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# Fertilizer Price Shocks in Smallholder Agriculture

## Cross-Country Evidence from High-Frequency Phone Surveys in Sub-Saharan Africa

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## Abstract

Since 2020, many countries in Sub-Saharan Africa have experienced disruptions to agricultural activities due to the adverse effects of multiple global crises. Notably, the Russian invasion of Ukraine caused a surge in inorganic fertilizer prices, which had potentially significant impacts on Sub-Saharan Africa's agriculture sector given that most countries in the region are net importers of inorganic fertilizers and the Russian Federation is the world's largest exporter. Using high-frequency longitudinal phone survey data spanning four years from six Sub-Saharan African countries, this paper examines the dynamics of smallholder agriculture against the backdrop of these crises, with particular focus on prices, availability, and use of inorganic fertilizer, as well as the strategies employed by farmers to cope with high fertilizer prices and other accessibility constraints. The results show that inorganic fertilizer prices have increased in the region since 2020, forcing smallholder farmers to adopt coping mechanisms that are less productivity-enhancing, making them even more susceptible to future crises. Specifically, farming households reduced the quantity of inorganic fertilizer applied, by applying it at lower rates or to a smaller area. In some cases, households sold assets or borrowed money to cope with the high prices of inorganic fertilizers. This calls for policies to help smallholder farmers in the region to build strong support systems to be more resilient and better able to cope with the adverse effects of rising inorganic fertilizer prices during polycrises and related shocks.

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# Fertilizer Price Shocks in Smallholder Agriculture: Cross-Country Evidence from High-Frequency Phone Surveys in Sub-Saharan Africa


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**WB Thematic Area:** Crop production; economic shocks and vulnerability.

## 1. Introduction

Since 2020, many countries in Sub-Saharan Africa have faced repeated disruptions to agricultural activities through the culmination of a number of crises. Most notably, the COVID-19 pandemic posed a serious risk to public health and led to widespread disruption of public life, transportation, and trade starting in March 2020. In parallel, some countries, such as Burkina Faso, Ethiopia and Nigeria, continue to be exposed to recurrent domestic conflicts and insecurity. The Russian invasion of Ukraine in February 2022 raised concerns about adverse effects on access to and prices of inorganic fertilizers - in view of many Sub-Saharan African countries being net importers of inorganic fertilizer and the Russian Federation being the world's largest exporter (Simoes and Hidalgo, 2011). These developments have been further compounded by rising inflation, tightening fiscal constraints, and growing macroeconomic imbalances across the region (IMF 2023). Understanding smallholder farmers' exposure to these crises and their coping strategies is fundamental for any policy response and the subject of this paper.

Crises aside, despite evidence of the role of inorganic fertilizer in increasing agricultural yields, smallholder farming systems in Sub-Saharan Africa have historically utilized relatively low rates of inorganic fertilizer vis-à-vis agronomic recommendations and farming systems in other regions (FAO, 2022). Minot and Benson (2009) point to an average fertilizer application rate of 13kg/ha for the region, with Sheahan and Barrett (2017) unveiling heterogeneity in application rates across countries, ranging from 1.2kg/ha (Uganda) to 146kg/ha (Malawi) among the six countries included in their study. The incidence of fertilizer application also varies significantly by country, with about 3, 17, and 77 percent of cultivating households applying any inorganic fertilizer in Uganda, Tanzania, and Malawi, respectively (Sheahan and Barrett, 2017).

The literature points to multiple barriers to fertilizer adoption, including imperfect markets, lack of access to credit, and limited or variable profitability often linked to soil health (Croppenstedt, Demeke, and Meschi, 2003; Marenya and Barrett, 2009; Xu et al., 2009). Duflo, Kremer, and Robinson (2008) find, for example, an annual rate of return of nearly 70 percent for maize on average when the most profitable level of fertilizer was applied in field trials in Kenya, though other rates of fertilizer application were found to be non-profitable (even with gains in yield as high as 63 percent on average). This has also attracted the attention of governments and their development partners. The onslaught of crises and the varied channels in which they may impact farmers and fertilizer application, through restricted market access, limited supply, and price shocks, among others, threaten to dampen already-low rates of fertilizer use with potentially significant impacts on agricultural production and productivity.

In this paper, we leverage high-frequency phone survey data to shed light on dynamics in African smallholder agriculture against the backdrop of these crises, particularly as they relate to the availability, use, and price of inorganic fertilizer. Our data come from the longitudinal high-frequency phone surveys (HFPS) implemented since April 2020. The LSMS-HFPS regularly fielded a rotating set of questions on agricultural practices and outcomes, which form the basis for this paper. This phone survey data is also complemented with data from the face-to-face longitudinal household surveys that have been conducted under the LSMS-Integrated Surveys on Agriculture (LSMS-ISA) initiative and that have served as the sampling frames for the LSMS-HFPS. Together, the data span the period from 2018 to 2024. In total, we rely on 34 waves of survey data across six countries, Burkina Faso, Ethiopia, Malawi, Nigeria, Tanzania and Uganda.

Using these data, we unpack the farmer experience with inorganic fertilizer over time, including not only incidence of use, but also the strategies employed by households in the face of price shocks and other constraints. We find that while the incidence of application remains relatively stable over most of the crisis period, a significant share of households reported using less than the amount that they needed, driving many households to apply fertilizer to a smaller share of their cultivated area or apply at a lower intensity. Some farmers tried to minimize further reduction by borrowing money or selling assets to buy the input, increasing their vulnerability to future shocks.

The remainder of the paper is organized as follows. Section 2 discusses the data utilized and the methodology deployed. Section 3 presents the results, and Section 4 discusses the importance and policy implications of these results. Section 5 concludes.

## 2. Data and Methods

### *2.1. High-Frequency Phone Surveys*

This paper uses data from a series of high-frequency phone surveys (HFPS) conducted in six SSA countries. The HFPS data used here have been collected primarily by national statistics offices,[1]

[1] The Ethiopia HFPS was implemented by a private survey firm, not the national statistics office.

with support from the World Bank's Living Standards Measurement Study (LSMS) team.[2] These six countries are part of the LSMS-Integrated Surveys on Agriculture (LSMS-ISA) project that fields longitudinal, multi-topic household surveys with focus on agriculture. Thus, the households included in the HFPS were also interviewed as part of the LSMS-ISA panel survey conducted in these countries. A uniform methodology was adopted in sampling, weighting, and implementing the HFPS across the countries, making cross-country comparison feasible. In each country, the most recent face-to-face survey prior to the start of the pandemic formed the frame for the HFPS. The HFPS was designed to be nationally representative, with rural/urban stratification.

The HFPS collects information on various indicators, including demographic information, shocks and coping strategies, economic sentiments, employment and business operation, and agriculture, among others. The current study uses data primarily from the agriculture and price modules. Given the season-specific requirements of agriculture data, the HFPS rounds that collected agriculture information were implemented either at the end of the main agriculture season or split across the post-planting and post-harvest periods in the respective countries. The agriculture module collects information on crops planted and area; harvest; fertilizer access, use and challenges with access and coping strategies; among others. While the HFPS began after the onset of the COVID-19 pandemic, the timing of implementation and number of rounds completed to date varies across countries. Table A1 gives the sample distribution across countries and the rounds of the phone survey data used for the analysis. Figures A1-A6 visualize the timeline of data collection.

### *2.2. Variable Creation*

The information collected through the HFPS that is most relevant to the objectives of this study broadly falls into three categories, described below. Not all information was collected across all rounds of the HFPS such that data availability varies by country and over time. Unless explicitly specified otherwise, all information collected was with respect to the latest agricultural season.[3]

First, we collected information on agricultural engagement, which comprises information on the incidence of crop farming among all households, the share of crop-farming households that

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[2] This survey is part of the World Bank's effort to support the collection of monthly high-frequency phone surveys to monitor the impact of the COVID-19 pandemic and external shocks on households. https://www.worldbank.org/en/programs/lsms/brief/lsms-launches-high-frequency-phone-surveys

[3] For interviews conducted after planting but before harvesting, this was the ongoing agricultural season. For interviews conducted after harvesting, this referred to the recently completed agricultural season.

could not conduct their agricultural activities as usual in the reference agricultural season, and the reasons for disruption to agricultural activities.

Second, we collected detailed information on extensive (whether the household used any inorganic fertilizer) and intensive margin fertilizer use (how much inorganic fertilizer was used across all plots of the household; and how much was purchased). Depending on country and survey round, we also collected information on the different types of fertilizer applied. For intensive margin fertilizer use, respondents reported the total quantity of fertilizer used across all plots of the households in a unit of their choice. Wherever a quantity was reported in non-standard units, we use standardized conversion factors to express the quantity in kilograms. For those households that used no inorganic fertilizer, we collect information on their reasons. For those who used any fertilizer, we further ask whether households were able to acquire the full amount of fertilizer they desired. Those that responded that they could not acquire as much fertilizer as desired were asked how much more fertilizer (in kilograms or a unit of their choice) they would have liked to acquire. They were also asked about the reasons for the fertilizer shortfall and their coping strategies for having had less fertilizer than desired. We normalize all quantities reported (fertilizer quantity per hectare, purchased fertilizer quantity per hectare, fertilizer shortfall per hectare) by the total self-reported area under cultivation and winsorize at the 2.5 and 97.5 percentiles within each country.

Third, we collected information on fertilizer prices from two sources depending on the survey round. The first source of fertilizer price information comes from a dedicated prices module which, among others, collected information on the current price of inorganic fertilizer for all households reporting that fertilizer was available for sale in their community or a nearby location.[4] This question was not specific to any fertilizer type. The second source is the HFPS agriculture module which asked all respondents in crop-farming households to report the current price of inorganic fertilizer by fertilizer type.[5] Respondents reported on prices for either the types of fertilizer they used or, if they did not use any, for any type of fertilizer they could report on. Prices were reported in local currency units (LCU) for a certain amount of fertilizer and unit. We standardize all prices by expressing them in LCU per kilogram. If a household reported prices for

[4] Respondents did have the option to answer that they did not know the price.
[5] In Ethiopia (round 19) and Uganda (round 15), only those that used any inorganic fertilizer were asked to report on the price.

multiple types of fertilizer, we take the average price across all fertilizer types.[6] We winsorized the fertilizer price per kilogram at both the 5th and 95th percentiles within each country. In addition to quantitative data on fertilizer prices, we collected self-reported data on the change in fertilizer prices compared to the previous agricultural season and, for those reporting higher prices than last season, the strategies they used to cope with high fertilizer prices.

### *2.3. Estimation*

Our analysis is mostly descriptive, focusing on the estimation of national-level means by survey wave. To examine the correlates of fertilizer use and shortfall, we estimate linear probability models using OLS. When examining trends over time, we fit a linear trend for each country by regressing the dependent variable on a discrete variable taking the value of 1 for the first round we collected data on the outcome in that country, a value of 2 for the second data point, and so on. Throughout our analysis, we weight our estimates using the HFPS survey weights that are designed to correct for selection bias in the HFPS sample compared to a nationally representative sample (Ambel, McGee, and Tsegay 2021; Zezza et al. 2023).

