5. Crowdsourced data reveal threats to household food security in near real-time during COVID-19 pandemic

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The COVID-19 pandemic and related lockdown measures have disrupted food systems globally, leading to fluctuations in the prices of some food commodities, from local to national levels. Yet detailed data-driven evidence of the extent, timing, and localization of the impact on food security are rarely available quickly enough or with sufficient granularity to guide policy responses.

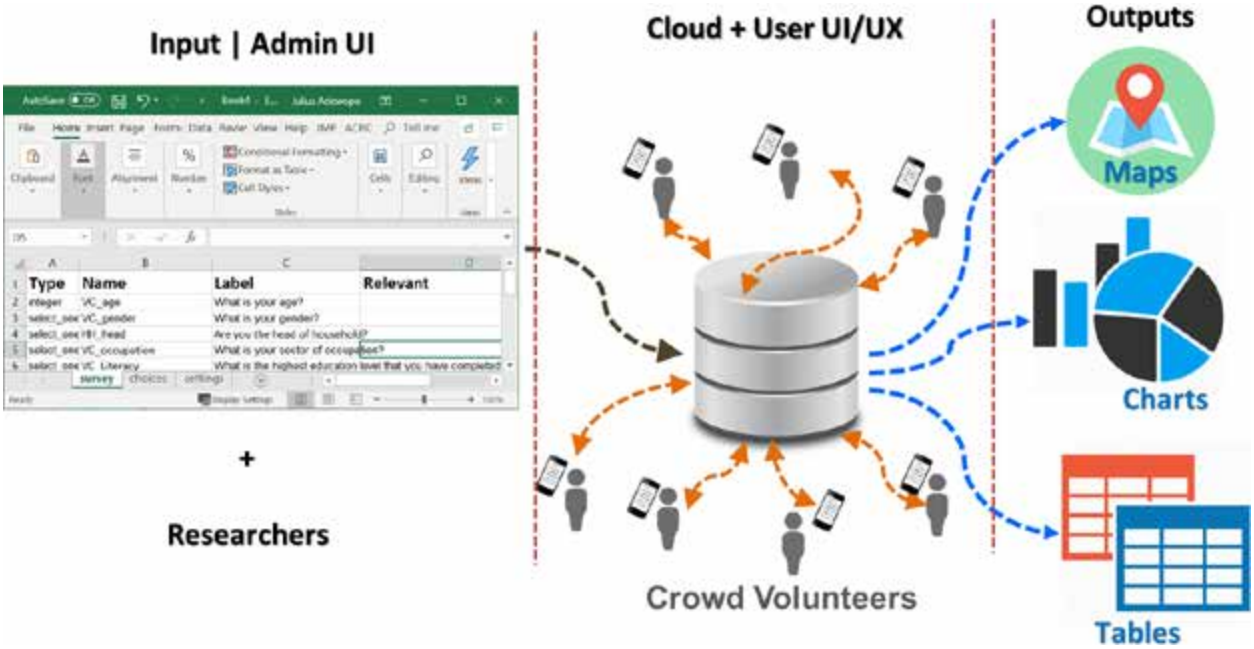
Several institutions regularly collect information on commodity prices in low- and middle-income countries (including FAO GIEWS-FPMA, World Food Programme Vulnerability Analysis and Monitoring [WFP-VAM], and the IFPRI Food Security Portal). But they are often unable to generate actionable data on sudden food system disruptions, and the time lag from data acquisition to sharing of data-driven intelligence erodes the potential for rapid response. Further, available price data are often limited in scope because they are monitored at specific markets and at highly coarse spatiotemporal scales (that is, monthly and at the [sub]national level). Therefore, they do not provide sufficient information to monitor and contextualize local (and extreme) changes in food prices or the impact on local livelihoods. Without consistent and concise data on food prices and market performance at local levels, policies, interventions, and responses to emergencies or shocks (such as COVID-19) are likely to be skewed, mostly to the disadvantage of poor rural and remote communities.

Innovating for actionable food price data

The proliferation of mobile phones and internet access in recent years has catalyzed the emergence of innovative data gathering techniques that show great promise in addressing these problems. Citizen participation via digital tools and platforms has the potential to provide near real-time monitoring of food prices, while empowering citizens as both providers and users of information. Our Food Price Crowdsourcing in Africa (FPCA) initiative was piloted and validated shortly before the onset of the COVID-19 pandemic, mainly in northern Nigeria, by the European Commission's Joint Research Centre (JRC), the International Institute of Tropical Agriculture (IITA), and Wageningen University and Research (WUR). The crowdsourcing system was set up with bespoke digital tools (including an open-data-kit app, bulk SMS app, Google Site, and Ona server platform) (Figure 1).

