Examining the Alignment of the CARI and IPC Food Security Assessment Systems

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Executive Summary
CARI and IPC Alignment Study

Background

The World Food Programme (WFP) utilizes two complementary tools to assess and report acute food insecurity (AFI): the Integrated Food Security Phase Classification (IPC) and the Consolidated Approach for Reporting Indicators of Food Security (CARI). The IPC serves as the internationally recognized standard for area-level, consensus-based assessments, while CARI is WFP's internal, algorithm-driven tool for household-level classification.

Although AFI numbers reported by IPC are the global benchmark, its limited coverage – currently available in less than 60 countries – poses a challenge. In contrast, CARI is implemented across more than 80 WFP operational contexts.

To address this gap and strengthen global AFI reporting, this study assessed the comparability or alignment between IPC and CARI and examines how CARI can support IPC in operational and strategic decision-making within the broader humanitarian community. The study was conducted using IPC and CARI data from 11 IPC countries in Africa, Latin America and Middle East.

High Level Findings

- **Moderate area-level alignment:** Across 1,044 areas in 11 countries, the alignment of CARI and IPC classifications was moderate overall, with stronger alignment in Afghanistan, Djibouti, and Guatemala.
- **Strong country-level classification:** CARI demonstrated 80% sensitivity and 86% specificity in identifying countries with widespread food insecurity (IPC Phase 3+), suggesting it is effective at identifying vulnerable countries.
- **Difference in CARI and IPC AFI prevalence:** Consistent with previous IPC Accuracy Study findings that compared an average of AFI indicators to consensus results, CARI generally reports higher AFI prevalence than IPC. This may be due to IPC's consensus process.
- **Robust methodology:** Results were consistent across sensitivity tests and alternative indicator configurations. Modifications to CARI inputs did not improve alignment.
- **Strengths of the two methodologies:** CARI's strength is its quick and replicable approach to household level targeting. IPC strength is its consensus approach presenting a strong voice for advocacy, fund raising and policy.

Implications

- **When available, IPC should continue to be relied** on for global AFI numbers.
- **CARI results should inform IPC discussions** by offering an objective benchmark based on household-level data and food security indicators.
- **Though there is divergence between CARI and IPC numbers, stakeholders should accept this divergence** as driven by the different methods of aggregation (algorithm vs. consensus). Therefore, in places where IPC is not available, CARI results should be adopted as reliable for reporting AFI.
- **CARI supports rapid targeting and program planning** at the household level.
- **CARI is not a substitute for IPC**, but a rapid, transparent alternative where IPC is not available.

Recommendations

1. **Retain and improve CARI** as a standalone rapid assessment tool.
2. **For areas where IPC analysis does not exist, CARI** prevalence should be adopted as robust AFI numbers for global reporting and advocacy**.**
3. **Incorporate CARI outputs** into IPC to support the consensus process.
4. **Refine economic indicators** used by CARI to develop an alternative to FES and ECMEN that is a simpler asset-based or other type of economic indicator.
5. **Expand use of rCARI** to improve reach and inclusion of access-constrained areas in global AFI.
6. **Enhance training and guidance** to clarify CARI's role within and beyond IPC settings.
7. **Enhance and promote high data quality standards during household surveys to improve CARI outcomes.**
8. **Promote regular and timely CARI data sharing.**

Conclusion

CARI and IPC are both important tools. CARI provides rapid, household-level analysis for targeting and operational planning, while IPC enables consensus-building to support a unified voice for advocacy and coordinated action. Together, they form a robust framework for assessing and addressing acute food insecurity. Efforts should focus on enhancing CARI's visibility within the broader humanitarian community—not as a replacement for IPC, but as a rigorous, transparent, and reproducible tool. With strong indicator foundations and broad geographic coverage, CARI offers a credible alternative for estimating AFI prevalence, particularly in countries where IPC is not available. A stronger, reliable and robust CARI is the backbone of a robust IPC analytical framework.

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Tables and Figures

Acronyms

AFI	Acute Food Insecurity
CAR	Central African Republic
CARI	Consolidated Approach for Reporting Indicators of Food Security
CFSVA	Comprehensive Food Security and Vulnerability Assessment
CH	Cadre Harmonisé
CSI	Coping Strategies Index
ECMEN	Economic Capacity to Meet Essential Needs
EFSA	Emergency Food Security Assessment
ENSA	Evaluation Nationale de la Sécurité Alimentaire
FCS	Food Consumption Score
FES	Food Expenditure Share
FEWS	Famine Early Warning System Network
FSMS	Food Security Monitoring Systems
FSNAU	FAO's Food Security and Nutrition Analysis Unit
FSOM	Food Security Outcome Monitoring
HHS	Household Hunger Scale
IPC	Integrated Phase Classification
KII	Key Informant Interview
LCS	Livelihoods Coping Strategies indicator
LVAC	Lesotho Vulnerability Assessment Committee
MEB	Minimum Expenditure Basket
PLSA	Pre-Lean Season Assessment
rCARI	Remote Consolidated Approach for Reporting Indicators of Food Security
rCSI	Reduced Coping Strategies Index
SFSA	Seasonal Food Security Assessment
TWG	Technical Working Groups
VAM	Vulnerability Assessment and Mapping
WFP	World Food Programme

1. Introduction

When faced with an emergency or dealing with structural food insecurity, information can save lives. Who are the food insecure or vulnerable people? How many are there? Where do they live? How badly affected are they and which groups are affected the most? Answering these and other questions requires food security assessment systems to be in place in vulnerable areas.

