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Food Security and Agriculture Information Systems Landscape Analysis

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Executive Summary

This report presents a high-level landscape analysis of global food security and agriculture information systems. The objective is to analyze the current state of affairs with regards to the leading systems, their functions, gaps, overlaps, and opportunities for improvement.

The study reviewed 26 different global food security and agriculture information systems, with a close examination of their effectiveness and efficiencies in ensuring that core food security information is available to decision makers for any country of concern in near real time. The study closely examined the linkages between agriculture and food security information systems to determine the degree to which agriculture systems are adequately informing food security analysis, and, conversely, the degree to which food security systems are informing development-oriented interventions for agriculture.

A detailed analysis of existing agriculture and food security information systems was conducted to identify best practices, overlaps and gaps in the current state of affairs. The study also provided characteristics of model food security and agriculture systems.

The analysis shows that the landscape of agricultural and food security systems is complex, consisting of a combination of both as well as several comprehensive systems that address both domains. About half of the systems provided primary information that comes from original sources, while the remainder were information aggregators, which combine and visualize information from multiple other (primary) data providers.

The analysis indicated that many of the selected systems present overlapping information services. Examples were overlap in the collection and monitoring of global, national and local food price data, crop monitoring systems and related bulletins and reports, and duplicative and oftentimes conflicting numbers on the severity and magnitude of acute food insecurity situations.

At the same time, the analysis also identified several gaps in information services when compared to what is needed to create an ideal agricultural and food security monitoring system. A critical gap was the lack of any systems that monitor livestock and fishery conditions, which are key components of the diet in many countries. Another gap was the imperfect geographical coverage of local price monitoring and agricultural market systems. For food security analysis critical gaps existed in the geographic coverage to include all countries of concern; and to make linkages between acute and chronic food insecurity to inform both humanitarian and development-oriented interventions.

The study identified opportunities to make better use of global information systems by linking them up more explicitly to share data, bring models together, and conduct joint analysis. This is not about ‘reinventing the wheel’, rather it's about rationalizing existing expertise and investments. Emerging opportunities include:

Opportunity 1: *Establish inter agency networks and collaborations*

Opportunity 2: *Shift from agency-owned silos to a global public good*

Opportunity 3: *Increase the use of advanced analytical approaches and technologies*

Opportunity 4: *Link better with regional and national systems*

Opportunity 5: *Address critical data weaknesses*

Opportunity 6: *Make better linkages between chronic and acute food insecurity*

Opportunity 7: *Rationalize donor financing of information systems to be more strategic*

The study concludes with the following key recommendations for consideration by global funders of agriculture and food security information systems:

Recommendation #1: Develop a common vision for a global public good that can deliver core and essential information required to achieve SDG 2.

Recommendation #2: Rationalize donor financing for agriculture and food security information systems to be more strategic, sustained, efficient, and effective towards creating a global public good that can deliver core and essential information. And conversely, it is recommended that donors stop financing systems in an ad hoc and fragmented manner, which creates redundancies, inefficiencies, and critical information gaps.

Recommendation #3: Leverage the influence of the international donor community to lobby for a global institutional mandate and structure for a public good (such as the SDG custodial model) that can provide core and essential agriculture and food security information.

Recommendation #4: Leverage donor influence with agencies implementing information systems to commit to data sharing and interoperability, and in particular to link to existing platforms that are already integrating information from various systems to provide a single trusted source of food security and agriculture analysis (e.g., AMIS, GEOGLAM and IPC).

Recommendation #5: Commission a study that conducts a critical evaluation of the costs and benefits of the existing systems, eventually resulting in the selection and support of a limited number of specialized and integrated systems.

Recommendation #6: Finance efforts to develop systems and analyze not just acute food insecurity, but chronic food insecurity as well; and to make stronger linkages between acute crises and their underlying/structural causes which can inform development-oriented interventions in agriculture, policy, and economic growth.

Recommendation #7. Finance efforts to provide critical data gaps, in particular nutrition/mortality data with SMART surveys, and conflict analysis.

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Acronyms

AI - Artificial intelligence

API - Application Programming Interface

ACAPS - The Assessment Capacities Project (but no longer used)

AMIS - Agricultural Market Information System

ASAP - Anomaly Hotspots of Agricultural Production

DataM-CD - Data portal of agro-economics Modelling Country Dashboards

DHS - Demographic and Health Surveys

FAM - Famine Action Mechanism

FAS - Foreign Agricultural Service

FEWS NET - Famine Early Warning Systems Network

FIES - Food Insecurity Experience Scale

FSD - Food Systems Dashboard

FSIN - Food Security Information Network

FSMS - Food Security Monitoring Systems

FSP - Food Security Portal

GEOGLAM - Group on Earth Observations Agricultural Monitoring

GFSI - Global Food Security Index

GIEWS - Global Information and Early Warning System

GUI - Graphical User Interface

HiH - Hand-In-Hand Geospatial Platform

IPC - Integrated Food Security Phase Classification

LSMS-ISA - Living Standards Measurement Study - Integrated Surveys on Agriculture

MICS - Multiple Indicator Cluster Surveys

OCHA - Office for the Coordination of Humanitarian Affairs

VAM - Vulnerability Analysis and Mapping

1. Introduction and Objectives

This report presents a high-level landscape analysis of global food security and agriculture information systems. The objective is to analyze the current state of affairs with regards to the leading systems, their functions, gaps, overlaps, and opportunities for improvement.

The overall goal of the study is to ensure that decision makers at all levels have the essential and core information needed in order to address rising levels of both acute and chronic food insecurity[1] through both humanitarian and development-oriented interventions. In order to achieve the SDG 2 goal of ending hunger it is vital to have well-functioning and integrated global food security and agriculture information systems with global coverage and frequent updates on the world's most vulnerable people.

The analytical approach and structure of the study includes:

- **Section 2**: Identification of food security and agriculture systems for review, which was based on input from key stakeholders and the authors judgement on which systems are well known and/or figure prominently in global decision making. Many of these systems overlap and provide valuable information on both topics, making it a challenge to clearly delineate some systems as being exclusively food security or agriculture systems.
- **Section 3**: Analysis of current best practices, overlaps, and gaps in food security and agriculture information needed to inform strategic decision making for both humanitarian and development-oriented interventions. The authors based this analysis on publicly available information plus their expert judgement to compare and contrast the various systems.
- **Section 4**: Presentation of optimal/model characteristics of food security and agriculture information systems that would best serve the needs of decision makers for both humanitarian and development-oriented interventions.
- **Section 5**: Identification of key opportunities for improving the current state of global food security and agriculture information systems.
- **Section 6**: Identification of key recommendations for actions for global decision makers to improve the efficiency and effectiveness of food security and agriculture information systems.

[1] The concepts of acute and chronic food insecurity are highly related, and yet distinct. The authors define them as follows: Acute food insecurity is evident when there are very severe levels of food insecurity with high levels of acute malnutrition and with **immediate risks to lives and livelihoods**. From a temporal perspective, acute food insecurity can either be persistent/ongoing, periodic/regular, or episodic and based on an acute event. Chronic food insecurity is evident when there are ongoing deficiencies in dietary intake which is evident with nutrient micro deficiencies and stunting rates, and with **long term effects on health and livelihoods**. Chronic food insecurity has structural/developmental causes, and also puts populations at greater vulnerability to shocks and thus risk of acute food insecurity. A population can be: chronic and not acute; acute and not chronic; or both acute and chronic simultaneously. It is imperative to understand these differences so as to inform strategic interventions, and the linkages between humanitarian and development-oriented actions.

2. Description of Information Systems

The study selected 26 information systems and databases that provide information on food security and/or agricultural market and crop information that can be used as in input in food security assessments and warning systems (Table 1). For completeness, two systems are included (FAM/Artemis and CountryStat) that no longer seem updated but contain useful information and insights into the current state of food security analysis. Two systems are operated by inter-agency collaborations (AMIS and GEOGLAM), two by knowledge institutes (FSD and CropWatch), one by a company (GFSI), three by national governments (FEWS NET, FAS, and DHS) and the remaining 18 by international institutions.

Figure 1 presents an overview of the systems juxtaposing the type of information: oriented towards agricultural information, food security information or a mixture, and the frequency of information: real-time, infrequent (i.e. less frequent than annual) and anything in between. In addition, it shows the number of countries that are covered as well as if the systems provide (at least partly) primary information (i.e. raw data that comes from the original source) or only secondary information (i.e. data that is taken from other information systems).