## 3. Results

### *3.1. Agricultural Engagement*

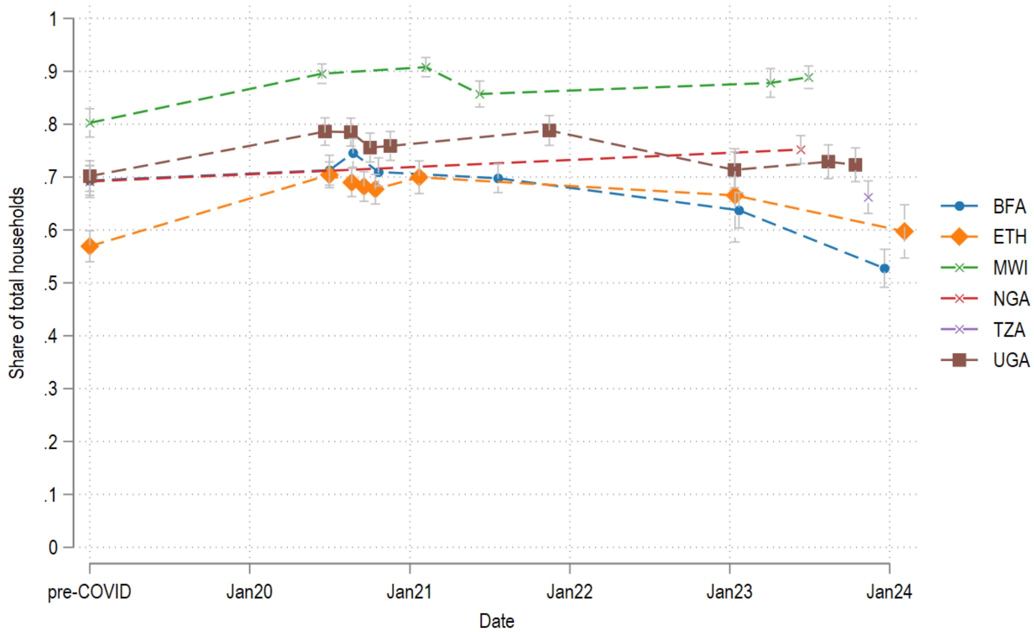
To provide context, we first show the share of households engaged in crop farming over time (Figure 1). For five of our study countries – Burkina Faso, Ethiopia, Malawi, Nigeria, and Uganda – we observe this before the COVID-19 pandemic and then at various points during and after it, from 2020 to 2024. In the pre-COVID period, between 56 percent (Ethiopia) and 80 percent (Malawi) of households engaged in crop farming. The first data points during the COVID-19 pandemic suggest there is a significant increase in the household-level incidence of crop farming, as pandemic lockdowns limited other income generating activities, of 5.2 points in Burkina Faso, 13.5 points in Ethiopia, 9.3 points in Malawi, and 8.4 points in Uganda (Figure 1).

The initial increase at the onset of the pandemic leveled off during the course of 2020 but remained above pre-COVID levels until 2023 in Ethiopia, Malawi, and Nigeria. In Malawi and

[6] We do so to maximize longitudinal coverage as fertilizer prices as reported in the price module and as reported in the agriculture module were collected across distinct survey rounds. To lend confidence to this approach, we compared the most common fertilizer types, compound and nitrogen-based fertilizers, using the type-specific price data. The median difference in prices across the two types was approximately zero.

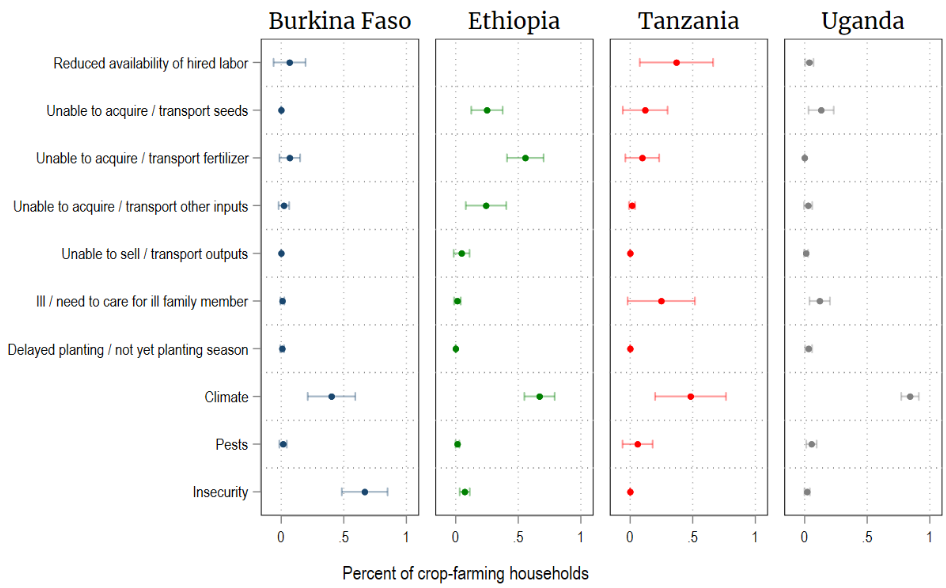
Nigeria, the share of households engaged in crop farming remains above pre-COVID levels as of early 2024. In Ethiopia and Burkina Faso, there is a notable drop in the share of households engaged in crop farming between early 2023 and early 2024 of 10.9 points and 6.8 points, respectively.

**Figure 1. Share of households engaged in crop farming over time**




In addition, nearly 25% of those in Ethiopia who did cultivate crops as of early 2024 report that they could not conduct farm activities as usual, compared to 9 percent in Uganda, 6.3 percent in Burkina Faso, and 1.6 percent in Tanzania (Table A3). In Ethiopia, the three main reasons for this disruption to agricultural activities are climate (66.9 percent), lack of fertilizer (55.6 percent), and lack of seeds (25 percent). Climate is the most important reason for disruptions reported by farmers not only in Ethiopia but in all countries (Figure 2).

**Figure 2. Reasons for disruption of agricultural activity**




Note: Survey timings: BFA (01/24), ETH (02/24), TZA (11/23), UGA (10/23)

### *3.2. Incidence of Fertilizer Use*

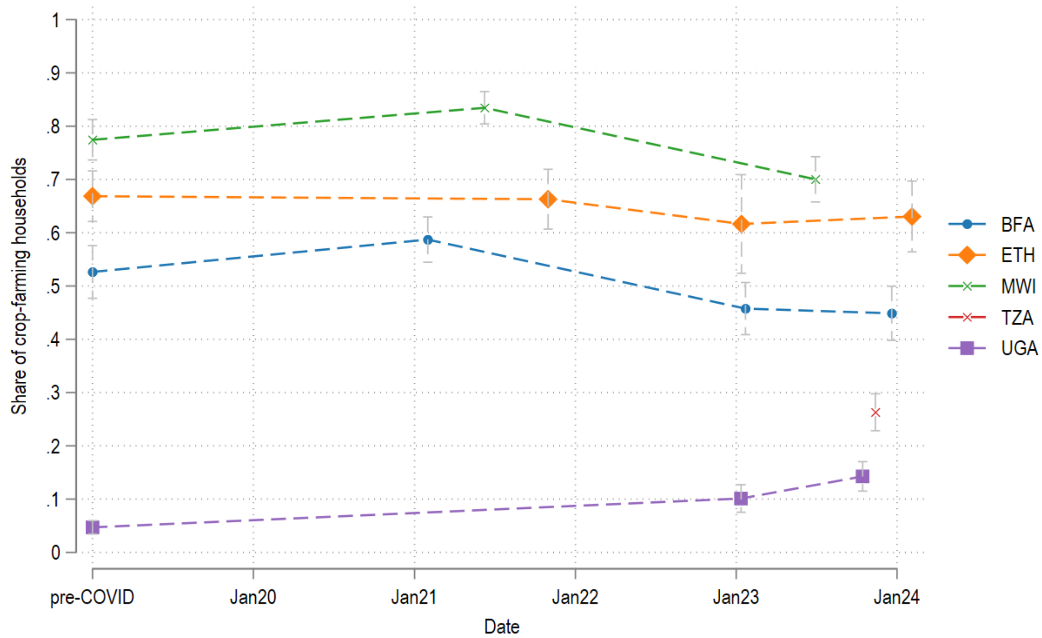
The incidence of fertilizer use, the share of farming households who reported applying inorganic fertilizer, in Burkina Faso, Ethiopia, Malawi, Tanzania and Uganda over 2019-2024 is presented in Figure 3. The pre-COVID incidence, from lowest to highest, was 4.7% in Uganda, 52.6% in Burkina Faso, 66.9% in Ethiopia, and 77.4% in Malawi. This order continued during the COVID period and after with some fluctuations in the trends. Notable changes in the trends were a decline in Burkina Faso and Malawi respectively by about 7.7 and 7.4 percentage points over the period 2021-2023, a period that overlapped the Russian invasion of Ukraine. The trend in Ethiopia shows little movement.

Three observations can be made in the level and dynamics of the incidence of inorganic fertilizer use in these countries. First, there is considerable variation between countries in the share of farming households who reported inorganic fertilizer use (Figure 3). The proportion ranges from the lowest 4.7% in Uganda (pre-COVID) to 83.5% in Malawi (June 2021). The pattern is consistent over time. This pattern is in line with previous studies that estimated fertilizer use in a few countries including Uganda (Sheahan and Barrett, 2014). Second, although inorganic fertilizer use among smallholder farmers in Sub-Saharan Africa (SSA) is in general low, three of the five countries in this study are above the SSA average (FAO, 2022; Ricker-Gilbert, 2022, Sheahan and Barrett, 2014). Third, our findings suggest that the share of households who used inorganic fertilizer, specifically in Ethiopia and Uganda, did not decrease during the period of the COVID-19 pandemic and the Russian invasion of Ukraine.[7]

Over our study period there are statistically significant time trends in Burkina Faso, Malawi, and Uganda. In Burkina Faso and Malawi, the incidence of fertilizer use fell whereas in Uganda, there was a slight increase (though the magnitude remains low relative to the other countries included (see Table A6)). In Ethiopia, the linear time trend is negative but not statistically significant. Separate regression analysis, presented in Table A7, highlights the relationship of fertilizer use with household wealth and remoteness. In all countries for which a household wealth index can be constructed, which excludes Tanzania, the relationship between fertilizer use and household wealth quintile is positive (with the exception of Nigeria), suggesting that poorer households are less likely to use fertilizer relative to wealthier households, without controlling for other potential correlates. When explanatory variables are added that proxy the degree of connectedness of a household, for the countries where these data are available (Ethiopia, Malawi, and Nigeria), the direction of the relationship between household wealth and fertilizer use holds and there is evidence that remoteness it correlated with a lower likelihood of fertilizer use in Ethiopia and Nigeria.

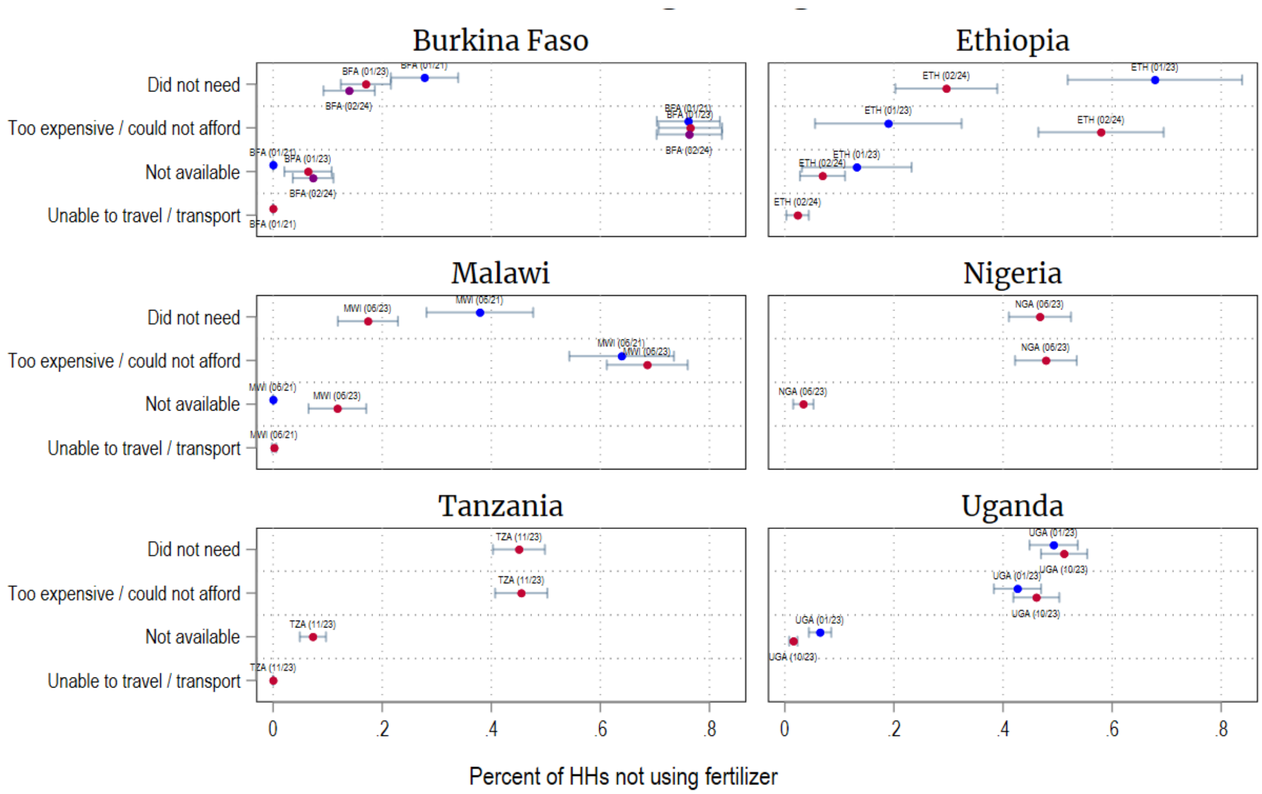
[7] This could be due to the limitation of the incidence indicator to capture the full impact of price and availability of fertilizer in the market. Discussion of coping mechanisms, in the subsequent sub-section, suggests that many farming households reduced the quantity of fertilizer use.

