IPC ATARI Report #1

KEY OPPORTUNITIES FOR ADVANCED TECHNOLOGIES AND ARTIFICIAL INTELLIGENCE IN IPC

Acknowledgements

This effort was led by Nicholas Haan and Leila Oliveira with senior technical advice from Thomas Gabrielle, Arvid Halma, and Francesco Mosconi. A team of technical advisors (in alphabetic order): Jannie Armstrong, Thomas Gabrielle, Arvid Halma, Kaija Korpi, Francesco Mosconi, Melanie Rabier, and Manuel Veiga.

Key support was provided by Jerry Arguello, David Baltaxe from Unanimous AI, Scott Drimie, Barbara Fratulloro, Kudzai Kariri, Quraishia Merzouk Sergio Regi with strategic guidance from Jose Lopez and Sophie Chotard.

Commitment towards this effort from all Swarm members, the IPC Steering Committee, the IPC Technical Advisory Group, and the ATARI Working Group are greatly appreciated and we look forward to future collaborations in our shared mission of improving food security analysis.

I. Introduction

In late 2019, the IPC GSU and Steering Committee established the Advanced Technology and Artificial Intelligence (ATARI) initiative with the overarching objective of identifying technology and innovation opportunities to improve the IPC (ATARI Inception Report). ATARI is premised on the observation that current IPC processes- while well established and developed over the past 17 years- have not caught up to the technological possibilities that currently exist or will exist in the near future. The purpose of ATARI Report #1 is to present findings on key recommendations for technology development for the IPC.

The ATARI initiative was designed to be a two-stage process including:

- Stage 1 to recommend technologies that should be adapted and integrated into IPC
- Stage 2 to adapt and integrate selected advanced technologies in IPC

Figure 1: Objectives and Outcomes of the two stages

	Stage One	Stage Two
Objective	**To recommend technologies that should be adapted and integrated into IPC**	**To adapt and integrate selected advanced technologies in IPC**
Outcomes	1. IPC ATARI working group established and active 2. Potential advanced technologies to be used for IPC identified and critically evaluated (White Paper) 3. Strategic plan for development and integration of ATARI in IPC (endorsed by TAG and SC)	Advanced technologies designed and prototyped (informed from Stage 1) Prototypes field tested and revised based on learning Advanced technologies developed and ready to be integrated in IPC process

ATARI Report #1 addresses Stage One of the ATARI initiative, in terms of making recommendations for technologies to be adapted and integrated into IPC.

Changing Food Security Analysis Landscape

The food security analysis landscape is rapidly changing, with a number of institutions actively developing cutting edge innovations. These include the WFP Hunger Map, World Bank's ARTEMIS Project, FAO's Hand in Hand Geo-Spatial Platform, ACF's nutrition measurement systems, DARPA's efforts to model food insecurity, and many others (see this link for an overview of partner advanced technology initiatives and this link for an database of global food security information systems). At the same time, there are strong trends in the humanitarian field that demand Anticipatory Action led by the Global Food Security Network, OCHA, and others. Meeting these demands will require advances in the way food security analysis and projections are conducted, such that they are rooted in evidence-based analysis, have truly global coverage, and can be updated with high frequency and include regular forecasting directly linked to decision making and resource allocation.

Rapidly Accelerating Advanced Technologies

The advanced technology landscape is dramatically changing, with digital transformations happening in nearly all aspects of society. Based on the inherent property of computing power decreasing in cost and increasing in performance at exponential rates (i.e. effectively doubling every year), a whole suite of technologies are radically disrupting analog approaches and creating entirely new, beyond the horizon, opportunities to solve challenges. Such technologies include: artificial intelligence and machine learning, sensors, internet of things, robotics, digital manufacturing, internet connectivity, digital biology, virtual reality, blockchain, and many more. A truism for any organization, product, or service is captured by the Silicon Valley adage: *Disrupt yourself or be disrupted.* Innovation is an imperative, not an option. This requires fresh examination of the goals and objectives of an organization, and to allow for breakthrough thinking, innovations, and partnerships to create products and services that are 10x faster, 10x cheaper, and/or 10x better. This is a unique time in human history to embrace radical innovations and think anew how to solve big challenges.

If the IPC embraces new opportunities for innovation and leveraging advanced technologies, it will dramatically increase the ability to assess and forecast food insecurity, and be situated at the center of humanitarian and food security innovations. Conversely, if the IPC does not also embrace this new reality, it is almost certain to be overtaken by other initiatives that do, and be rendered obsolete.