Figure 1: Overview of food security and agricultural information systems

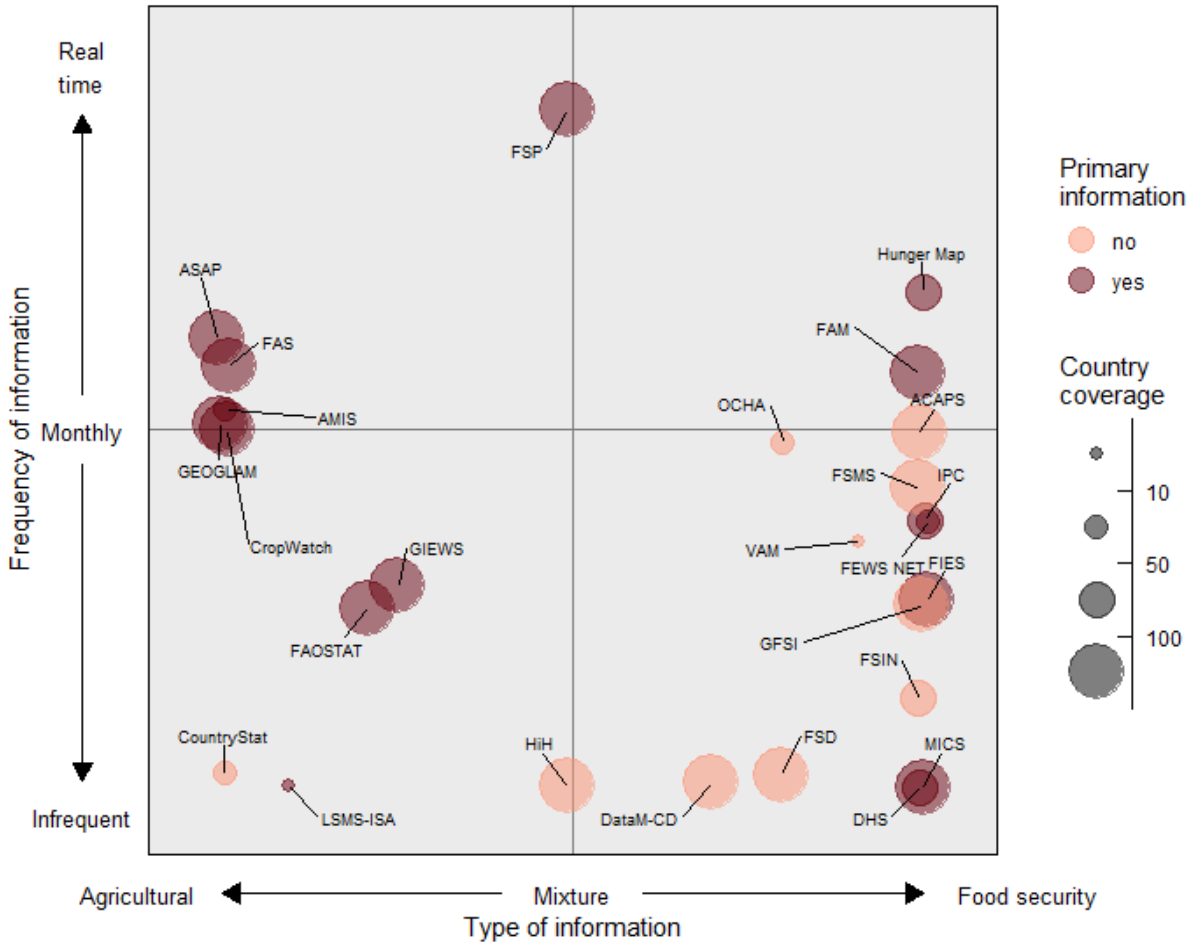


Table 1: List and Description of Systems Reviewed

Name	Organization	Description	Website
Food Security Information Network (FSIN) - Global Network Against Food Crises	FAO and multi partners	FSIN is a technical platform for exchanging expertise and best practices on food security and nutrition analysis. It promotes independent and consensus-based information and highlights critical data gaps.	https://www.fsinplatform.org/
Integrated Food Security Phase Classification (IPC)	FAO and 15 Global Partners	The IPC provides decision-makers with core estimates of severity and magnitude of acute and chronic food insecurity and malnutrition using evidence and consensus-based analysis to inform emergency responses as well as medium- and long-term policy and programming.	www.ipcinfo.org
Hunger Map	WFP	Near real-time monitoring of food security situations in more than 90 countries to inform WFP planning and resourcing.	https://hungermap.wfp.org/
Food Security Monitoring Systems (FSMS)	FAO, WFP, GFSC	The objective is to have light but comprehensive nationally - led monitoring systems that rapidly inform decision-makers of the trends in food and nutrition security and flag deteriorating situations.	https://www.wfp.org/publications/monitoring-food-security-technical-guidance-sheet
Vulnerability Analysis and Mapping (VAM)	WFP	To provide vulnerability data for food security analysis and in form WFP planning and resourcing	https://dataviz.vam.wfp.org/
Famine Early Warning Systems Network (FEWS NET)	USAID	FEWS NET provides unbiased, evidence-based analysis to governments and relief agencies who plan for and respond to humanitarian crises. FEWS NET analyses support resilience and development programming as well.	https://fews.net/
Famine Action Mechanism/ARTEMIS (FAM)	World Bank	The Famine Action Mechanism (FAM) is a global partnership dedicated to scaling up anticipatory and early action to protect lives and livelihoods from emerging food security crises. The specific food security monitoring component called ARTEMIS has been an effort to use artificial intelligence to forecast food insecurity. To date, however, that effort has not yet produced results that are reliable enough to inform decision making.	https://www.worldbank.org/en/programs/famine-early-action-mechanism
Food Insecurity Experience Scale (FIES)	FAO	The FIES is an experience-based metric of food insecurity severity, and is derived from household surveys.	http://www.fao.org/in-action/voices-of-the-hungry/fies/en/
Global Food Security Index (GFSI)	The Economist	The Global Food Security Index (GFSI) considers the issues of food affordability, availability, quality and safety, and natural resources and resilience across a set of 113 countries. The index is a dynamic quantitative and qualitative benchmarking	https://foodsecurityindex.eiu.com/

Name	Organization	Description	Website
		model constructed from 59 unique indicators that measure the drivers of food security across both developing and developed countries.	
Global Information and Early Warning System (GIEWS)	FAO	The Global Information and Early Warning System on Food and Agriculture (GIEWS) continuously monitors food supply and demand and other key indicators for assessing the overall food security situation in all countries of the world.	http://www.fao.org/giews/en/
United Nations Office for the Coordination of Humanitarian Affairs (OCHA)	OCHA	OCHA is developing systems to draw together wide ranging data sets on humanitarian situations, including food security--although it is not a food security specific information system.	https://data.humdata.org/
ACAPS	ACAPS	ACAPS supports the humanitarian community's work on severity and trends by diving into the current situation of more than 100 key crises around the globe, while helping actors anticipate and respond to emerging crises.	https://www.acaps.org/
Agricultural Market Information System (AMIS)	AMIS	The Agricultural Market Information System (AMIS) is an inter-agency platform, composed of G20 members plus Spain and seven additional major exporting and importing countries of agricultural commodities to enhance food market transparency and policy response for food security.	http://www.amis-outlook.org/
Hand-In-Hand Geospatial Platform (HiH)	FAO	The Hand-in-Hand Geospatial Platform is a supporting tool using the most sophisticated tools available, including advanced geo-spatial modeling and analytics to identify the biggest opportunities to raise the incomes and reduce the inequities and vulnerabilities of rural populations, who constitute the vast majority of the world's poor.	http://www.fao.org/hih-geospatial-platform/
Group on Earth Observations Agricultural Monitoring Crop monitor (GEOGLAM)	GEOGLAM	GEOGLAM provides open, timely, science-driven information on crop conditions in support of market transparency for the G20 Agricultural Market Information System (AMIS) as well as an early warning system for countries at risk of food production shortfalls.	https://cropmonitor.org/
FAOSTAT	FAO	FAOSTAT provides free access to food and agriculture data for over 245 countries and territories and covers all FAO regional groupings from 1961 to the most recent year available.	http://www.fao.org/faostat/en/#home
United States Department of Agriculture Foreign Agricultural Service (FAS)	USDA	The Foreign Agricultural Service (FAS) links U.S. agriculture to the world to enhance export opportunities and global food security.	https://www.fas.usda.gov/