Food security assessment and reporting are at the core of World Food Programme's mandate of addressing hunger and food insecurity. Food security is a multidimensional concept which requires a set of indicators for its measurement. Over time, several approaches have been developed to measure the magnitude and severity of food insecurity. It is crucial that these are transparent, compatible, and comparable in their results to transmit coherent messages to key stakeholders in order to trigger action. The Integrated Food Security Phase Classification (IPC) is a globally accepted, consensus driven analytical framework to inform stakeholders about the state of acute food insecurity. When IPC is not available, WFP and other actors rely on other recognized methodologies to assess food security and inform its operations. WFP adopted the Consolidated Approach for Reporting Indicators of Food Security (CARI) as a standard food security measurement methodology. First created in 2012, CARI is used to assess food security at the household level.

Given that both of these food security measurement approaches are actively used today, it is important to understand how they align with one another to effectively advise on their use. Thus, the *overall goal of this study* is to better understand the alignment of food security approaches and, to the extent possible, unify the communication regarding needs using a standard food security language.

To examine the alignment of CARI with IPC, *this study has four objectives*:

1. Articulate the history, context, purpose, and use of the two approaches;
2. Compare the two systems on measurement objectives, specific methods, and indicators;
3. Compare results at the area and national level;
4. Recommend changes, if appropriate, to CARI to better align with IPC.

In addressing these objectives, we focus on *two main questions*:

1. How do results on CARI classifications and IPC phases compare with each other across countries?
2. What are the advantages, if any, of having two systems that use different approaches?

2. History and use of the two approaches

The Integrated Food Security Phase Classification (IPC) was developed in 2004 as a common global tool for classifying the severity and magnitude of food insecurity and malnutrition, and to feed into strategic decision-making for food security interventions.

Initially IPC was developed to be used in Somalia by FAO's Food Security and Nutrition Analysis Unit (FSNAU). It later emerged as a multi-agency initiative, and provides a broad, consensus-based classification of food security at the area level. It incorporates both quantitative data, assumptions, and qualitative expert opinion, integrating a range of evidence to reflect the complexity of food security situations. It has become the accepted approach for informing response and resource allocation in a crisis context, in part because of its comprehensive consensus-building process among stakeholders, which ensures broader acceptance and validation of results. But it is also open to manipulation.[1]

IPC has processes for assigning prevalence and severity of acute food insecurity, chronic food insecurity, and malnutrition. Here we focus on acute food insecurity (AFI). The IPC has been regularly revised based on field applications and expert consultations. In August 2021, the Technical Manual Version 3.1 was released.[2] IPC uses primary data collected by several different assessments undertaken by partners to provide a snapshot of acute food insecurity, typically at a given administrative level (e.g., region, county, etc.). WFP is one of the largest providers of primary data that are used for IPC analyses, some of the same indicators that are used in CARI.

Table 1. IPC Acute Food Insecurity Reference Table

Phase	Household Group Condition
1-None	Able to meet essential food and non-food needs without engaging in atypical, unsustainable coping strategies
2-Stressed	Minimally adequate food consumption, but unable to afford some essential non-food expenditures without engaging in stress-coping strategies
3-Crisis	Food consumption gaps, OR, Marginally able to meet minimum food needs only with depletion of essential livelihood assets, or crisis-coping strategies
4-Emergency	Large food consumption gaps, OR, Mitigates consumption gaps with emergency livelihood strategies or asset liquidation
5-Catastrophe	Extreme lack of food, other basic needs even with full use of coping strategies. Starvation, death, destitution are evident.

Notes: Household group conditions adapted from IPC Technical Manual Version 3.1

[1] Daniel Maxwell and Peter Hailey. "The Politics of Information and Analysis in Famines and Extreme Emergencies: Synthesis of Findings from Six Case Studies." Boston: Feinstein International Center, Tufts University, 2020.
[2] IPC Global Partners, "Integrated Food Security Phase Classification (IPC) Technical Manual Version 3.1: Evidence and Standards for Better Food Security and Nutrition Decisions," 2021, https://www.ipcinfo.org/ipcinfo-website/resources/ipc-manual/en/.

At the core of the IPC AFI approach is a reference table describing the broad characteristics of household conditions across a color-coded continuum. **Table 1** displays an adaptation of this table from the latest technical manual. At each point on the continuum, the description includes a statement about the current food consumption of the household, connected to a statement about the status of their livelihood. For example, the food statements range from "able to meet essential food needs" to "food consumption gaps" to "extreme lack of food." Households that do not need to engage in unsustainable coping strategies to meet their needs are in the most favourable position with regard to their livelihood assessment, whereas those for which even full use of coping strategies is insufficient to avoid severe food insecurity are at the other extreme.

Key stakeholders (i.e., Technical Working Groups-TWGs) are brought together to consider food security indicators and contextual factors and build consensus on the area-level conditions using the color-coded breakdown described above. A key aspect of this process is the use of assumptions about market prices, exchange rate fluctuations, food assistance changes, local conflicts, and other factors that might have influenced changes between the time when data were collected and the "current period," when the IPC report is published. These assumptions are also used in projections, though in this report we do not focus on IPC projections to future periods.