**Figure 3. Incidence of Inorganic Fertilizer Use**




Farming households that did not use fertilizer were asked why they opted against, or were prevented from, utilizing fertilizer for the respective agricultural season. The response options we designed to capture need as well as constraints related to affordability, availability of supply, and mobility. Figure 4 presents, for two points in time for most countries, the share of households reporting each of the reasons for not applying fertilizer. A sizable share of crop-farming households that did not apply fertilizer reported simply not needing it. This share is as high as 67.8% in Ethiopia (January 2023), with more than 40% reporting this in Malawi, Nigeria, Tanzania, and Uganda. The remainder of households, those that desired fertilizer but did not apply it, point to high price rather than lack of supply or inability to travel to markets, and this appears fairly consistent across the time period covered. In Burkina Faso, more than 76% of farming households that did not apply fertilizer report that fertilizer was too expensive, barring them from using any. The same is true for 68.6% of households in Malawi (June 2023), 45.5% in Tanzania, 46.1% in Uganda (October 2023), and 47.9% in Nigeria. In Ethiopia there are more observed dynamics, with a 39 percentage point increase in the share of households reporting that affordability was preventing them from using any fertilizer from January 2023 to February 2024.

**Figure 4. Reasons for not applying fertilizer**



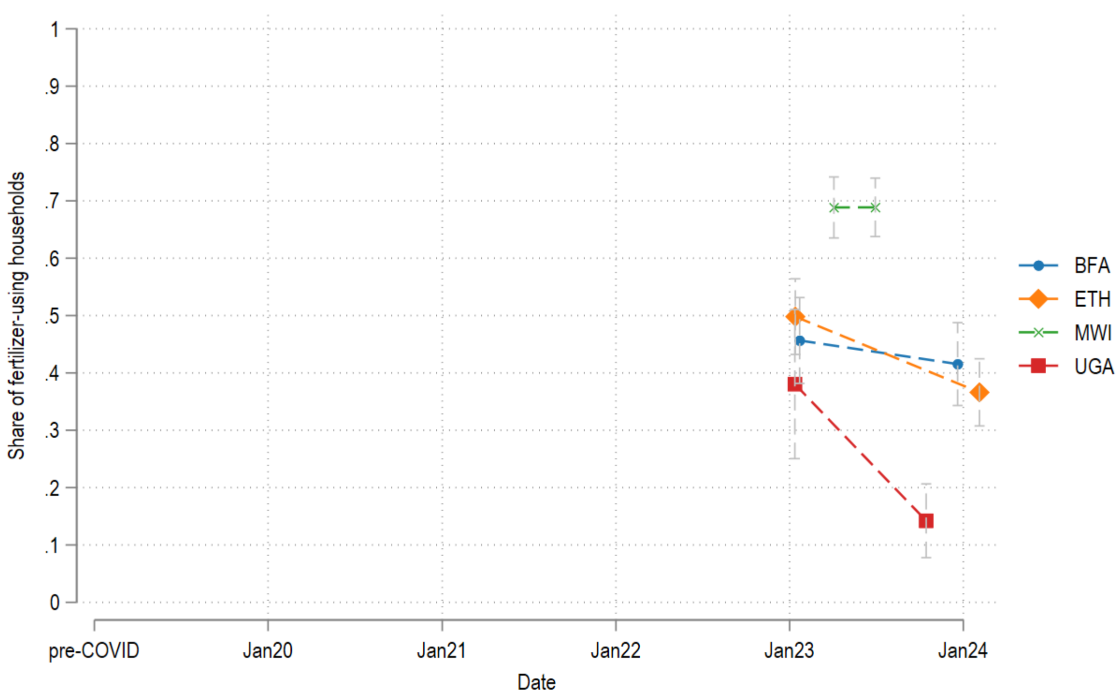

*3.3. Fertilizer Shortfall*

Among households that used fertilizer, a significant share utilized a lower quantity than desired. This ranges from 68.9% of fertilizer-using households in Malawi (February 2024) to 14.2% in Uganda (October 2023), as seen in Figure 5. From January 2023 to the end of 2023/beginning of 2024, there was a decrease in the share of household reporting a fertilizer shortfall in Uganda, Ethiopia, and Burkina Faso, though this decrease is only significantly different in Ethiopia and Uganda (Table A10). The incidence of fertilizer shortfall is negatively correlated with wealth quintile in Ethiopia, Malawi, and Nigeria, though with statistically significant coefficients in Ethiopia and Nigeria only, suggesting that poorer households are more likely to experience shortfalls (see Table A11). Similarly, households that are more remote tend to be more likely to experience fertilizer shortfalls, with increased distance to markets correlated with the incidence of shortfalls in Malawi, as well as increased distance to roads in Ethiopia and increased distance from population centers in Nigeria (Table A11).

The gap between quantity of fertilizer desired and quantity attained is non-negligible and varies across country. In Ethiopia and Tanzania, mean fertilizer shortfalls are estimated at 282 kg/ha and 311 kg/ha among households that reported a shortfall, respectively, with a lower median shortfall of 48 kg/ha in Uganda (though the sample size in that context is prohibitively small to be conclusive). These values translate into average shortfalls of 56 percent, 67 percent, and 66 percent of the total desired fertilizer quantity (Table A12). The depth of the shortfall is inversely related to wealth quintile in Ethiopia (Table A13), suggesting that poorer households are realizing greater gaps between fertilizer desired and fertilizer acquired.

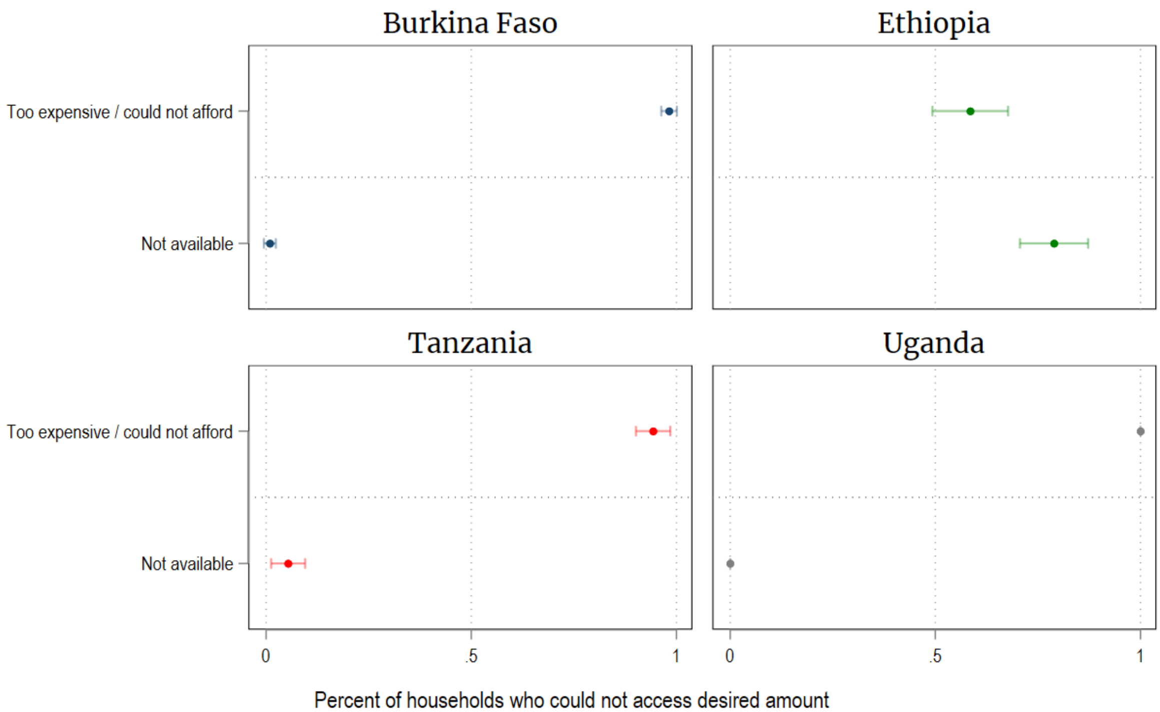
Households may be facing fertilizer shortfalls through two main channels: supply-side constraints and affordability. The results in Figure 6 suggest that affordability was nearly the sole driver of fertilizer shortfalls in Burkina Faso, Tanzania, and Uganda, while in Ethiopia both affordability and availability were common constraints.[8]

**Figure 5. Share of households that could not access desired amount of fertilizer**




[8] In Ethiopia, multiple responses were allowed and some households (approximately 38%) indicated both availability and affordability constraints.

**Figure 6. Reason for Fertilizer Shortfall**

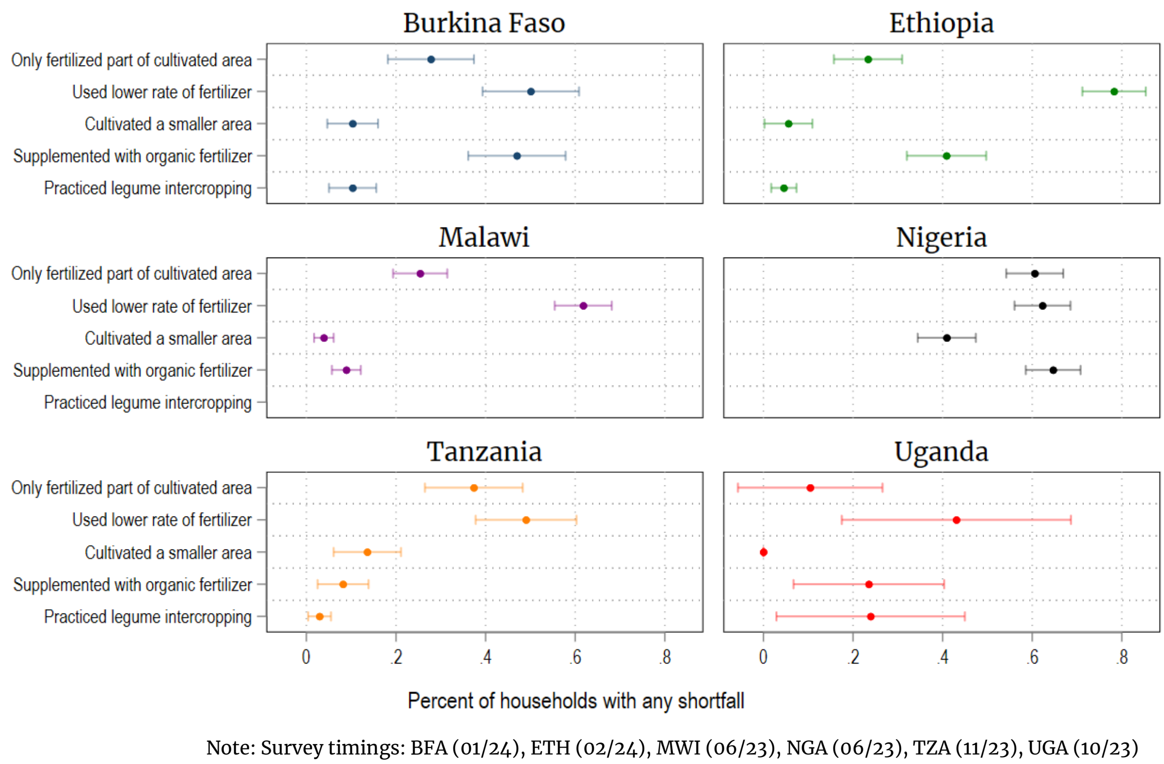



Note: Survey timings: BFA (01/24), ETH (02/24), TZA (11/23), UGA (10/23)

In order to cope with shortfalls in inorganic fertilizer, farming households adopted a myriad of strategies in production (see Figure 7). While some of the coping mechanisms complement or serve as substitutes for inorganic fertilizer use, others appear unfavorable to crop productivity. For instance, in Ethiopia and Burkina Faso, more than 40 percent of households supplemented the lower quantity of inorganic fertilizer with organic fertilizer, and nearly 24 percent of farming households in Uganda did the same. In Nigeria, nearly 65% of farming households that suffered shortfalls in inorganic fertilizer opted to supplement with organic fertilizer. Some households elected to practice legume intercropping, a strategy deemed productivity enhancing, when faced with fertilizer shortfalls, including 23.9% in Uganda, 10.3% in Burkina Faso, and smaller shares in Ethiopia and Tanzania.