A Collaborative Effort

The ATARI Initiative, while led by the GSU, is a collaborative effort involving close consultations with IPC partner organizations via the Technical Advisory Group (see this link for list), the Steering Committee, and the formation of the ATARI Working Group --a group of external advisors who are leaders in technology innovations.

The structure of this ATARI Report #1 includes four sections: Introduction, IPC Challenges and Diagnostics, Key Technology Opportunities, and Recommendations/Conclusions. This report is complemented with a companion report on the Artificial Swarm Intelligence pilot exercises--ATARI Report #2: Pilots for Increased Coverage and Frequency of IPC Classifications.

II. IPC Challenges

1. Introduction

A universal best practice for identifying technology opportunities for innovation is to start with a clear articulation of a problem to be solved and/or a vision to be achieved. That is, not to start with the premise of identifying interesting technologies and figuring out how to use them. The former approach-a problem based approach-ensures that technological innovations will meet real needs and not waste resources. The later approach-a technology driven approach-risks making investments for the sake of tappearing technologically innovative, and can distract an organization from its core product/service/mission. Adhering to this problem-based approach, the IPC ATARI initiative identified 10 top challenges faced by the IPC.

2. Findings

A. The Common Global Reference is at Risk
   - Technological developments for food security and crisis analysis by various organizations are extremely exciting and promising, however, on their own they risk undermining the achievement of the global community in developing and applying a common global scale and consensus for classification of food and nutrition crises.

B. New ad [illegible]

C. Consen [illegible]

D. Limited [illegible]

E. The IPC [illegible]

F. Limited ability to forecast, update and dynamically link to early warning systems and triggers [illegible]

G. Causal [illegible]

H. Data are [illegible]

I. IPC-do [illegible]

J. IPC communication is disconnected, duplicative, not frequent enough, and lacking [illegible]

K. Overarching Challenge: Global Coverage and Higher Frequency
   - In addition to the specific challenges noted above, the onset of the Covid-19 global pandemic has highlighted a vital and urgent need for global food security analysis systems to:

     1. radically increase the scale of global coverage to include any potential country facing food insecurity (i.e., not limited to countries that have recurrent/historic food insecurity)

     2. radically increase the frequency of food security updates and forecasts beyond the typically ad-hoc nature of IPC country updates, and shift to

a more frequent (e.g., quarterly) and predictable system for updating country and global food security forecasts.

3. Priority Challenges

In order to address many of the challenges listed above as well as the overall challenges of increased Global Coverage and Higher Frequency of Updates, the ATARI initiative recommends focusing on two key areas for developments:

A. **Data Management:** Data management includes data gathering, data processing (e.g., preparing automated visual dashboards), and data sharing.

B. **Analysis**: This includes making the IPC analysis process more efficient, while maintaining the consensus-based approach of the IPC; while also exploring emerging technological approaches for integrated food security analysis using artificial intelligence.

While the IPC faces additional challenges to the two noted above--including some which are core to existing IPC protocols such as communication and operations, as well as others which are outside the scope of IPC protocols such as data generation from the field--the initial focus of the ATARI initiative is on improving data management and analysis. At later stages the ATARI initiative may also investigate opportunities to address additional IPC challenges.

III. Priority Technology Opportunities for Data Management and Analysis

1. Introduction

With the focus on the two key challenges of data management and analysis, the ATARI initiative identified a wide range of technologies that could benefit the IPC. These technologies were identified through literature reviews, consultations with the ATARI Working Group, and review of recent developments od food security analysis systems.

