & Meyfroidt, 2011).

Some of the discussed land-use changes are likely to take effect immediately, while others may take much longer to materialize. They may also be different in the short and in the long term. For instance, agricultural households may decide to leave land fallow as an immediate reaction to disrupted markets. In the medium to long term, they may however decide to expand the area cultivated in order to compensate for lost employment opportunities in other sectors.

Materials and Methods

To provide insights into how the pandemic affects agricultural households' livelihoods and some of the underlying drivers of land-use change, we draw on (1) descriptive insights from survey data collected during the COVID-19 pandemic, and (2) a literature review on the effect of the pandemic on some of the underlying drivers of land-use change. Our analysis focuses on the underlying drivers discussed in the conceptual framework. It is important to mention, that actual land-use changes require a long time frame to materialise and cannot be teased out from the data at hand.

Descriptive analysis of survey data

We use the COVID-19 High-Frequency Phone Survey (HFPS) by the Development Data Group of the World Bank for eight African countries, namely Burkina-Faso, Chad, Ethiopia, Malawi, Mali, Nigeria, Uganda, and Zambia[1] (World Bank, 2020d, 2020b, 2020a, 2020e, 2020f, 2020g, 2020h, 2020i). The goal of these surveys is to monitor the socioeconomic impacts of the COVID-19 pandemic and inform policy responses and interventions. For four of these countries – Ethiopia, Malawi, Nigeria, and Uganda – the data collection is part of the Living Standards Measurement Study – Integrated Survey on Agriculture (LSMS-ISA) program. For these countries, a subsample of households that had been interviewed for the LSMS-ISA surveys was selected. The other countries use national sampling frames. All surveys have a national coverage representative of the population in urban and rural areas with valid phone numbers. An overview of the surveys is provided in the Appendix. In line with the conceptual framework, we focus on the household aspects that correspond to the underlying drivers of land-use change; namely market access, income, education, and migration. To consider household vulnerability, we further focus on shocks and coping with shocks. Due to differences in the survey instruments, we cannot consider all eight countries in each step of our descriptive analysis. For consistency and comparability, our analysis is based on data from the first (or second) wave of each survey.[2] To allow for an assessment of how shocks and shock coping evolve over time, we take advantage of the fact that Burkina Faso contains information on coping in five survey waves. The first survey waves were collected between April and June 2020, i.e. a time during which reported case numbers were still low, but strict lockdown measures had already been implemented (see the section on the COVID-19 pandemic in Africa). Since our main focus is on land-use decision-making processes by agricultural households, we restrict our analysis to households engaged in agriculture.[3]

Our primary aim is to provide descriptive insights into how the COVID-19 pandemic affects agricultural households. We refrain from generalising these results for the entire population and for all agricultural households due to selection and non-response biases associated with phone surveys. Our sample is likely to be biased towards slightly richer and less remote households (Josephson et al., 2021, p. 563).

Literature review

Our literature review on the impacts of COVID-19 on agricultural households sources literature from the World Health Organisation (WHO) Global Research Database and Google Scholar. We use these databases as they also contain recent grey literature, including working papers and technical reports. This is important due to the recency of the COVID-19 pandemic. The WHO Global Research Database is particularly suited as a comprehensive database of multilingual and multiregional literature published on COVID-19, sourcing from major scientific data bases such as Scopus and the Web of Science. Key search terms include 'smallholder', 'agricultural household,' '(household) income,' 'migration,' 'market (access),' 'education,' 'learning loss,' 'technology adoption,' 'household labour,' 'coping,' 'livelihoods,' and 'land-use.' We screen the titles and abstracts to eliminate studies that do not focus on agricultural households. We have a focus on Africa, but include studies from other world regions if they add insight to an otherwise neglected aspect. We then review all selected studies and supplement additional studies from cross citations. This results in a total of 54 studies used in the literature review (see an overview in the Appendix).

Results: How the pandemic affects agricultural households' livelihoods?

Insights from survey data

First, we look at **market** access and related agricultural activities in Burkina-Faso, Chad, Ethiopia, Malawi, Mali, Nigeria, Uganda, and Zambia. Household respondents were asked whether they had been able to pursue agricultural activities in a normal manner since the outbreak of the pandemic.

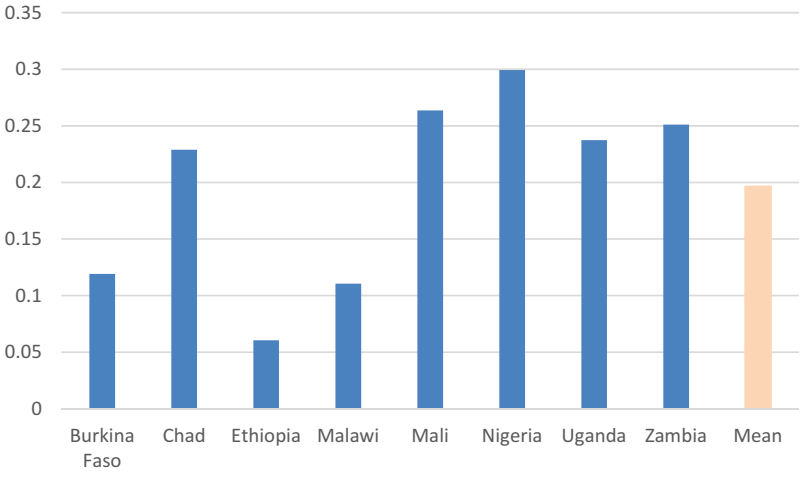

Figure 4. Share of households reporting to not being able to pursue agriculture in a normal manner from March to June 2020 (N = 8,536).

Figure 4 reports the share of households who reported that they could not pursue agricultural activities in a normal manner, ranging from 30% in Nigeria to only 6% in Ethiopia. The mean across these countries is about 20%.

We display the reasons these households mention in Figure 5. Of the households who report not being able to pursue agriculture in a normal manner, the most important reason given is that they were required to stay at home. Other important reasons are restrictions on movement and travel.