Various approaches to crowdsourcing real-time food price data collection have been tested over the past decade in developing countries (Seid and Fonteneau 2017; Zeug et al. 2017). Most of these initiatives faced difficulties in achieving meaningful crowd participation, in including enough commodities, or in setting up efficient data-processing methods to generate or share accurate and representative information.

FIGURE 1 Simplified schema of the FPCA tool, as piloted in Nigeria

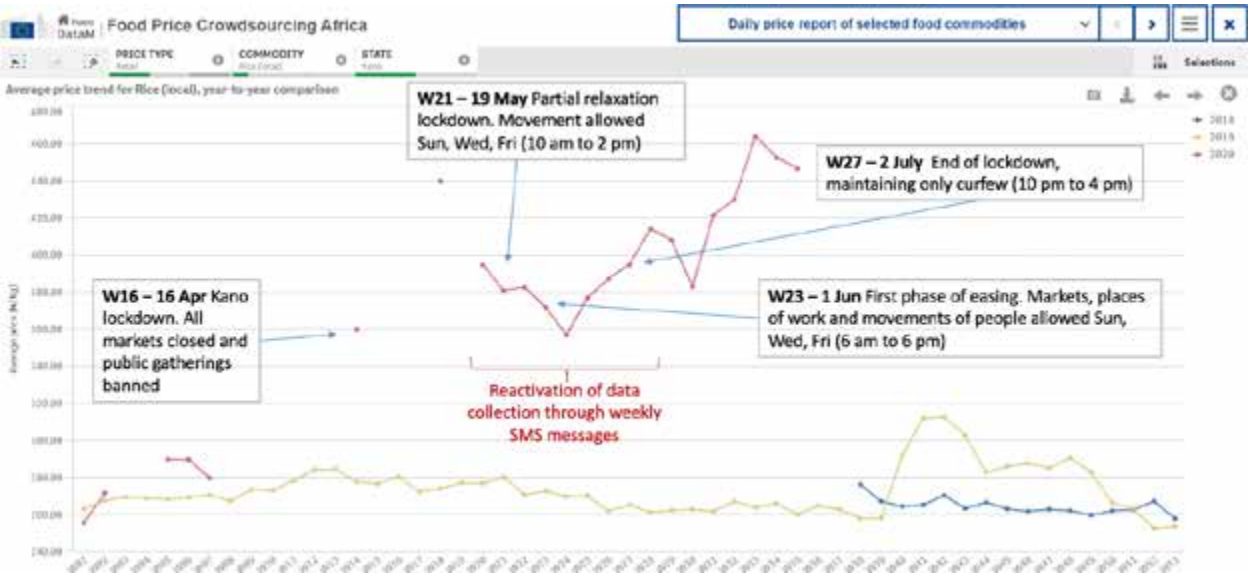


The FPCA project team developed, deployed, and tested the system (and process) for crowdsourcing daily prices for six staple food commodities, georeferenced through the mobile phones of volunteers. Aware of the challenges faced by earlier crowdsourcing initiatives, we used several approaches for forming a sufficiently large and motivated crowd, and developed a new method for automated quality control and data validation. To encourage participation, the project employed information leaflets and radio advertisements, nudges (text messages including social norms and information sharing), and micro-rewards (small monetary incentives).

To ensure that the most reliable data are shared with the public, a rigorous statistical algorithm was developed to automate quality control and check the validity of each submitted datapoint before aggregating the data over time and across locations (mainly at the level of local government areas – LGAs). In the first step, submitted data were spatiotemporally validated (using the auto-recorded time and geo-location) based on the assumption that prices should be similar at closer points (in time and space) for specific market segments in the value chain. In a second step, the data were reweighted to ensure reliability, resembling a formal spatial sampling design (see Solano-Hermosilla et al. 2020 for details). Then the quality-checked data series were disseminated to the public in real time through the web dashboard (Figure 2).

After an initial testing period (September 2018–September 2019), the raw crowdsourced data and auto-checked data were validated. The average weekly crowdsourced prices were comparable with those collected from specific markets by FEWSNET, and monthly by the National Bureau of Statistics (see Arbia et al. 2020). Further, a recent (June–September 2021) validation of crowdsourced data

FIGURE 2 Snapshot of the FPCA web dashboard for FPCA tool



Source: FPCA web dashboard and Kano State government.

Note: Image of web dashboard showing data visualization for unweighted retail prices of local rice (naira/kg) in Kano state. COVID-related measures and post-lockdown measureas implemented by Kano state are indicated for the corresponding weeks.

relative to coordinated ground-truthed data collection from markets within the focal geographies showed similar positive results (Figure 3).