On the contrary, a substantial share of farming households used a lower application rate of inorganic fertilizer (78.3% of households in Ethiopia, about 50% in Tanzania and Burkina Faso, about 62% in Malawi and Nigeria, and nearly 43.1% in Uganda), while some households reported applying inorganic fertilizers to only a fraction of the cultivated area. A smaller share of households in each country opted to reduce the total area under cultivation to cope with the shortfall in fertilizer, ranging from 0% in Uganda to 40.9% in Nigeria.

**Figure 7. Strategies for Coping with Fertilizer Shortfall**




## *3.4. Fertilizer Prices*

Much of the narrative around fertilizer in recent years, particularly since the Russian invasion of Ukraine, has been around the price of inorganic fertilizers. As seen in the preceding sections, many households reported affordability as the key reason for not applying fertilizer, or for applying less than desired. As part of the HFPS surveys, households were asked to report, qualitatively, on changes in fertilizer prices compared to the previous season. In January 2023, nearly all (96.6%) households using fertilizer in Ethiopia reported the fertilizer prices were "higher" or "much higher" than the preceding season.[9] Building on the increases reported in January 2023, in early 2024, roughly 81 percent of households in Ethiopia reported further fertilizer price increases (Figure 8).

[9] The early rounds of the HFPS surveys in Ethiopia and Uganda only asked fertilizer prices from households that applied any fertilizer, contrary to later rounds and other countries where the question was asked of all farming households as part of the agriculture module.

More than 87 percent of households in Burkina Faso who were interviewed in January 2023 reported increased prices, with nearly 64 percent reporting price increases at the end of 2023. The incidence was lower among households in Tanzania (42.4%, November 2023) and Uganda (31.5%, October 2023) (Table A16).

**Figure 8. Households reporting increased fertilizer prices relative to preceding season**

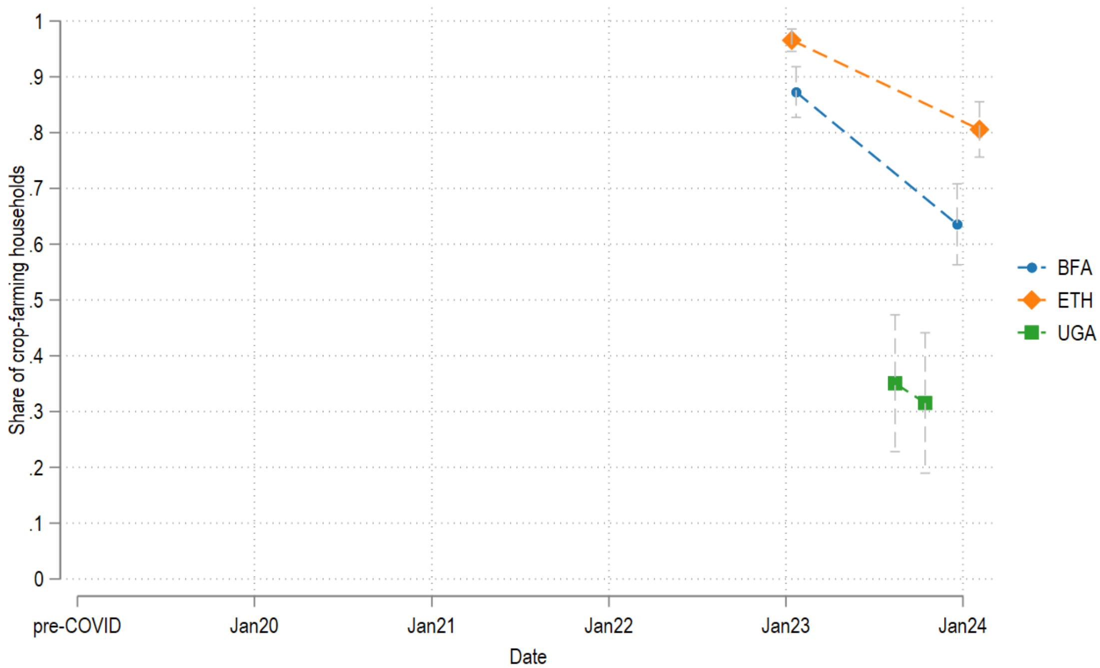
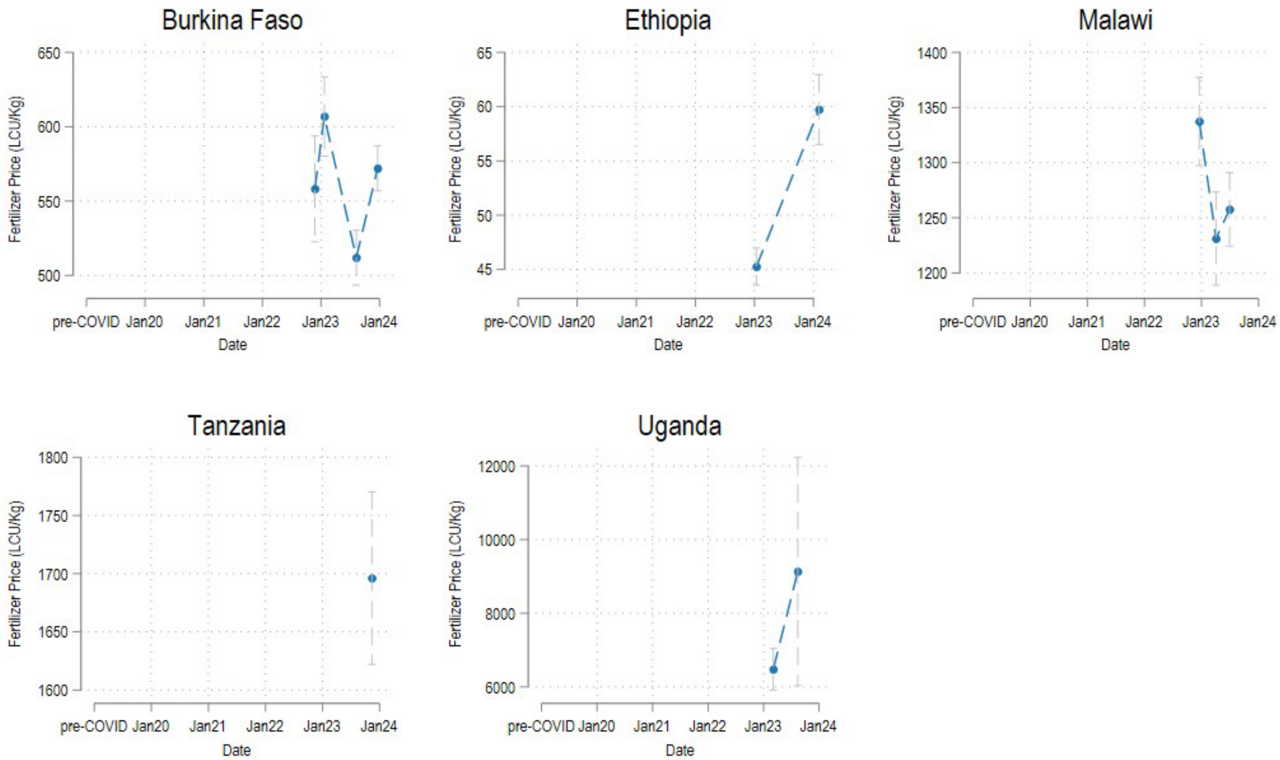


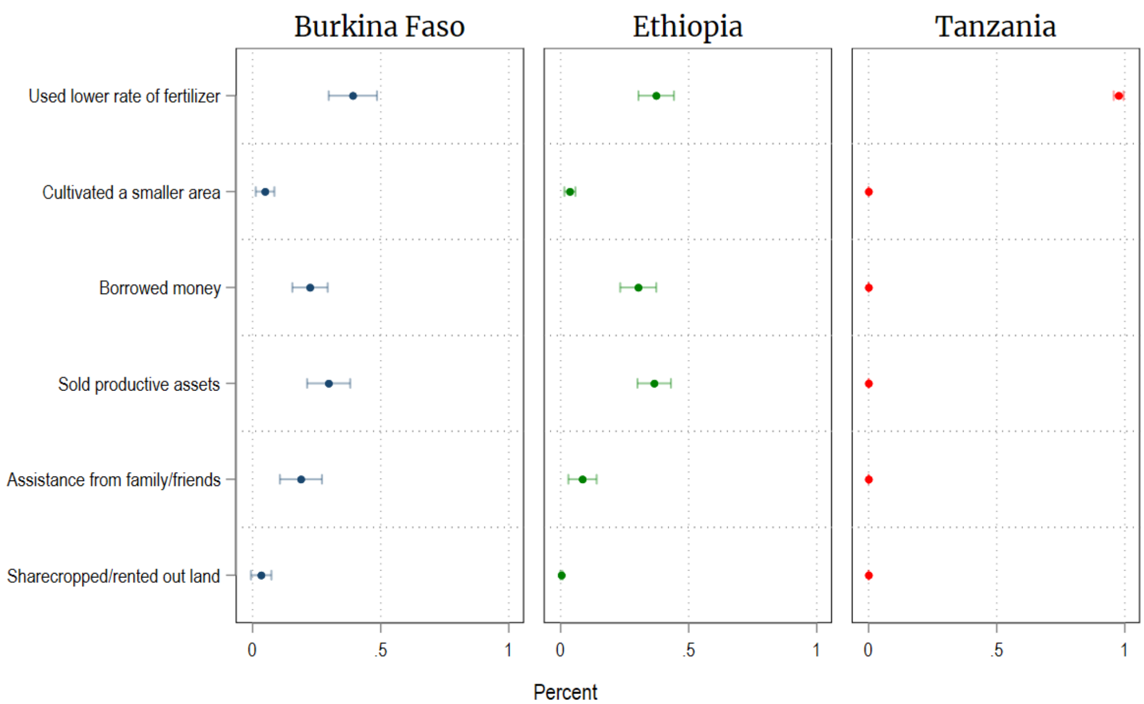
**Figure 9. Fertilizer prices**




In addition to the reports of relative fertilizer price changes from season to season, respondents were also asked for quantitative fertilizer prices at certain points in time. Figure 9 plots the average price of inorganic fertilizer per kilogram. Additional data on fertilizer prices will become available through the HFPS over time, lengthening the time series. In Ethiopia the average price of fertilizer increased by roughly 15 ETB/kg (unadjusted), or approximately 33%, from January 2023 to February 2024. Prices in Uganda reportedly rose from 6,480 UGX/kg to 9,134 UGX/kg on average, an increase of about 41%, between March and August 2023. In Burkina Faso, fertilizer prices fluctuated but within a relatively tight range, growing by roughly 2.5% between November 2022 and January 2024. Contrary to the experience in other countries, households in Malawi reported a decline in fertilizer prices of about 6% (December 2022 to June 2023).