Currently, IPC is conducted in 39 countries and its analogue, Cadre Harmonisé (CH), is conducted in 17 countries in West Africa. However, IPC/CH is not available for all 59 countries and territories with food crises identified by the 2024 Global Report on Food Crises (GRFC),[3] nor in all the 82 countries where WFP operates. When IPC is unavailable, WFP and other actors rely on other recognized methods to assess food security and inform its operations.

The Consolidated Approach for Reporting Indicators of Food Security (CARI) is one such method that was adopted by WFP. It was developed in 2012 to streamline the agency's food security measurement approach because, at the time, disparate methods were being used by country offices. A review of 29 reports from that time found that nine different methods were used to assess food insecurity.[4] Less than half of these methods included the Food Consumption Score (FCS). Many of these were "black box" approaches, using techniques that were opaque or developed for specific datasets. A standardized and small set of indicators was chosen that reflected availability on the different surveys used by field offices.

Since its adoption, CARI has been used for assessment of household food security, household-level profiling, targeting, and prioritization of people in need of assistance. CARI provides data for the purposes of household targeting and prioritization, which

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[3] FSIN and Global Network Against Food Crises. 2024. GRFC 2024. Rome. Available at: https://www.fsinplatform.org/grfc2024

[4] WFP, "Assessing Food Security at WFP: Towards a Unified Approach. Design Phase Report," Rome: Food Security Analysis Service, WFP, 2012.

goes beyond the possible use of the IPC. In December 2021, the CARI methodology was updated to enhance food security analysis, and to provide better alignment and compatibility with the new IPC version 3.1.[5] The guidance also recommended use of a new indicator, Economic Capacity to Meet Essential Needs (ECMEN), although this indicator was not available on the surveys analysed for this report.

CARI was developed to provide standardized information to WFP that is timely, simple, transparent, and actionable. Rather than a consensus process based on area-level classifications, CARI is based on a specific algorithm using household-level data from WFP surveys. Households are classified into food security categories based on a simple average of information about their current consumption and future coping capacity, the same two concepts that are central to the IPC's household reference table described above. This was intentional, so that WFP analysts at the country level could contribute relevant data to the IPC process. Also analogous to IPC, the categories are color-coded from green to red, indicating progressively worsening food security, with categories labelled food secure, marginally food secure, moderately food insecure, and severely food insecure (see **Table 2**).

Table 2. Comparison between CARI and IPC reference tables

CARI	IPC
1-Food secure	1-None
2-Marginally food secure	2-Stressed
3-Moderately food insecure	3-Crisis
4-Severely food insecure	4-Emergency
	5-Catastrophe

However, unlike IPC, CARI does not include a designation equivalent to the "catastrophe" or "famine" phase that is coloured dark red. This was intentional in the design of CARI, because action is needed by WFP when there is severe food insecurity (i.e., an emergency) to avoid things getting worse. If information guides action, for WFP, when there is an assessment of severe food insecurity, it is time to act.

[5] WFP, "Technical Guidance for WFP: Consolidated Approach for Reporting Indicators of Food Security (CARI) Guidelines," December 2021. https://docs.wfp.org/api/documents/WFP-0000134704/download/?_ga=2.82456470.1845913047.1729131304-1467195517.1667912790

Once an appropriate dataset is available, the CARI algorithmic approach allows an analyst to produce results quickly. This allows for internal monitoring and operational decision-making within the agency. It also allows for targeting assistance and prioritizing insufficient resources to specific areas or population groups identified in survey-collected variables, such as within refugee camps. As mentioned previously, it provides a needed alternative assessment in countries that do not have an IPC process. Finally, the process of preparing CARI, from data collection to analysis, allows WFP analysts to contribute needed data inputs to an IPC assessment.

IPC analyses are slower, typically only starting when data are made available by WFP and others. It involves a number of stakeholders who review more data inputs, consider their reliability and contextual appropriateness, and come to consensus based on this review. This consensus allows for a greater buy-in from local and international communities and assists with the communication around food insecurity using a more coordinated approach. On the negative side, this process also allows for interference from stakeholders with a particular agenda. **Table 3** summarises some of these and other differences between the two systems.

Table 3. Comparison of CARI and IPC first-level indicators

	CARI	IPC
Level of analysis	Household	Regional/area
Indicators	See Table 4 and Appendix Table 1 (full list)	
Outcome levels	Four (Food Secure; Marginally Food Insecure, Moderately Food Insecure, Severely Food Insecure)	Five (Phase 1-None/Minimal; Phase 2-Stressed; Phase 3-Crisis; Phase 4-Emergency; Phase 5-Catastrophe)
Primary use	Monitoring, targeting, operational decision-making	Current, projected status, policy decisions and coordination among multiple stakeholders
Developed by	World Food Programme	Multi-agency
Year developed	2012	2004
Approach	Algorithmic	Consensus (“convergence of evidence”)
Temporality	Cross-sectional	Cross-sectional and Projection of future outcomes
Data used	Single-survey dataset	Survey data from various sources
Analysts	Food security analyst	Technical Working Groups (multi-stakeholder)
Countries implementing	82	~56

