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A White Paper on Identifying Priority Variables on Households, Firms and Markets for Understanding Micro-Dynamics of Food Security in Insecure Situations

Report for the World Bank

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Executive Summary

The earlier famine and other forms of acute and severe food crises can be identified, the sooner programmatic responses can be designed and implemented. Often, however, these earliest stages fall into a grey area: where food insecurity is too severe to be considered a development problem but not severe enough to be considered a humanitarian one. In turn, in the period when programmatic interventions could be most useful, funding levels are often at their lowest. This opens up an urgent need to provide timely information on deteriorating food security trends and to confirm that this deterioration constitutes a crisis.

How these trends and confirmations can be captured, however, is an open question. Significant debate has taken place on how to accurately capture food security, even in non-crisis contexts. While food consumption diaries are often considered as a 'gold standard' in the field, they are far from perfect and are often cumbersome and difficult to collect, even in more standard situations. Other approaches, such as collecting information on the amount spent on food, are less cumbersome but prone to other errors, including weaker inference. Households could equally spend more on food due to increases in income, or changes in preferences, as from food insecurity, for example.

In the context of both idiosyncratic and covariate food crises, where deteriorations often take place very rapidly, practical concerns arise with the collection of survey data that goes beyond these standard measurement problems. Standard surveys are often collected with years between waves; while even more frequent ones could miss the crisis onset period entirely. Similarly, given the close relationship between conflict and food insecurity, collecting any data in person could be tricky. In this White Paper, we explore the requirements of a survey-based early warning system for the onset of severe food crises, then consider specific variables that should be collected in order to populate this system.

We argue that any system needs to comprise two stages: the first is designed to ascertain that trends are deteriorating, indicating that a crisis could be imminent; the second aims to confirm whether or not these deteriorating trends constitute a food crisis. Further, it implies that what is most important – in this context – is to correctly identify deteriorating trends in given locations. This requires data that can be collected at high frequency from a panel of individuals, which in turn imposes restrictions on the collection methodologies, and which variables should be considered. We conclude that, due to survey fatigue, survey duration, and access concerns that data should be collected remotely, from a large number of panels. This allows data to be collected in an on-going, near-continuous, manner, while each individual in the survey answers questions much more infrequently.

This data collection design imposes restrictions on the variables that can be collected. Multi-response or in-depth food diaries, especially over extended time periods, cannot be collected in this manner, for example. We therefore propose a number of tweaks to standard survey questions that allow them to be collected easily, and remotely, whilst holding strong ties to either the identification or confirmation stages. From this, we conclude that modern survey techniques can be a strong part of the armory in the early identification of food security crises; but that how surveys are collected, how often they are collected, and the variables that are collected in them must be tailored to the task at hand.

1. Introduction

From a humanitarian and programmatic perspective, the early identification of (future) famine and other severe manifestations of food insecurity is highly desirable. The earlier the onset of such food shocks can be identified the earlier humanitarian programs can be rolled out to mitigate the crises. This is particularly important due to what we consider the "dual gap" that occurs when food insecurity is deemed too severe to be viewed as a development problem but not, yet, severe enough to be a humanitarian one. In that scenario, there is both a lack of information and analysis and a lack of funding to prevent a worsening of food insecurity. Almost ironically, locations in such situations may receive less support towards countering food insecurity than places with chronic but non-acute food insecurity, even though the beginning of the crisis is potentially much more damaging to malnutrition. In other words, the analytical and programmatic toolkit to prevent rather than to treat food insecurity is still woefully lacking.

This dual gap is further complicated by the political economy of food insecurity, where the decision about whether or not to declare a food security crisis may harm or benefit different actors' material, political or reputational standing. Given these considerations, there is an element of discrete and indeed subjective choice in declaring a crisis and hence in triggering a surge of funding, which in turn might have opportunity costs for other crises as resources are very limited. Actors hence might tend towards caution, weighing type I risk against type II risk, possibly leading to an under-provision of support for people and regions suffering from severe food insecurity.

This White Paper takes a fresh look at input data for the prediction and prevention of famine and other forms of severe food crisis. We focus in detail on micro-level data that are a) desirable, b) currently available, and c) currently used for these purposes. We thus aim to provide understanding on how micro-level data can be better used for food crisis prediction, and how they can be improved in terms of the variables captured, the collection methodologies applied and the frequency of response. We spell out two clear uses of this data in the early detection of food crises: the first is to monitor trends in variables related to food security, at semi-regular intervals, over a long period of time, in order to identify major declines. The second is to look, in details, at situations and locations where these declines are observed in order to "verify" the food security crisis. In turn, the same types of variables, collected and used in different ways, are useful in both phases.

We consider four related questions:

1. How can trends in food insecurity be captured both accurately and in a timely fashion?
2. At which point does declining food security potentially become a crisis?
3. How can data be collected that confirms whether or not a region is in crisis or is facing a crisis?
4. What data should be collected to confirm this?

Effectively, we propose to consider two distinct phases: low intensity monitoring and high intensity monitoring, with some critical thresholds of the former triggering the latter. We do so because we believe that the *timing* of the deterioration of a crisis is its key parameter. If this can be established, then other, more nuanced and context-specific analytics and measures can be put in place to determine how best to help people prevent or cope with that particular food insecurity.

When broken down in such a way, this makes our question and our suggested approaches substantively different from the more general food security measurement literature.[1] In this literature, a supposed "gold standard" is to ask individuals what they have eaten in the last 24-hours (e.g. Hoddinott and Yohannes, 2002; Wiesmann, Biesalski, Von Grebmer, and Bernstein, 2015). More generally, it has been proposed that, "the 'holy grail' of food security measurement would be a single measure that is valid and reliable, comparable over time and space, and which captures different elements of food security" (Maxwell, Vaitla, and Coates, 2014). However, food security remains an "elusive" concept (Barrett 2010) and single measure does not yet exist (e.g. Ballard, Kepple, and Cafiero, 2013; Maxwell, Coates, and Vaitla, 2013) – or, what the analyses cited before suggest is, indeed, that it possibly cannot exist. Rather, various approaches have proven to be, in some ways, effective and in some ways defective, with a range of trade-offs implied in each.

By contrast, we do not seek to develop options for a measure that satisfies all of these constraints. Rather than capturing the "right" level of food insecurity in the "right" places and at the "right" times, we seek to develop a range of proxies that – for a given location – accurately capture the dynamics of food security and, particularly, that accurately capture *when* food insecurity worsens – and when such a worsening should trigger further, detailed monitoring. In turn, our approach overcomes many of the definitional complexities of food (in)security, particularly relating to usage and quality, as well as the quantity, of food. In this regard, we view the suggestions presented in this White Paper to be complimentary, rather than an alternative, to other efforts to measure food insecurity or to capture the onset of major food crises.[2]

We structure the remainder of this report into eight sections. In Section 2, we discuss the purpose and scope of the work; in Section 3, we present the definitions that will guide the work; in Section 4, we discuss the key concepts we use and develop in this Paper; in Section 5, we set out our approaches to innovative data collection; in Section 6 we recommend specific variables to be collected; in Section 7 we review which of the specific indicators have been captured in multi-topic large-N household surveys in the five Priority Countries in the World Bank's Famine Action Mechanism framework, and how (i.e. the survey questions used); and in Section 8, we conclude and summarize our recommendations for future work.

[1] Among many other contributions, see Castetbon (2017); de Haen, Klasen, and Qaim (2011); Headey and Ecker (2013); Jones, Ngure, Pelto, and Young (2013); Knueppel, Demment, and Kaiser (2010); Lappé et al. (2013); Maxwell, Caldwell, and Langworthy (2008); Maxwell et al. (2013); Pangaribowo, Gerber, and Torero (2013); Pinstrup-Andersen (2009); and Webb et al. (2006).

[2] Among many other contributions, see Brown and Funk (2008); de Waal (1989); Enenkel et al. (2015); Fritz et al. (2019); Funk et al. (2019); Novella and Thiaw (2013); Verdin, Funk, Senay, and Choularton (2005); Verdin and Klaver (2002).

2. Purpose and Scope

We view the purpose of this White Paper along the lines of the four levels discussed in Section 1. That is, we seek to provide suggestions on how underpinning trends in food security can accurately be identified over time and, more importantly, how deteriorations in these trends can be captured and captured at the soonest possible stage. In this regard, the purpose of the first component of our measure is to act as a switch that decides when or if more in-depth data collection is required. This brings us to the second level, which is designed to act as a "false positive break". That is, any given measure of (declining trends in) food insecurity might be prone to influence from other circumstances not related to food insecurity. For example, a particularly dry period may not, by itself, result in worsened food insecurity if those living in affected regions have strong and positive coping strategies. In turn, even where a measure of food insecurity falls below some critical threshold, it could be due to a real food insecurity crisis; or some other extraneous factor. Level two aims to establish whether or not a given trend deterioration is the result of a food crisis, which requires a specific set of programmatic interventions, or some other factor (which might require different interventions or none at all).

The third and fourth aspects consider the data that is required in order to facilitate learning in the first and second levels. That is, what data collection methodologies are useful to capture dynamic time trends in food insecurity; which are useful to subsequently capture the extent and / or dynamics of a crisis; and which variables should be collected in order to accurately establish this to be the case at the earliest possible stages.