Households reporting an increase in fertilizer prices were asked how they coped with such increases. While for faming households in Tanzania reduction in the quantity of fertilizer applied per unit area is the single most important strategy employed to cope with the high prices of inorganic fertilizer, farming households in Burkina Faso and Ethiopia adopted a number of strategies during the production process (Figure 10). Most importantly, farming households in Burkina Faso and Ethiopia resorted to using lower rates of fertilizer, borrowing money to purchase the input, selling productive asset in order to purchase the input, as well as seeking assistance from friends and family. Households' sale of productive assets implies that the high prices of inorganic fertilizer are forcing households to drain down their limited assets, making them more vulnerable to any potential shocks.

**Figure 10. Strategies for coping with high fertilizer prices**




Note: Survey timings: BFA (01/24), ETH (02/24), TZA (11/23)

Regression analysis provides insights into the price elasticity of fertilizer use, quantities purchased, and magnitude of shortfalls. Regression analysis exploring the relationship between price and fertilizer use (incidence) is presented in Table A20. Fertilizer prices are inversely related to the incidence of fertilizer use in Malawi, Nigeria, and Tanzania, though the relationship is only statistically significant in Tanzania.[10] Similarly, the relationship between quantity of fertilizer

[10] Ethiopia and Uganda are excluded here as in the early rounds of the HFPS in these countries, fertilizer prices were only asked of households using any fertilizer.

purchased (kg) is negative across the same set of countries, but only significant in Tanzania (see Table A21).

## 4. Discussion and Policy Implications

During the 2020-2024 period multiple factors were in play, and farmers faced unusually high prices as a result. Using nationally representative, longitudinal, and cross-country microdata from household surveys in six Sub-Saharan African countries, we unpack the implications of the price shocks on farmers, and the heterogeneous strategies employed by households with respect to inorganic fertilizer use.

The share of farming households utilizing inorganic fertilizer does not appear to have been harshly dampened during this period, with statistically significant negative time trends in Burkina Faso and Malawi but with moderate magnitudes, a finding potentially contrary to expectation. Though incidence of use was relatively stable, those that did not apply fertilizer were on the poorer end of the wealth distribution and reported affordability as a key barrier to adoption, potentially hinting at longer-run issues of input affordability beyond this crisis period.

While we do not find large changes in fertilizer use at the extensive margin, important insights emerge with respect to the intensive margin. A significant share of fertilizer-using households, up to 70 percent in Malawi and more than 45 percent in Burkina Faso, Ethiopia, Malawi, Nigeria, and Tanzania, reported a shortfall in the quantity of fertilizer acquired. These shortfalls were predominantly due to affordability as opposed to availability-related constraints, and tended to affect poorer households more than those at the upper end of the wealth distribution. In light of price shocks and related fertilizer shortfalls, farming households employed a variety of coping strategies. Some farmers reduced the intensity with which they applied fertilizer (i.e., reduced the application rate) while others reduced the area in which it was applied. Some households, in the face of price shocks, sold assets or borrowed money from friends and relatives to purchase the input. These strategies threaten to reduce agricultural productivity, while also indebting households and/or depleting their savings.

Many farming households, in the recent period of global crises and observed shocks to fertilizer prices, have been pushed to take measures that could dampen productivity and/or increase their vulnerability to future shocks. While many different interventions were implemented in different countries during the crisis period (Amaglobeli et al., 2023), most of the policy responses were targeted at reducing the impact of food price increases. Consideration should be made also of the potential shock to food prices stemming from reduced application of inorganic fertilizer and related reductions in local food production. Input subsidy programs have the potential to address issues fertilizer affordability, though studies have shown that the cost of input subsidy programs can outweigh their benefits (Jayne and Rashid, 2013) and that increasing fertilizer use alone may not be profitable due to associated expenses in acquiring the input as well as lack of complementary inputs such as improved seeds, irrigation and credit (Liverpool-Tasie, Omonona and Sanou, 2015).

This study has some limitations. Though the experience of farmers in six countries is represented, and represented at various points in time, the findings would be strengthened with the inclusion of additional country coverage as well as additional data points for each country. Data on the agricultural experience is not as well represented or as harmonized across countries immediately after the onset of the COVID-19 pandemic as it is in later years, which limits our ability to analyze precise time trends at the onset of that crisis. Additionally, given the mode of implementation of the surveys, through mobile phone, the sample may be biased towards farmers that are less remote and/or less poor. Though the use of survey weights addresses this concern in part, the findings may be seen as a lower bound as households without mobile phones, and whom price shocks may be expected to impact most severely, are excluded from the HFPS sample.

## 5. Conclusions

This study examined recent trends in inorganic fertilizer use by smallholder farmers in six Sub-Saharan African countries over the 2018 – 2024 period in view of price increases following multiple global and local crises such as the COVID-19 pandemic, the Russian invasion of Ukraine and, in some countries, conflict and insecurity. Using high-frequency longitudinal phone survey data from these countries implemented around the same period, in conjunction with face-to-face surveys conducted on the same sample of households before the crisis period, this study documents the dynamics of incidence and use of inorganic fertilizer and farmer's coping strategies.

The results highlight the varied responses by farmers to the price shocks prevalent in this period. While the share of households using fertilizer remained relatively stable in most of the studied countries, in early 2023 more than 45 percent of fertilizer-using households in Burkina Faso, Ethiopia, Malawi, Nigeria, and Tanzania reported shortfalls in the quantity of fertilizer acquired, reaching nearly 70 percent in Malawi. These fertilizer shortfalls were sizable, with average shortfalls being more than 55 percent of the total desired quantity in Ethiopia, Tanzania, and Uganda. The findings point towards affordability as the primary constraint, as opposed to availability of supply, driving some households to use fertilizer at lower rates or on smaller areas, and in some cases to borrow money or sell assets to cope with high prices. These coping strategies are not only likely to reduce agricultural productivity and production, but also they have the potential to increase the vulnerability of farming households.

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**Table A1. HFPS fieldwork rounds and sample distribution by country**

| Country | Survey round | Fieldwork end | Sample size | HHs farming crops |
|---|---|---|---|---|
| Burkina Faso | EHCVM 2018-19 | | 1,968 | 886 |
| | 1 | Jul-20 | 1,965 | 1,124 |
| | 2 | Aug-20 | 1,860 | 1,130 |
| | 3 | Oct-20 | 2,013 | 1,152 |
| | 11 | Jul-21 | 1,924 | 1,047 |
| | 16 | Jan-23 | 1,668 | 889 |
| | 21 | Jan-24 | 1,832 | 840 |
| Ethiopia | ESS 2018-19 | | 3,247 | 670 |
| | 3 | Jul-20 | 3,058 | 1,058 |
| | 4 | Aug-20 | 2,835 | 947 |
| | 5 | Sep-20 | 2,770 | 863 |
| | 6 | Oct-20 | 2,703 | 834 |
| | 9 | Jan-21 | 2,077 | 649 |
| | ESPS 2021-22 | | 2,876 | |
| | 14 | Jan-23 | 764 | 556 |
| | 19 | Feb-24 | 2,566 | 903 |
| Malawi | IHPS 2019 | | 1,726 | 1,143 |
| | 1 | Jun-20 | 1,729 | 1,356 |
| | 7 | Feb-21 | 1,560 | 1,292 |
| | 11 | Jun-21 | 1,541 | 1,223 |
| | 17 | Apr-23 | 1,317 | 1,039 |
| | 18 | Jun-23 | 1,345 | 1,078 |
| Nigeria | GHS 2018-19 | | 3,267 | 2,155 |
| | 21 | Jun-23 | 2,429 | 1,785 |
| Tanzania | 9 | Nov-23 | 1,988 | 1,320 |
| Uganda | UNPS 2019-20 | | 2,224 | 1,752 |
| | 1 | Jun-20 | 2,225 | 1,887 |
| | 2 | Aug-20 | 2,197 | 1,877 |
| | 3 | Oct-20 | 2,144 | 1,752 |
| | 4 | Nov-20 | 2,135 | 1,715 |
| | 7 | Nov-21 | 1,948 | 1,655 |
| | 11 | Jan-23 | 1,665 | 1,284 |
| | 13 | Aug-23 | 1,765 | 1,421 |
| | 15 | Oct-23 | 1,729 | 1,344 |
| Total | 34 rounds | | 71,060<br>(16,857 distinct HHs) | |

**Table A2: Share of households farming crops.**

| | Mean | Std. Err. | *N* |
|---|---|---|---|
| **Burkina Faso** | | | |
| pre-COVID | 69.4 | 1.4 | 1,968 |
| 2020/07 | 71.3 | 1.4 | 1,965 |
| 2020/08 | 74.6 | 1.4 | 1,860 |
| 2020/10 | 71.0 | 1.4 | 2,013 |
| 2021/07 | 69.8 | 1.4 | 1,924 |
| 2023/01 | 63.7 | 1.7 | 1,668 |
| 2024/01 | 52.8 | 1.8 | 1,832 |
| **Ethiopia** | | | |
| pre-COVID | 56.9 | 1.5 | 3,247 |
| 2020/07 | 70.4 | 1.2 | 3,058 |
| 2020/08 | 69.0 | 1.4 | 2,835 |
| 2020/09 | 68.2 | 1.4 | 2,770 |
| 2020/10 | 67.7 | 1.4 | 2,703 |
| 2021/01 | 70.0 | 1.6 | 2,077 |
| 2023/01 | 66.5 | 4.5 | 764 |
| 2024/02 | 59.7 | 2.6 | 2,566 |
| **Malawi** | | | |
| pre-COVID | 80.3 | 1.4 | 1,726 |
| 2020/06 | 89.6 | 0.9 | 1,729 |
| 2021/02 | 90.8 | 0.9 | 1,560 |
| 2021/06 | 85.7 | 1.3 | 1,541 |
| 2023/04 | 87.8 | 1.4 | 1,317 |
| 2023/06 | 88.9 | 1.1 | 1,345 |
| **Nigeria** | | | |
| pre-COVID | 69.2 | 1.5 | 3,267 |
| 2023/06 | 75.2 | 1.4 | 2,429 |
| **Tanzania** | | | |
| 2023/11 | 66.2 | 1.6 | 1,988 |
| **Uganda** | | | |
| pre-COVID | 70.2 | 1.5 | 2,224 |
| 2020/06 | 78.6 | 1.3 | 2,225 |
| 2020/08 | 78.5 | 1.3 | 2,197 |
| 2020/10 | 75.6 | 1.4 | 2,144 |
| 2020/11 | 75.9 | 1.4 | 2,135 |
| 2021/11 | 78.8 | 1.4 | 1,948 |
| 2023/01 | 71.4 | 1.7 | 1,665 |
| 2023/08 | 72.9 | 1.6 | 1,765 |
| 2023/10 | 72.3 | 1.6 | 1,729 |

Note: Share of households farming crops. All means in percent.

**Table A3: Share of crop-farming households with disruption to their agricultural activity.**

| | Pooled | BFA | ETH | TZA | UGA |
|---|---|---|---|---|---|
| Disruption to ag activity | 9.9 | 6.3 | 23.3 | 1.6 | 9.0 |
| | (0.88) | (1.19) | (2.96) | (0.41) | (1.11) |
| *N* | 4,407 | 840 | 903 | 1,320 | 1,344 |

Note: Share of crop-farming households with disruption to their agricultural activity in most recent round. Standard error in parentheses. Survey timing: BFA (01/24), ETH (02/24), TZA (11/23), UGA (10/23).

**Table A4: Reasons for disruption to normal agricultural activity**

| | BFA | ETH | TZA | UGA |
|---|---|---|---|---|
| Lack hired labor | 6.6 | | 37.0 | 3.7 |
| | (6.36) | | (14.15) | (1.69) |
| Lack of seeds | 0.0 | 25.0 | 12.0 | 13.2 |
| | | (6.36) | (8.65) | (5.09) |
| Lack of fertilizer | 6.8 | 55.6 | 9.7 | 0.0 |
| | (4.11) | (7.39) | (6.53) | |
| Lack of other inputs | 2.1 | 24.2 | 1.5 | 2.8 |
| | (2.12) | (8.19) | (1.16) | (1.66) |
| Unable to sell outputs | 0.0 | 4.7 | 0.0 | 1.1 |
| | | (3.22) | | (0.82) |
| Illness | 0.9 | 1.4 | 24.8 | 12.1 |
| | (0.77) | (1.34) | (12.99) | (4.13) |
| Delayed planting | 0.7 | 0.0 | 0.0 | 3.1 |
| | (0.74) | | | (1.40) |
| Climate | 40.2 | 66.9 | 48.3 | 84.2 |
| | (9.48) | (6.14) | (13.68) | (3.54) |
| Pests | 1.5 | 1.4 | 5.9 | 5.5 |
| | (1.48) | (0.77) | (5.82) | (2.09) |
| Insecurity | 66.7 | 7.2 | 0.0 | 2.0 |
| | (9.12) | (2.05) | | (1.10) |
| *N* | 55 | 186 | 24 | 132 |

Note: Reasons for disruption to agricultural activity in most recent round. Standard error in parentheses. Survey timing: BFA (01/24), ETH (02/24), TZA (11/23), UGA (10/23).