2. Current Status of IPC Information Support System

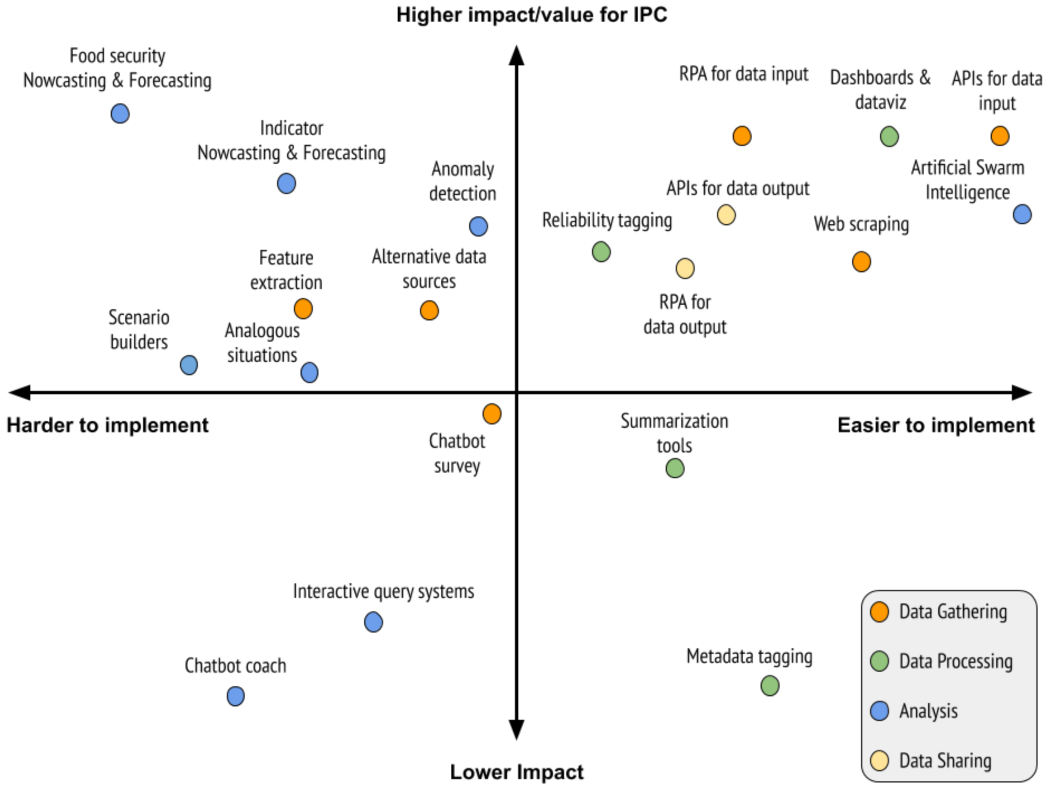
The IPC Information Support System (ISS) is the existing online application used to digitize the IPC analytical process. Country teams use the ISS to complete all 4 functions of the IPC protocols. The ISS is database driven-all data entered are stored in tables and retrievable for analysis and sharing. With respect to data management, function 2 of the IPC includes building the evidence repository, and thus forms the main data gathering module of the ISS. Currently, data are entered manually into the repository; often as an image of a chart, table, or map. The data are then used as evidence during the analytical steps to determine the phase and population for each area of analysis.

ISS version 1 includes automation to streamline the work of the analysts. Certain routine tasks or repeated operations are automated. For example, the map and population table are built from the Analysis Worksheet step 4, without the need for the user to construct the map or table. The ISS team updates the application based upon feedback from the country users. Further updates will be informed by field experience as well as new technologies assessed by this ATARI initiative.

3. Key Technology Opportunities

Key technology opportunities for Data Management and Analysis are mapped on Graph 1. Technologies are assessed based on a comparison of 'potential value for IPC' and 'complexity of implementation', and further discussed in this section.

Graph 1: Mapping of Technology Opportunities for Data Management and Analyses



4. Data Management: Data Gathering, Processing, and Sharing

Data Management broadly includes the processes of data/evidence gathering, processing, and sharing. Each of these processes is currently done via manual and human intensive methods. The ATARI initiative has identified a number of technologies that could automate each of these processes, and thus make the whole system significantly more efficient.

A. Data Gathering

Data gathering refers to the IPC process of drawing together a wide range of data sources such as field surveys, websites/on-line data, databases of market prices, satellite imagery, etc. It is important to make a distinction between data *gathering* (which is in the scope of the IPC), and data *generation* (which is outside the scope of the IPC per se, and is reliant on partner organization efforts and other sources).

There are three typical ways of accessing online data: using Application Programming Interfaces (APIs)/machine-to-machine protocols, scraping data from unstructured web pages, and using automated tools for data entry (Robotic Process Automation). The first two source types are most reliable and require the least implementation effort, and therefore would be preferred for earlier stages for the IPC.

- **APIs for data input**: Application programming interfaces (APIs) are machine-to-machine protocols to request structured data, mostly in JSON or CSV format. The use of an API data source allows users to update the data regularly and automatically, always providing the most recent snapshot of the indicator.