In this regard, this White Paper has two major purposes:

1. To provide suggestions on the key variables and corresponding data collection methodologies that capture deteriorations in food security trends, particularly over the short time windows in which the earliest phases of a crisis likely unwind.

2. To provide suggestions on the key variables and corresponding data collection methodologies that can be used to confirm whether or not a crisis in occurring, and conditional on that, the extent and nature of the crisis at hand.

3. Definitions

In this White Paper, we do not seek to dispute, disrupt or duplicate definitions of food (in)security. Therefore, we defer to the standard definition that food security occurs "when all people, at all times, have physical, social and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (World Food Summit, 1996). Consequently, we define a deterioration of food insecurity as the worsening of any single, or any combination of multiple, aspects of this definition.

We define a food crisis as per Timmer (2010): "…a food crisis occurs when rates of hunger and malnutrition rise sharply at local, national or global levels". We follow this particular definition as it distinguishes a food crisis from either chronic food insecurity or chronic malnutrition, due to the dynamic implication of things getting worse from *any* given baseline. In that regard, we view famine as a particularly severe and/or widespread food crisis event. These key definitions serve to underpin the concepts discussed in the next section.

Finally, food insecurity predominantly occurs in in settings characterized by insecurity, uncertainty, extreme fragility, violence, and/or emergency conditions, which typically involve a partial breakdown or severe malfunctioning of national institutions. We characterize these settings as being fragility-, conflict- and/or violence-affected areas (FCV).

4. Key Concepts

A range of creative indicators have been developed over the last three decades that aim to act as early warning systems for famine (see references in the introduction). Other devices have been proposed that seek to quantify (acute and / or severe) episodes of food insecurity (e.g. Maxwell and Frankenberger, 1995). Yet a common criticism of these indicators is that many of the approaches viewed as desirable and feasible have failed to fully adopt key lessons from the seminal research from the likes of Amartya Sen (e.g. Barrett, 2010). That is, "...starvation is the characteristic of some people not having enough to eat... not the characteristic of there not being enough food to eat." (Sen, 1981). Put another way, changes in the availability of food may indicate impending problems but it is not a sufficient condition. Rather, it is only one of a range of potential causes.

It follows that attempts to measure food (in)security in terms analogous to food availability stand in slight contrast to the most frequently cited definitions, at least in the sense that availability is merely the first of a set of pillars on which the concept rests. The other pillars relate to "access" to food (that is, the capacity of a person, household or even place to obtain the food that is available); and "utilization" (that is, both the types of food that can be consumed and, in turn, the ability to extract the nutrients from available foodstuffs).

Put another way, this allows us to turn Sen's dictum on its head – just because there is a net increase in food availability does not mean that the benefits of this increase are spread evenly across a heterogeneous population with heterogeneous entitlements to it and heterogeneous capacities to extract nutrients from it. Variations in access and utilization exist both across and within population groups and even amongst individuals in the same household. In turn, some hunger may be hidden, within villages and within households. Capturing these subtleties is no insignificant matter but highly relevant as hidden hunger may be substantial in scale.

We therefore consider a key and general concern that relates to the trade-offs involved in any efforts to collect food insecurity data.[3] Almost any empirical approach is going to capture some aspects of food insecurity but not others. It is, thus, critical to prioritize which elements in the measurement of food insecurity are most relevant for our purpose and the questions at hand. In some instances, this implies that there is a need to make value judgements about which are most relevant and most valuable. In turn, these value judgements and their implications will guide much of our suggested approach. We use the remainder of this section to spell out these priorities, which we split into three segments: *Timing of Data Collection*; *Variables Linked to Food Insecurity*; and *Data Collection Methodology*. Subsequently, we discuss some of the trade-offs inherent within, and across, these domains. In this regard, whilst we discuss them below in silos we note that decisions relating to one domain have significant implications for the other domains.

[3] These debates, including empirical analyses on the relative performances of different measures, are discussed in detail elsewhere, including in the literature cited in this document. In this regard, we do not seek to rehash these arguments, other than to note that most measures of food insecurity trade-off practicality and desirability, with a mixed range of impacts on the quality and comparability of those measures.

4.1 Timing of Data Collection

Most food shocks are transitory and are caused by short-term fluctuations, for example, in employment or health status of food prices (Barrett, 2010). In other words, especially at the household or individual levels, acute deteriorations in the level of food security can occur within a very short period of time. Such concerns can, relatively easily, be scaled up, however. Many economic and health crises, that affect much larger swathes of the population, also onset over very short durations, as can political crises. In turn, approaches that rely on annual, or even longer, gaps between waves of data collection would capture the earliest aspects of a food crisis only with a significant amount of good luck.

In this sense, high frequency data collection may seem like a dominant strategy yet questions of cost, practicality and what can be measured must all be considered, as well as more "down to earth" concerns. For example, if asking individuals to recall what they've eaten (and how they have prepared it) in the last 24 hours is a "gold standard" then it provides the benchmark against which other approaches should be compared. Yet it is distinctly infeasible to ask individuals or households to report on this both regularly and the, implied, long-term tracking of food security needed to learn about short-term trends. Such concerns grow in scale, especially if such an approach were to serve cross-country or even global monitoring purposes. Cost and access concerns might be the most obvious problems with such an approach, but survey fatigue, too, could be problematic, even if repeated cross-sections are used in the same locations. This implies a trade-off between the quality (or at least, the depth) of the data that can feasibly be collected and the regularity with which it can be collected.

4.2 Measuring Food Insecurity

There are various conceptual approaches of measuring food security at the micro level. In this section, we will briefly review dominant approaches, while we discuss *specific variables* Section 6.

The influential article by Maxwell et al. (2013) suggests that there are seven major empirical approaches to capturing food insecurity. The seven approaches based on these concepts: (general) coping strategies; food-related coping strategies; access to food; severity of hunger; food consumption; dietary diversity; and self-assessed ratings of food insecurity. FAO often focuses on slightly different concepts, including measurements of (children's) nourishment and anthropometrics (e.g. de Haen, Klasen, and Qaim, 2011), and behaviors households use when they have to cope with stress and/or do not have enough food or enough money to buy food (Baliki, Brück, and Stojetz 2018b, 2018a).

It has further been suggested that "big data", such as satellite data, large-scale survey data, administrative data and data extracted from media and online communication platforms can capture important information on food security measures at the micro level (Frelat et al., 2016). Assessments from expert interviews may also be a promising approach to capturing food security (Wolfe and Frongillo, 2001), while yet another new avenue is based on sentiments or subjective well-being indicators, beyond ratings of one's food security (Kahneman and Krueger, 2006).

A range of studies to date has attempted to compare the performance of at least some of these different techniques for capturing food insecurity (e.g. Barrett, 2010). For

instance, some note a "worrying" lack of consistency across the estimates of food insecurity when comparing the FAO's standard indicators, data drawn from household food consumption surveys and childhood anthropometrics (De Haen et al., 2011). Others point out large differences between the FAO indicator on malnutrition (which suggests that 39% of individuals in twelve sub-Saharan African countries are malnourished) and household survey data, which suggest that 59% of people are (Smith et al., 2006).

Headey and Ecker (2013) conduct comparative work for a slightly different set of indicators, including calorie deprivation, monetary poverty, dietary diversity and self-reported measures of hunger. Similar to the measures discussed above, they find significant differences in performance across these indicators, and discuss relative strengths and weaknesses for each. These conclusions are corroborated by qualitatively similar results from various other studies (e.g. Lappé et al., 2013; Maxwell et al., 2013; Pangaribowo, Gerber, and Torero, 2013; Pinstrup-Andersen, 2009).

The major lesson that can be drawn from these perspectives is that all measures of food insecurity have strengths and weaknesses and that there is no conclusive evidence regarding which approach is better. Different approaches used to date show striking differences in the results they generate, and none are best in all criteria. Therefore, analysts need to make value judgements regarding what aspects and measures of food security are the most relevant, most complete or most accurate. In turn, these choices will have implications for both *how* the corresponding data can be collected and *how frequently* it can be collected.

4.3 Data Collection Methodology

We consider four broad categories of data collection: in-person data collection; ICT-based data collection; national-level aggregate data collection; and remote data collection.[4] In cases one and two, this implies direct interaction between enumerators and respondents; in the fourth case, no interaction at all with individuals, and in the third case, likely some mixed approach. Additionally, in cases one and two, we consider three different levels of interaction: individuals / households that have been (randomly) sampled; individuals / households who volunteer their participation; and individuals who are specifically sought out (such as identifiable experts).

It logically follows that the data collection methodology that is preferred imposes structures both on the variables that can be enumerated and the frequency with which they can be collected. At the same time, however, how the data is collected is also influenced by such concerns. For example, should one wish to capture anthropometric measurements as a proxy for nutrition, it is not *prima facie* clear how one could hope to collect it, accurately, using remote technologies. Similarly, given the complexity of the "food diaries" implied by the "gold standard" approach, it is unlikely that text-message--based approaches will be sufficient. Of further concern is that individuals might answer the same questions in different ways, depending on the data collection methodology. In turn, some approaches might, simply, not be comparable with others, suggesting a need for consistency in how data is collected. Broadly, however, as the most "practical" of the trade-offs listed here, we view that how the data is collected should be determined by the desired frequency of data collected and the variables one wishes to capture.