**Table A5: Share of crop-farming households that used any inorganic fertilizer.**

| | Mean | Std. Err. | *N* |
|---|---|---|---|
| **Burkina Faso** | | | |
| pre-COVID | 52.6 | 2.5 | 886 |
| 2021/01 | 58.7 | 2.2 | 1,142 |
| 2023/01 | 45.8 | 2.5 | 889 |
| 2024/01 | 44.9 | 2.6 | 840 |
| **Ethiopia** | | | |
| pre-COVID | 66.9 | 2.4 | 670 |
| 2021/10 | 66.3 | 2.9 | 672 |
| 2023/01 | 61.6 | 4.7 | 556 |
| 2024/02 | 63.0 | 3.4 | 903 |
| **Malawi** | | | |
| pre-COVID | 77.4 | 1.9 | 1,143 |
| 2021/06 | 83.5 | 1.5 | 1,253 |
| 2023/06 | 70.0 | 2.2 | 1,076 |
| **Nigeria** | | | |
| 2019/01 | 43.8 | 2.0 | 1,279 |
| **Tanzania** | | | |
| 2023/11 | 26.3 | 1.8 | 1,319 |
| **Uganda** | | | |
| pre-COVID | 4.7 | 0.6 | 1,627 |
| 2023/01 | 10.1 | 1.3 | 1,284 |
| 2023/10 | 14.3 | 1.4 | 1,344 |

Note: Share of crop-farming households that used any inorganic fertilizer. All means in percent.

**Table A6. Time trends in the incidence of inorganic fertilizer use**

## Used any inorganic fertilizer

| | (1) Burkina Faso | (2) Ethiopia | (3) Malawi | (4) Uganda |
|---|---|---|---|---|
| Survey round | -0.0360*** | -0.0151 | -0.0394*** | 0.0477*** |
| | (0.0114) | (0.0137) | (0.0147) | (0.00783) |
| Constant | 0.596*** | 0.683*** | 0.851*** | 0.00152 |
| | (0.0305) | (0.0336) | (0.0302) | (0.0138) |
| Observations | 3,757 | 2,801 | 3,472 | 4,255 |
| R-squared | 0.006 | 0.001 | 0.006 | 0.017 |

Note: Results from OLS regression of the outcome on a variable indicating the n'th data point over time for this variable. The variable is 1 for the first round in which data on the outcome was collected, 2 for the second instance, and so on. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

### Table A7. Correlates of fertilizer use

**Used any inorganic fertilizer**

| | (1)<br>Ethiopia | (2)<br>Ethiopia | (3)<br>Malawi | (4)<br>Malawi | (5)<br>Nigeria | (6)<br>Nigeria | (7)<br>Burkina Faso | (8)<br>Uganda |
|---|---|---|---|---|---|---|---|---|
| Wealth quintile | 0.0204* | 0.0481*** | 0.0600*** | 0.0619*** | -0.0250*** | -0.0252*** | 0.0728*** | 0.0138** |
| | (0.0120) | (0.0142) | (0.00808) | (0.00794) | (0.00904) | (0.00899) | (0.0101) | (0.00551) |
| Distance to nearest market | -0.00141*** | | -0.000967 | | -6.55e-05 | | | |
| | (0.000395) | | (0.000975) | | (0.000288) | | | |
| Distance to nearest road | 0.000820 | | 0.000785 | | -0.00346** | | | |
| | (0.00102) | | (0.00137) | | (0.00148) | | | |
| Distance to nearest population center | -0.00232*** | | -0.000171 | | -0.000992 | | | |
| | (0.000755) | | (0.00115) | | (0.000678) | | | |
| Constant | 0.754*** | 0.531*** | 0.613*** | 0.586*** | 0.547*** | 0.508*** | 0.349*** | 0.00946 |
| | (0.0463) | (0.0480) | (0.0397) | (0.0332) | (0.0394) | (0.0335) | (0.0361) | (0.0154) |
| Observations | 2,786 | 2,786 | 4,507 | 4,511 | 3,064 | 3,064 | 3,757 | 4,027 |
| R-squared | 0.105 | 0.017 | 0.081 | 0.080 | 0.069 | 0.062 | 0.042 | 0.019 |
| Survey Wave FE | YES | YES | YES | YES | YES | YES | YES | YES |

Note: Results from OLS regression of extensive margin fertilizer use on household characteristics. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

**Table A8: Reasons for not applying fertilizer.**

| | | Did not need | Too expensive | Not available | Unable to travel |
|---|---|---|---|---|---|
| **Burkina Faso** | | | | | |
| 2021/01 | Mean | 27.8 | 76.1 | 0.0 | 0.0 |
| | Std. Err. | 2.1 | 2.0 | 0.0 | 0.0 |
| | *N* | 472 | 472 | 472 | 472 |
| 2023/01 | Mean | 17.0 | 76.5 | 6.4 | |
| | Std. Err. | 1.8 | 2.0 | 1.2 | |
| | *N* | 441 | 441 | 441 | |
| 2024/01 | Mean | 13.9 | 76.3 | 7.3 | |
| | Std. Err. | 1.6 | 2.0 | 1.2 | |
| | *N* | 448 | 448 | 448 | |
| **Ethiopia** | | | | | |
| 2023/01 | Mean | 67.8 | 19.0 | 13.2 | |
| | Std. Err. | 3.4 | 2.9 | 2.5 | |
| | *N* | 187 | 187 | 187 | |
| 2024/02 | Mean | 29.6 | 58.0 | 6.9 | 2.3 |
| | Std. Err. | 2.5 | 2.7 | 1.4 | 0.8 |
| | *N* | 327 | 327 | 327 | 327 |
| **Malawi** | | | | | |
| 2021/06 | Mean | 37.9 | 63.9 | 0.0 | 0.2 |
| | Std. Err. | 3.6 | 3.6 | 0.0 | 0.3 |
| | *N* | 184 | 184 | 184 | 184 |
| 2023/04 | Mean | 31.6 | 59.7 | 6.4 | |
| | Std. Err. | 2.5 | 2.7 | 1.3 | |
| | *N* | 334 | 334 | 334 | |
| 2023/06 | Mean | 17.4 | 68.6 | 11.8 | |
| | Std. Err. | 2.2 | 2.7 | 1.8 | |
| | *N* | 307 | 307 | 307 | |
| **Nigeria** | | | | | |
| 2023/06 | Mean | 46.8 | 47.9 | 3.4 | |
| | Std. Err. | 1.9 | 1.9 | 0.7 | |
| | *N* | 686 | 686 | 686 | |
| **Tanzania** | | | | | |
| 2023/11 | Mean | 45.1 | 45.5 | 7.3 | 0.0 |
| | Std. Err. | 1.6 | 1.6 | 0.8 | 0.0 |
| | *N* | 951 | 951 | 951 | 951 |
| **Uganda** | | | | | |
| 2023/01 | Mean | 49.3 | 42.6 | 6.5 | |
| | Std. Err. | 1.5 | 1.5 | 0.7 | |
| | *N* | 1,144 | 1,144 | 1,144 | |
| 2023/10 | Mean | 51.2 | 46.1 | 1.6 | |
| | Std. Err. | 1.5 | 1.5 | 0.4 | |
| | *N* | 1,157 | 1,157 | 1,157 | |

Note: Reasons for not applying fertilizer among HHs not applying fertilizer. All means in percent.

**Table A9: Share of households using fertilizer that could not access the desired amount.**

| | Mean | Std. Err. | *N* |
|---|---|---|---|
| **Burkina Faso** | | | |
| 2023/01 | 45.7 | 3.8 | 397 |
| 2024/01 | 41.5 | 3.7 | 392 |
| **Ethiopia** | | | |
| 2023/01 | 49.8 | 3.4 | 369 |
| 2024/02 | 36.6 | 3.0 | 576 |
| **Malawi** | | | |
| 2023/04 | 68.8 | 2.7 | 705 |
| 2023/06 | 68.9 | 2.6 | 769 |
| **Nigeria** | | | |
| 2023/06 | 47.8 | 2.3 | 1,096 |
| **Tanzania** | | | |
| 2023/11 | 47.3 | 3.9 | 367 |
| **Uganda** | | | |
| 2023/01 | 38.1 | 6.6 | 111 |
| 2023/10 | 14.2 | 3.3 | 184 |

Note: Share of households using fertilizer that could not access the desired amount. All means in percent.

**Table A10: Linear trend in share of fertilizer-using households that could not access desired amount**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | Burkina Faso | Ethiopia | Malawi | Uganda |
| Survey round | -0.0411 | -0.132*** | 0.000192 | -0.238*** |
| | (0.0521) | (0.0417) | (0.0328) | (0.0712) |
| Constant | 0.498*** | 0.630*** | 0.688*** | 0.619*** |
| | (0.0836) | (0.0696) | (0.0543) | (0.134) |
| Observations | 789 | 945 | 1,474 | 295 |

Note: Results from OLS regression of the outcome on a variable indicating the n'th data point over time for this variable. The variable is 1 for the first round in which data on the outcome was collected, 2 for the second instance, and so on. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

**Table A11. Incidence of fertilizer shortfall**

**Any fertilizer shortfall (dummy)**

| | (1)<br>Ethiopia | (2)<br>Malawi | (3)<br>Nigeria |
|---|---|---|---|
| Distance to nearest market | -0.00157*** | 0.00357** | -0.00107** |
| | (0.000506) | (0.00166) | (0.000520) |
| Distance to nearest road | 0.00575*** | 0.00204 | -0.00554 |
| | (0.00199) | (0.00285) | (0.00418) |
| Distance to nearest population center | -0.000795 | -0.00181 | 0.00218* |
| | (0.00106) | (0.00210) | (0.00124) |
| Wealth quintile | -0.0415** | -0.0186 | -0.0384** |
| | (0.0177) | (0.0153) | (0.0163) |
| Constant | 0.611*** | 0.693*** | 0.624*** |
| | (0.0758) | (0.0714) | (0.0635) |
| Observations | 945 | 1,472 | 1,096 |
| R-squared | 0.039 | 0.015 | 0.024 |

Note: Results from OLS regression of extensive margin fertilizer shortfall on household characteristics. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

**Table A12: Fertilizer shortfalls (means)**

| | Quantity purchased (kg/ha) | | Shortfall (kg/ha) | | Shortfall as % of total desired quantity | | |
|---|---|---|---|---|---|---|---|
| | Mean | Std Err | Mean | Std Err | Mean | Std Err | N |
| Ethiopia | 233.35 | 25.30 | 281.50 | 26.49 | 55.66 | 1.57 | 218 |
| Tanzania | 169.88 | 19.62 | 311.07 | 33.93 | 67.12 | 1.31 | 162 |
| Uganda | 23.70 | 5.46 | 47.93 | 9.27 | 65.77 | 3.39 | 33 |

Note: Shortfall defined as the quantity of inorganic fertilizer a household desired but did not acquire.