Related IPC Function	ATARI Methods	Example	Potential for IPC
Function 2, Step 2	APIs	https://sdmx.data.unicef.org/ws/public/sdmxapi/rest/data/UNICEF,WASH_HOUSEHOLDS,1.0/.WS_PPL_W-UI...?format=csv	Use: TWG, GFP Level: **high** Timeline: **short** Complexity: **low**

Examples of sources that provide an API are reported in the table below:

Description	Reference	Method
World Bank Open Data	https://data.worldbank.org/	Downloadable files, API
Humanitarian Data Exchange	https://data.humdata.org/	Downloadable files, API
FAO Hand in Hand Geospatial Platform	https://data.apps.fao.org/	Downloadable files, API

An extensive list of sources of websites that provide useful evidence for IPC analyses has been identified here.

- **Robotic Process Automation for Input**: RPA is a form of business process automation based on imitation of user actions. In contrast to scripting languages, RPA proceeds by recording the user actions and then repeating the user's actions in an automated manner. Here are some of the tasks that can be automated with RPA:
  - Logging into an application / website with password
  - Connect to an API
  - Copying and Pasting Data
  - Moving files and folders
  - Extracting and processing structured data
  - Extracting and processing data from semi-structured content (PDFs, Emails, Forms)
  - Read and write to databases
  - Open email attachments

RPA could be used to integrate data sources such as excel files coming from analysts on the ground, as well as to extract information from reports. It could also be used to automate parts of the downstream tasks in the analysis. Example datasets for which RPA could be useful include: 1) The FEWSNET website for market prices and agro-climatic data (https://fews.net), and 2) the ACAPS website for crisis updates (https://www.acaps.org/).

Related IPC Function	ATARI Methods	Example	Potential for IPC
Function 2, Step 2	RPA	https://acleddata.com/data-export-tool/	Use: TWG, GFP Impact: **high** Timeline: **mid** Complexity: **mid**

- **Web Scraping**: Web Scraping an automated process to extract data from a website, when an API is not available. If a source website does not provide an API but has one or more pages with tables, figures or other relevant data, an automated scraper can periodically extract, format and import the data from the website into a database for further processing. Scraping solutions include commercial standalone tools, open source libraries and service platforms.

Related IPC Function	ATARI Methods	Example	Potential for IPC
Function 2, Step 2	Web Scraping	https://coronavirus.jhu.edu/	Use: TWG, GFP Impact: **high** Timeline: **low** Complexity: **low**

- **Alternative data sources**: Indicators from social media messages can be used for timely trend analysis. When food prices are reported in social media/SMS, detection of the food items, quantity and price may be automatically extracted from a free format message, making reporting easier and more real-time.

Related IPC Function	Analytics Capability	ATARI Methods	Example	Potential for IPC
Function 2,Steps 2+3	Descriptive	Natural language processing, Rule based methods, Statistical	https://dataforgood.fb.com/ https://labelbox.com/docs/nlp/named-entity-recognition	Use: GFP Impact: **mid** Timeline: **mid** Complexity: **mid**

		methods		

- **Feature extraction**: Feature extraction involves using machine learning methods to automatically extract features from satellite images and could be used to provide additional indicators, such as population density, movement and poverty.

Related IPC Function	Analytics Capability	ATARI Methods	Example	Potential for IPC
Function 2, Step 2	Descriptive	Statistical methods, Computer vision	https://www.worldpop.org/ https://arxiv.org/abs/1902.05433	Use: TWG, GFP Impact: **mid** Timeline: **mid** Complexity: **mid**

B. Data Processing

Once there is gathered data available, that data/evidence needs to be prepared for optimal usage by the IPC analysts. This entails enriching the raw data by fusing different sources, identifying trends to fill in gaps or predict the future, derive new indicators from repurposed sources, and displaying that evidence in a visually accessible and meaningful manner for the IPC analysts. The wide suite of technologies applicable include: statistics and modelling, graphic visualization, machine learning and artificial intelligence.

- **Summarization tools**: Summarization tools utilize machine learning methods to automatically summarize long text into shorter snippets for easier integration as evidence. They also allow for complex data extraction from documents, thus improving accessibility of availability of evidence

Related IPC Function	Analytics Capability	ATARI Methods	Example	Potential for IPC
Function 2, Step 2	Descriptive	Natural language processing, Statistical methods	https://beta.openai.com/	Use: TWG, GFP Impact: **mid** Timeline: **short** Complexity: **low**

- **Metadata tagging**: Evidence provided by users can be categorized and labeled automatically, by analysing the (textual) content, such as keywords, locations, time frames described. This improves accessibility and speeds up selecting relevant evidence from assessments.