Name	Organization	Description	Website
Living Standards Measurement Study - Integrated Surveys on Agriculture (LSMS-ISA)	World Bank	The LSMS-ISA project collaborates with the national statistics offices of its eight partner countries in Sub-Saharan Africa to design and implement systems of multi-topic, nationally representative panel household surveys with a strong focus on agriculture.	https://www.worldbank.org/en/programs/lsms/initiatives/lsms-ISA
Food Systems Dashboard (FSD)	Johns Hopkins University and The Global Alliance for Improved Nutrition	The Food Systems Dashboard combines data from multiple sources to give users a complete view of food systems.	https://foodsystemsdashboard.org/food-system
IFPRI Food Security Portal (FSP)	IFPRI	IFPRI provides up-to-date information about dynamic developments in the world food system to monitor food security situations and food prices, as well as tools for policy analysis and capacity development.	https://www.foodsecurityportal.org/
CountrySTAT	FAO	CountrySTAT is a web-based information system for food and agriculture statistics at regional, national and subnational levels. The objective of CountrySTAT is to improve access to food and agricultural statistics to support data analysis and evidence-based decision making and facilitate informed policy making and monitoring with the goal of eradicating extreme poverty and hunger.	http://www.fao.org/in-action/countrystat/en/
Data portal of agro-economics Modelling - DataM Country Dashboards (DataM-CD)	EU JRC	DataM-CD presents infographics about food/nutrition security and relevant macroeconomics and agro-economics indicators produced by several organizations and gathered by country.	https://datam.jrc.ec.europa.eu/datam/mashup/COUNTRY_DASHBOARDS/
CropWatch	Chinese Academy of Science	The CropWatch assesses national and global crop production and related information using remote sensing and ground-based indicators.	http://www.cropwatch.com.cn/htm/en/index.shtml
Anomaly Hotspots of Agricultural Production (ASAP)	EU JRC	Support EU aid and assistance policies and provide building blocks for a European capability for global agricultural monitoring and food security assessment.	https://mars.jrc.ec.europa.eu/asap/
Demographic and Health Surveys (DHS)	USAID	The Demographic and Health Surveys (DHS) Program is an initiative to collect and analyze representative data on population, health, HIV, and nutrition by means of nationally representative household surveys.	https://dhsprogram.com/
Multiple Indicator Cluster Surveys (MICS)	UNICEF	The MICS initiative generates data on key indicators on the well-being of children and women, and helping shape policies for the improvement of their lives	https://mics.unicef.org/

In total, 9 out of the 26 systems that are located on the left-hand side of the figure can be considered as agriculture information systems as they predominantly present information on topics such as crop conditions (GEOGLAM crop monitor, CropWatch, JRC ASAP), food prices and agricultural market information (AMIS, USDA/ERS FAS, CountrySTAT and to a lesser extent FAOSTAT and GIEWS, which also present several food security related indicators). LSMS-ISA is collaboration between the World Bank and national statistics offices in eight Sub-Saharan African countries to design and implement systems of nationally representative household surveys with a strong focus on agriculture but also covering food security related indicators. Two systems (FAO HiH, IFPRI FSP) are located in the middle as they present a mixture of agricultural and food-security information and data.

The remaining 15 systems are categorized as food security systems as their focus is on providing information on the food security status or forecast. While each of these systems provides valuable information, there are clear distinctions in the type of information they provide.

Only a few of the systems generate the analysis to determine core food security information (e.g., how severe, how many, where, when, why) for both current and forecasted food insecurity in a consistent and comparable manner. FEWSNET, IPC, Hunger Map, and WFP VAM stand out among the other systems as core providers of this information. The FAO Food Insecurity Experience Scale (FIES) is a single index system that monitors food insecurity in a consistent manner over time, however, on its own it is lacking in causal analysis, triangulation, and the ability to forecast. DHS and MICS are initiatives to collect nationally representative information on population, health, HIV, and nutrition, with a particular focus on women and children, including a substantial number of variables that are relevant for the measurement of food security.

Other systems, such as FSIN, HiH, CountryStat and DataM-CD can be considered as ‘information aggregators’, which predominantly combine and visualize information from multiple other (primary) data providers. An example is the FSIN publication Global Report on Food Crises, which draws heavily from IPC (and its companion Carde Harmonisé in the Sahel) for its analysis. Other systems represent high-level indices such as the Economist Intelligence Unit’s Global Food Security Index that are for an entire country and are updated only annually.

An initiative that has received significant attention over the past several years is the World Bank’s Famine Action Mechanism (FAM), and the analysis component of that initiative called ARTEMIS. ARTEMIS has been a bold attempt at using artificial intelligence and machine learning to model and forecast food insecurity based on readily available information. However, although the initiative shows promise on the future use of technology in this space, to date ARTEMIS has yet to produce results which can reliably analyze and predict food insecurity.

The majority of information systems present data at monthly annual or infrequent (less frequent than annual) intervals. Among the agricultural systems, the exceptions are USDA/ERS FAS and JRC ASAP, which provide updates of most of their data every week and 10-days, respectively. Among the food security systems, FAM and the Hunger Map present at least a part of their information at a higher frequency than monthly. IFPRI FSP, stands out as it updates most of the information, albeit limited in scope, at daily intervals.

3. Best Practices, Overlaps, and Gaps

3.1. Agricultural Information

As the main supplier of food and a source of income in many countries, the agricultural sector is a key driver of food security. Changes in food supply (e.g. because of droughts negatively affecting crop yield), market conditions (e.g. increase or strong fluctuations in global and local food prices) and policies (e.g. export bans) may lead to acute and/or chronic food insecurity in vulnerable regions. Several of the selected systems were specifically established to monitor these issues and serve as food security early warning systems.

A prime example is the GEOGLAM crop monitor, which is an international effort to provide open and timely information on global crop growing conditions and agro-climatic factors for both major food import and export regions and countries where food security is extremely vulnerable. Similar services are provided by JRC ASAP and CropWatch, which at the same time feed into GEOGLAM as partners.

Another example, related to GEOGLAM, is AMIS, an inter-agency platform to enhance food market transparency and policy response for food security, which was launched in response to the global food price hikes in 2007/08 and 2010. Key information services that are provided include international food price, supply and demand, and policy monitoring. Comparable information on (inter)national agricultural markets and policies is also provided by US Department of Agriculture Foreign Agricultural Service (FAS) and FAO GIEWS, which both also include a global crop monitoring tool.

FAOSTAT and CountrySTAT are two FAO operated databases with detailed statistical (sub)national information on the agricultural sector, including price, trade and production data. The main difference between the two is that the former is a continuously updated, consistent and harmonized dataset, while the latter is a collection of raw data from national statistical agencies that is only sporadically updated. LSMS-ISA is a collection of nationally representative panel household surveys with a strong focus on agriculture for eight Sub-Saharan countries. The detailed information on household income and consumption is a potentially rich source of information for the analysis of long-term chronic food security albeit with limited geographical coverage.

Finally, agricultural information is provided by several of the more comprehensive food security information systems (see below), in particular the Hunger Map, VAM and FEWS NET. All three initiatives provide data on local food prices and include (sometimes very basic) crop monitoring tools.

Table 2 highlights best practices, overlaps and gaps in agricultural information that is provided by the 26 selected systems.

Table 2: Assessment of Agricultural Information

Component	Count n (%)	Best practice	Significant overlaps	Critical gaps
Agricultural conditions monitoring	9 (35%)	GEOGLAM crop monitor.	Overlap between various crop monitor systems although several feed into GEOGLAM; Overlap between country and regional analysis reports/bulletins.	Livestock monitoring not systematically conducted globally; No fishery monitoring.
Food commodity price monitoring	4 (20%)	FSP global food price volatility warning, global commodity price and national price monitor.	FSP and AMIS both present daily global food commodity prices.	-
Local food price monitoring	8 (31%)	VAM local market price forecasts and alerts; FSP national price monitoring for selected countries.	Geographical overlap in local food price data of VAM, FEWS NET and GIEWS (see FSIN, 2015).	Likely gaps in local food price information coverage in VAM, FEWS NET and GIEWS (see FSIN, 2015).
Market & trade information	13 (50%)	AMIS market monitor and database.	Overlap between country and regional analysis reports/bulletins	AMIS only provides market and trade information for 27 large food commodity exporters and importers, while GIEWS only covers sub-Saharan countries. Global coverage by one system is lacking.
Market & trade policy monitoring	8 (31%)	AMIS policy monitor; FSP food trade policy monitor; Reports and bulletins of FEWS NET, GIEWS, FAS, IPC and VAM.	Overlap between country and regional analysis reports/bulletins.	AMIS only provides market and trade information for 27 large food commodity exporters and importers. Other systems cover a selected number of countries. Global coverage by one system is lacking.

3.1.1. Overlaps

A large number of systems represent or include a crop monitoring component (i.e. ASAP, FAS, GEOGLAM crop monitor, CropWatch, GIEWS, and FEWS NET). Several of these are partnering with GEOGLAM, which represents a joint effort of the international community to share and combine crop assessments. Nonetheless, many organizations, even including GEOGLAM partners, still offer their own websites, graphic user interfaces (GUIs), and bulletins/reports. This creates confusion as it is not clear to users where to go and which source of information to use.

There also exists overlap in global commodity price monitoring systems. Both AMIS and IFPRI FSP provide a GUI to visualize and track price fluctuations of major global food commodities (e.g. maize, rice, wheat and soybeans) but it is not clear if they present the same or consistent information.

Similarly, FEWS NET, GIEWS and VAM all present an approach to monitor local food prices in a large number of developing countries and emerging economies. A detailed comparison found

a ‘fairly high’ (FSIN, 2015, p. 4) overlap between the datasets of these three providers.[2] A quick comparison shows that there is still considerable overlap at present.

Finally, FEWS NET, GIEWS and VAM present regular bulletins and reports with national (and sometimes regional) food security assessments that include an evaluation of market and trade information and policies. Often the documents cover the same countries, effectively providing the same or similar analyses.