**Table A13. Depth of fertilizer shortfalls**

## Log fertilizer shortfall (kg/ha)

| | (1)<br>Ethiopia |
|---|---|
| Distance to nearest market | -0.00144 |
| | (0.00225) |
| Distance to nearest road | -0.000776 |
| | (0.00846) |
| Distance to nearest population center | 0.00144 |
| | (0.00690) |
| Wealth quintile | -0.137** |
| | (0.0567) |
| Constant | 5.761*** |
| | (0.240) |
| Observations | 218 |
| R-squared | 0.044 |

Note: Results from OLS regression of the amount of additional fertilizer that could not be acquired on household characteristics. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

**Table A14: Reasons for not having been able to access desired amount of fertilizer.**

| | BFA | ETH | TZA | UGA |
|---|---|---|---|---|
| Too expensive | 98.2 | 58.5 | 94.3 | 100.0 |
| | (0.96) | (4.68) | (2.12) | |
| Not available | 0.9 | 78.9 | 5.4 | 0.0 |
| | (0.74) | (4.21) | (2.09) | |
| *N* | 189 | 234 | 162 | 33 |

Note: Reasons for not having been able to access desired amount of fertilizer. Standard error in parentheses. Survey timing: BFA (01/24), ETH (02/24), TZA (11/23), UGA (10/23).

**Table A15: Share of crop-farming households that reported increase in fertilizer price relative to the past agricultural season.**

| | Mean | Std. Err. | *N* |
|---|---|---|---|
| **Burkina Faso** | | | |
| 2023/01 | 87.3 | 2.3 | 439 |
| 2024/01 | 63.6 | 3.7 | 382 |
| **Ethiopia** | | | |
| 2023/01 | 96.6 | 1.0 | 368 |
| 2024/02 | 80.6 | 2.5 | 572 |
| **Malawi** | | | |
| 2023/04 | 68.8 | 2.7 | 705 |
| 2023/06 | 68.9 | 2.6 | 769 |
| **Nigeria** | | | |
| 2023/06 | 47.8 | 2.3 | 1,096 |
| **Tanzania** | | | |
| 2023/11 | 42.4 | 3.2 | 546 |
| **Uganda** | | | |
| 2023/08 | 35.1 | 6.3 | 109 |
| 2023/10 | 31.5 | 6.4 | 118 |

Note: Share of crop-farming households that reported increase in fertilizer price relative to the last agricultural season. All means in percent.

**Table A16: Self-reported fertilizer price change compared to last agricultural season.**

| | BFA | ETH | TZA | UGA |
|---|---|---|---|---|
| Much higher | 22.1 | 35.4 | 10.7 | 2.5 |
| | (3.14) | (3.09) | (1.84) | (1.27) |
| Higher | 41.4 | 45.1 | 31.7 | 29.1 |
| | (3.84) | (3.25) | (3.04) | (6.43) |
| About the same | 26.3 | 14.2 | 38.8 | 45.8 |
| | (3.43) | (2.24) | (3.07) | (6.53) |
| Lower | 8.4 | 5.2 | 17.0 | 22.7 |
| | (2.06) | (1.39) | (2.35) | (5.62) |
| Much lower | 1.7 | 0.0 | 1.8 | 0.0 |
| | (0.71) | (0.01) | (0.96) | |
| *N* | 382 | 572 | 546 | 118 |

Note: Reported change in fertilizer price compared to last agricultural season. Standard error in parentheses. Survey timing: BFA (01/24), ETH (02/24), TZA (11/23), UGA (10/23).

**Table A17: Mean fertilizer price (LCU/Kg).**

| | Mean Price (LCU/Kg) | Std. Err. | *N* |
|---|---|---|---|
| **Burkina Faso** | | | |
| 2022/11 | 550 | 18 | 184 |
| 2023/01 | 606 | 14 | 505 |
| 2023/08 | 511 | 9 | 511 |
| 2024/01 | 568 | 8 | 434 |
| **Ethiopia** | | | |
| 2023/01 | 45 | 1 | 366 |
| 2024/02 | 60 | 2 | 571 |
| **Malawi** | | | |
| 2022/12 | 1,337 | 20 | 776 |
| 2023/04 | 1,231 | 22 | 1,005 |
| 2023/06 | 1,258 | 17 | 883 |
| **Nigeria** | | | |
| 2023/06 | 441 | 48 | 122 |
| **Tanzania** | | | |
| 2023/11 | 1,696 | 38 | 541 |
| **Uganda** | | | |
| 2023/03 | 6,914 | 341 | 382 |
| 2023/08 | 9,478 | 1,740 | 403 |

Note: Fertilizer price in LCU/Kg.

**Table A18: Coping strategies for high fertilizer prices.**

| | | Used lower rate of fertilizer | Cultivated a smaller area | Borrowed money | Sold productive assets | Assistance from family/friends | Sharecropped/ rented out land |
|---|---|---|---|---|---|---|---|
| **Burkina Faso** | | | | | | | |
| 2023/01 | Mean | 45.7 | 1.6 | 15.8 | 35.3 | 6.9 | 0.8 |
| | Std. Err. | 2.5 | 0.6 | 1.8 | 2.4 | 1.3 | 0.4 |
| | *N* | 397 | 397 | 397 | 397 | 397 | 397 |
| 2024/01 | Mean | 39.1 | 4.8 | 22.4 | 29.7 | 18.8 | 3.3 |
| | Std. Err. | 3.3 | 1.4 | 2.8 | 3.0 | 2.6 | 1.2 |
| | *N* | 226 | 226 | 226 | 226 | 226 | 226 |
| **Ethiopia** | | | | | | | |
| 2023/01 | Mean | 14.1 | 0.6 | 17.6 | 57.1 | 5.0 | 0.8 |
| | Std. Err. | 1.9 | 0.4 | 2.0 | 2.6 | 1.2 | 0.5 |
| | *N* | 350 | 350 | 350 | 350 | 350 | 350 |
| 2024/02 | Mean | 37.3 | 3.6 | 30.3 | 36.5 | 8.5 | 0.3 |
| | Std. Err. | 2.3 | 0.9 | 2.2 | 2.3 | 1.3 | 0.3 |
| | *N* | 452 | 452 | 452 | 452 | 452 | 452 |
| **Tanzania** | | | | | | | |
| 2023/11 | Mean | 97.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Std. Err. | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | *N* | 237 | 237 | 237 | 237 | 237 | 237 |

Note: Coping strategies for high fertilizer prices among those reporting increased prices since last season. All means in percent.

**Table A19: Coping strategies for not having been able to access the desired amount of fertilizer.**

| | | Only fertilized part of cultivated area | Used lower rate of fertilizer | Cultivated a smaller area | Supplemented with organic fertilizer | Practiced legume intercropping |
|---|---|---|---|---|---|---|
| **Burkina Faso** | | | | | | |
| 2024/01 | Mean | 27.8 | 50.1 | 10.3 | 47.0 | 10.3 |
| | Std. Err. | 3.3 | 3.6 | 2.2 | 3.6 | 2.2 |
| | *N* | 189 | 189 | 189 | 189 | 189 |
| **Ethiopia** | | | | | | |
| 2024/02 | Mean | 23.3 | 78.3 | 5.6 | 40.9 | 4.6 |
| | Std. Err. | 2.8 | 2.7 | 1.5 | 3.2 | 1.4 |
| | *N* | 234 | 234 | 234 | 234 | 234 |
| **Malawi** | | | | | | |
| 2023/06 | Mean | 25.4 | 61.8 | 3.9 | 8.9 | |
| | Std. Err. | 1.9 | 2.2 | 0.9 | 1.3 | |
| | *N* | 510 | 510 | 510 | 510 | |
| **Nigeria** | | | | | | |
| 2023/06 | Mean | 60.6 | 62.3 | 40.9 | 64.7 | |
| | Std. Err. | 2.2 | 2.1 | 2.2 | 2.1 | |
| | *N* | 516 | 516 | 516 | 515 | |
| **Tanzania** | | | | | | |
| 2023/11 | Mean | 37.4 | 49.0 | 13.6 | 8.2 | 2.9 |
| | Std. Err. | 3.8 | 3.9 | 2.7 | 2.2 | 1.3 |
| | *N* | 162 | 162 | 162 | 162 | 162 |
| **Uganda** | | | | | | |
| 2023/10 | Mean | 10.4 | 43.1 | 0.0 | 23.5 | 23.9 |
| | Std. Err. | 5.4 | 8.8 | 0.0 | 7.5 | 7.5 |
| | *N* | 33 | 33 | 33 | 33 | 33 |

Note: Coping strategies for not having been able to access the desired amount of fertilizer. All means in percent.

**Table A20. Price elasticity of fertilizer use (incidence).**

| Variable | (1)<br>Burkina Faso | (2)<br>Malawi | (3)<br>Nigeria | (4)<br>Tanzania |
|---|---|---|---|---|
| Log fertilizer price, winsorized | 0.1036* | -0.00850 | -0.0108 | -0.349*** |
| | (0.0607) | (0.0378) | (0.0709) | (0.0991) |
| Constant | 0.663* | 0.661** | 0.472 | 3.246*** |
| | (0.359) | (0.266) | (0.414) | (0.729) |
| Observations | 882 | 1,772 | 122 | 541 |
| R-squared | 0.019 | 0.031 | 0.001 | 0.054 |
| Survey Wave FE | YES | YES | YES | YES |

Note: Results from OLS regression of extensive margin fertilizer use on log fertilizer price. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

**Table A21. Price elasticity of fertilizer purchases.**

| Variable | (1)<br>Ethiopia | (2)<br>Tanzania |
|---|---|---|
| Log fertilizer price, winsorized | -0.106 | -1.069*** |
| | (0.185) | (0.314) |
| Constant | 5.531*** | 12.73*** |
| | (0.722) | (2.298) |
| Observations | 546 | 335 |
| R-squared | 0.002 | 0.070 |

Note: Results from OLS regression of log total fertilizer purchased per hectare on log fertilizer price. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