[4] We abstract from "big data" here as, technically speaking, "big data" would not be collected for this purpose but "only" requires the additional analysis of such data.

4.4 Reflections on the Trade-Offs

Given the dynamic nature of food crises, and the fact that a move to crisis (or at least, the move to the early identifiable features of a crisis, if not necessarily the most pernicious realized impacts of such a crisis) can occur over a very short period of time, we view regular data collection as a pure dominant strategy. That is, not only do we view it as the best available option, we view it as such despite the trade-offs that it imposes elsewhere. For example, common surveys, such as LSMS, MICS and DHS, often have multiple years between waves, suggesting that it is likely some waves miss entire crisis periods. Even annual surveys run the risk of missing the periods in which crises onset, however, suggesting more rapid, or even on-going, data is required. Such data could be collected quarterly, monthly, or weekly, for example. Partly this may also depend on growing seasons and typical patterns of agricultural trade.

This imposes constraints on both how data can be collected and on the types of information that can be collected. Key characteristics of FCV are insecurity, uncertainty, extreme fragility, violence, and/or emergency conditions, resulting in a high level of volatility in local circumstances, a low level of institutional capacity to collect data, and the incompleteness or total absence of high-quality data – particularly at the individual level. Physical insecurity, for instance, makes the collection of data difficult in a very real sense; and, amongst its other adverse effects, it is likely that conflict drives particular forms of migration, reinforcing the complexity of collecting multiple waves of data from the same households. In combination, this makes the task of analyzing and predicting the micro-dynamics of food security even more challenging in the insecure environments in which such problems are likely to be most entrenched. In turn, it is unlikely that, in such situations, monthly data can be collected using in-person surveys, even using multiple cross-sections or rolling panels. This is furthered by concerns relating not just to sampling and attrition but also to survey fatigue and duration. In this regard, we conclude that ICT-based and remote data collection techniques are most desirable and feasible for the collection of survey data from individuals. This can be complemented with other forms of crowd-sourcing and crowd-seeding.

On this basis, we can include or exclude certain clusters of variables. For example, this precludes, entirely, any efforts to collect (child) anthropometric measurements. It also reduces the usefulness of other approaches, such as in-depth food consumption or other household surveys on practicality grounds. Thus, in the next sections, we make recommendations based on the variables that are feasible to collect, given these two exclusion criteria.

This brings us to another concern, which is the unit of analysis. In this regard, we are broadly agnostic, in the sense that while it might be difficult to remotely identify, for example, a household head, questions can be asked at the individual, household, or even neighborhood level. In this regard, we consider methods and variables that can collect data at these multiple levels.

A final question opens up in this scenario, which relates to when and how frequently the data should be collected. Related to this are questions regarding sample size. We propose, broadly, that a single answer can cover both. Even with remote data collection methods, survey or reporting fatigue might set in. In turn, asking a small sample of individuals any given question once per week runs some of the same risks as regular in-person surveying. In turn, repeated resampling coupled with selective attrition runs the risks of encountering structural biases in the sample. In this regard, we note that it is desirable to

maintain a panel, where the same individuals answer the same questions at multiple points in time. Coupled with the high frequency requirement for the data, however, a single panel is insufficient.

Rather, we propose what we call, in short-hand, the "multiple panel" approach, which is a variant of the rotating panel approach (in which panel members stay in the panel for a fixed number of waves, replacing a fraction of all households in each wave). In our suggested approach, for each short period of time (for example, a given week or even a given day), there exists a unique representative sample. Individuals in this panel are surveyed repeatedly, but with comparatively large gaps between. For the next temporal unit, exists another panel, who are also interviewed infrequently. In the case where the desirable temporal unit is a week and the desirable gap is around two months, this would imply the requirement of seven separate panels. In this setting, data comes in almost continuously but the probability of a given individual experiencing survey fatigue is significantly lowered. As each panel should be representative, however, this requires a very large sample, especially if the focus falls on multiple regions within a given country.

4.5 Desirable Features of Indicators

Based on the discussion in the previous sub-sections, we conclude that any indicator of food insecurity and food insecurity dynamics in FCV should exhibit three basic features:

1. Data should be collected at very *high frequency.*

2. Consequent of the required frequency, it should be possible to collect data in a way that does not require enumeration teams to be present in the field – in surveys from specifically sampled individuals; from those who self-select their interest; or on behalf of the whole community by specifically selected "seeds".

3. Data should be collected from *multiple individuals* with overlapping geographic remits in seeded approaches and from *multiple panels* for survey and crowd-sourced approaches and (allowing for high frequency of incoming data, strong maintenance of the representativeness of the data, and low survey fatigue).

5. Approaches for Indicators and Priority Variables

In this section, we will discuss *approaches* to data collection, noting that without further research, there are currently no particular dominant strategies or preferred approaches. We discuss *specific variables* that should be collected in Section 6.

We consider four potential units of analysis: (1) remote sensing, such as of land usage, land coloration, nightlights, etc.; (2) representative samples of individuals living in (potentially) food insecure FCV situations; (3) self-selected samples of individuals living in (potentially) food insecure FCV scenarios (crowd-sourcing); and (4) specifically selected (but non-representative) samples of individuals living in (potentially) food insecure FCV scenarios who report on their own conditions and those around them (crowd-seeding).

We argue that any early identification of a food crisis in FCV contexts generally involves two phases.[5] *Phase 1* is concerned with capturing the harbingers and conditions of a food crisis, *Phase 2* is focused on verifying an existing food crisis. Both phases are equally important for designing suitable programmatic interventions based on the outcomes.[6]

In the remainder of this section, we introduce and consider potential data collection approaches for both Phase 1 and Phase 2 in the early identification of food crises. While we illustrate each approach for either Phase 1 or Phase 2, we note that all approaches can be useful for both phases. We also do not present this list as exhaustive but, rather, as a reflection of the three most promising approaches we have, hitherto, identified.

5.1 Capturing the Conditions for a Crisis

Based on the definitions provided in Section 3, the usual pre-condition for the onset of a food crisis is a (significantly) worsening trend in food security. In turn, in order to capture such trends (at least on the assumption that a place, country or region has already been established as being of interest), one requires a time-series of observations linked to food security and an analysis of the trends within it. In situations where trends are worsening, the basic pre-condition for crisis is satisfied. What is an acceptable, or unacceptable, time period across which such deteriorations endure or an unacceptable threshold below which the measure should not fall are highly important considerations. However, being more specific on what those thresholds should be is likely to be location specific, requires deeper and specific research, and is beyond the scope of this White Paper.

The "Color of the Land" Approach

This approach relies on the remote sensing of land in the place(s) of interest and seeks to match the color(s) of the land with food production capacity. For example, higher proportions of yellow or brown in the same piece of land is likely to be correlated with reduced food production. In this particular example, the emergence of such colors might

[5] A more literal suggestion would be that it takes place in three phases, with the first stage determining whether or not it is worthwhile tracking food security levels in a given location at all. However, as we deal specifically with FCV, we do not specify this directly as a country having FCV status is likely sufficient for it to satisfy this first constraint.

[6] Such interventions would then take place in a subsequent phase of our generic timeline, which also requires monitoring. How to measure the impact and the effectiveness of food security interventions in FCV is, however, beyond the scope of this paper.

relate to reduced rainfall. This might beg the question as to why we do not observe weather data directly, given that it is also available at high frequency and high geographic disaggregation. We note, however, that places with high (or higher) levels of resilience – such as those with irrigation or access to ground water – may experience the same weather shock very differently to less resilient places. In turn, the color of the land captures both the weather shock itself and a place's capacity to deal with that shock, more accurately capturing the lack of resilience that could result in a food crisis. In turn, deteriorations in land color, that can be directly related to food production, likely capture adverse food security dynamics.