Related IPC Function	Analytics Capability	ATARI Methods	Example	Potential for IPC
Function 2, Step 2	Descriptive	Natural language processing	https://cloud.google.com/ai-platform/data-labeling/docs	Use: GFP Impact: **low** Timeline: **low** Complexity: **low**

- **Reliability taggings**: When gathering data automatically, analysing the quality / completeness / errors in columns of sheets can indicate how reliable it is. This can vary day by day for known datasets. Being able to indicate uncertainty/unreliability is of value for the analysis process later on.

Related IPC Function	Analytics Capability	ATARI Methods	Example	Potential for IPC
Function 2, Step 4	Diagnostic, Descriptive	Statistical methods	https://centre.humdata.org/clean-your-data-with-data-check/	Use: TWG, GFP Impact: **high** Timeline: **mid** Complexity: **mid**

- **Dashboards & data visualization:** Automatically generated dashboards from data sets can be presented in a consistent and meaningful manner to the IPC analysts. In particular thematic dashboards for Contributing factors (Hazards and vulnerability, Food access, Food utilization) and Outcomes (Food consumption, Nutritional status, Mortality) with the latest insights available are of high value.

Related IPC Function	Analytics Capability	ATARI Methods	Example	Potential for IPC
Function 2, Steps 4, 10	Diagnostic	Visualization	WFP World Hunger Map	Use: TWG, GFP Impact: **high** Timeline: **mid** Complexity: **mid**

C. Data Sharing

Data sharing refers to the ability of the IPC data management systems (i.e., the ISS in its current form and in the future) to be able to automatically share key data/information nuggets with other systems both within the IPC (e.g., the communication system) and external to the IPC (e.g., with partner organizations).

- **APIs for data output**: APIs provide an automated way to share data to IPC users and partners is via application programming interfaces. It allows users to integrate and process IPC results in their own processes. An API is a machine-to-machine protocol to request structured data, mostly in JSON format, given defined parameters, such as period and region. Specifically, REST APIs and GraphQL are good candidates to share results in computer networks.

Related IPC Function	Example	Potential for IPC
Function 3	UN Ocha's Humanitarian Data Exchange API	Use: TWG, GFP Impact: **high** Timeline: **low** Complexity: **low**

- **Robotic Process Automation for Data Output:** Robotic Process Automation (RPA) is a form of business process automation based on imitation of user actions. It proceeds by recording the user actions and then repeating it, aiding repetitive tasks of composing reports, sharing it via different channels, often requiring many manual steps.

Related IPC Function	Example	Potential for IPC
Function 3	-	Use: TWG, GFP Impact: **mid** Timeline: **mid** Complexity: **mid**

D. Analysis

Integrated food security analysis is inherently extremely complex, requiring evaluation of a wide range of indicators/data and the need to contextualize that data within the realities of a given situation. The current IPC processes are built on the central approach of human expert consensus building, which serves two main purposes: 1) it brings together multiple experts who have different perspectives and knowledge of a given situation, leading to a more complete and rigorous analysis, and 2) it builds key stakeholder ownership and buy-in on the IPC results, which is more likely to lead to a coordinated and timely response.

However, with both the emergence of new technologies and data sources as well as the increased global pressures to have more timely and complete global coverage of food security analysis, the ATARI initiative has identified a number of technologies which have potential to make the consensus building process more efficient as well as to potentially automate some or all aspects of the analysis.

- **Artificial Swarm Intelligence (ASI)**: ASI is a technology-enhanced approach to augmenting human intelligence and reaching consensus. It is based on the principle that humans working together--simultaneously and collectively--are able to create 'super human intelligence' that is better and more efficient than humans working individually or in a non-dynamic fashion. ASI is built on the same principles as 'swarms' in nature (e.g., bees, birds, fish, etc) that are able to solve complex challenges by working together. Unanimous AI is a leading technology provider that has built a ASI platform that can readily be used for IPC analysis. See this link for an ppt overview of Unanimous AI.