**Figure A1: Data collection schedule - Burkina Faso**

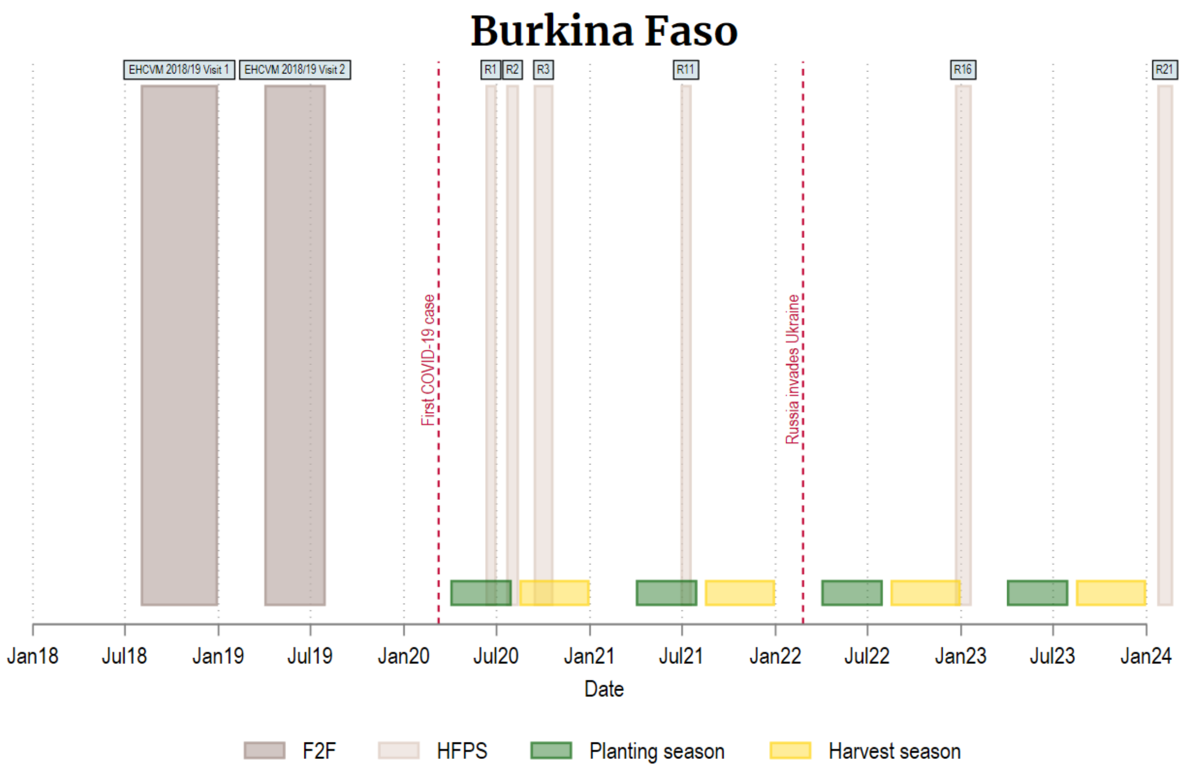

**Figure A2: Data collection schedule - Ethiopia**

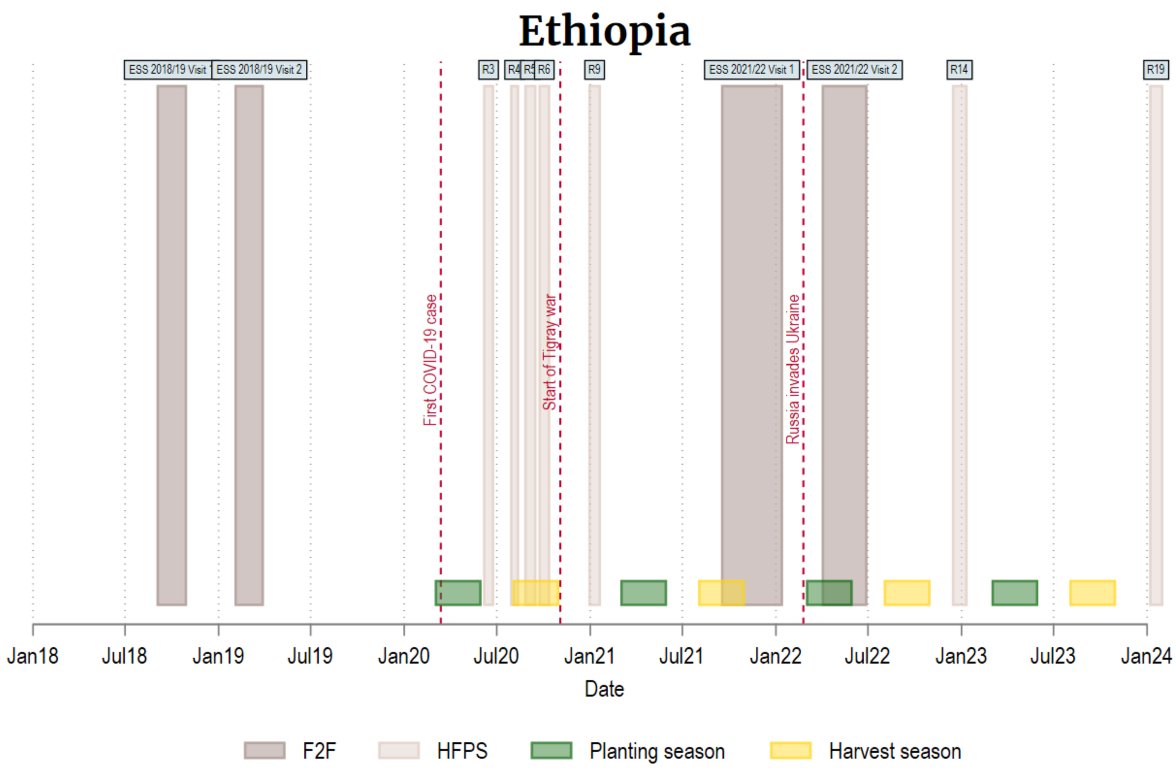

**Figure A3: Data collection schedule - Malawi**

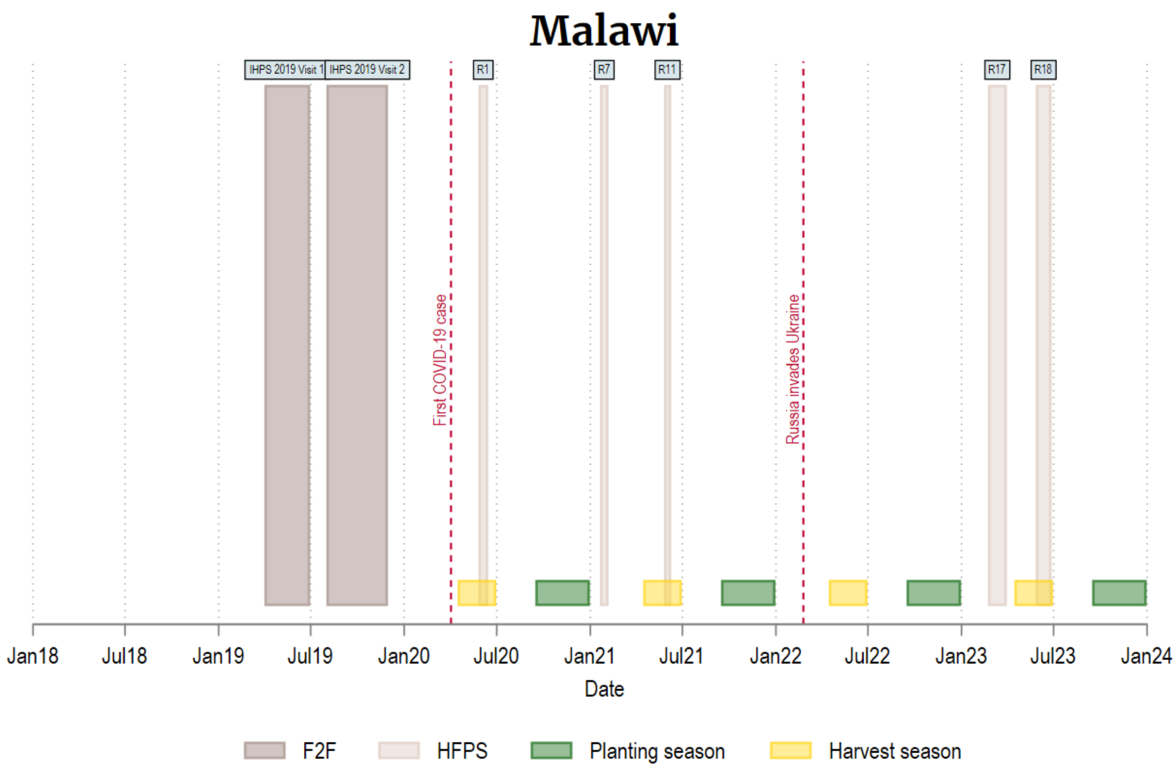

**Figure A4: Data collection schedule - Nigeria**

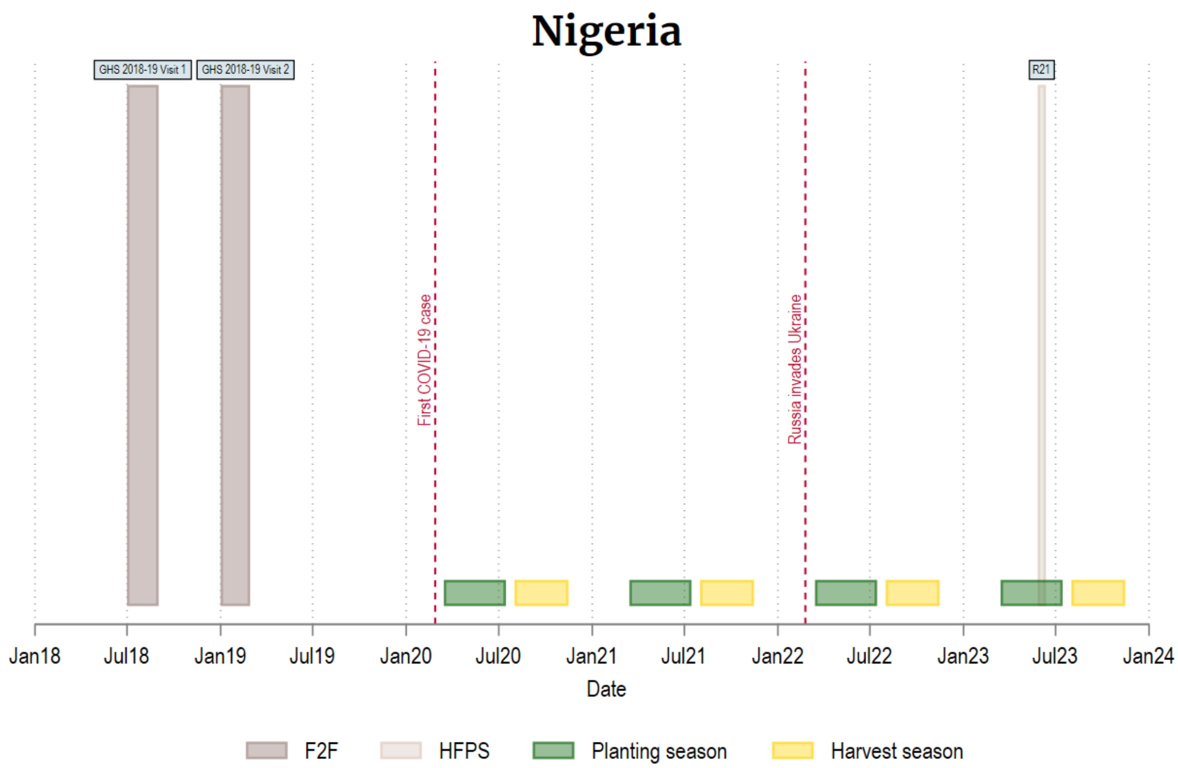

**Figure A5: Data collection schedule - Tanzania**

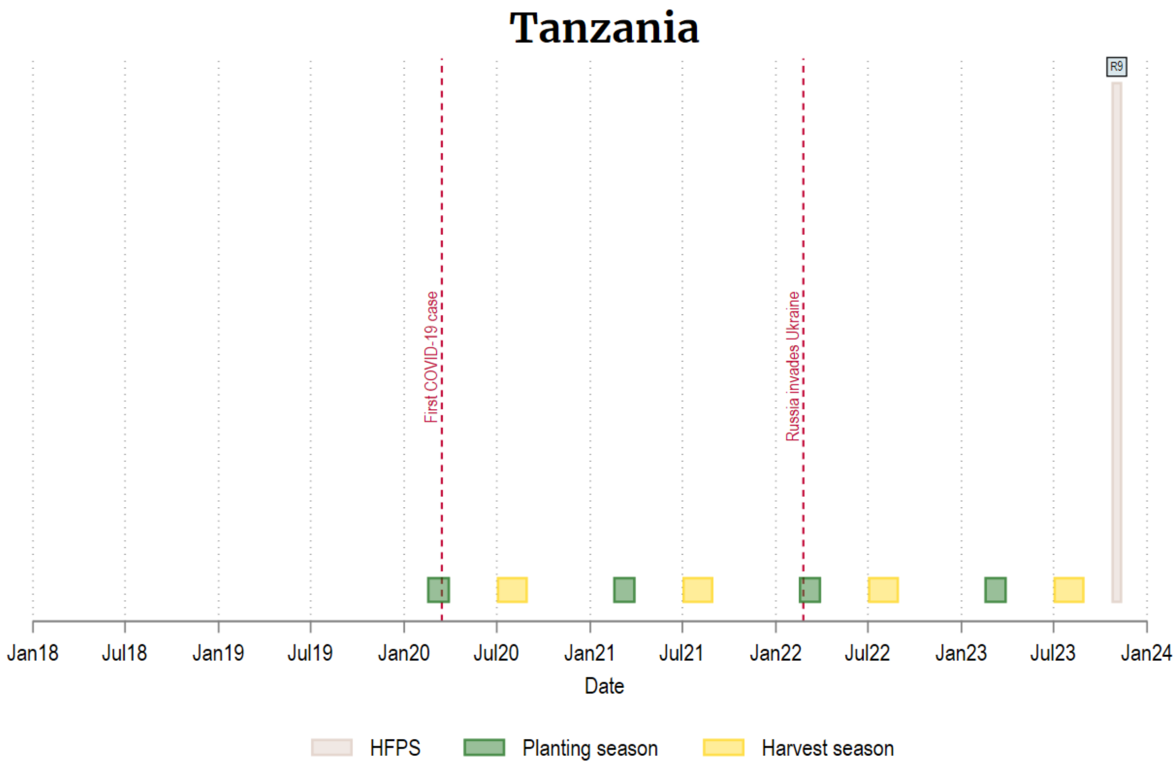

**Figure A6: Data collection schedule - Uganda**