In **Table 4**, we outline the indicators used in both CARI and IPC. CARI divides its indicators into those representing current food consumption status and those assessing a household's coping capacity. Current food consumption is assessed with the Food Consumption Score (FCS) and the Reduced Coping Strategies Index (rCSI). To assess a household's coping capacity, or its ability to access food in the face of future shocks, CARI includes indicators related to a household's income status and asset depletion. A household's Food Expenditure Share (FES) proxies for the former, while the Livelihood Coping Strategies indicator (LCS) can provide a proxy for asset depletion. These coping capacity indicators were in the initial design of CARI, but the 2021 guidance now suggests that a newer measure can substitute for the Food Expenditure Share when available, namely a household's Economic Capacity to Meet Essential Needs (ECMEN). This, too, is a measure of economic vulnerability and assesses the ability of the household to meet its needs by comparing a given household's expenditures to a Minimum Expenditure Basket (MEB).

IPC's first level outcomes also refer to characteristics of food consumption and livelihood change, though it takes a more complex approach to food consumption, including information on seven different indicators or approaches. These include the same two used by CARI, as well as five others. Energy intake, though it appears in IPC documentation, is rarely used due to challenges in data collection and processing.

IPC also uses second level indicators, which describe nutritional status (e.g. Global Acute Malnutrition based on weight-for-height z-scores) and mortality. It also includes food security contributing factors describing food availability, access, utilization, and stability, as well as water security and hazards and vulnerability.

Table 4. Comparison of IPC and CARI indicators and approaches

	CARI	IPC
Current status/ Food consumption	Food Consumption Score	Food Consumption Score
	Reduced Coping Strategies Index	Reduced Coping Strategies Index
		Household Dietary Diversity Scale
		Household Hunger Scale
		Food Insecurity Experiences Scale
		Energy intake
		Household Economy Analysis
Coping capacity/ Livelihood change	Livelihood Coping Strategies indicator	Livelihood Coping Strategies indicator
	Food expenditure share OR Economic capacity to meet essential needs	

Notes: See Appendix Table 1 for additional details on the indicators used in both systems.

CARI calculates an overall food security classification for each household with a simple average of that household's score on two summary indicators: current status and coping capacity. Each of these summary indicators, which are scored on a four-point scale based on the four food security classes in Table 2, are themselves combinations of two indicators. For current status, the FCS and the rCSI are combined by assigning households to one of the four food security categories as follows:

1 = Acceptable FCS
2 = Acceptable FCS and rCSI ≥ 4
3 = Borderline FCS
4 = Poor FCS

For coping capacity, a household's ECMEN or FES is converted to the 4-point scale, as is their LCS, and these two indicators are averaged together. See Appendix Table 3 and 4 for additional details how scoring CARI and how the results, including other indicators, are presented in console form.

3. Methods

3.1. Qualitative methods

Key informant interviews with administrators, practitioners, and scientists about CARI and IPC can provide contextual information about how the tools are used, problems seen in the field, and their acceptance in the donor community. We interviewed individuals from the following organizations:

- IPC Global Support Unit
- IPC Technical Advisory Group
- IPC Country Focal Point (South Sudan)
- IPC Technical Working Group (Yemen)
- Food Security Information Network (FSIN)
- FEWS Country Office (Somalia, Yemen)
- FAO Country Office (Yemen)
- FAO Data in Emergencies Hub (HQ)
- WFP Headquarters (RAM)
- WFP Regional Offices (East Africa, Middle East & North Africa)
- WFP Country-Level VAM and Program Offices
- University Professor

Interviews with key informants (n=13) were conducted online via Zoom and were recorded and automatically transcribed for analyses. Interviews were open-ended and varied depending on the particular roles and responsibilities of the individual, but in general followed a core set of questions to evaluate perspectives on the alignment of the two measurement systems (see Appendix Table 2 for the interview guide). All transcripts were reviewed by the study team and key themes were extracted. Interviews were analysed deductively, and because these interviews were exploratory, saturation was not prioritized. However, some themes, such as the specific utility of CARI vs. IPC were stated in many interviews, signalling convergence.

3.2. Quantitative methods

Datasets, provided by WFP, which included simultaneous area-level results on both CARI and IPC were available for eleven countries: Afghanistan, Burundi, Central African Republic, Djibouti, Ethiopia, Guatemala, Lesotho, Pakistan, South Sudan, Sudan, and Zimbabwe (Figure 1; Table 5).

The combined or "pooled" dataset included 1,044 time-place observations, that is, areas within countries (e.g. Kandahar province in Afghanistan) for a specific survey year (2021). Most countries had data from at least two years, except for Guatemala, Ethiopia, and South Sudan, which each had one.