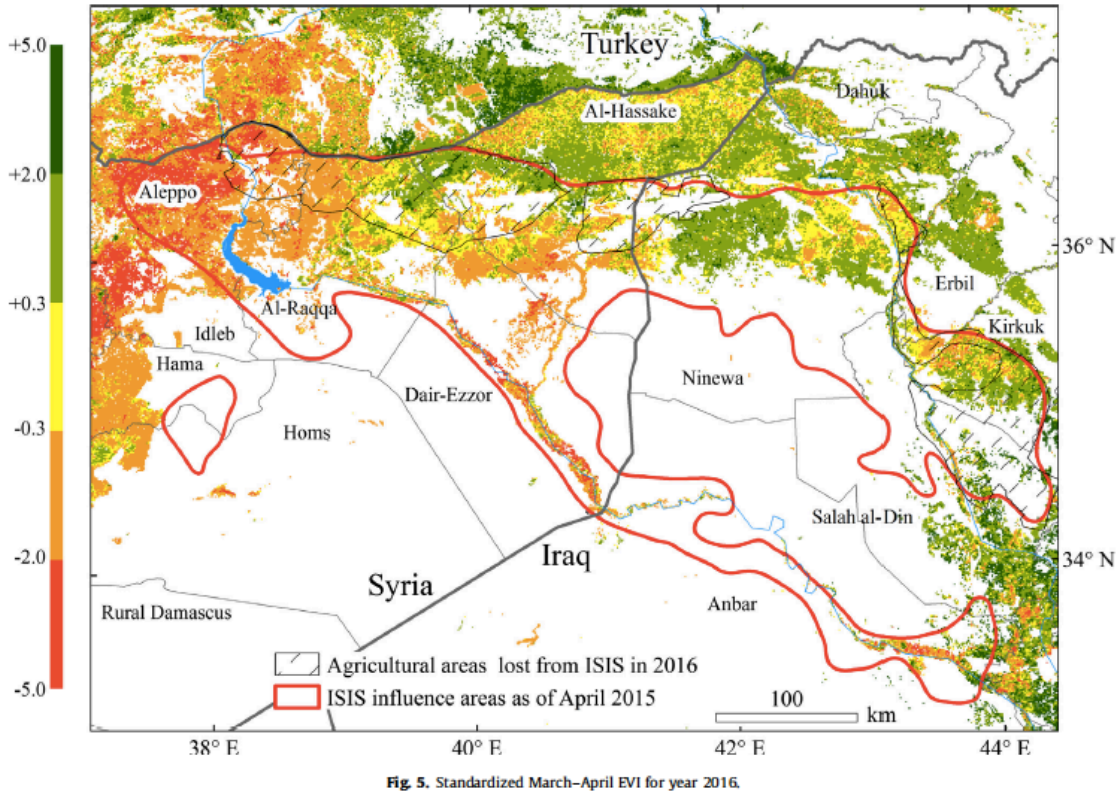

Fig. 5. Standardized March–April EVI for year 2016.

Figure 1: Color of the Land in ISIS-held Areas in Syria, 2016
Source: Jaafar and Woertz (2016)

The key benefits of the approach are regular data that can be analyzed in an on-going manner and that can be used to span large geographic areas. In turn, concerns pertaining to sample structure and representativeness do not arise. This allows the collection of accurate information on food production, and its impacts on the lives of large groups of individuals at comparatively little effort and marginal costs. Furthermore, it is likely that such monitoring could be automated to some extent, and especially so as technological change will facilitate both the sensing and the (machine) learning on the data thus generated. Some initial "manual" calibration may be required but it is likely to be a relatively low-cost effort.

Perhaps the key weakness of this approach is that it does not quite satisfy Sen's concerns, as it is a measure of food production, only. In turn, it does not capture the capacity of a region to access food via other coping strategies. In this regard, whilst food production goes down, a location's access to it does not necessarily follow suit. In turn, however, the implication that food can be imported could be indicative of problems elsewhere, including in places that do not display deteriorating land coloration.

The "Specialized Large-N Survey" Approach

This approach relies on collecting single, and very simple, indicators, regularly, from a large number of randomly sampled individuals, who are sent questions via text message or other ICT technologies. Rather than asking a range of survey questions regarding income, food purchases and food consumed, this approach attempts to reduce it to a single question – for example, the proportion of income a household spent on food in the last week. In this example situation, both a decrease in household income or an increase in the price of food are captured as one would expect, all other factors held constant, the same trend (of an increased percentage spend on food) to emerge. This implies that complex concerns, such as the net impacts of food price increases on famers, can be overcome by proxying the net effect. As each individual panel that comprises this sample is representative, the (moving) average of each wave should reflect the true average value of a given variable, ensuring that trends, rather than idiosyncrasies, are captured. In turn, dynamic analyses of these trends identify periods and places with deteriorating trends.

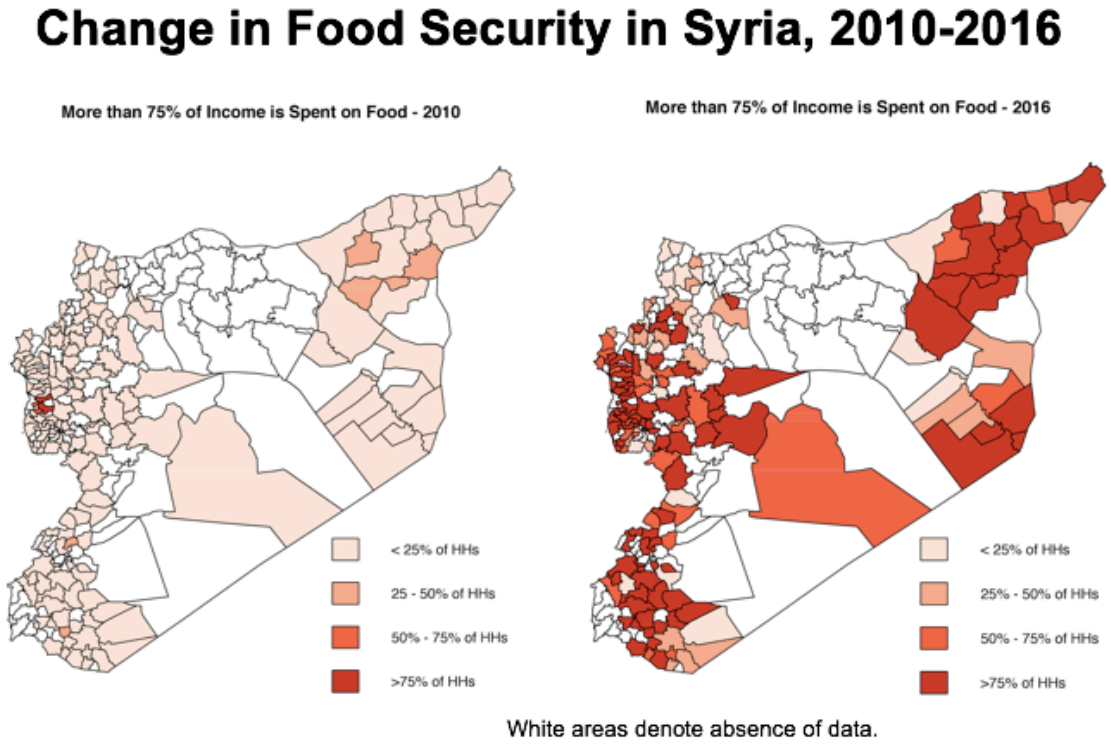

Figure 2: Percentage of Income Spent on Food in Syria, 2010-2016
Source: Authors' calculations based on FAO data

The key benefit of this approach is that it provides an understanding, at the individual level, of the dynamics pertaining to food security. In other words, it allows us to treat different clusters of individuals differently, rather than assuming that all experience a given shock in the same way. That this can be captured, regularly, with a single question with a simple response, lends itself very well to remote surveying techniques that are not needlessly exclusive. For example, such an approach does not require an internet connection and could be conducted via text message. Similarly, there are few structural barriers for individuals responding to such text messages (other than the absence of mobile phone signal).

The key drawback of this approach is that it zooms in on a single question. Thus, it necessarily captures only one narrow aspect of food security, but may not capture other dimensions if these follow different trends.

The "Identifying Local Experts" Approach

This approach seeks to, *ex ante*, identify individuals in regions of interest who are well-placed to report signs of potential food security crisis. Such individuals could include, for example, expert herders or pastoralists (who can be identified by yields, herd size, etc.). In this situation, these "experts" will be asked to report information on behalf of others living in the same location. That is not to say that they will report on the conditions of specific individuals but, rather, what the expert expects will happen within the relatively near future. This could be reported directly or in terms of actions taken by the expert – for example, a decision to deviate from a usual herding route, which could be captured with GPS trackers.

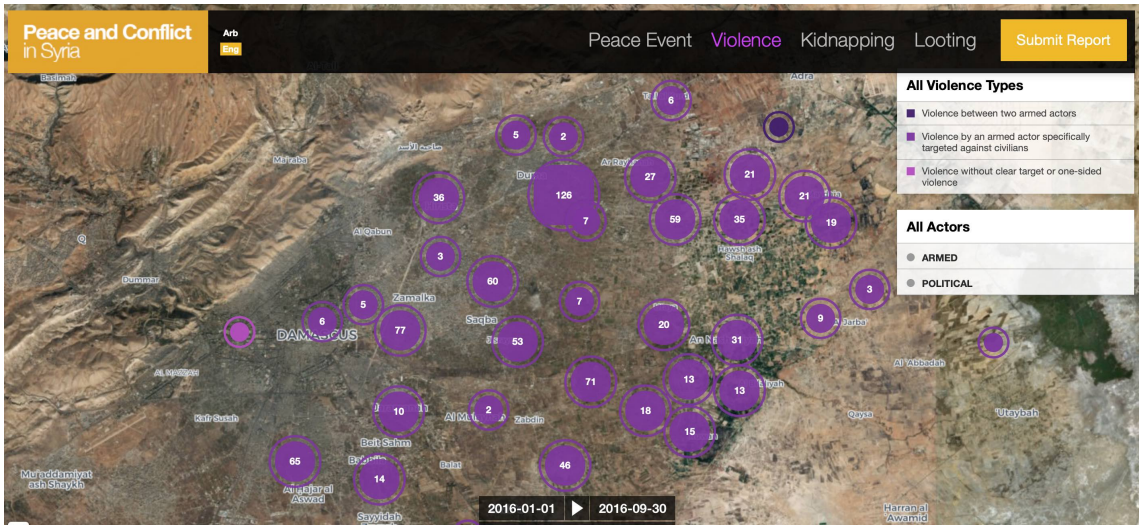

Figure 3: Local Experts Reporting on Violence near Damascus, 2016
Source: Authors' calculations based on own data

The key benefit of this approach is that data is collected from a relatively small number of individuals, who have been selected by the analyst. This allows the analyst to put together reasonably detailed and structured questions, as well as the necessary infrastructure to report on these questions. That individuals are identified as experts (broadly, those who have done well, despite living in very difficult circumstances and who, therefore, can be relied upon to interpret particular hints or signs better than the population as a whole) will significantly reduce noise in terms of reports. Similarly, dealing with a small number of crowd-seeded reporters allows the analyst to conduct training, that could improve the accuracy and quality of reports. Furthermore, the usefulness of the reports themselves can be graded as events unfold, giving the experts differing weights over time in the analysis. Another advantage is that experts could be equipped with mobile, or even satellite, phones, thus making only areas with no coverage inaccessible for this data collection effort (in contrast to the previous approach).