Related IPC Function	Analytics Capability	ATARI Methods	Example	Potential for IPC
Function 2, Steps 3	Diagnostic, Descriptive, Predictive	Boids, Clustering, Machine Learning	https://unanimous.ai/	Use: TWG, GFP Level: **high** Timeline: **low** Complexity: **low**

- **Food Security Nowcasting & Forecasting**: Integrated food security nowcasting and forecasting involves using AI and machine learning to partly/fully automate IPC Phase classifications (the World Bank ARTEMIS effort is a good example of this). This does not necessarily mean there is no human intervention , but rather that the time of experts is used more effectively, for reviewing and augmenting the automatic classification. Food security prediction is useful to get a more complete picture of the current situation with incomplete evidence, or to peek into likely future situations, driving anticipatory action.

Related IPC Function	Analytics Capability	ATARI Methods	Example	Potential for IPC
Function 2,Steps 4+10	Predictive	Classification and regression algorithms	https://documents.worldbank.org/en/publication/documents-reports/documentdetail/304451600783424495/predicting-food-crises	Use: GFP Impact: high Timeline: long Complexity: high

- **Indicator Nowcasting & Forecasting**: While food security nowcasting and forecasting tries to estimate the integrated IPC classification, indicator-specific modeling of indicators estimate useful measures (e.g. food consumption score, market prices, etc) from alternative sources that are more frequent or otherwise easier to come by than the original source (e.g. household surveys). It serves the purpose of predicting missing values of interest.

Related IPC Function	Analytics Capability	ATARI Methods	Example	Potential for IPC
Function 2,Steps 2+3	Predictive	Classification and regression algorithms	https://link.springer.com/article/10.1007%2Fs41060-020-00213-5	Use: GFP Impact: high Timeline: mid Complexity: high

- **Anomaly detection**: Anomaly detection would generate automated alerts when relevant changes take place (e.g, risk factor monitoring), and can form the basis of a data-initiated call to action. Economic shocks and hazards can be detected automatically.

Related IPC Function	Analytics Capability	ATARI Methods	Example	Potential for IPC
Function 2, Step 2	Diagnostic, Descriptive	Anomaly detection	https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2019EF001456	Use: GFP Impact: high Timeline: mid Complexity: mid

- **Analogous situations**: Analogous situation analysis uses machine learning to identify previous years to help assess a situation and determine the IPC classification. An interactive query tool could provide a set of historically similar situations and their outcomes as suggestions.

Related IPC Function	Analytics Capability	ATARI Methods	Example	Potential for IPC
Function 2, Step 4	Diagnostic, Descriptive	Collaborative filtering, Clustering, Pattern matching	-	Use: TWG, GFP Impact: **mid** Timeline: **long** Complexity: **mid**

- **Scenario builders**: Scenario builders leverage the power of trained models to shed light on most influential factors and explore alternative outcomes. Getting a feeling for the working of internal models by trying out different circumstances, yields insight on the robustness of an outcome, thus improving adoption of results.

Related IPC Function	Analytics Capability	ATARI Methods	Example	Potential for IPC
Function 2, Steps 9, 10	Diagnostic, Descriptive	Simulation & modelling	-	Use: GFP Impact: **high** Timeline: **long** Complexity: **high**

- **Interactive query systems**: Interactive query systems provide functionality akin to 'google searches' within the ISS, which would make searching and retrieving information from the ISS more accessible. Also known as automated dialogue systems, users can iteratively refine their query with text or voice to get tailored insights.

Related IPC Function	Analytics Capability	ATARI Methods	Example	Potential for IPC
Function 2, Steps 3	Diagnostic, Descriptive	Natural language processing, conversational agents, faceted search	Chatbot technology and personal assistants (Google Assistant, Siri, Amazon Alexa)	Use: GFP Impact: **low** Timeline: **long** Complexity: **mid**

- **Chatbot coach**: Chatbot technology can be used for personalized, self-paced education and guidance to TWG members. It can either pro-actively give feedback on assessments made by the user, or be used as a question answering mechanism to help assess a situation.