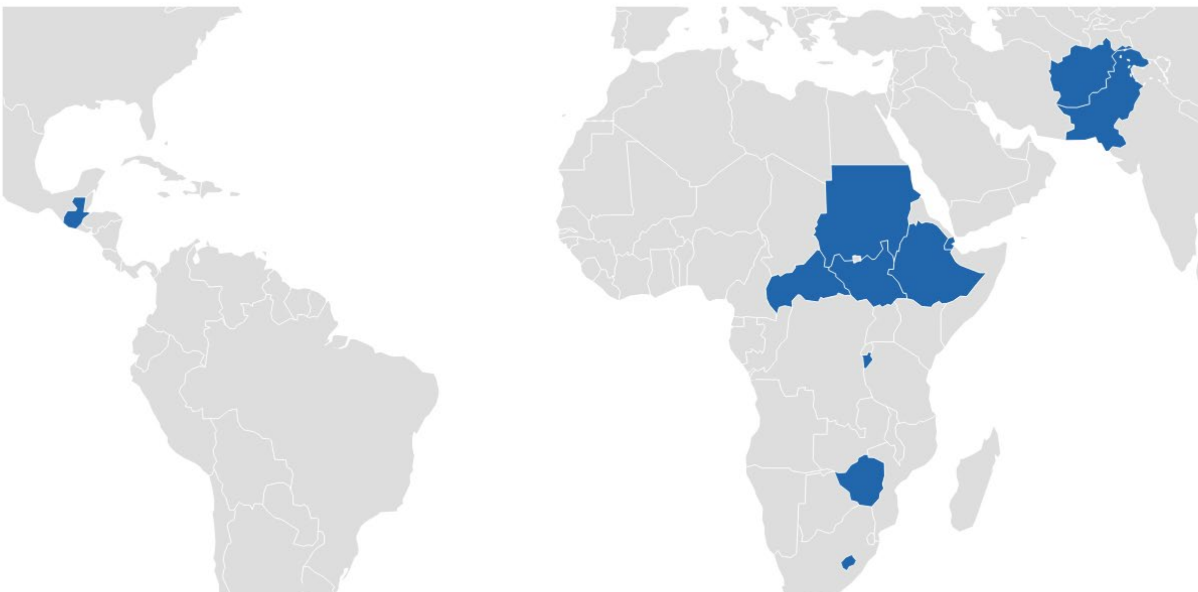

Figure 1. Map of countries with available CARI and IPC data

Table 5. Overview of data used in this analysis, by country and year

Country	Years of data collection
Afghanistan	2019, 2020, 2021[a]
Burundi	2020[a], 2021[a], 2022
Central African Republic	2020, 2021
Djibouti	2020, 2022
Ethiopia	2019
Guatemala	2022
Lesotho	2019, 2021
Pakistan	2019, 2020, 2021
South Sudan	2019
Sudan	2020, 2021
Zimbabwe	2019, 2020

[a] Indicates two separate rounds of data collection in the same year

For each geographic area, the available datasets included the percent of the sample in each of the IPC phases, as well as the percent in each of the CARI classes. IPC percentages were obtained from IPC reports by WFP analysts. CARI percentages were calculated by WFP analysts using standard procedures outlined in agency technical manuals.[6]

Because assessments were made from the two systems contemporaneously, we were able to compare performance of the two approaches, that is the prevalence rates in IPC phases with CARI classes. For our analyses, we focused on the percent of the combined population in IPC Phases 3 and 4, i.e., those in "crisis," or "emergency." We grouped them together, both to facilitate analysis and because of the overriding concern for intervention with this group at high risk of negative outcomes. This was the same strategy used in the IPC Accuracy Study.[7] Our comparisons of the prevalence rates in the combined IPC Phases 3 and 4 were made with CARI prevalence rates in the combined classes 3 and 4 (moderate and severe food insecurity). For conciseness of terminology, throughout this report, we refer to this population with the shorthand terminology of "high-risk" group, rather than spelling out "those experiencing crisis or emergency," or "those experiencing moderate or severe food insecurity."

For IPC, a given geographic area will be composed of households classified in various phases across the food security spectrum. For example, a given area might have 20% of the households classified in Phase 4, 10% in Phase 3, 40% in Phase 2, and 30% in Phase 1. However, it is important for IPC to highlight high priority areas, and colour coding an area on a map is one way to do this. To assign one phase (or colour) to an entire area, IPC uses the 20% rule.[8] This rule assigns the highest phase to an area which includes at least 20% of the population or more. In the above example, that area would be designated as "Phase 4," because 20% of the population was classified in phase 4. Another area in which 15% of the population was classified in Phase 4 and 10% in Phase 3, would get a designation of "Phase 3," because at least 20% of the population is Phase 3 or higher. We assigned areas with CARI classes using an analogous 25% rule following CARI guidance.

Our descriptive analysis begins with a basic frequency histogram indicating the percent of areas assigned by the above rules to each of the 4 IPC phases and 4 CARI classes. Underlying that visual representation is a contingency table, a 4 X 4 table, in which the percent in each phase or class are tabulated. We test the relationship between the two approaches with a chi-square test.

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[6] WFP, "Technical Guidance for WFP: Consolidated Approach for Reporting Indicators of Food Security (CARI) Guidelines," December 2021. https://docs.wfp.org/api/documents/WFP-0000134704/download/?_ga=2.82456470.1845913047.1729131304-1467195517.1667912790
[7] Lentz E, Baylis K, Michelson H, Kim C, "IPC Accuracy Study: Analyzing the internal consistency of the IPC AFI and AMN analyses, IPC, 2024.
[8] IPC Global Partners, "Integrated Food Security Phase Classification (IPC) Technical Manual Version 3.1: Evidence and Standards for Better Food Security and Nutrition Decisions," 2021, https://www.ipcinfo.org/ipcinfo-website/resources/ipc-manual/en/.