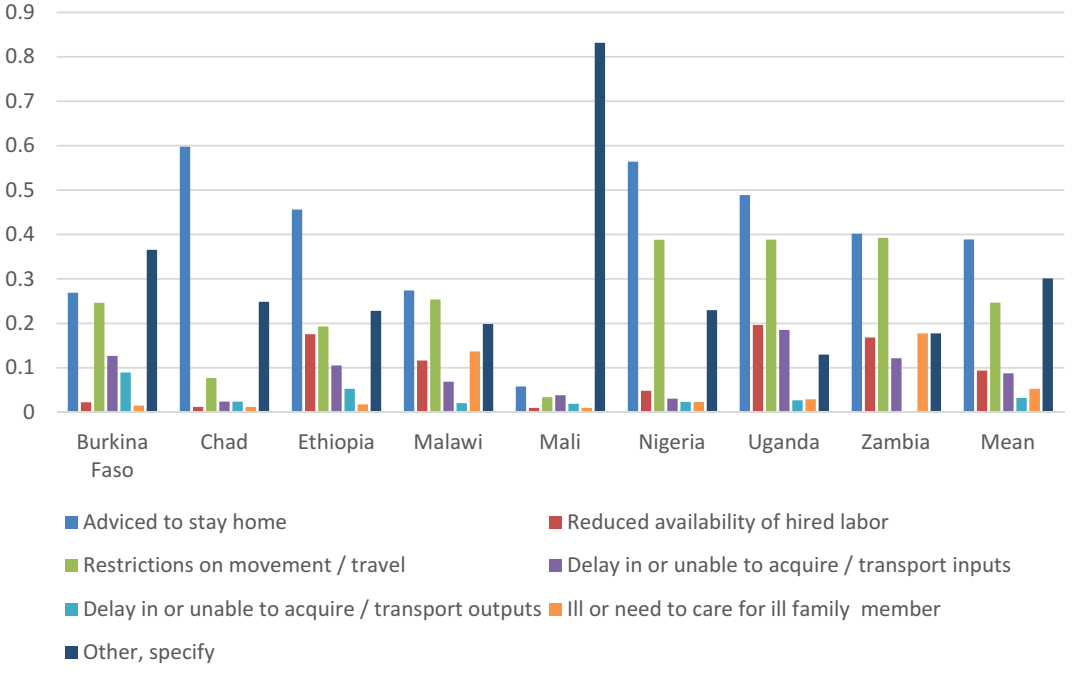

Figure 5. Please note: in most surveys, more than one reason could be given. However, in Chad and Mali, only one main reason could be given.

However, we observe some differences across the eight countries. For instance, the reduced availability of hired labour is of little importance in Burkina Faso, Chad, Mali and Nigeria (less than 5% of households mention this reason), but plays a more important role in Ethiopia, Malawi, Uganda and Zambia (between 10 and almost 20% of households mention this reason). Across all countries, only few households report they were unable to acquire or transport inputs (8.8%) and that they were unable to sell or transport outputs (3.2%). However, in Burkina Faso, Ethiopia, Uganda and Zambia, slightly more households mention accessing inputs as a challenge (more than 10%).

Second, we provide an overview on self-reported decreases in **income** sources since the COVID-19 pandemic from seven countries[4] (Figure 6). It is evident, that households lose income from many sources. Both the agricultural sector and the non-farm sector are severely affected: across all countries, between 46 and 72% of households report decreases in agricultural incomes; and between 71 and 91% of households report reductions in non-farm business incomes. The picture for wage employment is mixed with more than half of households reporting a reduction or a loss of incomes in Chad, Malawi, Mali and Nigeria, and Uganda, whereas the share of households reporting reductions in income from wage employment in Ethiopia and Zambia is well below 50% (26% in Ethiopia and 37% in Zambia). We also observe a strong reduction in remittances (73–80% report reductions or total losses in Malawi, Mali, Nigeria, Uganda and Zambia; for Ethiopia, 48% of households report reductions, for Chad the data is missing). Overall, we conclude that most rural households across several African countries report severe reductions in various income sources, spanning from the agricultural and non-farm sector, to wage employment and remittances.

Third, we look at the impact of the COVID-19 pandemic on **education**. To get a first impression, we look at 5,659 households from Burkina Faso, Chad, Malawi, Mali, Nigeria, Uganda, and Zambia with school-age children who were asked whether the children or anyone else from the household were in contact with their teachers (Figure 7).[5] Overall, only 13% answered 'yes.' There are some regional variations, Chad and Malawi performed worse, with only about five percent of households agreeing, whereas in Burkina Faso, Mali and Nigeria about 20% of households agreed with this statement. This indicates severe learning losses during the first lockdown period across all countries.

Fourth, we focus on **migration**. Survey data from Burkina Faso, Chad, Malawi, Nigeria, and Uganda contains information on whether a household member returned to his or her rural home due to COVID-19. Across all countries, there are only 75 household members who give this as

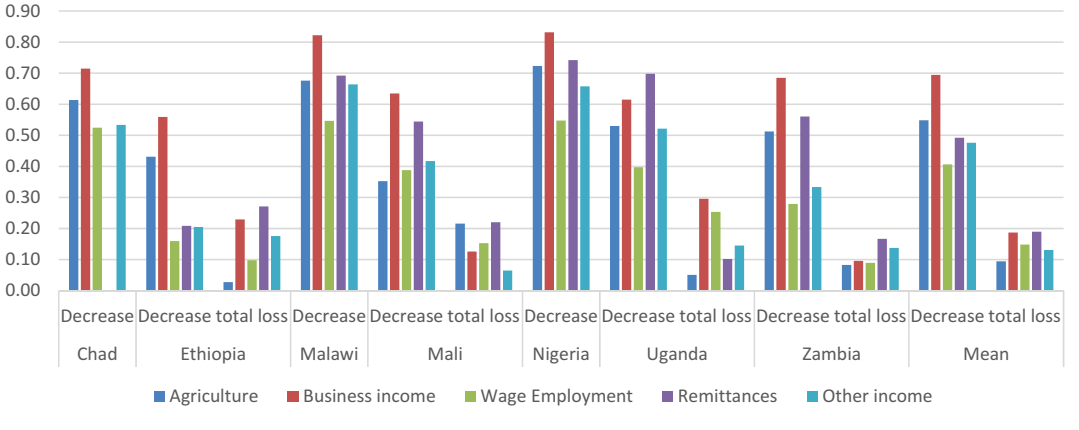

Figure 6. Share of households from Chad, Ethiopia, Malawi, Mali, Nigeria, Uganda, Zambia (from all households reporting on specific income source) who report income reductions and total losses (N = 7,859). Please note: Chad, Malawi, and Nigeria do not report 'total loss' but only report decreases. Chad does not report any information on changes in remittances. Households could multiselect income sources, leading to different sample sizes across different income sources as not each household has income from all sources (e.g. in Chad 846 households report on agriculture, but only 273 on non-farm business income).