3.1.2. Gaps

Several gaps related to the provision of agricultural information for food security analysis are identified. A major gap is the lack of an operational tool to monitor livestock and fishery conditions. This strongly contrasts with crop monitoring, for which there is a lot of overlap in information systems. GEOGLAM Rangeland and Pasture Productivity (RAPP, https://www.geo-rapp.org/) is an effort to monitor the status and productivity of pastures and rangelands but it seems that the website is no longer updated. None of the evaluated information systems offers tools to monitor the availability of wild fish and aquaculture as sources of food.

A potential gap is the geographical coverage of local food price monitoring systems. According to a review (FSIN, 2015), the three major local food price monitoring systems (GIEWS, FEWS NET and VAM) do not include food price data for around two dozen developing countries. This study did not analyze potential gaps in price information that may exist at present.

There are also gaps in the geographical coverage systems that track market and trade information. The AMIS Market Database offers supply and demand statistics for 27 major, producing, importing and exporting countries focusing on food commodities (maize, rice, wheat and soybean), while GIEWS presents similar data but only for Sub-Saharan African countries in its Cereal Supply and Demand Balances reports.

The same gap exists in relation to monitoring of market and trade policy information. The AMIS Policy Database systematically collects and presents information on trade measures and domestic measures related to the four AMIS crops as well as biofuels but is limited to the aforementioned 27 countries. IFPRI FSP COVID-19 Food Trade Policy Tracker has a global coverage but only tracks information on trade policies (e.g. export bans). Reports and bulletins of GIEWS, FEWS NET, VAM and IPC address the impact of market and trade policies on national food supply and demand but are limited to countries experiencing food insecurity. Ideally, there would be one single system that presents comprehensive information on food supply and demand and policy information with global coverage.

3.2. Food Security Information

Food security information systems have made tremendous progress over the past decade, with significant investments from the likes of FEWSNET, WFP, FAO, IPC, and others to improve the rigor and relevance of information to mitigate acute food insecurity in particular. International global standards have been developed, led by the multi partner IPC with 15 international partners endorsing the classification system for categorizing acute and chronic food insecurity. Analysis has become more robust and based on a deep understanding of livelihoods, as exemplified by FEWSNET’s use of the Household Economy Approach. WFP continues to innovate with both its deep analysis of food insecurity with VAM and also with more recent cutting edge innovations of The Hunger Map, which draws together mass survey data with machine learning and a user-friendly graphic interface. FAO is investing significantly in the use of a simple to administer survey tool called the Food Insecurity Experience Scale (FIES) for

[2] FSIN (2015), Review of global food price databases: Overlaps, gaps and opportunities to improve harmonization.

regular monitoring of food insecurity globally, with comparability over time and space. The World Bank's FAM initiative (which includes a sub component called ARTEMIS that was meant to forecast food security) broke new ground with its efforts to model food insecurity with AI and machine learning. The FAM-ARTEMIS effort has yet to produce usable results and is currently not in use. However, it is just a matter of time and further investment before such approaches become more reliable.

Table 3 highlights best practices, overlaps and gaps of information systems providing food security information.

Table 3: Assessment of food security information

Component	Count n (%)	Best practice	Significant Overlaps	Critical Gaps
Vulnerability & Causes	9 (35%)	FEWSNET, IPC, VAM	FEWSNET and IPC directly in some cases, also with related systems that provide complimentary info e.g., GIEWS.	Causal analysis tends to be more on immediate causes, and not underlying cause, which would be more informative for development oriented intervention. Analysis of conflict dynamics and forecasting is a major gap.
Food Security Pillars (availability, access, utilization, stability)	5 (12%)	FEWSNET, IPC, GIEWS, VAM	FEWSNET, IPC and VAM have considerable overlaps	-
Food Consumption & Livelihoods	7 (27%)	IPC, FEWSNET/HEA,VAM, Hunger Map	FEWSNET, IPC and VAM have considerable overlaps	-
Nutrition & Mortality	5 (12%)	IPC, FEWSNET	FEWSNET and IPC	Timely nutrition and mortality data (in particular) are critical gaps for food security systems--especially for severe areas on brink of famine
Primary producer of actionable Information for Humanitarian Decision Makers: Acute Food Insecurity Severity, location	8 (31%)	IPC, FEWSNET, Hunger Map, VAM, FIES	Sometimes redundant and/or conflicting information from IPC, FEWSNET, Hunger Map	-.
Primary producer of actionable Information for Development Decision Makers on chronically food insecure countries: severity, location	2 (8%)	IPC with its classification system for Chronic Food Insecurity	-	Significant gaps in the # of countries covered with chronic food insecurity analysis, and also with showing the linkages between acute and chronic food insecurity to inform strategic interventions
Coverage of all countries with acute and/or chronic food insecurity	0 (0%)	No single system generates all countries with food insecurity (including both chronic and acute), however significant coverage is provided by Hunger Map, IPC, FEWSNET	FEWSNET, IPC, Hunger Map, VAM	Critical Geographic gaps exist for some countries with acute and/or chronic food insecurity. Also temporal gaps of timely and predictable updates and forecasts (with FEWSNET being an exception with regular and predictable quarterly updates for the countries they cover)

3.2.1. Overlaps

One of the more striking observations is the considerable overlap of systems both in terms of countries covered and information provided. This can lead to redundancy as well as conflicting information. In particular, the IPC, FEWSNET, and The Hunger Map are all aiming to provide similar types of information on severity, numbers, location etc. FEWSNET aligns with the IPC system because it directly uses the IPC classification system to communicate findings. However, although FEWSNET uses the IPC common reference table and categories for classifying food insecurity, FEWSNET analysis differs from the IPC analysis process in that it is not a consensus based process involving key stakeholders; whereas the IPC analysis process is consensus based and involved key stakeholders from national governments, UN, and NGO agencies.

The Hunger Map, although it also displays IPC information, uses its own system for communicating food insecurity, which is not directly comparable to FEWSNET or IPC findings. The FAO FIES uses a single index to monitor both acute and chronic food insecurity. While the use of a single indicator is useful for internal consistency and comparability, it is not comparable with other systems. That said, a major development recently is the inclusion of the FIES into the IPC Reference System, which will enable the 'bringing together' of FIES with other food security indicators.

3.2.2. Gaps

Despite the promising successes of these systems, there remain critical gaps to inform strategic decision making. While FEWSNET, IPC, and VAM regularly incorporate vulnerability and causal analysis in their systems, a consistent weakness is the examination of underlying and structural causes of food insecurity, which is necessary to inform more development oriented interventions.

The analysis of conflict in a robust and consistent manner as a driver of food insecurity remains to be a critical gap, particularly in cases of extreme food insecurity and borderline famine situations. Conflict is inherently a complex and politically sensitive phenomenon, and yet it is vital towards understanding and forecasting future food security scenarios. Conflict mediation is also vital as part of comprehensive intervention strategies. A recent study done by FAO and WFP highlights the challenges of conflict analysis [3]

A critical gap in food security systems is that they rely on strong nutrition and mortality data for the essential triangulation of their analysis. That said, these systems were not designed to generate nutrition and mortality information. Rather, these are provided by SMART surveys typically implemented by national governments, UNICEF, and a number of NGOs (e.g, ACF). But this data is intensive and thus expensive to collect, involving anthropometric measurements and surveys asking sensitive questions about mortality. This challenge becomes particularly acute in conflict areas with limited humanitarian access – the very areas for which this information is most vital in order to determine the severity of situations, particularly areas that are borderline famine conditions (e.g., South Sudan, Yemen, and others).

Another gap is in the analysis of chronic food insecurity. The IPC with its chronic food insecurity scale and protocols stands out as the best effort to do so. However, analysis of chronic food

[3] *Monitoring food security in countries with conflict situations.* A joint FAO/WFP update for the members of the United Nations Security Council. April 2021. Issue #8

insecurity is yet to be regularly implemented and thus it leaves gaps in vital information for development focused decision makers.

And lastly, a glaring gap is that no system regularly covers all the countries of humanitarian concern. This dilemma already existed prior to COVID-19, and the limitations of the global systems became more blatant as new countries that have not typically been covered by information systems became food insecure due to the complex dynamics of COVID-19. As other global threats emerge – in particular climate change - there is an urgent need to fill this gap and ensure any and all countries experiencing food insecurity are covered by the information systems.

3.3. Cross-cutting Features

Table 4 presents best practices and comments for a range of information system features that are applicable to both food security and agriculture-oriented information systems. Key aspects are briefly discussed below.

Information access and sharing. Most systems offer three functionalities to share agricultural and food security information and analysis: (bulk) download options, graphical user interfaces (e.g. maps and dashboards) and publication of reports and bulletins with detailed (country-specific) assessments. Only 9 out of the 26 systems offer an application programming interface (API) that makes it possible to programmatically access the data.