Understanding which areas have the largest high-risk populations would be useful for directing aid, so we ranked areas based on the size of their high-risk populations and compared the rankings from IPC and CARI using the Spearman’s Rank Correlation (or Spearman’s Rho), with a significance level set at 0.05.

Not only the ranking, but the size of the overall population in these high-risk groups is important. Thus, we use a t-test to examine whether there is a difference between the two assessment approaches in the mean area-wide “high-risk” population (i.e. IPC Phases ≥ 3; CARI classes ≥ 3) for a given country.

Finally, we used linear regression (OLS) models to assess the relationship between IPC (dependent variable) and CARI (independent variable) across the pooled sample and within each country, with the following specification:

$$IPC = \beta_0 + \beta_1 CARI + u$$

In these models, IPC and CARI represent the prevalence of households in the high-risk groups (i.e. in IPC phases ≥3 or CARI classes ≥3) obtained using each assessment approach. For the pooled sample, we included country-level fixed effects, as the areas within each country are not independent. We used the adjusted R^2 statistic to evaluate the proportion of variance in IPC that was explained by this model. Models with significant beta coefficients and an adjusted $R^2 > 0.25$ were considered to be an indication of a strong alignment of CARI with IPC. Cut-points for R^2 are arbitrary and based on conventions in different fields of study. In social science empirical modelling, an $R^2 \geq 0.1$ is acceptable.[9] In clinical medicine, where assessment test statistics often have parallels to those used in food security indicators, an $R^2 > 0.15$ is meaningful.[10] Lin and Wiegand (2023) have argued that an R^2 as low as 0.25 can have value in ecology for promoting additional exploration.[11] Our study is interdisciplinary, so taking conventions from these other fields into account, we settled on 0.25 as a conservative threshold.

A summary of the statistical tests and overall approach to evaluate the strength of the alignment of the two food security measurements approaches is outlined in Table 6. CARI and IPC were considered to be strongly aligned if the percent of areas assigned to each phase/class by the two approaches was significantly associated, if the ranking of area prevalence in high-risk categories agreed based on Spearman’s Rho, if the mean differences in area prevalence in high-risk classifications did not significantly diverge, and if CARI results area-level prevalence results are associated with those

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[9] Ozili, PK. "The acceptable R-square in Empirical Modeling for Social Science Research," SSRN Electronic Journal, 2022. DOI: 10.2139/ssrn.4128165.
[10] Gupta A, Stead TS, Ganti L. "Determining a Meaningful R-squared Value in Clinical Medicine. Academic Medicine and Surgery, 2024. DOI:10.62186/001c.125154.
[11] Lin Y, Wiegand K. "Low R^2 in Ecology: Bitter, or B-side?" Ecological Indicators. 2023;153:110406. DOI: 10.1016/j.ecolind.2023.110406.

from IPC. If these conditions were partially or not met, the two approaches were considered to be moderately or weakly aligned, respectively.

Table 6. Overall summary of tests and classification of degree of alignment

	Association of percent of areas assigned to IPC phases and CARI classes	Correlation of rankings of areas by prevalence in high-risk groups	Mean difference in area prevalence in high-risk groups	Association of IPC with CARI on prevalence in high-risk groups	Overall strength of alignment
Statistic	Chi-Square	Spearman's Rho	Paired T-test	B-coefficient, Adjusted R^2	Sum of alignment scores from each indicator
Results Table	Table 7	Table 8	Table 9	Table 10	Table 11
Strong (2 points)	—	≥ 0.61	Not significantly different	Beta-coefficient significant and Adjusted $R^2 > 0.25$	5-7 points
Moderate (1 point)	Significant association	0.41 – 0.60	Significantly different by < 10 pct points	Beta coefficient significant and Adjusted $R^2 \leq 0.25$	3-4 points
Weak (0 points)	Not significant	≤ 0.40 or not significant	Significantly different by ≥ 10 pct points	Beta-coefficient not significant	1-2 points

4. Results

The results section is divided into qualitative results from our key informant interviews (4.1) and quantitative results from both pooled and country-level datasets (4.2).

4.1. Key informant interviews

Key informants indicated that the CARI and IPC for AFI assessment are not used interchangeably. In countries with an active IPC, CARI results are withheld from public release to minimize confusion around food security indicators. However, CARI's underlying metrics, such as the Food Consumption Score (FCS), and the reduced Coping Strategies Index (rCSI), are usually incorporated into IPC processes. CARI provides granular data, allowing analysis of food insecurity at the household level, which is useful for parsing vulnerability among groups such as refugees and internally displaced persons (IDPs). While CARI uses a standardized algorithm, IPC is consensus-based and involves diverse stakeholders. The Famine Early Warning System Network (FEWS), is often labelled as “IPC compatible,” but lacks the consensus component of IPC, and is sometimes prioritized over CARI for understanding area-level acute food insecurity (AFI), when an IPC process is not established.

There is currently no established method to compare the food security estimates of CARI and IPC, though key informants noted that CARI may often indicate higher levels of food insecurity due to its objective, data-driven nature. IPC, on the other hand, is viewed as more conservative, perhaps because of contextual factors like influence from partner agencies, governments, or others surrounding an IPC process. However, during IPC discussions, Technical Working Groups (TWGs) sometimes come to consensus on higher phase classifications for projections, in anticipation of shocks, such as drought.