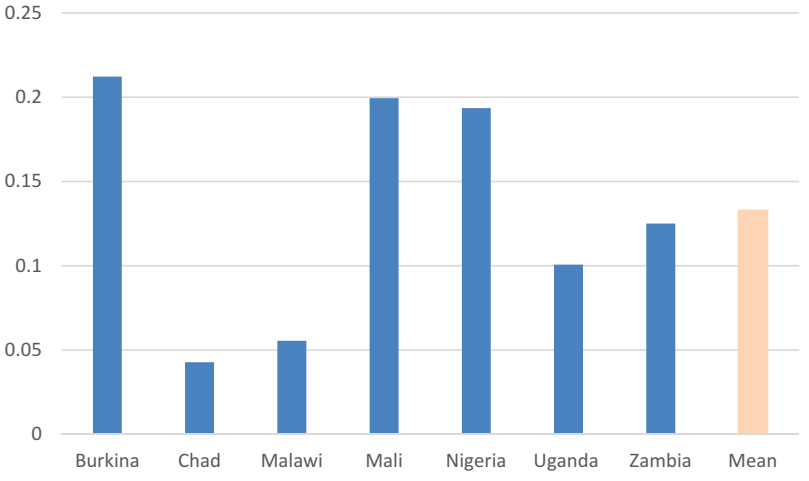

Figure 7. Share of households who report to have been in contact with children's' teachers (N = 5,659).

a reason for returning to their rural household. Of these, 47 are from Uganda. However, another reason given is 'return from work migration,' mentioned by an additional 195 household members, which could of course also be linked to COVID-19.

Fifth, we look into the **shocks** that affect agricultural households in Burkina Faso, Chad, Malawi, Mali, Nigeria, and Uganda (see, Figure 8).[6] While we cannot link these shocks directly to COVID-19, it is informative to see which shocks households have had to deal with since the outbreak of the pandemic, in particular when thinking about vulnerability. Across these countries, there is quite some variation: The most severe shock in most countries is the increase in the price of the main foods consumed. This shock affects more than 80% of households in Nigeria, more than 60% of households in Chad and Malawi, about 30% of households in Burkina Faso, and less than 30% of households in Mali. While more than 30% of Nigerian households report to have been affected by disruptions of farming, livestock and fishing activities, this shock affects less than 20% of households in Burkina Faso, Chad, Malawi, and Mali (not reported in Uganda). Increases in input prices play a minor role in Burkina Faso, Chad, Mali, and Uganda (less than 10% of households), but more than 50% of households in Nigeria and about 30% of households in Malawi report to have been affected by this shock. Decreases in selling prices are

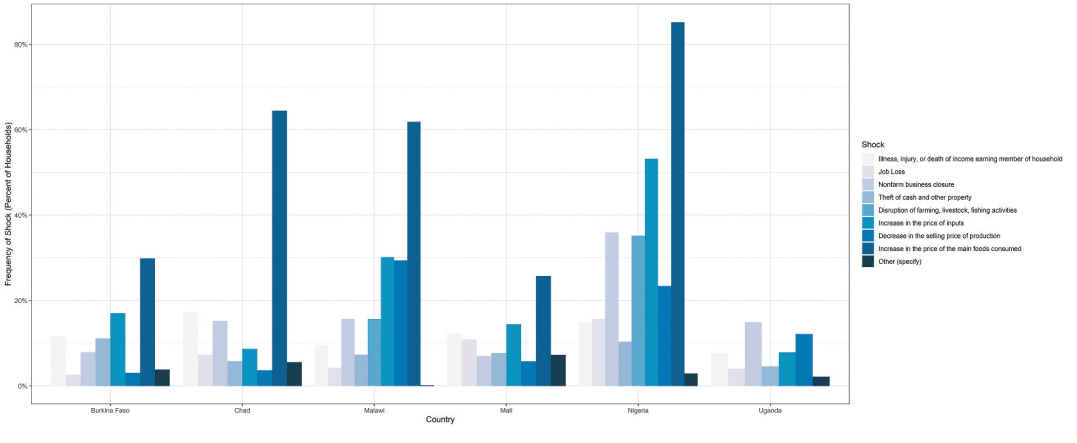

Figure 8. Shocks reported by households in Burkina Faso, Chad, Malawi, Mali, Nigeria, and Uganda (households who report at least one shock N = 5,638).

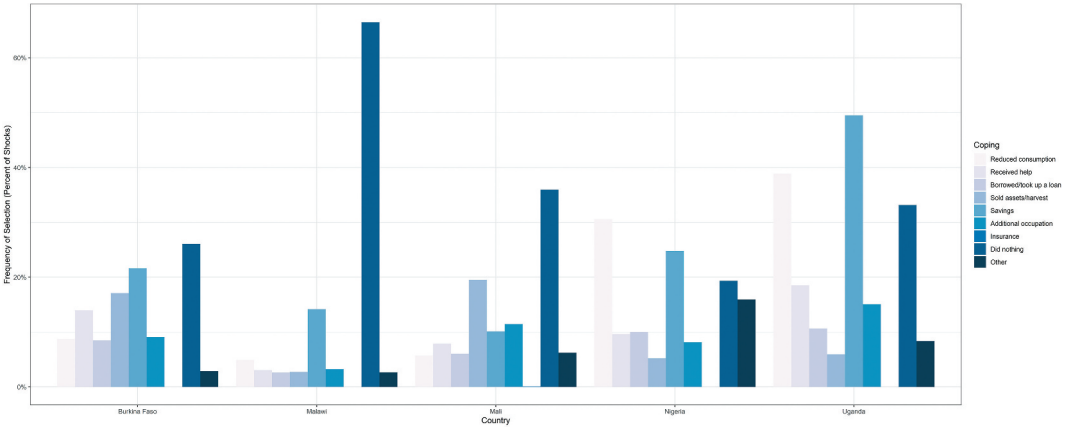

Figure 9. Shock coping in Burkina Faso, Malawi, Mali, Nigeria, and Uganda (all shocks reported N = 10,720).

a frequent shock in Malawi (almost 30% of households) and Nigeria (more than 20% of households). Job losses and the closure of non-farm business play a role in Nigeria (more than 10 and more than 30% of households report these shocks), and to a lesser extent in the other countries.