The pandemic, and the associated need to gather evidence for action, justified further scaling-up and validation of the price crowdsourcing system. The system was reactivated during the COVID-19 lockdown of May–June 2020, and in 2021, the pilot was expanded from two states to four, and the number of crowd volunteers was increased from 738 to 1,200, and additional commodities and market types were added. Expansion of FPCA's geographic coverage, volunteer participation, and data flow confirmed the scalability of this approach.

Data-driven insights on commodity prices and COVID-related impact

Reactivation of the FPCA data system from May 12–June 16, 2020, coincided with the period when lockdown measures severely disrupted the food system in northern Nigeria and elsewhere. Motivational text messages were sent to volunteers weekly, triggering an immediate resurgence of data submissions. The platform provided timely and accurate information on trends of food prices at various locations, demonstrating its potential to support policy or humanitarian responses to cushion the impacts on food security and livelihoods (Adewopo et al. 2021).

The crowdsourced data showed a steep increase in food prices, trailing the lockdown timeline (Figure 3). Maize and rice prices increased on average by 26 percent and 44 percent, respectively,

FIGURE 3 Comparison of data submitted by FPCA crowd volunteers with ground-referenced data, weekly averaged data (June–Sept. 2021)

Note: WM-Crowd = white maize crowd data; WM-Ref = white maize ground-referenced data; SB-Crowd = soybean crowd data; WM-Ref = soybean ground-referenced data; FPCA = Food Price Crowdsourcing in Africa program.

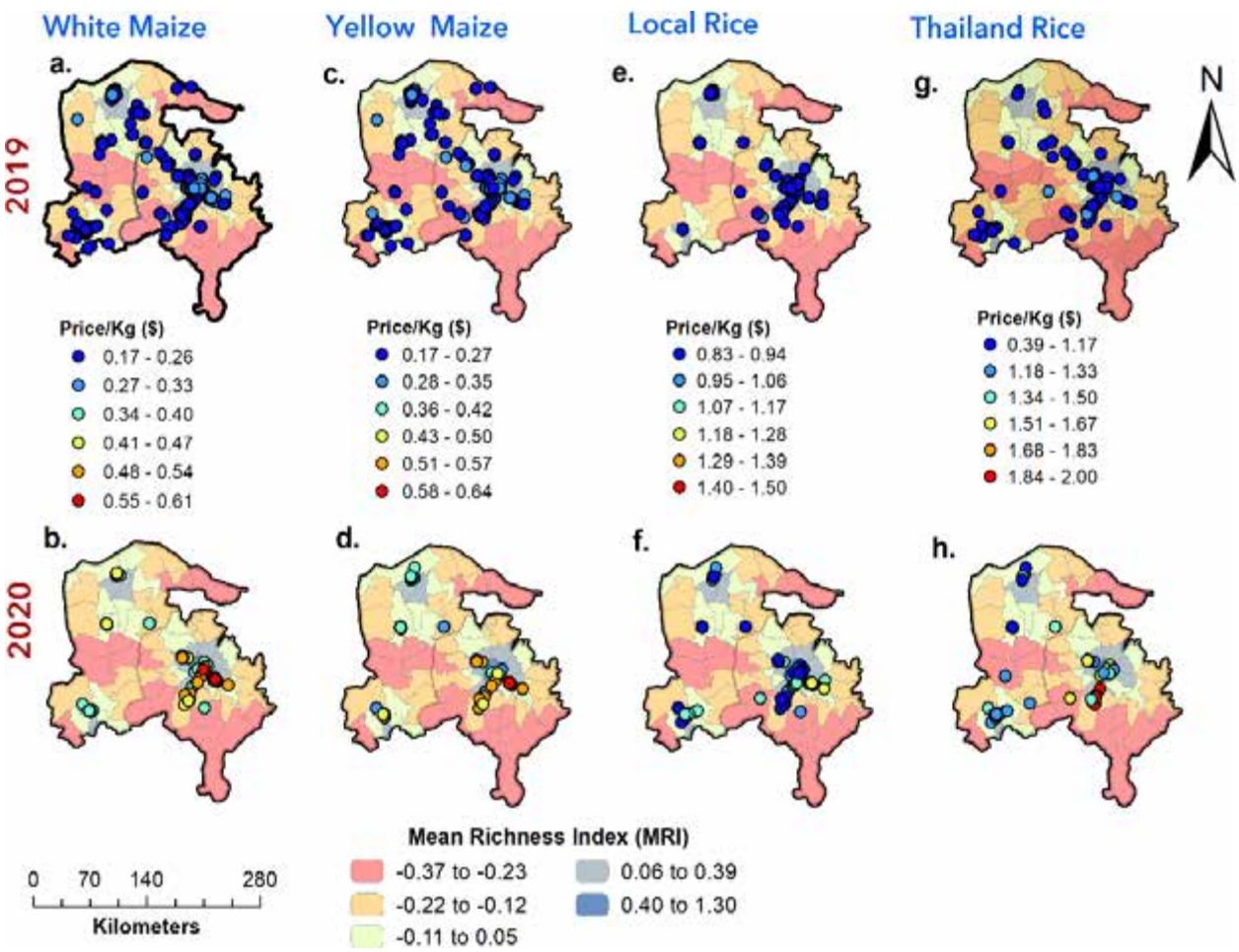
compared with the same period in 2019. Price increases were slightly higher in urban than in rural areas. Notably, the data also showed that prices continued to rise after the lockdown measures were relaxed. For instance, local rice continued to be sold at prices about 50 percent higher than in 2019.