Data reliability and analysis are other areas of differentiation between CARI and IPC. CARI is viewed as more objective because it relies on standardized syntax. Some concerns, however, exist around potential overestimation of food insecurity, especially when indicators like the FES are considered, or when indicators like the FCS include cut-offs that may not capture dietary sufficiency among populations with monotonous diets.[12] The rCSI can also be problematic when demographics do not align with the surveyed population, as was noted in Ukraine where households were asked about children under-5, despite this age demographic not being present in many surveyed households. To the extent that IPC is influenced by these latter two indicators (FCS and rCSI), it can affect their estimates as well.

IPC’s reliability is influenced by its reliance on TWGs, which include members who may have vested interests in food security outcomes. In Yemen, for example, key informants cited government interference, data manipulation, and access issues as major challenges affecting IPC data quality in the North. This has been seen in other countries as well.[13]

4.2 Quantitative results

Quantitative results are divided into a section on the overall pooled dataset, and a section describing country level results.

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[12] Mivoet W, Becquey E, Van Campenhout B. “How well does the Food Consumption Score capture diet quantity, quality and adequacy across regions in the Democratic Republic of the Congo (DRC)?” Food Security 2019;11:1029-1049

[13] Daniel Maxwell and Peter Hailey. “The Politics of Information and Analysis in Famines and Extreme Emergencies: Synthesis of Findings from Six Case Studies.” Boston: Feinstein International Center, Tufts University, 2020.

4.2.1. Results on pooled data

We pooled data from eleven countries to assess the alignment of the CARI and IPC approaches across multiple regions, including eight countries in Africa, two in Asia, and one in Latin America. Most of the comparisons focused on the agreement between the two approaches in classification of households into the "high-risk" category, either the crisis or emergency phases for IPC, and the moderate or severe food insecurity categories for CARI.

Based on technical guidance, we assigned areas (N=1,044) to CARI classes based on the 25% rule, and IPC phases using the 20% rule (see methods, page 17, para 3). **Figure 2** displays a frequency histogram of the areas assigned to different IPC phases and CARI classes.

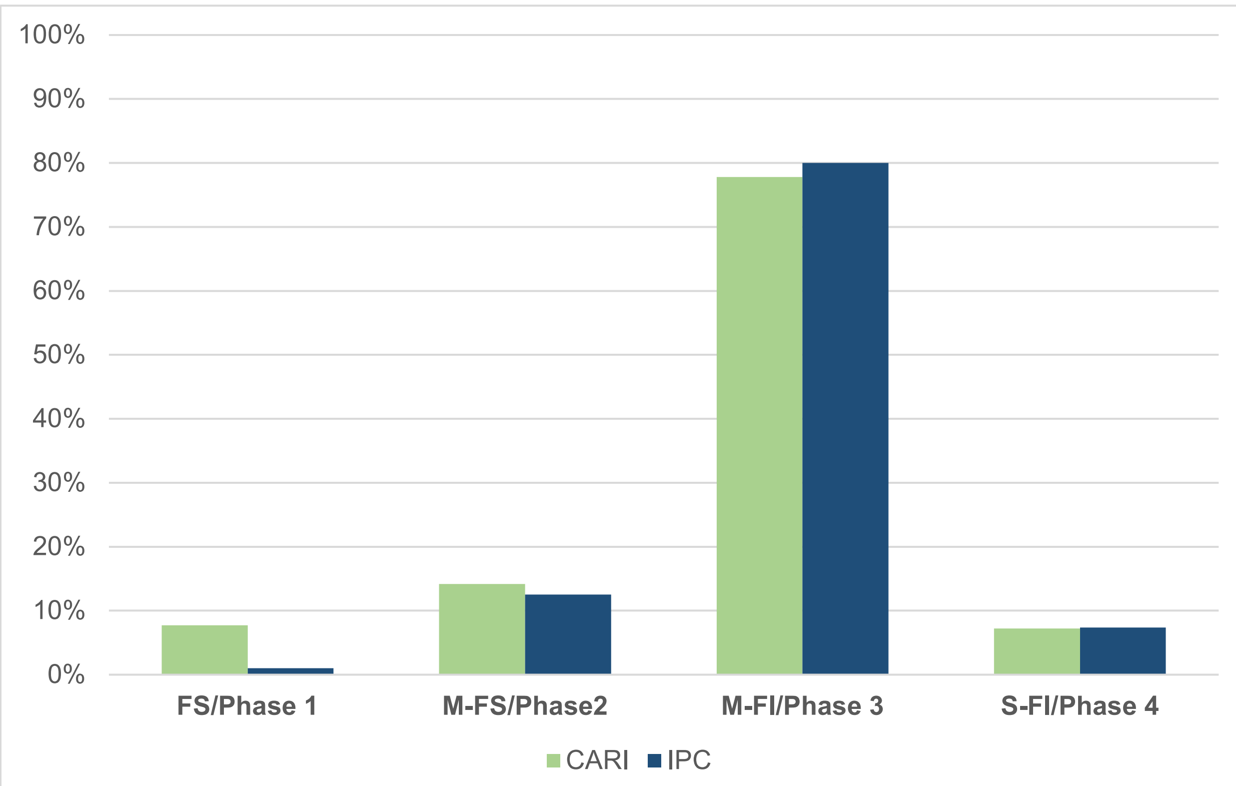

Figure 2. Distribution of areas into IPC Phases and CARI Classes (n=1,344).
Areas were classified using the 20% rule for IPC and the 25% rule for CARI (see page 17). CARI abbreviations: FS=Food Secure; M-FS=Marginally Food Secure, M-FI=Moderately Food Insecure; S-FI=Severely Food Insecure. See Table 1 for description of IPC Phases. χ^2 $p<0.001$.