Finally, we focus on the major shock coping strategies of rural households in Burkina Faso, Malawi, Mali, Nigeria, and Uganda[7] (see, Figure 9). An important response of households in Malawi (relevant to more than 60% of all shocks), Mali, Uganda (both more than 30%), Burkina Faso (more than 20%), and Nigeria (less than 20%) was to do nothing to address shocks. Reducing consumption was a particularly important strategy for households in Uganda and Nigeria (more than 30%). Households in Burkina Faso, Nigeria (more than 20%) and Uganda (almost 50%) addressed shocks by relying on savings. Receiving help was used as a strategy by more than 10% of shocks in Burkina Faso, and Uganda; borrowing or taking up a loan was used as a strategy in about 10% of shocks in Nigeria and Uganda; and the sale of assets or harvest was an important strategy in Burkina Faso and Mali (almost 20%).

Burkina Faso has information on shocks and shock coping for five waves, allowing us to see how trends evolve over time from July 2020 to June 2021 (Figure A1 and Figure A2 in the Appendix). We can see that the frequency of shocks reduces after the second wave, when lockdown measures were being eased. Looking at shock coping, it is evident that more and more households do nothing in response to shocks in Burkina Faso (from more than 20% in the second wave up to almost 60% of shocks in the tenth wave). A coping strategy that becomes more important over time is reducing consumption and selling assets or harvests. More shocks are also addressed by borrowing and receiving help.

Insights from the literature

A study from China, based on web crawler technology and text mining methods, finds that the most important impact of COVID-19 counter-measures on agricultural production is on crop production, including delayed planting, shortage of agricultural inputs and labour (Pan et al., 2020). This shows the seriousness of COVID-19's impact on agricultural households.

In our literature review, we first focus on agricultural **markets** which are vulnerable to disruptions in global supply chains and in trade (Hoyweghen et al., 2021; Morton, 2020; Nchanji et al., 2021; Tamru et al., 2020). The level of integration in international agricultural markets is a key determinant of the extent to which smallholders are affected by disruptions in global supply chains. In Ethiopia, for instance, the global economic slowdown associated with the COVID-19 pandemic resulted in a reduction in the demand for export coffee. Limited transportation opportunities increased costs

and made it difficult for smallholders to export coffee (Tamru et al., 2020). Smallholders integrated in domestic value chains have also been affected. In response to the reduced demand for fresh fruit and vegetables, caused by COVID-19 related market disruptions, smallholders in Senegal producing for the domestic market reduced their production areas and opted to leave land fallow instead. Nearly a fifth of smallholders interviewed also stated that due to the uncertainty associated with the pandemic, they preferred growing staple crops rather than horticultural crops in the upcoming growing seasons (Hoyweghen et al., 2021).

Smallholders that are dependent on family labour and integrated in traditional supply chains that involve family members and small or medium sized traders may be less vulnerable to global macroeconomic shocks, such as the COVID-19 pandemic (Hoyweghen et al., 2021). However, these smallholders may still be affected by national stringency policies that restrict movement and hinder accessibility to input, output and food markets (Aggarwal et al., 2020; Krauss et al., 2021; Morton, 2020). For example, in Nigeria, restricted travel and the closure of markets resulted in the cutting of ties with traders and labourers which led to spoilage of farm produce and food shortages (Ilesanmi et al., 2021; Yegbemey et al., 2021). Similarly, Middendorf et al. (2021) and Middendorf et al. (2021) find that loss of access to local and urban markets are among the major shocks for smallholder farmers in Burkina Faso and Senegal in the wake of the COVID-19-pandemic.

Second, we focus on smallholder access to **agricultural technologies**. Disrupted supply chains and national containment policies related to the COVID-19 pandemic limit smallholders' access to technologies such as fertilizers (Balana et al., 2020). During the pandemic, agricultural extension and advisory services have been disrupted, leading to a reduction in face-to-face extension and an attempt to expand digital extension which proves challenging in rural contexts (Alvi et al., 2021; Amjath-Babu et al., 2020; Baffoe-Bonnie et al., 2021; Prosper Bright et al., 2021). However, many of these effects are only anticipated in the long run since most COVID-19 related containment policies were only implemented after the harvesting seasons (Teachout & Zipfel, 2020). When asked about the next cropping season, 40 to 60% of smallholders in Malawi anticipated that they would have challenges in procuring inputs if the pandemic persists into the year 2021 (Nyirenda et al., 2021). These effects are expected to persist if disruptions are prolonged since there will be reduced capacities for the manufacturing, importation and transportation of key chemical components for fertilizers and pesticides. The production of seeds is also likely to be affected, as seed processing often involves the import of foundation seed, which will be constrained by border restrictions (Willy et al., 2020).

Policies that restricted mobility and closed many businesses had severe impacts on **household income** (Egger et al., 2021; Miguel & Mobarak, 2021; Teachout & Zipfel, 2020; Turiansky et al., 2021). Mahmud and Riley (2021) find that rural households in Uganda lose up two-thirds of their non-farm income seven to eight weeks after the lockdown in Uganda. The biggest income losses are due to reductions in household profits from closed enterprises, such as retail shops and household breweries, and as a result of lower labour income from salaried and casual work. Janssens et al. (2021) also find that households from Kenyan villages lose about two-thirds of their income due to decreased labour demand and a reduction in gifts and remittances six weeks after lockdown measures had been imposed. Similar negative impacts on households income are reported for Ethiopia, Malawi, Nigeria, and Uganda (Balana et al., 2020; Contreras-Gonzalez et al., 2020; Hirvonen et al., 2021; Josephson et al., 2021; Kansiime et al., 2021; Obayelu et al., 2021). A recent study that analyze the impacts of the pandemic on income sources across several survey waves in Ethiopia, Malawi, Nigeria and Uganda shows that the share of households reporting income losses reduces over time indicating recovery. For instance, the share reduced by 35 and 36% in Ethiopia and Uganda respectively. However it is not clear how the levels of income compare to pre-pandemic levels (Furbush et al., 2021).