The most obvious drawback of this approach is whether or not it is actually possible to identify such "experts" and, indeed, whether or not there will be variations in quality across such experts. While this can, in part, be analyzed (for example, by checking whose reports proved to be true), it does not immediately follow that such an individual will live in each neighborhood. Related to that is the impact that the loss of an individual expert

– either through sample attrition or death – would have on the quality of information. At worst, this introduces potential structural breaks into the time-series of certain locations. In part, however, these concerns could be overcome by asking individuals to report on overlapping geographic spaces. Furthermore, changes in the location from which reports would be sent may be indicative in themselves of changes in conditions of food security.

5.2 Verifying a Crisis

In each of the three cases mentioned above, in addition to the unique benefits and drawbacks, is the risk of Type I error (the false positive). That is, the risk that the measure will predict that a crisis is beginning, when in fact the trend relates to some other factor not related to food security. This could occur because the capacity to cope with shocks is high in a given location but is not captured by the measure; or by some other omitted process, such as the onset of violent conflict, which requires separate and different interventions. Likewise, Type II error could occur (the false negative), where a true crisis remains undetected. In this regard, the second stage (which can be considered the "in-depth" phase) is required. This phase occurs when some threshold in stage one is satisfied and a decision is taken to move to a more in-depth data collection process. Hence, this threshold has to be set to minimize both types of error and, thereby, to reduce the influence of political economy considerations mentioned in the Introduction.

In turn, in this sub-section, we consider a range of data collection methodologies for this verification stage. Again, these are presented as those identified as the most promising by the research team, rather than an exhaustive list of all possible options. In this sub-section, we note that the geographic spread of the observations should decrease markedly (as only places with worryingly worsening trends are analyzed in this stage), but this should come with the trade-off of larger samples and higher frequency data.

The "Coping" Approach

In the first instance, we do not necessarily pretend such an approach is "original". Indeed, the idea of using coping strategies as a measurement device for food insecurity and a tool for capturing crises has been established by the literature (Maxwell, Caldwell, and Langworthy, 2008; Maxwell and Frankenberger, 1995). We note, however, some subtle differences between our approach and existing suggestions. First, the existing work proposes a forward looking, hypothetical question that asks individuals which coping strategies they would use, should they experience problems. This has the benefit of implying that some coping strategies might already be exhausted or are otherwise unavailable. It cannot, however, specify why and does not suggest, immediately, that households are presently experiencing acute food insecurity. That is, even a household with little recourse to coping strategies may not experience a worsening of its food situation in the week after the question is asked.

By contrast, we propose to ask two questions: which coping strategies were available at the beginning of the previous week, and which have been used since then. Upon receiving an affirmative answer that coping strategies have been exhausted, those individuals will be asked why. In this way, we know which strategies were available, which have been exhausted, and the reasons why they have been. As this captures real use of strategies that are linked to food insecurity and that may be considered adverse, it can be used to confirm the onset of a crisis. Differing approaches to actual data collection are available, relating either to open-style questions that allow individuals to report whichever

strategies they want, or closed questions sent by the analyst. Each has benefits and drawbacks. Open questions are easier for respondents to reply to but more difficult to analyze, for example. As before, such data should be collected from multiple panels at high frequency.

The "Experimental" Approach

The use of "experimental" data is also not new (Pinstrup-Andersen, 2009), but, again, we propose a variation on the theme. First, previously suggested approaches rely on asking individuals to rate their food security. This has the problem that individuals might respond based on their own expectations. Thus, those least affected by food insecurity who experience a minor change that deviates from their preferences may report sharper declines than those who experience real problems, based, simply on expectations. Cognitive dissonance literature, too, could be relevant for such implicit biases. Second, questions tend to be asked, statically, about experiences, which might not be useful in terms of early warning – if individuals have already begun to experience a crisis, it might be too late (in contrast to coping strategies, which they might move to in expectation of future problems).

We therefore propose that questions are asked in a forward looking way – that is, individuals are asked to rank their food security in the coming period. We argue that this overcomes both the temporal concern and those relating to biases, as individuals relate future expectations to those held in the present. A variant on this approach is to ask about food security indirectly, such as asking individuals to report on their expected welfare. This should further overcome biases but comes at the cost of some accuracy foregone. However, based on the trends that are identified in the first stage, it should be relatively easy to believe that declining happiness is related to food insecurity, rather than some other omitted process. Again, such questions should be asked, at high frequency to multiple representative panels.

The "Crowd-Seeded Local Markets" Approach

This approach builds on disparate literatures that seeds trained reporters into communities and asks them to report on the community under observation. In this regard, reports should be highly accurate, as seeds are trained how to report what they observe, and can cover many aspects of food insecurity, as seeds can be provided with the necessary equipment. Unlike in other situations, such as political or other violence, potential perceptive biases are also less likely to arise. This can be further overcome by ensuring that seeds have responsibility for overlapping geographic areas, rather than discrete ones. We propose that seeds should be asked to report on a range of variables related to food security, proxied by what they can observe at local markets. This includes the prices of staples at the local market, the quality and variety of produce at the local market, the quantity available, and how busy the market is. This data should be reported frequently, with each individual responsible for visiting two to three markets per week, and each market covered by at least two seeds. Seeds must, therefore, be identified and trained very rapidly, once trends begin to deteriorate and the markets under interested also identified. As expensive and time consuming as this could be, it offers critical benefits over approaches that rely on large samples, including lower noise and lower analytical requirements.

The "Self-Reported Trouble" Approach

This approach asks individuals who have never had contact with the analyst to write regarding their private circumstances and builds on the placement of adverts in locations experiencing worsening food security trends in the first phase. These adverts (or randomly sent text messages) will ask individuals to send a text message (or to reply by return text message) if they are experiencing difficulties feeding themselves or their families. Some reward might be offered, although this requires consideration regarding incentive-based biases. This approach does not concern itself, explicitly, with the contents of the text messages but, rather, simple volume of messages, arguing that if a food crisis is taking place, the number of received text messages should increase in time, either by pure volume or from unique telephone numbers. This approach has many desirable features, not least that expensive start-up costs and time lags caused by necessary preparation are avoided. At the same time, it is unclear if, or how, individuals could be encouraged to write without introducing other biases. For example, incentivizing responses might encourage individuals to write, whether or not they are experiencing problems. Allowing individuals to write saying they're not experiencing any problems, by contrast, would complicate the analysis and would require some collection of the contents of the messages. In turn, the process could be noisy, making it difficult to establish worsening trends at early stages.

6. Specific Variables

6.1 Variables Currently Being Used

Current efforts already use an impressive range of variables to detect and predict food insecurity. Fig. 4 provides an overview of datasets and specific variables currently included in food insecurity prediction by the World Bank.

Summary of data sources

	Variable	Temporal resolution	Source
Core Datasets	IPC Phase	Bi-annual	IPC, CILSS
	IPC Population Distribution	Bi-annual	IPC, CILSS
	Humanitarian Assistance Tag	Quarterly	FEWS NET
	NDVI Anomalies (disaggregated by land type)	10-day, monthly	WFP (MODIS)
	Rainfall (disaggregated by land type)	10-day, monthly	WFP (CHIRPS)
	Conflict - count of events and fatalities	Monthly	ACLED
	Market Prices (food and non-food goods)	Monthly	WFP, FSNAU, CLiMIS
Contextual Layers	Geographic (land cover, length of growing period, built-up area, cropland/pasture area)	Time-invariant /annual	ESA-CCI, FAO
	Demographic (population density, infant mortality rate, travel time to cities)	Time-invariant / annual	GPW
	Economic (Gridded GDP, road density)	Time-invariant	World Bank ENR
	Environmental (soil erosion, air pollution, land productivity long-term trends)	Time-invariant	World Bank ENR
Alternative Sources	Evaporation Stress Index / SPEI	Monthly	NASA
	Night-time lights	Monthly	NASA
	Soil Moisture	Monthly	VanderSat
	Temperature, precipitation, NDVI	Monthly	Descartes Lab
	High-resolution imagery-derived signals		Orbital Insight

- Current dataset covers 7 countries, (429 districts, GAUL admin 2)
- Core datasets undergo various transformations and interactions:
  - Monthly imputations (IPC)
  - Spatial and temporal lags
  - Imputation of missing values
  - Spatial smoothening
- Key data gaps:
  - Humanitarian Assistance
  - Market disruptions

Figure 4: Data currently used by the World Bank for food insecurity prediction
Source: Piffaretti, Spencer, and Andree, 2018

The used measures span a large array of geographic, climatic, demographic, political and economic conditions, and domestic prices for food and non-food market goods that the literature has linked to food security. The information is taken from a diverse set of high-quality databases provided by prominent organizations like the IPC, World Bank or NASA. The frequency of observations in these measures varies and ranges from daily data, as for rainfall, to annual data, as for the infant mortality rate, while time-invariant characteristics of regions and countries, such as land cover, are also accounted for.