Collection of household level information. 11 out 26 of the selected systems collect household survey data. LSMS-ISA, DHS and MICS are initiatives to regularly (often every 2-3 years) organize internationally comparative and representative household surveys for multiple countries. LSMS-ISA has a strong focus on income, expenditure, food consumption and agricultural information but covers only eight African countries. An advantage of LSMS-ISA, DHS and MICS is that they are representative at the subnational level and are available for multiple years, which makes them an important source of information to track and analyze long-run chronic food security. A major disadvantage is that they do not present recent (i.e. current year or month) data because of the complexities of organizing and post processing of large household surveys and are therefore less useful to monitor acute food security. To overcome this problem the Hunger Map uses mobile technology (e.g. live voice calls, SMS and interactive voice response technology) referred to as mVAM to collect near real-time data to remotely monitor household food security and nutrition, and food market-related trends. The FAO collaborates with Gallup Poll to implement the Food Insecurity Experience Scale (FIES), which is household level data collected annually for national level analysis, and also subnational at more frequent intervals for areas of higher food insecurity.

Table 4: Assessment of Cross Cutting Features

Feature	Count n (%)	Best practice	Comments
Information access and sharing			
API	9 (35%)	FAOSTAT, FAS, GIEWS, VAM	Several systems have an advanced API but the overall number of systems with an API is relatively low.
(Bulk) download	19 (73%)	FAOSTAT	Nearly all systems provide the option to download tables and figures and several make it possible to do a bulk download of nearly all available information at once.
GUI	19 (73%)	Hunger Map	Nearly all systems offer a graphical user interface to visualize data, which often include the possibility to select variables and depict maps.
Reports/bulletins	18 (69%)	GEOGLAM, FEWS NET, IPC, VAM, FSIN, CropWatch	Many systems offer reports and bulletins with detailed, often country-specific, analysis on agriculture and food security conditions.
Data source and generation			
Generate primary data	16 (62%)	FEWSNET, Hunger Map, IPC, GIEWS, GEOGLAM, FAOSTAT	About half of the systems provide primary information that comes from the original source, while the remainder are information aggregators, which combine and visualize information from multiple other (primary) data providers (e.g. HiH, DataM-CD, CountryStat).
Collection of household information	11 (42%)	LSMS-ISA, DHS, MICS, Hunger Map, FIES	Collection of primary household data is limited to a few sources, some of which collect rapid food security information (e.g. WPF mobile telephone surveys), while others are complex national household surveys that cover both agricultural and food security information (e.g. LSMS-ISA, DHS and MICS).
Indicators based on international standards	5 (19%)	IPC, FEWSNET, GIEWS, FAOSTAT, AMIS	The use of international standards for food security analysis is vitally important to ensure comparability of analysis over space and time. If various systems use their own standards, then their analysis is not compatible with other systems, and thus not comparable.
Near real-time data provision	4 (15%)	FSP, AMIS, Hunger Map	Near real-time data provision is limited to a very small number of systems and variables, in particular global food commodity prices and to a much less extent food consumption scores.
Forecasts	11 (42%)	GEOGLAM, AMIS, FEWSNET, IPC	Concerning food security, while FEWSNET and IPC do conduct forecasts, there is significant improvement to be had on increasing the frequency of the updates and the reliability of the forecasts. Predictive analytics is an opportunity.
Subnational information	20 (77%)	E.g. IPC, FEWSNET, Hunger Map	Several systems contain sub-national information including grid (e.g. GEOGLAM) and regional levels (e.g. Hunger Map).
Advanced analytical approaches (e.g. AI and machine learning)	5 (19%)	FSP, Hunger Map, IPC	Machine learning and linguistic algorithms are only used by a few systems and for a narrow set of indicators.
Governance and collaboration			
National government ownership	7 (27%)	FAOSTAT, GEOGLAM, AMIS, IPC, DHS, LSMS-ISA, MICS	Several systems closely work with national statistical agencies to collect information (e.g. FAOSTAT, LSMS-ISA, DHS and MICS), which often contains a capacity building element. Others engage with national governments and institutions to create agricultural and food security information components. (e.g. IPC, GEOGLAM and AMIS).
Inter-agency collaboration	3 (12%)	GEOGLAM, AMIS, IPC	Only three out of the 26 systems represent collaborative international efforts to offer one single information system that combines information from various international institutions and national agencies
Private sector engagement	7 (27%)	WFP Hunger Map, FIES, GFSI	Few systems work with the private sector to collect information (FIES) or to improve analysis and visualization (Hunger Map). In one occasion, the system is provided by a private entity (the Economist GFSI).

Near real-time data provision. None of the systems presents (near) real-time data. The systems that come closest are the IFPRI FSP and the WFP Hunger Map. The FSP presents a food price variability early warning system that uses high-frequency daily food commodity price information and a media analysis tool that tracks (COVID-19) food security related news items. The WFP Hunger Map aims for real time updates through regular household surveys conducted remotely combined with additional variables and machine learning to conduct 'now casting' of food security status.

Advanced analytical techniques. Despite rapid progress in the use of artificial intelligence and machine learning, only a few information systems in the sample have started to incorporate these techniques for agricultural and food security prediction and forecasting. FSP offers a Food Price Media Analysis System, which uses sophisticated linguistic object network-mapping algorithms to analyze the relationships between key terms found in media articles that may influence commodity price volatility. ARTEMIS/FAM explored a statistical forecasting approach to predict the outbreak of food crises, whereas the Hunger Map combines machine learning and data analytics to predict and track the magnitude and severity of hunger in close to real-time.

Forecasts. GEOGLAM real time crop monitoring system is able to forecast potential yield gaps based on satellite data. This is particular important to fast growing crops, e.g. soybean, maize, where any minimum delay in expected climate events, may harm the entire season planning.), FEWSNET, Hunger Map, and the IPC regularly provide forecasts of food security. FEWSNET has a well-structured and predictable process of providing quarterly updates and forecasts. The Hunger Map aims to provide 'now casting' in real time--essentially predicting near term food security based on current conditions and probability of change. The IPC regularly provides analysis of both current and projected (forecasted) situations, often including two different projection periods (one about 3 months out and another about 6 months out).

Subnational information. It refers to systems that collect and process sub-national data (e.g. region, state, province, municipality, grid and household). Systems that contain high country coverage with subnational data available are usually the most detailed as it can grasp the local contextual factors in different regions of the world, which enable a geographical comprehension on food security. Therefore, it requires highly detailed data, which comes from national agencies or robust techniques of data acquisition and processing (e.g. satellite, meteorological, census). On the agricultural side, GEOGLAM is the most detailed information system, providing up-to-date information on crop conditions at grid level. On the food security side, a number of systems analyze food insecurity at subnational levels including FEWS NET, IPC, The Hunger Map WFP VAM, and FAO FIES. These systems, however, are not comparable among themselves in a long-term perspective due to data limitation, but ultimately because they are made for different purposes.

Inter-agency collaboration. Regarding agriculture information systems, only AMISGEOGLAM are functional and collaborative international efforts to offer one single information system that combines information from various international institutions and national agencies. AMIS was launched in 2011 by the G20 Ministers of Agriculture following the global food price hikes in 2007/08 and 2010 and brings together all major trading countries of agricultural commodities. GEOGLAM crop monitor was designed in support of market transparency for the G20 Agricultural Market Information System (AMIS).

Among food security information systems, the IPC stands out as both unique and an excellent example of inter-agency collaboration among UN, NGO, and government agencies. The IPC conducts evidence based and consensus-based analysis using rigorous protocols for building consensus among experts.

4. Characteristics of Optimal/Model Food Security and Agriculture Monitoring Systems

Using the Integrated Food Security Phase Classification (IPC) analytical framework adopted by 15 global partner agencies (www.ipcinfo.org), the study presents the type and scope of actionable information (i.e. agricultural and food security components) that these global systems--in an ideal scenario--should be providing in a consistent manner. Moreover, global systems should also include (not necessarily all) cross-cutting features to ensure the provision of unbiased and transparent information, and in accordance with best scientific practices.

From a high level, global decision makers' perspective, there are desired characteristics that food security and agriculture information systems should have. For sure, given the vast complexity of both food and agriculture systems, there is a wide array of information that could be provided for decision support. However, listed below are core characteristics that global decision makers should be able to expect from these systems in order to inform both humanitarian and development interventions.