Generally, Nigeria's National Bureau of Statistics (NBS) reported slightly lower average price increases compared to the crowdsourced data; however, these price reports are published about two weeks after observation, and are available as monthly averages only by state (not LGAs). In contrast, the geo-referencing of each crowdsourced price data submission can support scaling-up of the data and mapping of price hotspots at village, ward, city, LGA, state, and national levels.

These hotspots were mainly observed in urban areas during COVID-19 lockdowns. Combining the price data with a spatial richness index grid (Figure 4) shows higher prices in May–June 2020 in richer and mostly urbanized areas. But rural areas, where poverty rates exceed 70 percent, were hard-hit as well, with average price increases of 22 percent for maize and 42 percent for rice posing a threat to food security.

The picture in urban areas is complex. The average level of richness is higher, suggesting that urban households may be better positioned to absorb the steep price increases, for example, by reducing nonfood expenditures or altering consumption patterns (see findings from Ethiopia). But Nigeria's urban areas are also characterized by high income inequality with a narrow middle-income class and many living below the poverty line (World Bank 2019). Thus, substantial price spikes (rice prices, for example, increased by more than 50 percent in several urban areas) in combination with job and income losses (NBS-World Bank 2020) indicate that the COVID-19 crisis threatens food security for low- and middle-income earners in urban areas in addition to the rural poor (ElKahdi et al. 2020).

FIGURE 4 Mapping crowdsourced commodity prices and richness, Kano and Katsina states



Lessons and prospects

The successful set-up and implementation of the FPCA system illustrates the potential of engaging citizens through a mobile app to crowdsource spatially and temporally rich data in near real time. In addition, the ease of activating the tool remotely for price monitoring in an emergency showcases its potential to generate timely evidence to guide responses to sudden food system shocks.

However, some caveats should guide aspirations for food price crowdsourcing systems. These include the possibility that volunteer data contributors are not fully representative of the focal region's population. For instance, educated males living in urban areas were overrepresented in the Nigeria project. On one hand, this may be inconsequential if the volunteers exercise due diligence in submitting data across all market segments. On the other, such "elite" and "patriarchal" dominance may

skew the market representation, such that fewer datasets are submitted from markets that are patronized by less-educated and economically disadvantaged groups, including women. Additional efforts are needed to boost the participation of more vulnerable populations, and improve the coverage of remote, less populated, and often highly food-insecure areas. Also, sustaining data contributions over time may be challenging if nudges and/or micro-rewards are no longer available to incentivize volunteers. Although the pilot FPCA showed that the crowd volunteers can be activated easily and successfully and at relatively low cost, the effect of the initial nudge can easily wane with time, and periodic nurturing of volunteers is indispensable. Similarly, a regular or continuous renewal of the cohort of volunteers may also be helpful to sustain robust data submission.

Overall, our findings suggest that smartphone-based, citizen-driven price data collection can complement traditional price data collection systems in terms of timeliness, spatial granularity, and responsiveness to market disruptions – not only caused by the COVID-19 pandemic but also other problems, including conflicts, climate shocks, and policy shifts. At scale, this approach can also support longer-term monitoring of vulnerable regions to catch incipient price spikes. Finally, this initiative can inspire national systems and policymakers to further explore entry points for integration of rapid and localized data into their planning and responses for food security. Globally, as governments and other stakeholders grapple with uncertainties and rapid system changes, crowdsourcing approaches and other emerging tools will be increasingly necessary to provide timely, well-targeted policy responses.

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