6.2 Limitations

From a micro-level perspective addressing households, firms and markets, we see four main limitations of the currently used database:

First, compared to other conditions, the included information on institutional and political conditions under fragility, conflict, and violence is by far the weakest. Conflict event data, such as from ACLED, is very useful as it is geo-coded and can be used for analysis down to very small spatial units and it is increasingly available in (near-)real-time. Yet, it is strongly focused on violent events, such as battles between groups, which only capture a fraction of the realities people face in FCV settings (Justino, Brück, and Verwimp, 2013; Brück et al., 2016; Verwimp, Justino, and Brück, 2018) and that might cause food insecurity (Brück and D'Errico, 2019; Martin-Shields and Stojetz, 2018; Justino 2012).

Better and more data on the institutional and political environments in FCV zones is required for detecting the full diversity, nature and drivers of food insecurity. For instance, the local and regional conditions that conflicts at the subnational and group level induce need to be much better accounted for. These conditions often directly transform households, firms and markets, affect their functioning, and sometimes change quickly and frequently. Critical conditions also include non-violent aspects of conflict beyond violence, such as regional wartime governance by armed groups and the political economy of food systems during conflict (Arjona, Kasfir, and Mampilly, 2015; Justino and Stojetz, 2018; Justino, 2017). Capturing the complex but fundamental role of FCV conditions for food security outcomes thus requires highly disaggregated, reliable, and high-frequency data, with sufficiently wide geographic coverage.

Second, there is a lack of "behavioral" measures of food security in the menu of variables. As discussed in Section 4, many prominent approaches to food security depart from individuals' behaviors and the consequences of these behaviors. For instance, these emphasize direct behaviors, such as food-related coping strategies, as well as immediate ramifications, such as nutritional status.

The existing set of input variables should thus be complemented with high-quality information on how individuals are affected by and cope with fragility, conflict, and violence, most importantly considering strategies related to food security. Observing actual micro-level behavioral responses under adverse conditions in situ is challenging, but there is growing empirical data on the coping strategies of conflict-affected individuals and households to protect their productivity, livelihoods and food security as well as their impacts. As advanced by Maxwell and Frankenberger, 1995, information on coping strategies, for instance, can likely be collected frequently (as per the exact wording: "data could be collected weekly"), but (of course) requires some level of interaction (either in person or via the use of ICT).

Third, new technology and techniques enable (even) better capture of agricultural production in food security detection and forecasting.[7] Food insecurity and FCV conditions are concentrated in regions where livelihoods dominantly lie in the agricultural sectors. In Africa, for instance, where risks and levels of food insecurity are among the highest, 70 percent of the population rely on agriculture for their food supply (Paul, Shonchoy, and Dabalen, 2015). In these cases, food security is intimately linked to agricultural production and perhaps most directly for subsistence farming and related forms of livelihoods where how much households can consume directly depends on how much they produce. In turn, agricultural production is an important channel how FCV conditions shape food security outcomes. For instance, these factors can affect capital and labor inputs, their prices, and markets price for local produce, all affecting food security.

Therefore, more refined measures of agricultural production should enter detection and prediction models of food insecurity. Capital and labor inputs, their prices, and markets price can now be measured and monitored in sophisticated ways, exploiting and combining recent advances in modern data, such as in the availability of satellite data, large-scale survey data, and administrative data. Satellite data on agricultural production, for example, requires a highly specialized set of data collection and analysis methodologies, but can effectively be collected continuously.

[7] This specifically also includes non-sedentary or non-stationary forms of agriculture, such as herding.

Fourth, the currently used information is mostly not disaggregated by social strata. While some natural variables, such as weather conditions, are disaggregated by "land type", heterogeneity across social groups and characteristics is currently not reflected. Both the precursors and the symptoms of food insecurity have covariate and idiosyncratic dimensions. That is, some can be systematic and the same for a society, while other vary from societal group to societal group, or even from person to person. This suggests that the occurrence of a shock is only one aspect of the food insecurity situation of a place – the capacity of the place, or the individuals living there to cope is another. It follows that collected variables should ideally consider not just the former but also the latter.

While any model will usually be specified for some level of multi-person aggregation, societal groups defined by characteristics such as age, gender, ethnicity or networks could improve current models. For instance, the relevant variable at the national, regional or pixel level may be "defined" by a societal group. To illustrate, the most powerful input variable may be the *infant* mortality rate (which is included in current World Bank models) rather than the general mortality rate; splits of this variable by gender and by clusters of ages would also be revealing. Similarly, the *female* population density may have more explanatory power than the overall population density. Such group-specific measures are often available in a useful way, in the sense laid out above, and non-parametric modelling techniques may be particularly helpful in identifying the relevant measure.

6.3 Micro Variables that Should Be Added with Priority

Against the background of the limitations of the current information base for food insecurity modelling, we now proceed to recommend five variables that should be added with (highest) priority for Phase 1 (capturing the conditions of a crisis) and follow-on, in-depth Phase 2 (verifying a crisis) analyses. These five variables are:

1. Adverse coping strategies
2. Food consumption
3. Subjective well-being and expectations
4. Exposure to conflict and fragility and
5. Subnational agricultural production and consumption

For each variable, we present specific indicators that can be collected using the approaches discussed in Section 5, ensuring that the indicators exhibit the desired features outlined in Section 4. For each variable, we also recommend three "best approaches" to collecting them. "Best" here means that we view these approaches as the most powerful for generating specific indicators with the desired features.

Some specific indicators have been elicited in previous data collection efforts, predominantly via multi-topic large-N household surveys. For the five Priority Countries in the World Bank's Famine Action Mechanism framework, we will document in Section 7 which of the specific indicators have been captured in multi-topic large-N household surveys, and how (i.e. the survey questions used), providing a case study of data availability and data gaps.

Adverse Coping Strategies

Specific indicators:

1. (Food-related) coping strategies, such as: limiting portion size, reducing the number of meals, borrowing food, and restricting consumption by adults for small children to eat
2. Use of harmful livelihood coping strategies (e.g. selling assets)
3. Percentage of income spent on food

Best approaches:

1. Specialized large-N survey
2. Coping approach
3. Local experts

Food Consumption

Specific indicators:

1. Extent of food consumed
2. Dietary diversity of food consumed

Best approaches:

1. Specialized large-N survey
2. Experimental
3. Crowd-seeded local markets[8]

Subjective Well-being and Expectations

Specific indicators:

1. Self-rated food security
2. Life satisfaction
3. Expectations about prices
4. Expectations about harvests in a panel

Best approaches:

1. Specialized large-N (panel) survey
2. Experimental
3. Self-reported trouble

Exposure to Conflict and Fragility

Specific indicators:

1. Events of one-sided violence
2. Local public good provision by ruling actor(s)
3. Approval rating of ruling actor(s)
4. Intracommunal tensions

Best approaches:

1. Color of the land
2. Specialized large-N survey

[8] Seed informants cannot report on what people eat, but could report on what is sold most in local markets and what people grow.

3. Local experts

Subnational Agricultural Production and Consumption

Specific indicators:
1. Agricultural output
2. Agricultural yield
3. Local (high-frequency) food prices

Best approaches:
1. Color of the Land
2. Crowd-Seeded Local Markets
3. Specialized large-N survey

7. Priority Variables in WB Priority Countries

In this section, we review and draw lessons from existing multi-topic, large-N survey work. The purpose is twofold. First, we attempt to better understand what key information on the priority variables identified in Section 6 is currently being collected in this way. Second, we detail how the existing survey measures can inform collecting "better" data via the recommended approaches discussed in Section 5, deriving 11 specific indicators to be assessed (labelled I1-I11 below).

To do so, we focus on the five priority countries of the World Bank's Famine Action Mechanism, Afghanistan, Chad, Somalia, South Sudan and Yemen. We review survey instruments for all multi-topic large-N surveys for these countries featured in the World Bank's Microdata Library, which include DHS, High Frequency Surveys, LSMS, and MICS. We augment this set with national household surveys conducted by FAO, which are usually called Food Security and Nutrition Monitoring System (FSNMS) surveys. While much existing information on conducted FAO surveys, their timing, and the instruments is only partially or not at all available, we include them here as they are conducted relatively frequently (typically multiple times per year) and contain many variables related to food security.

Table 1 provides an overview of existing surveys in the five countries. As these surveys typically use standard questionnaires, we review the survey instruments used for most recent wave of data to be collected in each of the five priority countries. For the case of LSMS, no information is available on the World Bank's Microdata Library for any of the five priority countries, illuminating the complexity of collecting high-quality multi-topic survey data in complex environments. We thus review the most recent LSMS model questionnaire. For the case of FAO surveys, our database of all existing surveys is incomplete, but we indicate when – to the best of our knowledge – the most recent survey was conducted. We review the questionnaire used in the most recent wave in Yemen, which was made available to us for review by FAO staff.