The containment policies have led to the **closure of education establishments and schools** resulting in prolonged school absences (Dessy et al., 2021; Josephson et al., 2021; Le Nestour et al., 2020). Short- and long-term learning losses are considered severe, in particular in the

African context where schools also take on an important role in preventive health care (Addae, 2020; Angrist et al., 2021; Wolf et al., **2021**). Such closures may also result in changes in household composition since some household members that were previously in school can now work in agriculture. It is feared that school closures raise the level of child labour (Ahad et al., 2020; Idris, 2020). Experiences from the Ebola pandemic show that school closures increase dropout rates, especially in the poorest households (Smith, 2021). This fear is fuelled by insights into how only few children from poor households stayed in contact with their teachers during school closures in Ethiopia, Malawi, Nigeria, and Uganda. Many households are unable to use technologies such as radio, television and mobile learning apps; this particularly affects poor households (Josephson et al., 2021). In Ethiopia, it has been shown that inequalities between urban and rural students increase during the pandemic (Belay, 2020). Inequalities in access and engagement in remote learning in peri-urban Ghana are also thought to increase inequalities. For instance, children from higher socio-economic status, and children experiencing less economic hardship during the pandemic, participate more in remote learning and perform better in literacy and math tests (Wolf et al., 2021). This, in turn, may constrain future upward mobility (Schotte & Zizzamia, 2021).

Labour markets are strongly affected by containment policies, in particular workers in the informal sector are hard-hit (Balde et al., 2020). Nearly 90% of labour markets in Africa are dominated by informal workers. These informal workers were worst affected in countries with stringent lockdown measures, since remaining at home meant losing income, their jobs and livelihoods (African Development Bank, 2021; Balde et al., 2020; Schotte et al., 2021; Schwettmann, 2020). This of course has implications for how rural households can participate in labour markets. Households active in agriculture may be forced to be less reliant on hired labour due to lost income and travel restrictions, as has been found for Nigeria (Obayelu et al., 2021). This was also the case in Mali during the Ebola pandemic (De La Fuente et al., 2020). As for Indonesia, Hammad et al. (2021) find that household members who can no longer work in tourism reallocate their labour to agriculture, a similar shift to agriculture can be expected for African countries that are dependent on nature tourism and have experienced COVID-19 related business closures. Mahmud and Riley (2021) observe how households increase the amount of time dedicated to agriculture and livestock in Uganda to cope with income shocks. Increases in household labour have been associated with several land-use choices, such as the use of more sustainable land-use practices, expansions of crop areas and switches to more labour intensive crops (Mahmud & Riley, 2021).

Moreover, the pandemic has had severe impacts on **migration** (World Bank, 2020c). First, restricted mobility may have prevented people from migrating, both nationally and internationally. Second, migrants were severely affected by the economic consequences of the pandemic and may have lost their jobs. This may lead to reverse migration, many households reported that they migrated out of Dakar to rural areas of Senegal (Le Nestour et al., 2020). However, reverse migration is still more prominent in countries where temporal and seasonal work is common (Boillat & Zaehringer, 2020), such as India (Dandekar & Ghai, 2020; Singh et al., 2020; Menon & Vadakepat, 2020; Mukhra et al., 2020). In Nigeria's Delta State an increase in rural-to-rural migration was observed due to the pandemic. Migrants moved to rural areas with better soil and land characteristics which resulted in higher yields for the migrant receiving rural communities (Ofuoku et al., 2021). In addition, the economic hardship placed on migrants may have negatively affected the amount and frequency of remittances (Abel & Gietel-Basten, 2020; Bisong et al., 2020; European Commission, 2020; Withers et al., 2021).

Finally, it is particularly vulnerable households who are strongly affected by the pandemic and struggle **coping** with the consequences (Lioutas & Charatsari, 2021; Schotte & Zizzamia, 2021; Teachout & Zipfel, 2020). Since the shock caused by the COVID-19 pandemic is a hyper-covariate shock that extends beyond individuals (idiosyncratic) and communities (covariate) to regional and global levels, vulnerable households will require innovative coping and adaptation strategies (Krauss et al., 2021). Based on findings from urban South Africa, Schotte and Zizzamia (2021) find that the co-

variate nature of the shock, renders social networks and informal insurance mechanisms ineffective. This leads households to rely on savings and government grants, and default on insurance payments. Studies from Nigeria report that households compensate for income losses by foregoing on consumption, accepting lower farmgate prices, selling farm and household assets, borrowing from friends, family and local, lenders and dipping into their savings (Balana et al., 2020; Obayelu et al., 2021; Yegbemey et al., 2021). Most agricultural households are financially excluded and resort to informal credit and sources of additional income in times of crisis. Turiansky et al. (2021) observe that even households that are financially included in Kenya, Uganda and Nigeria, do rarely use their financial access to weather the pandemic shocks.

Households in Nigeria and Uganda adjust their agricultural practices when faced with COVID-related shocks and plant fewer crops, reduce the amount of fertilizer applied and crop area cultivated or increase labour in agriculture (Mahmud & Riley, 2021; Obayelu et al., 2021). Simulations suggest that more people fall into extreme poverty in Africa (an additional 9.1%) and that savings vanish, leaving households without any resilience to future shocks (Teachout & Zipfel, 2020).

Discussion: Implications for land-use decisions by agricultural households

The high-frequency phone surveys from eight African countries and the literature review enable us to assess how the COVID-19 pandemic affects agricultural households' livelihoods. Changes in livelihoods in turn affect the underlying factors of land-use decision-making. We can now validate our conceptual framework based on these descriptive and literature insights. Results are summarized in Table 1.