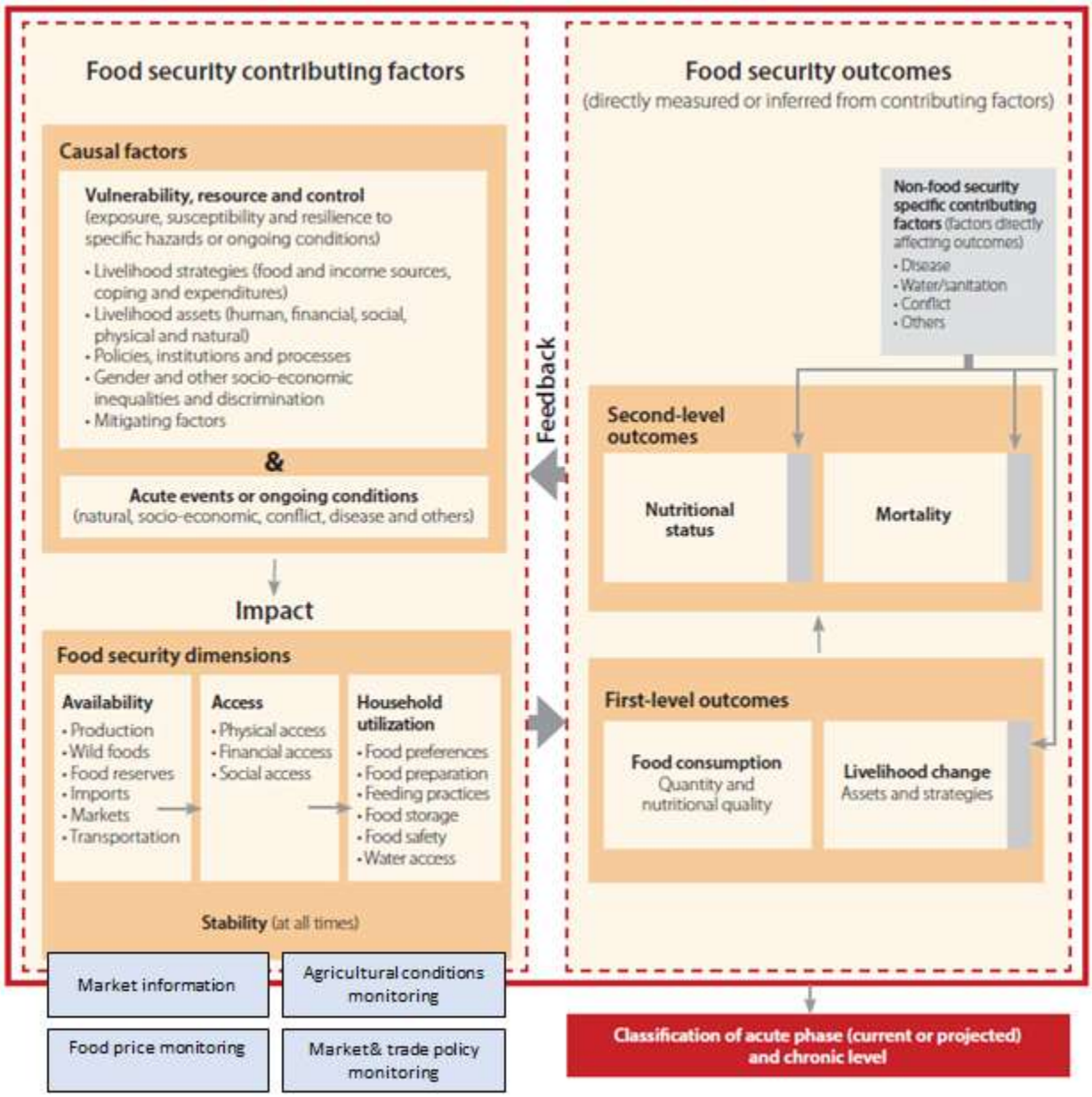
4.1. Model System: Agricultural Information Components

Agricultural conditions monitoring. A component that is able to assess current and near future availability of food, in particular key cereals such as maize, rice and wheat that make up a large part of the diet in many regions but also livestock and fishery. The tool must provide local, timely and accurate information on crop yield, livestock and fishery and conditions and operate as an early warning system to signal the potentially negative impact of climate shocks (e.g. droughts) and possibly also pests and social disturbances (e.g. emerging local conflicts) on local crop production. Key input for a crop conditions monitoring tool are high-resolution and (near) real-time meteorological data (e.g. precipitation, temperature and evapotranspiration), remote sensing (e.g. vegetation indices) and auxiliary information (e.g. national crop calendars) and modelling.[4]

Food commodity price monitoring. Large food price volatility is a major concern for explorers, importers, producers and consumers as it creates large uncertainty on income and expenditure. A food commodity price monitoring tool provides reliable and high-frequency price updates of major food commodities (e.g. maize, rice, wheat) prices in global markets as well as an assessment of its volatility. It can serve as an early warning system for unusual periods of excessive price variability that require timely response. Food commodity price data can be taken from commercial data providers (e.g. Bloomberg) and specialized international organizations (e.g. International Grains Council).

[4] Fritz, S. et al. (2019), A comparison of global agricultural monitoring systems and current gaps, Agricultural Systems, 168, 257-272, https://doi.org/10.1016/j.agsy.2018.05.010.

Figure 2: The IPC Food Security Analytical Framework.



Source: IPC (2019), Technical Manual version 3.0, p.31, The Integrated Food Security Phase Classification (IPC) Global Partners and authors.

Local food price monitoring. Food prices are an important determinant of food accessibility for the poor, who spend a large share of their income on food purchases and small-farmers, who receive a large part of their income from the sale of food crops. A local food price monitoring tool provides reliable information on local and national prices for a large number of crops that make up the local diet. Near real-term national food price data can sometimes be collected from national governments and information systems. The collection of local food price data requires the organization of local market surveys as recent data is mostly not available from standard statistical sources.

Market and trade information. Information on production (e.g. planting and harvested area), consumption (for feed, food and fuel), stocks and trade of food commodities provide key information on potential food shortages as well as expected changes in food prices. Country-level data can typically be taken from national statistical offices or global databases maintained by international organizations. A market information component provides easy access to this type of information at the national and potentially the subnational level.

Market and trade policy monitoring. Market and trade policies affect local, national and sometimes even global markets potentially resulting in food price, fluctuations as well as changes in food supply and demand that can have a negative impact on food security. A market and trade policy monitoring tool, tracks major changes in national agricultural market policies (e.g. change in stocks, subsidies and minimum price) as well as trade policies (e.g. export bans and non-tariff barriers) related to food markets. It is complementary to collection of market and trade information but requires a different monitoring system as data is not easily available and often descriptive instead of quantitative.

4.2. Model System: Food Security Information Components

Food Insecurity Vulnerability and Causes. The ways in which people are vulnerable to food insecurity differs depending on a wide range of factors, such as livelihood systems, agro-ecological systems, socio economic dynamics, and many more. As well, direct causes of food insecurity can range from drought, cyclones, conflict, and many others. It is essential to understand these dynamics in order to inform development-oriented food security interventions and to establish systems that can provide early warning.

Food Security Pillars. The globally established pillars of food security include availability, access, utilization, and stability. Each of these is important for measuring, forecasting, and understanding the contributing factors of food insecure situations.

Food Consumption and Livelihoods. While food security is a complex and multifaceted phenomenon, it is most directly manifested in the quantity and quality of food consumed by individuals, which can vary according to gender, age, whether a woman is childbearing, and other dynamics. Quality is critical in terms of meeting micronutrient requirements for healthy lives. Oftentimes, food insecurity households will make tradeoffs with livelihoods, such as potentially engaging in negative coping strategies (e.g., withdrawing from school, being put at health risk via prostitution, selling capital assets, etc.). These can put households in a downward spiral and as such is a critical element of food security analysis.

Nutrition and Mortality. The anthropometric measuring of nutrition and mortality rates provides concrete evidence of food insecurity. As such these measures are important for triangulating the effects of food insecurity. However, nutrition and mortality can also have other causes than food insecurity (e.g., disease, conflict, etc.).

Actionable Humanitarian and Development Information. Humanitarian and development interventions need to be informed by basic information on acute and chronic food insecurity that should be a shared reality of all stakeholders, including questions of: How severe is the situation? How many people? Where are they? When? And Why? This basic set of information should be provided using globally accepted standards in order to ensure comparable results across countries and over time to be able to inform rational allocation of resources based on need and coherent strategies.

4.3. Model System: Cross Cutting Features

In addition to the specific features described above for agriculture and food security systems, there are a number of model system features that would ideally exist in both.

Country Coverage. From a human rights perspective, all countries and localities experiencing acute or chronic food insecurity should be included in systems for addressing global food insecurity. Monitoring of agricultural markets requires global coverage, or at least that of most important importers and exporters as these are instrumental in driving global food commodity prices.

API. Global systems with Application Programming Interface (API) provide data access services without the direct intermediation of the web interface. The API facilitates and expands the data collection capabilities as well as readiness in exploratory data analysis.

Bulk download. Systems that present processed information should ideally offer bulk download options to provide data access for transparency and exploratory purposes.

GUI. Systems with a Graphical User Interface (GUI) are important to provide to the user a first interaction with the data or even to conduct quick analysis prior to the data acquisition.

Reports/bulletins. Reports and bulletins represent a more detailed data analysis offered by the system. These documents are usually characterized by their high temporal frequency (e.g. monthly, quarterly) and they may also include the causal analysis of the data.

Generate primary data. Systems that conduct the survey and coordinate the data collection. In addition, systems that gather all the data that are readily available, pre-process (i.e. organize, clean) and re-distribute.

Collection of household information. Systems that set the protocol for collecting household data. Usually, these surveys are organized in cooperation with national offices, which are responsible to define the sampling size and conduct the interviews.