Country	Survey	Year(s)
Afghanistan	DHS	2018; 2014-2015; 2012
	MICS	2010-2011; 2003; 2000 (East); 1997
	FAO	2018 (latest)
Chad	DHS	2014-2015; 2004; 1996-1997
	World Health Survey	2003
	MICS	2019 (design phase); 2000; 2010
	FAO	2018 (latest)
Somalia	High Frequency Survey	2017; 2016
	Somaliland Household Survey	2013
	MICS	2011 (Northeast and Somaliland); 2006; 2000; 1997 (Northeast); 1996 (Northwest)
	FAO	2018 (latest)

South Sudan	High Frequency Survey	2017; 2016 (x2); 2015
	DHS (including Sudan)	1989-1990
	MICS	2010; 1999
	FAO	2018 (latest)
Yemen	DHS	2013; 1997; 1991-1992
	MICS	2003; 1996
	FAO	2018 (latest)

Table 1: Overview of existing standard multi-topic large-N Surveys in FAM Priority Countries

7.1 DHS

DHS surveys from three different survey phases are relevant for our purpose: Phase I (Sudan, 1989-1990); Phase VI (Yemen, 2013); and Phase VII surveys (Afghanistan, 2018; Chad, 2014-2015). Despite DHS data being collected in four of the five priority countries, they are done very infrequently. The last DHS data collected in South Sudan, for example, was collected almost thirty years ago. This does not, however, preclude that there are useful exemplar variables in DHS that could provide the basis of our final recommendations.

We find that none of the priority variables listed in Section 6 are captured directly in DHS. In Phase I (and in all subsequent phases), the major variables collected pertaining to nutrition and food security are children's anthropometric measurements (height and weight). From these measurements z-scores can be calculated, in order to ascertain children's nutritional status – especially whether or not they are malnourished. Given the notorious difficulty, even for trained enumerators, in collecting such data and the equipment required to do so, it is difficult to believe that this data can be collected remotely and at high frequency.

In Phase VI and VII, men's and women's surveys include a small number of questions about family construction, including the number of boys and girls born to the family that have subsequently died. Such questions could be reformulated to be collected remotely and at high frequency. However, an event as extreme as a child's death is a) likely a highly traumatic thing to ask individuals about regularly, especially those who have already lost children, and requires special techniques and training; and (b) likely to be a later-stage symptom of a crisis, in the situation where the death is related to food insecurity.

7.2 High Frequency Surveys

High Frequency Surveys are meant to take place regularly by design. However, even gaps as narrow as six months between waves can result in critical lags in the early identification of problems. In terms of content, these surveys provide a number of model questions pertaining to our key outcomes that could be collected at (even) higher frequencies and via different techniques. For instance, these surveys ask whether households members have eaten, and what they have eaten: *"When was the last time that any of the household members had a meal?"* and variants, asking when the last time members of the household ate particular foodstuffs, including, "bread and cereals", "meat" and "pulses and

vegetables". Similar questions are included about consumption in the previous seven days.

While insightful, these survey items raise questions of how high, or low, to set the bar for these indicators, what can be inferred, and how to generalize. A key reason is that many aspects of household level consumption are likely to be highly context specific, and / or such information may mask different outcomes at the individual level. For example, households in traditionally vegetarian societies having not eaten meat in a long time is hardly surprising and does not relate to food security. Households in the world's poorer regions may more often rely on staples other than meat for their nutritional requirements. Relatedly, asking at the household level may, for instance, capture that the household head is not food insecure, but if the rest of family did not eat a meal for much longer, large-scale hidden hunger would not be detected. This suggests a trade-off: the individual, rather than the household, is likely often a better unit of observation and it is important to collect information on what individuals have consumed. But at the same time, surveying the individual level will often significantly increase the difficulty of collecting large-scale information at high frequency and remotely.

That said, the general template of these questions is highly useful, particularly for capturing conditions for a crisis (Phase 1). We find interest in what individuals have consumed in the last week, but would rather emphasize the potential of capturing self-assessed levels of food security. We recommend studying the following indicator, which can be collected regularly and remotely, and allows researchers to track when things are getting better, or when they are deteriorating, especially when reports are aggregated across small geographic areas.

I1: "In the past seven days, did individual X consume the usual amount of staple foods that he/she would in a regular week? Binary response: Yes/No."

We note that our recommended questions represent the questions to be explored via the different techniques. By "individual X" we refer to individuals residing in the context under study. For the specialized large-N survey approach, the questions may be directly translated into specific survey questions asked to interviewees, by replacing "individual X" with "you".

7.3 LSMS Surveys

LSMS surveys cover an extraordinary range of topics in great depth. As noted several times, the idea that such a survey can be done in complex environments frequently is, at best, fanciful. This is reflected by the fact that there are no LSMS surveys in any of the five FAM priority countries listed on the World Bank's Microdata Library. In this absence, we instead review a questionnaire from a non-FAM priority country (Malawi), on the understanding that key lessons might still be drawn from the wider LSMS effort. We note a number of variables collected in these surveys are of potential use.

First, LSMS includes a detailed questionnaire that matches the supposed "gold standard" of consumption in a short period prior to the survey – asking individuals *how much* of particular foodstuffs they have consumed in the past week (Module G in the Malawi questionnaire we reviewed). The survey asks individuals about whether or not they've consumed a particular item; the quantity of consumption; the cost of that consumption; how much was produced from own-consumption; and how much came from gifts or other sources; for up to 135 different foodstuffs. Although providing highly nuanced data

on consumption, as well as allowing the creation of valid proxies of micronutrient consumption, it again seems unlikely that such data can be collected remotely and at high frequency, reiterating the concerns we raised for the consumption measures in High Frequency Surveys.

More tractable questions are asked in a dedicated food security section, which asks a range of questions on: a) concerns about having enough food; b) nutrition-based coping strategies; c) typical numbers of meals eaten; d) whether or not the household faced a situation where there was not enough food in the last year; and e) how this situation arose. As some of the questions are short and closed form, the can easily be collected frequently and remotely, in slightly adapted formats. Specifically, we recommend that the following adapted questions could be assessed:

I2: "In the past seven days, did individual X worry that he/she would not have enough food the next day? Binary response: Yes/No."

Increases in affirmative responses to this question would be highly useful in Phase 1 of our approach, establishing that confidence regarding access to food is diminishing in particular places.

I3: "In the past seven days, how many days did individual X have to:

- ***(a) Purchase lower quality foods than he/she would usually purchase?***
- ***(b) Limit portion sizes at mealtimes?***
- ***(c) Reduce the number of meals eaten in a day?***
- ***(d) Restrict food consumption?***
- ***(e) Borrow food or rely on help from others?***

Response to include all letters for which the answer is Yes."

This is particularly useful for Phase 1 assessments. In situations where it is shown that trends are worsening, this should be followed up with questions trying to capture the underlying reasons. Noting that there is an implicit hierarchy in the (a) to (e) options listed above, individuals who answer in the affirmative at a given level could be asked *why* this situation has arisen:

I4: "What caused individual X to do [choose from (a), (b), (c), (d), (e)] in the last week?

- ***(a) Poor household food stocks***
- ***(b) Increase in prices in the local market***
- ***(c) Reduction in household income***
- ***(d) Lack of food in the market***
- ***(e) Unable to reach market***

Response to include all letters for which the answer is Yes."

In both of the previous two sets of questions, the answer codes may require significant thought. Beyond Phase 1, where it is key to include potential responses that indicate the precursors of a food security crisis, such indicators could also be useful for Phase 2, but the relevant responses needed to detect an active food crisis may differ.

Somaliland Household Survey

Like standard LSMS, this specific survey contains an in-depth module that asks about food consumption in the previous week. In this instance, questions are asked on consumption of 126 different types of food. Notes are also made that enumerators can show participants pictures of certain foodstuffs, in order to help overcome definitional

difficulties. This adds further to the concerns we have raised about how useful such data is for our purposes.

World Health Surveys (WHO)

We also reviewed the World Health Surveys designed for lower income countries. One question that appears to be particularly relevant for our purposes is Q0801: *"In the last 4 weeks, how much did your household spend on food, including things as rice, meat, fruits, vegetables and cooking oils. Include the value of any food that was produced and consumed by the household and exclude alcohol, tobacco and restaurant meals."*

While amounts spent on food items is of high interest, our prior discussions illuminate a number of potential problems with the exact question. First, it is unclear what an increase in the spent amount would imply. On the one hand, it could imply that staples are becoming more expensive, which could be an indication of concern. On the other, it could be an indication of a household preferring (and being able to afford) more expensive and desirable foods. Similarly, spending less could be taken to be reflective of a reduction in prices, which seems unlikely to indicate problems; but could equally relate to a household being unable to sustain previous levels of spending, which could be more problematic. Second, the four-week reference period may be too long.

A small update to such questions could again allow cleaner inference and avoidance of potential logical inconsistencies. We believe such a question is best placed to assess the extent of coping with adverse conditions. Specifically, we suggest looking at the percentage of household income spent on food, and how this changes over short periods of time. For Phase 1, we would determine that increasing percentage spends are potentially indicative of the onset of problems. In Phase 2, questions such as having enough food to eat, and the reasons why this is the case, as elucidated above, could be useful for confirming that the trends are pointing towards a crisis. We recommend the following question to be assessed:

I5: "In the past seven days, what percentage of its income did household X spend on food? Please include things like rice, meat, fruits, vegetables and cooking oils. Please do not include alcohol or tobacco, or meals purchased in restaurants. Response a number between 0 and 100."