First, many households report that they could not pursue their agricultural activities normally. This is mostly driven by stay at home orders, as well as restrictions on movement. However, access to markets does not seem to have been the major problem during the first lockdown, albeit there is some variation across countries. This could be indicative of the timing of the lockdowns and agricultural seasons, as some households may have already planted or harvested before the lockdown. It could also be indicative of the lagged effects of lockdowns and other restrictions in rural

Table 1. Pandemic impacts on the underlying drivers of land-use change and the assumed effects on land-use.

Pandemic impacts on underlying drivers . . .	Effect on rural households (based on high-frequency phone surveys/ literature)	Assumed effect on land use (based on models of land-use decisions)
Access to markets	-/~ in the short term only modest negative effects on access to markets (in rural areas), in the longer term expected to continue and increase such negative effects	Ambiguous: Short term: reduction in agricultural area, in particular for cash crops Medium- to long-term: expansion in agricultural area
Agricultural technologies	- Reduction in access to agricultural technologies	Ambiguous: Depending on the technology and market conditions, both expansion and reduction in agricultural areas possible
Incomes	- stark reduction of incomes ranging from agricultural income, off-farm income, domestic and international remittances to savings and pension	Ambiguous: General expectation is a reduction in agricultural area – however, if other income opportunities are gone, expansions of agricultural areas expected. In dense areas: switch to labour-intensive crops and land-use practices
Education	- reduced contact to teachers, short- and long-term learning losses, inequalities between rural and urban areas grow	Expected to lead to more people in agriculture, households are then likely to turn towards more labour-intensive agriculture
Migration	~ No evidence of significant reverse migration in the short-term. Likely to play a role in certain regions, might become more important in the long-term. - Reduction of remittances	Right now, no effect expected. If reverse migration is witnessed in the long-term (or regionally), we would expect more working-age household members and more labour-intensive agriculture. Generally expected to lead to expansions in agricultural area, but highly context-sensitive.

areas. In many African countries, COVID-19 cases were first observed in urban areas and containment policies in these settings were tougher. This is in line with Aggarwal et al. (2020) who find modest effects of the lockdown on subsistence farmers' access to markets in Malawi and Liberia. They attribute these modest effects to the remoteness of rural areas and the lockdown exceptions made for subsistence farmers. *Based on our knowledge on the underlying drivers of land-use decisions, we would expect that reduced access to output and input markets in the short-term may lead households to decrease the area of land cultivated, in particular for cash crops targeted at urban and international markets. Conversely, if access to input markets is reduced in the medium-to long-term, households may expand their agricultural land to compensate for losses in access to inputs and food.*

Second, based on the literature, we expect serious reductions in access to agricultural technologies, in the medium- and long-run (Nyirenda et al., 2021; Willy et al., 2020). *The effect of a general reduction in access to agricultural technologies is ambiguous. Depending on the technology and market conditions, we expect an expansion or contrastingly, a reduction of agricultural areas.*

Third, we observe a stark reduction in income. This applies to multiple income sources, ranging from agricultural and off-farm income to domestic and international remittances. This is also reflected in the literature, for instance, Contreras-Gonzalez et al. (2020) report that eighty percent of households in Malawi, Uganda and Nigeria and forty six percent of households in Ethiopia reported a reduction in income after the onset of the COVID-19 outbreak. While it is well-established that income is a key determinant of land-use changes, its precise impact on land-use is ambiguous. This is because income determines the household's current land-use and, at the same time, this land-use also influences income levels (Hettig et al., 2016). *Generally, we would expect that a reduction in income may cause households to reduce the area of land used for cultivation, pasture or ranching. However, as off-farm income opportunities are heavily affected by the pandemic, agricultural activities may be the most viable income generating activity and hence, we would expect an expansion of agricultural areas – where agricultural households have this option. However, agricultural households that live in dense areas without much scope for expansion may switch to labour intensive crops (if access to labour is not restricted by the pandemic) and land-use practices.*

Fourth, concerning education, we find strong evidence that school-aged children had no or little contact to their teachers. Angrist et al. (2021) estimate short-term learning losses from half a year to over a year and long-term learning losses of about 2.8 years in sub-Saharan Africa. With learning from home becoming more important, the digital divide between urban and rural areas has to be considered. Studies report that school closures during the pandemic increased inequalities between urban and rural students (Belay, 2020; Josephson et al., 2021; Smith, 2021). *The effect on land-use is not clear-cut. Since additional years of education have been found to increase the probability to engage in off-farm employment (*Busch & Geoghegan, 2010*), it is likely that long-term learning losses will result in fewer people engaging in off-farm employment. In turn, we expect more people to stay in agriculture. With more household members available to work in agriculture, we expect households to turn towards more labour-intensive agriculture.*

Fifth, during the first lockdown, we do not see any signs of significant reverse migration, and thus would not expect any implications for land-use, yet. However, this does not mean that the effects on migration should be neglected: severe restrictions on movements that might have prevented reverse migration flows were still in place at the time of data collection. Moreover, migrants might have managed to cope with this first lockdown period, but might not cope with prolonged periods of unemployment. This could then result in reverse migration at later stages of the pandemic. In this context, it is important to consider regional differences in the engagement of seasonal or migrant workers. It might thus well be, that reverse migration is a bigger issue in Asian countries rather than African countries due to the higher number of seasonal and temporal workers. Most reports on reverse migration focus on Indian migrants (Dandekar & Ghai, 2020; Singh et al., 2020; Menon &

Vadakepat, 2020; Mukhra et al., 2020). *If we witness reverse migration regionally and/ or in the long-term, this would lead to increases the working-age population and may result in more labour-intensive agriculture.*

We observe a reduction in remittances, which is also reflected in the literature (Abel & Gietel-Basten, 2020; Bisong et al., 2020; European Commission, 2020; Withers et al., 2021). *Generally, remittances (like increases in off-farm income) are associated with lower rates of deforestation as off-farm investments play a more important role. A reduction in remittances would thus be expected to increase agricultural expansions; however, this is highly contingent on context factors.*

Our insights point towards rather ambiguous effects on land-use – highly contingent on context factors. This is in line with Malek et al. (2019), who stress the importance of contexts and development stages for land-use decisions. They distinguish different household typologies with different underlying driving forces and land-use choices. The majority of land-use decision makers in Africa's rural areas are poor and cultivate small amounts of land, ranging from land-use aimed at survival to more market-oriented smallholder farming. The COVID-19 shock is likely to push smallholders towards land-use aimed at survival, which is also the typology that is responsible for the highest rates of deforestation. Hence, in the context of increased vulnerability resulting from the pandemic, it becomes ever more important to support sustainable land management.