Related IPC Function	Analytics Capability	ATARI Methods	Example	Potential for IPC
Function 2, Steps 3	Diagnostic, Descriptive	Natural language processing, conversational agents, faceted search	Chatbot technology and personal assistants (Google Assistant, Siri, Amazon Alexa)	Use: GFP Impact: **low** Timeline: **mid** Complexity: **mid**

IV. Conclusions and Recommendations

1. General

A. There is an urgent need to integrate advanced technologies and artificial intelligence into the IPC, while continuing to design IPC processes for human-based analysis of acute food security classification. While human-based consensus and analysis processes will remain core to the IPC in the immediate term, this report identifies a number of technological opportunities for innovations to improve existing IPC processes conducted by TWGs--referred to here as Track 1. In addition, it is imperative that the IPC anticipate global needs for food security analyses, as well as global trends in technologies that can enable new and more efficient approaches to said food security analysis. If the IPC GSU does not make these investments, other initiatives will do so regardless of what the IPC does; this could potentially render the IPC obsolete. The IPC is already 'behind the curve' with regards to technological developments, and as such, there is an urgent need to make new technological investments and innovations.

B. Technology innovations for IPC will need to be accompanied by innovations in various IPC processes and protocols. An inefficient process with complex technology will not result in improved efficiency, but rather, in more inefficient processes. In order to enable the partnership to conduct analyses that are timely, frequent, robust and responsive to decision makers needs, technology advances will need to be implemented onto efficient processes, and will benefit from simple and clear protocols.

2. Priority Technologies for integration in IPC

This section describes the identification of immediate and longer-term opportunities for improving the IPC focusing on technologies that respond to the priority needs of analysts including data management and data analyses. Identification for priority technologies to be integrated in IPC is based on: 1) the potential value of the technology for the IPC, and 2) the likely complexity of implementation (see Graph 1 for a mapping of these technologies and Section III for a more detailed description of each).

A. The IPC should immediately invest in the integration of technologies that are of high value and ease of implementation. The technologies that have high value for IPC, and are neither complex or costly to be integrated in IPC processes and systems (in particular the ISS) recommended for immediate integration into existing processes include:

1. Artificial Swarm Intelligence (ASI) for consensus building and analysis.
2. Application Programing Interfaces (APIs) for data input and output
3. Robotic Process Automation (RPA) for data input and output

4. Web Scraping for information gathering
5. Dashboards and data visualizations for presentation of evidence to IPC analysts.

B. **The IPC should consider development of technologies identified as having high potential value to the IPC, but which are more complex to implement.** The technologies that would yield great value for IPC but require significant investments and as such are recommended for further exploration and potential development include:

1. Food security nowcasting and forecasting with AI and machine learning
2. Specific indicator nowcasting and forecasting with AI and machine learning
3. Automated anomaly detection for early warning
4. Analogous Situation analysis with machine learning
5. Scenario Building with machine learning
6. Summarization tools with natural language programming
7. Automated assessment of evidence Reliability Scores
8. Automated quality checks of household survey data used for IPC analysis purposes
9. Alternative data sources (e.g., social media, internet of things, etc)
10. Feature extraction from imagery (e.g., satellite imagery)

C. **Developing applications of AI and machine learning will require a certain level of financial investment that needs to be estimated and committed.** Building AI based analysis systems would require new sources of funding and partnerships to develop and maintain the systems. Further funding is specifically important to develop the technologies that have great value but are more complex to be integrated.

D. **The ATARI strategy should be built in a manner that compliments and links to existing efforts from partner agencies - and partners should also build their respective systems in a manner that supports the IPC.** One of the key strengths of the IPC is the strong international partnerships with organizations that have deep and wide expertise conducting food security analysis, and that are developing their own technological capacities to conduct food security analysis; and as such a strategic approach needs to be developed to make best use of these partners capabilities. As IPC partners plan their own technology development strategies, these efforts should also be linked and built into the IPC ATARI strategy.

E. **Technologies and innovations are potentially beneficial to a broad range of IPC processes.**
Technologies should be explored in a manner that is also beneficial to the additional aspects of IPC processes (e.g., communications, quality assurance, operations, etc.)

F. **The IPC Partnership should invest in prototyping technologies to increase the global coverage and frequency of food security analyses.** The ATARI initiative has identified and prototyped a number of technologies that would enable a global forecasting system. These technologies and innovations allow for a rethinking of the typical role IPC plays in country-level, TWG led analysis; and its ability to inform global decision making which requires increased global coverage and higher/regular frequency of food security forecasts. Prototypes to meet key criteria for a scalable global forecasting system should consider key lessons learnt from the ASI pilot, including 1) the need to have tools to build consensus in a more efficient manner with a clear end-point 2) the need to simplify and standardize tools and processes for human-based analyses 3) the need to maximize the potential of technology for gathering, processing and sharing evidence in a clear standard manner, and 4) to ensure evidence-based rigour of IPC analyses.