For this indicator, aggregation to the regional level may be especially informative. For example, it seems improbable that the income spend on food purchases in a given region would for all households change in the exact same way and at the exact same time, and household level variation may be noisy. Yet, strongly informative patterns and alarming trends may be discovered at the aggregate level.

7.4 MICS

Since 1996, various multiple indicator cluster surveys (MICS) have been conducted in the five FAM priority countries by UNICEF. Notably, the 2019 survey in Chad, which is currently being designed, will be the first MICS survey to be implemented in these countries since 2011. This fact further emphasizes the lack of available high-frequency information from multi-topic large-N surveys.

MICS are based on model questionnaires, which, like LSMS surveys, cover a great range of topics in great detail. In addition to a household questionnaire, MICS surveys place

particular emphasis on surveying the well-being of women household and children under five. We review the latest model questionnaire ("MICS 6").

In addition to in-depth information related to adverse coping strategies and food consumption that is similar to that covered by the other surveys already discussed, MICS also contains useful survey item on two other priority variables: exposure to conflict and fragility, as well as subjective well-being and expectations. Specifically, we recommend assessing the following (minimally adapted) question on perceived safety ("VT 20"):

I6: How safe does individual X feel walking alone in her/his neighborhood after dark? Response: Very safe; Safe; Unsafe; Very unsafe."

We also find interest in a question related to victimization ("VT22"), which probes various grounds of victimization, and suggest making it explicitly about food:

I7: In the past 4 weeks, has individual X personally felt discriminated against or harassed on the basis of how much he/she had to eat and/or resources he/she had to buy food? Binary response: Yes/No."

In addition, life satisfaction is also covered by MICS. Individuals are asked to imagine a ladder *"with steps numbered from 0 at the bottom to 10 at the top."* Then the question reads ("LS2"): *"Suppose we say that the top of the ladder represents the best possible life for you and the bottom of the ladder represents the worst possible life for you. On which step of the ladder do you feel you stand at this time?"* The subsequent question LS3 introduces a comparative intertemporal perspective: *"Compared to this time last year, would you say that your life has improved, stayed more or less the same, or worsened, overall?"*

We recommend the following adapted questions could be assessed:

I8: "On a ladder from 0 to 10, where the top of the ladder (10) represents the best possible life for individual X and the bottom of the ladder (0) represents the worst possible life for individual X: On which step of the ladder does individual X feel he/she stands at this time? Response a number between 0 and 100."

I9: "Compared to this time last month, does individual X think that overall his/her life has strongly improved, slightly improved, stayed more or less the same, slightly worsened, strongly worsened? Response: Strongly improved; Slightly improved; Stayed more or less the same; Slightly worsened; Strongly worsened."

7.5 FAO Surveys

In the Faming Action Mechanism priority countries, and in fragile countries in general, FAO rarely conducts large-scale household surveys on its own. FAO, however, participates in multi-partner collaborations of household survey data collection, often multiple times per year. While the format of such surveys is slightly less standardized as for the other surveys reviewed, it is often conducted in the Food Security and Nutrition Monitoring System (FSNMS) framework, or at least based on it. Based on information provided by FAO, our review suggests that various efforts are relevant to our purposes. In Yemen, FAO engages in Famine Risk Assessment (2-3 times a year, multi-partner) and FSNMS (multi-partner) surveys; in Chad in food security and nutrition surveys (frequently, in collaboration with WFP); in Afghanistan in Seasonal Food Security Assessments (conducted annually by multiple partners, with the most recent wave in 2018 was done

by Food Security Cluster, WFP and FAO (at least); in South Sudan in FSNMS assessments (conducted twice a year, carried out jointly with WFP, and NGO partners from the Food Security and Livelihoods Cluster, and the national Government); and in Somalia food security and nutrition surveys (conducted twice a year by FAO's Food Security and Nutrition Analysis Unit (FSNAU) in collaboration with FEWS NET, and other local partners).

FAO surveys provide rich information related to food security. As many of the other surveys reviewed above, for our purposes the most valuable and actionable questions are related to two priority variables: adverse coping strategies and food consumption. They cover either in great detail, and all of the recommendation questions to be explored also follow from FAO surveys. In addition to these, FAO surveys also include questions on how food security is experienced subjectively, and on the quality and diversity of the food consumed. The latter could in principle be inferred from detailed consumption maps from a long list of foodstuffs. However, such an approach does not meet the criteria we set out for priority indicators and is also difficult to implement with the techniques we identified.

FAO surveys include some tractable questions in this regard, such as "*In the past 4 weeks (30 days), did you or any household member go to sleep at night hungry because there was not enough food?"*, (question G03 in the Yemen questionnaire), *and "How often did this happen in the past [4 weeks/30 days]?"* (question G04). In terms of nutritional diversity and value, our review deemed the following question as important and actionable: *"During the last 12 MONTHS, was there a time when you or others in your household were unable to eat healthy and nutritious food because of a lack of money or other resources?"* (question X02).

As noted previously, many aspects of household level consumption and perceptions are likely to be highly context specific. For instance, in certain places in the world people will go to bed "hungry" more often that in others in the absence of food crises, both from an objective and experience-based perspective. Similarly, the standard diet and nutritional value may vary strongly across sites in the absence of food crises. We therefore suggest to slightly modify the questions to make the level of perceived hunger comparable to the same household/place at different times and choose a shorter reference period. Therefore, we suggest assessing the following questions for large-scale, high-frequency and remote collection via our recommended techniques:

I10: "In the past seven days, on how many days did individual X go to sleep at night hungrier than usual, because there was not enough food? Response a number between 0 and 7."

I11: "In the past seven days, on how many days was individual X unable to eat the usual amount of healthy and nutritious food? Response a number between 0 and 7."

7.6 A Short Note on Variables Related to Agricultural Production

Beyond the measures discussed above, various surveys also include a range of questions focusing on land usage and agricultural production in agriculture modules.

These are often in-depth measures, but difficult to adapt for collection in ways that fit our requirements and purposes. While these data points themselves are useful, we believe that the preferred approach to measuring agricultural production for our purposes is based on remote sensing techniques. Specifically, we recommend the use of land usage and land coloration satellite data.

8. Conclusions and Recommendations

This White Paper takes a fresh look at the use of micro-level data for the early identification of famines and other acute food security crises.

We note, first, that any early identification of a food crisis generally involves two phases. *Phase 1* is concerned with capturing the harbingers and conditions of a food crisis while *Phase 2* is focused on verifying an existing food crisis. Both phases are equally important for designing suitable programmatic interventions based on the outcomes.

We argue that any indicator for these analyses should exhibit three features: it can be collected at very *high frequency*; it can be collected *remotely*; and it can be collected from *multiple individuals* (and from *multiple panels* for survey and crowd-sourced approaches).

Based on these considerations, we specify a (non-exhaustive) set of innovative approaches to micro-data collection for the early identification of food crises. We outline three approaches that we view as particularly useful for Phase 1: the *Color of the Land*, *Specialized Large-N Survey*, and *Identifying Local Experts* approaches. In addition, we discuss approaches that we view as particularly useful for Phase 2: the *Coping*, *Experimental Crowd-Seeded Local Markets*, and *Self-reported Trouble* approaches.

Against the background of the limitations of the current database for food insecurity modelling, we recommend five sets of variables that should be added with (highest) priority for the early identification of food crises. These five sets of variables are: *adverse coping strategies*; *food consumption*; *subjective well-being and expectations*; *exposure to conflict and fragility*; and *subnational agricultural production*. For each set of variables, we present specific indicators that can be collected using the innovative approaches, ensuring that the indicators exhibit the intended features.

Some of the specific indicators have been elicited in some previous data collection efforts, predominantly in multi-topic large-N household surveys. We document for the five Priority Countries in the World Bank's Famine Action Mechanism framework, which of the specific indicators have been captured in multi-topic large-N household surveys, and how (i.e. the survey questions used).

The surveys contain a series of measures that can be easily adapted for our purposes of producing indicators that can be assessed frequently and remotely via the recommended techniques for three out of the five sets of priority variables. These three variables are *adverse coping strategies*; *food consumption*; *subjective well-being and expectations*. By contrast, we find that *exposure to conflict and fragility* and *subnational agricultural production and consumption* cannot be well assessed by adapting existing survey questions. Two exceptions are intercommunal tensions and victimization, which can be well captured based on questions adapted from MICS instruments.

Our review yields two main recommendations:

First, we recommend assessing 11 specific questions on priority variables that follow from existing large-N multi-topic survey questions.

Second, we recommend complementing this with developing better measures of *exposure to conflict and fragility* and *subnational agricultural production and consumption*.

We argue that the former can be best captured via remote sensing techniques, specialized (rapid) large-N survey based on recent conflict exposure modules, and tapping local experts. For the latter, we believe that remote sensing techniques and specialized (rapid) large-N survey can also contribute important information on agricultural output and yields, while the single best approach to monitoring food prices at local markets accurately and frequently is training and tapping local "seed" informants that regularly report absolute prices of staple foods.

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