To have a better understanding about the vulnerability of agricultural households, we examine how agricultural households cope with shocks. Major shocks that households experience during the first wave of the pandemic are disruptions to farming, increases in input prices and prices of food consumed, decreases in output prices, non-farm business failures, and job losses. The coping strategies employed show that many households have no means to cope with such shocks: a large share of households respond by reducing their consumption, or do nothing at all. Some households still can tap into their savings or borrow from friends and family. However, these households may not be able to do so while the pandemic unfolds, as has also been suggested by simulation studies (Teachout & Zipfel, 2020). Consequently, shocks experienced during the first lockdown and the applied coping strategies show that households are already vulnerable and leave them more vulnerable. Looking at how shock coping evolves over time in Burkina Faso confirms this: more and more shocks are not being addressed, and consumption continues to be reduced.

Conclusions

In conclusion, COVID-19 affects agricultural households' livelihoods substantially, this is mainly reflected by reductions in various income sources and reduced access to education facilities. Following the lockdown measures of the first wave, we find limited evidence of reduced market access and return migration. In addition, smallholders' risk-coping capacities are weak and have been further weakened by the pandemic. Households' safety nets are strained and as a result cushioning the effects of ensuing lockdown measures will be more difficult. We thus expect that while some households will be able to cushion the impacts of the pandemic in the short-term, many will have difficulties doing so in the long-term. Our results further indicate that agricultural households may find it harder to diversify their livelihoods in the wake of the COVID-19 shock that affects various income sources. Thus, agriculture is likely to become a more important livelihood strategy for agricultural households in the years to come. At the same time, households lack the means to invest and will suffer from educational losses. As a result, households are likely to turn to labour-intensive agriculture. Accordingly, we expect COVID-19 to result in a more labour-intensive expansion of agriculture. However, context matters and thus impacts on land-use are likely to vary largely across the different smallholder

profiles. Land-use decisions adopted by agricultural households on the edge of survival will be very different from those adopted by market-oriented smallholders in the wake of the COVID-pandemic.

It is important to state that our analysis is limited by the data used, we can only provide detailed descriptive insights of the impacts of the first wave of the pandemic. Neither the data nor the literature to date does provide much insight on actual land-use changes. This is because it takes time until land-use decisions result in visible land-use changes. Accordingly, to assess actual medium- to long-term land-use changes, detailed longitudinal agricultural and land-use data is needed. At this stage, it is only possible to observe how some of the underlying drivers of land-use change have been affected by the global impacts and international and national policy responses during the first wave of the COVID-19 pandemic.

The pandemic is not over, neither in the Global North nor in the Global South. With only about 7% of the African population fully vaccinated (at the time of writing, December 2021 (Africa, 2021)), the African continent is likely to continue being affected by the pandemic. The effects on agricultural households that have already coped with previous waves need to be closely monitored. Vulnerable households need support to cope with the long-term impacts of COVID-19.

Notes

1. The HFPS also cover two more African countries, Djibouti and Kenya, which we do not use. Djibouti only covers urban regions, and Kenya's survey instrument differs largely from the other surveys. Thus, comparison with the other survey data is difficult and we focus on the remaining eight countries.
2. For Burkina Faso and Malawi, the first wave does not contain a shocks section. This is why we draw on the second wave in the shocks and shock coping part for these countries. These survey waves were collected in July and August 2020.
3. We identify such households by their reported involvement in agriculture. This can be determined by the question '*Do you or a member of your household work on a family agricultural exploitation where you grow crops or raise livestock*?' from the 'income and revenue' section or by '*In the last 12 months, which of the following were your household's sources of livelihood*?' with '*agriculture*' as one option from the 'income loss' section. We use both these questions to identify agricultural households. Due to the importance of agriculture in peri-urban areas, we use this approach rather than relying on the given distinction of 'urban' and 'rural.'
4. Burkina Faso does not have an income loss section. Thus, we cannot include Burkina Faso in this assessment.
5. In the education section, the Ethiopian survey is different and does not allow for a comparison.
6. We cannot include Ethiopia and Zambia in the shock and shock coping section as their survey instruments differ.
7. We cannot include Chad in the shock coping section, as Chad uses different codes and is thus not comparable to the other countries.

Acknowledgments

We are grateful to the associate editor and two anonymous reviewers with very constructive comments to an earlier draft version. We appreciate the help provided by Charlotte Bakker-Müller in proof-reading the manuscript. We thank the Development Data Group of the World Bank for providing access to their high-frequency phone surveys. We further thank the Our World in Data team, as well as the Blavatnik School of Government at the University of Oxford for their great efforts in providing data used in this paper.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Appendix A