Indicators based on international standards. Global systems that use methods and present indicators that are widely accepted by the society and the broad scientific community.

Near real-time data provision. Systems that offer data and tools for monitoring agriculture and food security indexes. Depending on the type of information, the near real time data provision can vary from hourly basis to quarterly basis.

Forecasts. Systems that provide early warnings for different food system components. From meteorological alerts impacting the food availability in the medium term to local disruptions (e.g. civil war, COVID-19 social distancing measures) that affect access to food in the short term.

Subnational information. Systems that contain information at sub-national level are able to provide a more detailed comprehension of the local contextual factors that lead to food (in)security in a given country.

Advanced analytical approaches (e.g. AI and machine learning). Systems that are able to collect, harmonize and process large amounts of multi-thematic data (e.g. from different food system dimensions) in order to predict or classify a given key attribute (e.g. levels of food insecurity).

National government ownership. Global systems that are resulted from multilateral cooperation among different countries or global systems that are simply owned by a specific country.

Inter-agency collaboration. Global systems that are resulted from multilateral efforts from international agencies without direct interference from national governments.

Private sector engagement. Global systems that require direct (financial and technical) support from private companies to keep the system in operation.

4.4. Summary Features of a Model System

While the above sections specify a number of key features that should be present in a model food security and agriculture systems, below is a basic summary of what's needed:

- Seasonal analysis of agriculture production for crops, livestock and fisheries--and how that will affect food security.
- Monitoring of (inter)national food markets, including food supply, demand, trade, prices and policies.
- Near real-time monitoring and analysis of acute and chronic food insecurity that generates core and essential information for decision support, including:
  - How Severe? The severity of the situation
  - How Many? Estimates of populations in need
  - When? Current and forecasted analysis; updated regularly and frequently
  - Where? Location of people experiencing food insecurity, ideally at administrative level 2 or lower.
  - Why? Identification of main drivers and causes
  - Who? Identification of characteristics of most affected
- Link the information on current status and early warning to anticipatory actions, based on the nature and severity of the situation.
- The geographic scale to cover any country of concern in the world
- The rigor and standards of a globally accepted reference system and standards for classifying food insecurity.
- Analysis built on objective, data-driven evidence including multiple aspects of food security.
- Multi-stakeholder consensus from the international community, and including national governments, that provides a single trusted source of core information about the nature and severity of food insecurity
- Related to the previous point, a model system, while aiming to be inclusive and consensus based with national governments, also needs safeguards to ensure unbiased analysis in highly politically contentious situations. As a member of the IPC Famine Review Committee, one author of this report can directly attest to the political pressure food security analysts can experience in highly charged situations such as the recent 'Famine Likely' classification for Pibor County in South Sudan. A thorough examination of the political economy of food security analysis can be found in a study titled "The Politics of Information and Analysis in Famines and Extreme Emergencies"[5].
- A model system would build on considerable investments already made and competencies of existing information systems rather than reinventing and duplicating accomplishments already achieved by successful systems.

Currently none of the systems reviewed in this study meet the characteristics of a model system. For food security analysis, three systems stand out as providing the most valuable information for decision support: WFP VAM/Hunger Map, FEWSNET, and IPC. That said, each has its own deficiencies. For WFP's Hunger Map, key deficiencies include reliance on a limited number of

[5] Maxwell and Hailey. *The Politics of Information and Analysis in Famines and Extreme Emergencies*. April 2020. Feinstein International Center of Tufts University.

indicators, not based on globally comparable international standards, and not based on multi-stakeholder consensus. For FEWSNET, key deficiencies include not being based on multi-stakeholder consensus and limited geographic coverage. And for IPC, key deficiencies include limited geographic coverage and unreliable frequency of updates for forecasts.

5. Key Opportunities

When examined collectively, significant progress has been made in food security and agriculture information systems, with examples of best practices clearly evident in various systems. The challenge is that despite all of these advances, global decision makers still do not have the core information required to address acute and chronic food insecurity. This study identified critical gaps and also redundancies that are not only inefficient uses of global resources, but also can create confusion with multiple and sometimes conflicting analyses. This can lead to further delays in urgent humanitarian responses and uncoordinated interventions.

As such, the study identified opportunities to make better use of global information systems by linking them up more explicitly to share data, bring models together, and conduct joint analysis. This is not about 'reinventing the wheel', rather it's about rationalizing existing expertise and investments. However, this would require willingness of agencies which can sometimes be resistant to collaboration and sharing of data and knowledge.

Opportunity 1: Establish inter-agency networks and collaborations

The most glaring opportunity is to make the best out of existing investments and progress by various systems and create a network whereby these systems can link up and share data and conduct joint analysis in a more systematic manner – ensuring all countries are covered and that the results are based on consensus and can be trusted. A good example of such global collaboration can be found with the SDG information management protocols whereby various agencies are designated 'custodians' of vital datasets needed for SDG tracking, with one organization having the mandate to maintain and manage the portal (in the case of the SDGs the UN Statistical Commission has this designation, see Box 1 for further details) that provides access to all combined information.

This type of model could readily be adapted for food security and agriculture systems, albeit with different datasets, agencies and coordination. It would include GEOGLAM and AMIS, which are already internationally recognized and endorsed inter-agency collaborations, as key 'custodians' to provide agricultural information, in particular crop and agricultural market monitoring, as well as a range of other institutions that would provide other essential information components of a comprehensive global food security monitoring system. A system of custodian organizations with clear mandates to specialize in the provision of certain information will contribute to reducing the extensive overlap that exists in nearly all agricultural and food security information components.

Ideally, a multi-partner institution would be given the mandate to collaborate with multiple partners and operate as an official hub and function as an information aggregator for all food security information. At the moment, the landscape of agricultural and food monitoring systems contains a number of systems (e.g. FAO HiH, JRC DataM-CD, FAO CountryStat, FSIN) that operate similarly, although not always with a unique food security focus, by combining information from primary data providers into a new system. Having multiple information aggregator-type systems leads to confusion as they might be regarded as competing sources of agricultural and food security information, while they may in fact display the same information. It also leads to fragmentation of scarce funding resources in a plethora of systems that are difficult to maintain and easily might become outdated. It would be more efficient to invest in sub-systems that specialize in providing one component of a food security system, which submit key indicators to a hub that combines, reshapes and visualizes all data so that it can be easily used by decision makers, analysts and other stakeholders.

Box 1: Institutional design to monitor the Sustainable Development Goals (SDGs)

The United Nations Statistical Commission (UNSD) created the Inter-agency and Expert Group on SDG Indicators (IAEG-SDGs) to develop and implement a global monitoring framework to track progress towards the 17 SDGs. The global indicator framework is contained in the Resolution adopted by the General Assembly on Work of the Statistical Commission pertaining to the 2030 Agenda for Sustainable Development (A/RES/71/313). The IAEG-SDGs is composed of Member States and including regional and international agencies as observers.

To coordinate the SDG monitoring, a lead specialist agency or 'custodian', an United Nations body or other international organization, was appointed, who is responsible for compiling and verifying country data to produce over 200 SDG indicators and submitting the data to the UNSD. Custodians are permitted to publish the country data in their own databases and use it for thematic reporting. They are also responsible for developing international standards, recommending methodologies for monitoring and strengthening national monitoring and reporting capacity. All final data to be submitted to UNSD will first be validated and approved by countries. The UNSD makes country data, regional and global aggregates and meta data available on the SDG Indicators Global Database, which also provides the data for the Secretary-General's annual report on "Progress towards the Sustainable Development Goals".

Source: https://unstats.un.org, https://www.sdg6monitoring.org/

Opportunity 2: Shift from agency-owned silos to a global public good

In line with Opportunity #1, there is a clear opportunity to rethink how information systems have been established over the years, which has typically been led by a particular agency and oftentimes in silos without explicit and strategic connections to other information systems in order to enhance complementarity and reduce redundancy. For sure, any improvements in the global systems will require considerations of political economy and the tendency of agencies and organizations to develop systems that work for their specific needs. What the world needs, however, is a global public good that provides vital food security and agriculture information for all countries of concern in near real time, with the scientific rigor and consensus that can be trusted for decision support. To achieve this and overcome agency resistance, a clear opportunity exists to establish a global mandate for these information systems to have the commitment and funding required to achieve the SDG 2 goal of ending hunger.

Opportunity 3: Increase the use of advanced analytical approaches and technologies and collaborate with the private sector.

The era of the digital transformation is affecting all aspects of society, and food security and agricultural systems stand to benefit greatly through increased use of technologies such as AI, machine learning, big data and others.

A key enabler of the opportunity to network up these systems will be the digitization of data and advanced technologies, including APIs, artificial intelligence, machine learning, big data, and others. The world is dramatically transforming in this era of exponential technological change. It is imperative that the food and agriculture information systems build on these advances to

improve the forecasting of key indicators and deal with missing data (e.g. lack of household-level and subnational data).

That said, a common mistake with technology innovation is to develop 'solutions looking for a problem', rather than careful analysis of what problems need to be solved and how technologies can (or cannot) add value.

The World Bank's FAM/ARTEMIS effort to use AI and machine learning to forecast food insecurity is illustrative of the effort to use advanced technologies. At the outset of the ARTEMIS project several years ago, the World Bank boldly stated that AI would be the solution for global food security monitoring, without first conducting a careful review of the current status, successes, and challenges of food security information systems. This was a case of technology being the answer with the question yet to be understood. The ARTEMIS project concluded in 2020 without delivering on the promised results of reliable food security forecasting. That said, clearly the longer term vision of the World Bank is correct that AI and machine learning will eventually be able to produce reliable and scalable results. Thus, such bold initiatives to leverage advanced technologies should not be brushed aside, but rather carefully learned from and built upon.

Historically, however, development agencies have not typically been at the cutting edge of technological development. Rather, the private sector tends to lead in the development of advanced technologies and innovation.

A clear opportunity exists for increased collaboration with private sector actors such as technology companies and data providers for improved food security and agricultural analysis. The Hunger Map (with its collaboration with Alibaba), FAO (with its collaboration with Gallup), and the IPC (with its use of Artificial Swarm Intelligence and collaboration with Unanimous AI) are good examples of the value of partnering with the private sector.

A critical challenge of collaborating with the private sector, however, is to not mirror the fragmentation of agency-based information systems with the fragmentation of private sector companies and technologies. The private sector, with all its strengths, is motivated by financial incentives which may hinder collaborative and integrated approaches to creating a public good.

Opportunity 4: Link Better with regional and national systems

Although this review of global food security and agriculture information systems was primarily focused on global systems, there exists a tremendous wealth of data and analysis from national and regional governmental systems.[6] These systems normally contain subnational level data with high temporal frequency and should not be seen as overlapping with global systems. Therefore, there is a great opportunity to better link these systems for a more holistic analysis, and one that builds from national and regional governmental capacities. This could represent a win-win integration by adding importance to the regional/national systems while they provide more accurate data to global systems.

In most regions of the world there exists regional bodies (e.g., IGAD, CILLS, ICPAC etc.) that are actively developing standards and systems for food security and agriculture monitoring. Linking to these systems can be a strategic way to help build governmental capacities and foster ownership of analysis among key governmental decision makers.

[6] Daniel Maxwell et. al. *Early Warning and Early Action for Increased Resilience of Livelihoods in IGAD Region*. March 2021. Feinstein International Center of Tufts University.

Opportunity 5: Address critical data weaknesses

Two critical data gaps exist for food security analysis to be timely and reliable: mortality data and conflict data. These become particularly vital for food security analysis in some of the most severe situations that border on famine (e.g., South Sudan, Tigray, Yemen, North Korea, and others). Indeed, the biggest hindrance to conducting famine analysis in recent years has been the lack of mortality data and conflict analysis. Strategies to address these gaps can include: 1) political pressure to assure humanitarian access and human rights, 2) increased funding for agencies or private companies to collect data, and 3) leveraging technology innovations to improve data collection (e.g., with high resolution satellite imagery, artificial intelligence for facial image analysis of malnutrition, social media scraping, and others).

Opportunity 6: Make better linkages between chronic and acute food insecurity

Achieving SDG 2 can only be accomplished by addressing both chronic and acute food insecurity. As such, the food security and agriculture information systems also need to make distinctions between acute and chronic food insecurity, and what types of interventions could be implemented to address both. Furthermore, the strategic analysis of chronic and acute food insecurity should be conducted in a manner that can inform the type of humanitarian responses that are best suited to support longer term developmental agendas. And likewise, developmental interventions should be done in a manner that reduces population vulnerabilities to shocks/hazards that can dramatically undermine investments in long term development.

In addition to the IPC acute food insecurity and nutrition classification systems, the IPC also has a chronic food insecurity classification system. That said, IPC chronic food insecurity analysis has only been rolled out in a limited number of countries to date. This is due to a mix of prioritization, technical development to ensure efficient processes, and clear linkages with decision making. The IPC Global Support Unit is currently commissioning a study on ways to improve the chronic analysis and expects to ‘re-launch’ IPC for chronic later this year.

Opportunity 7: Rationalize donor financing of information systems to be more strategic

Donor financing of information systems has historically been agency driven and not strategically designed to solve the global information needs for ending hunger. In short, it has been a supply side and opportunistic approach, rather than a demand driven and strategic approach. This tendency not only misses the mark to ensure the world has vital information to end hunger, but it is also financially inefficient in that it creates redundancies and is not strategically designed to complement investments in various components of agriculture and food security information systems. A tremendous opportunity exists to shift from single donor-based initiatives financing single agency-based initiatives towards a strategic approach that can meet the specifications of the model systems described above.

Together with the opportunities listed above, there are a number of risks of developing a common public good approach that should be considered, namely:

- Risk of one agency gaining too much power if a common hub approach is developed. This can be mitigated by advocating a multi-agency institutional and governance structure (e.g. the IPC)
- Risk of ‘group think’ if there is a ‘single trusted source of information’ that can contain systemic biases and actually lead to erroneous analysis, albeit analysis that may ‘feel right’ by the agencies involved but does not reflect the reality of the most vulnerable people. This can be mitigated by always encouraging the expression of dissenting opinions by agencies involved in consensus-based processes.

- Risk of time inefficiency by having a consensus-based process that requires the inputs of multiple stakeholders. This can be mitigated by developing clear and efficient protocols for information sharing and procedures to generate consensus-based analysis.
- Risk of stifling innovation in a world that is rapidly evolving with advanced technologies. This can be mitigated by developing a system that is technology agnostic and can readily incorporate advancements in technologies and emerging data sources.
- Risk of political interference in a ‘single trusted source’ where there is a concentration of information power. This can be mitigated by ensuring technical neutrality and a global mandate is provided (for example, the type provided to Special Envoys in highly contested and sensitive situations) that supersedes political interference.

6. Conclusions and Recommendations

Despite the tremendous investments and progress of food security and agriculture information systems over the past decades, the world is still lacking a single trusted source of information to inform both humanitarian and development interventions. Critical gaps exist to include all countries of concern with timely analysis of current and forecasted conditions, including severity, numbers, location, and causes to inform strategic planning.

The time has come for leading food security and agriculture agencies to think about building a global public good – not merely an agency-based initiative – that can provide core information on the world's food insecure people. The SDG model of custodians provides an example of how that can be done. Similar to the SDG model, this would require a global mandate to build a global public good for food security monitoring and analysis. As well, incentive structures need to be developed to promote collaboration among agencies and governments.

Key recommendations for consideration by global donors include:

Recommendation #1: Develop a common vision for a global public good that can deliver core and essential information required to achieve SDG 2. A next step could be to create a high-level working group of funders and representatives of international institutions to agree on the structure and functions of the model system.

Recommendation #2: Rationalize donor financing for agriculture and food security information systems to be more strategic, sustained, efficient, and effective towards creating a global public good that can deliver core and essential information. And conversely, it is recommended that donors stop financing systems in an ad hoc and fragmented manner, which creates redundancies, inefficiencies, and critical information gaps. The upcoming G7 meeting is a perfect opportunity to launch a new vision on how donors can work together for strategic financing and institutional lobbying.

Recommendation #3: Leverage the influence of the international donor community to lobby for a global institutional mandate and structure for a public good (such as the SDG custodial model) that can provide core and essential agriculture and food security information. A next step can include identification of the appropriate 'source' of the global mandate (e.g., from the United Nations), and to lobby for a formal charter to be issued to create or endorse such a body.

Recommendation #4: **Leverage donor influence with agencies implementing information systems to commit to data sharing and interoperability, and in particular to link to existing platforms that are already integrating information from various systems to provide a single trusted source of food security and agriculture analysis (e.g., AMIS, GEOGLAM and IPC).** A next step would be to develop a joint communique from donor agencies to information system agencies outlining this vision and priority.

Recommendation #5: Commission a study that conducts a critical evaluation of the costs and benefits of the existing systems, eventually resulting in the selection and support of a limited number of specialized and integrated systems. A next step would be to agree on the terms of reference for such a study and inform leading information system agencies of the process and request their full collaboration and sharing of financial and other information.

Recommendation #6: Finance efforts to develop systems and analyze not just acute food insecurity, but chronic food insecurity as well; and to make stronger linkages between acute crises and their underlying/structural causes which can inform development-oriented interventions in agriculture, policy, and economic growth. A next step would be

identifying a system that can provide chronic food insecurity analysis and provide ample funding to roll out the analysis globally.

Recommendation #7. Finance efforts to provide critical data gaps, in particular nutrition/mortality data with SMART surveys, and conflict analysis. A next step would be to identify institutions (e.g. UNICEF) to increase funding for nutrition/mortality SMART surveys, and also to finance systems such as the IPC with resources necessary to ensure conflict analysis is systematically included in food security forecasting for FCASs.

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