Additional figures

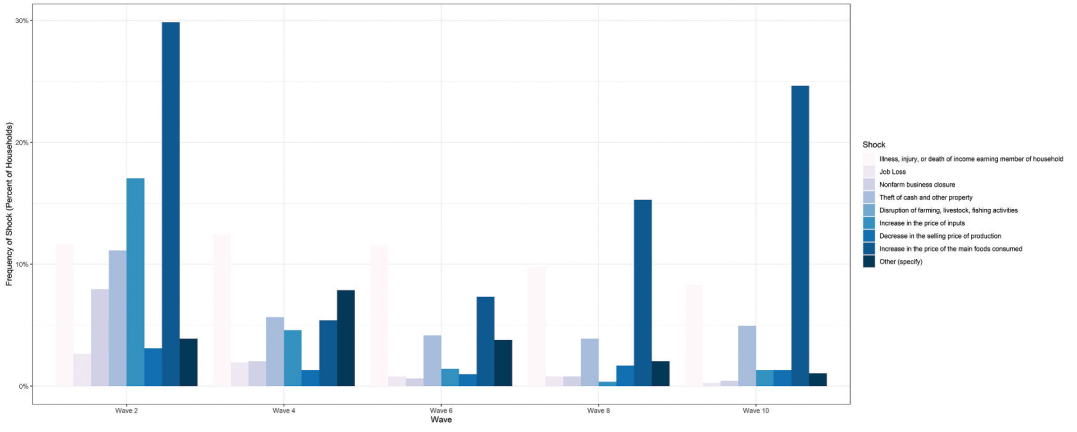

Figure 1. Shocks reported by households in Burkina Faso over time

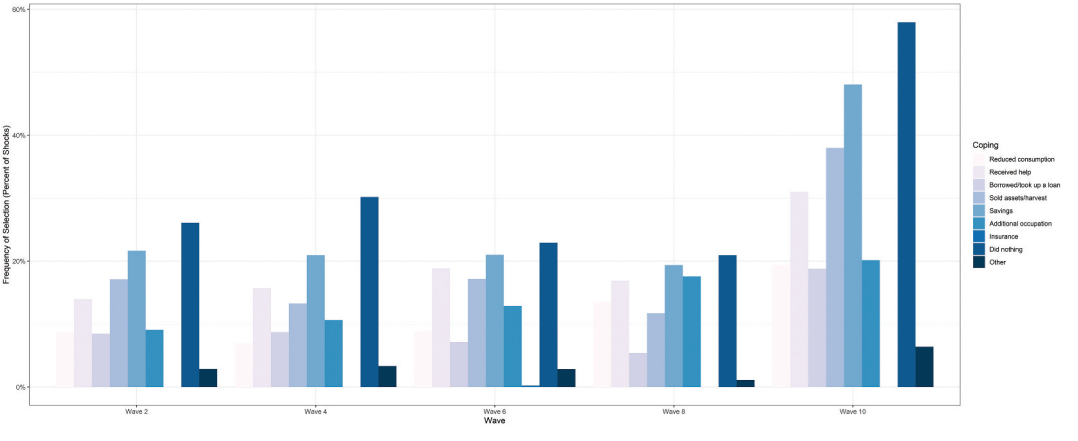

Figure 1. Shock coping in Burkina Faso over time.
(all shocks reported, N= 11,46 in wave 2, 573 in wave 4, 419 in wave 6, 444 in wave 8, and 516 in wave 10)

Data sources

Stringency index

The stringency index is comprised of several sub-indices, capturing different areas in which governments may have enforced lockdown measures. All of these sub-indices are ordinal, containing information, on different degrees of stringency for certain measures, e.g. no measures, recommended measures, or compulsory measures. For the stringency index, data from the following sub-indices was used: School closing, Workplace closing, Cancel public events, Restrictions on gatherings, Close public transport, Stay at home requirements, Restrictions on internal movement, International travel controls, Public information campaigns. To calculate the overall stringency index score, due to differences in ordinal scales and flag values, each sub-index score must be calculated first and is then averaged with equal weight.

Table A1. Overview on data from the high frequency phone surveys

						Used in our analysis...					
Country	Wave	Data Collection Start	Data Collection End	Sampling frame	number of agricultural households	Market access	Income	Education	Migration	Shocks	shock coping
Burkina Faso	1	09.06.2020	01.07.2020	Based on the 2018/19 Harmonized Living Conditions Household Survey (EHCVM). All households with valid phone numbers are the sampling frame for the HFPS.	1132	yes		yes	yes		
	2	20.07.2020	14.08.2020		1132					yes+ Appendix	yes + Appendix
	4	06.11.2020	02.12.2020		1116					Appendix	Appendix
	6	15.01.2021	01.02.2021		1106					Appendix	Appendix
	8	13.03.2021	01.04.2021		1072					Appendix	Appendix
	10	25.05.2021	15.06.2021		1060					Appendix	Appendix
Chad	1	27.05.2020	15.06.2020	Based on the Enquête sur la Consommation des Ménages et le Secteur Informel au Tchad (Ecosit 4). All households with valid phone numbers are the sampling frame for the HFPS.	862	yes	yes	yes	yes	yes	
Ethiopia	1	22.04.2020	13.05.2020	Based on the 2018/19 Ethiopia Socioeconomic Survey (ESS). All households with valid phone numbers (including reference phone numbers) are the sampling frame for the HFPS.	1046	yes	yes				

(*Continued*)

Table A1. (Continued).

						Used in our analysis. . .					
Country	Wave	Data Collection Start	Data Collection End	Sampling frame	number of agricultural households	Market access	Income	Education	Migration	Shocks	shock coping
Malawi	1	26.05.2020	14.06.2020	Based on Malawi Integrated Household Panel Survey (IHPS). All households with valid phone numbers (including reference phone numbers) are the sampling frame for the HFPS.	1359	yes	yes	yes	yes		
	2	02.07.2020	20.07.2020		1292					yes	yes
Mali	1	11.05.2020	03.06.2020	Based on Enquête Harmonisée des Conditions de Vie des Ménages (EHCVM). All households with valid phone numbers are the sampling frame for the HFPS.	935	yes	yes	yes		yes	
Nigeria	1	20.04.2020	11.05.2020	Based on wave 4 of the GHS-Panel conducted in 2018/19. All households with valid phone numbers (including reference phone numbers) are the sampling frame for the HFPS.	1520	yes	yes	yes	yes	yes	

(*Continued*)

Table A1. (Continued).

						Used in our analysis...					
Country	Wave	Data Collection Start	Data Collection End	Sampling frame	number of agricultural households	Market access	Income	Education	Migration	Shocks	shock coping
Uganda	1	03.06.2020	16.06.2020	Based on wave 8 of the Uganda National Panel Survey (UNPS). All households that had phone number for at least one household member or one reference individual are the sampling frame for the HFPS	1906	yes	yes	yes	yes	yes	
Zambia	1	05.06.2020	26.06.2020	Based on a masterlist of phone numbers that have been collected during previous nationally-representative surveys in Zambia.	488	yes	yes	yes			

*previously diagnosed by a specialist; **lasting more than 6 weeks in the last year