Visually there seems to be relatively decent alignment, and the underlying contingency table shows a significant association between the two approaches (Appendix Table 21). Although CARI and IPC classify the same percent of areas into the phase/class 4, IPC assigns a slightly higher percent of areas to phase 3 than does CARI to moderate food insecurity (or class 3).

A ranking of areas by highest need can be important for assigning assistance. To assess if priority areas would rank similarly between the two approaches, we ranked areas based on the prevalence of their populations in high-risk categories and assessed this using Spearman's correlation coefficient. The analysis revealed a moderate alignment of CARI and IPC across the pooled dataset (rho: 0.58; $p<0.001$).

Assistance depends not only on prioritizing aid, but also on understanding the magnitude of need. We tested whether the mean area prevalence in high-risk categories differed between the two approaches. CARI results showed a mean prevalence of 42% in moderate and severe food insecure classes compared with 29% in IPC phases 3 and 4, a statistically significant difference of 14 percentage points (**Table 9**, first row).

If CARI overstates the prevalence in high-risk groups, it would be useful to see if this is consistent across areas. We developed a regression model to test this. Using the pooled data, we found a significant β-coefficient of 0.40 ($p < 0.001$), with a 95% confidence interval of 0.37-0.43. The adjusted R^2 was 0.38.

Overall, using our pooled dataset and criteria for assessment of alignment in Table 6, we found a moderate alignment of CARI with IPC, with an overall score of 4 out of 7 points.

4.2.2. Country-level results

Pooled results described above might differ by specific country. To better understand this, we applied our tests to data from each country. These results are described in this section.

As with the pooled data, we first compared the percent of areas in each country assigned to the different IPC phases and CARI classes using the 20% rule. **Table 7** reports the results of our Chi-Squared tests of association between IPC and CARI on this variable. We found significant associations for six of the countries: Afghanistan, Djibouti, Guatemala, South Sudan, Sudan, and Zimbabwe. For Burundi, Central African Republic, Ethiopia, Lesotho, and Pakistan, there was not a significant association between IPC and CARI. Frequency histograms for the percent of areas assigned to each IPC phase and CARI class based on guidance for the 11 countries are shown in the Appendix Figures 1-11. Cross-tabulations for these data are in Appendix Tables 22-32.

Table 7. Tests of association between IPC and CARI on percent of areas assigned to each phase/class[1] for pooled and country-level data.

Country (n=)	χ^2	p-value
Overall (1,044)	255.886	<0.001
Afghanistan (136)	29.799	<0.001
Burundi (40)	4.912	0.086
Central African Republic (115)	1.390	0.708
Djibouti (22)	6.600	0.010
Ethiopia (74)	1.254	0.534
Guatemala (22)	15.086	<0.001
Lesotho (20)	2.857	0.091
Pakistan (57)	4.470	0.107
South Sudan (78)	9.072	0.011
Sudan (360)	89.248	<0.001
Zimbabwe (120)	10.549	0.032

[1] IPC phase assigned using 20% rule; CARI class assigned using 25% rule.

Table 8. Correlation between IPC and CARI on the ranking of areas based on prevalence in high-risk groups, overall and by country

Country (n=)	Spearman's Rho	p-value
Overall (1,044)	0.578	<0.001
Afghanistan (136)	0.624	<0.001
Burundi (40)	0.421	0.007
Central African Republic (115)	0.152	0.105
Djibouti (22)	0.710	0.0004
Ethiopia (74)	0.082	0.489
Guatemala (22)	0.905	<0.001
Lesotho (20)	-0.202	0.392
Pakistan (57)	0.555	<0.001
South Sudan (78)	0.325	<0.001
Sudan (360)	0.561	<0.001
Zimbabwe (120)	0.336	0.0002

The correlation between the two measurement approaches in their area ranking based on the prevalence assigned to one of the high-risk categories (IPC/CARI ≥ 3) is displayed in **Table 8**. There was a strong correlation (rho ≥ 0.61) for Afghanistan, Djibouti, and Guatemala and a moderate correlation (0.41 ≤ rho ≤ 0.60) for Burundi, Pakistan, and Sudan, as well as for the overall pooled dataset. A weak correlation was shown in other countries.

We tested whether there was a difference between the two approaches in the mean area-wide prevalence of those assessed to be in the high-risk categories (**Table 9**). For most of the countries, there was a significant difference between the two measurement approaches, but this was not the case for Djibouti and Guatemala, indicating strong alignment of the two systems in these countries. For all other countries except Zimbabwe, CARI mean results were higher than those for IPC. For CAR, Ethiopia, and Zimbabwe, mean differences between IPC and CARI in the prevalence in high-risk groups were within 10 percentage points.

Table 9. Mean area prevalence in high-risk groups (IPC/CARI ≥3) for IPC and CARI and mean difference between them

Country (n=)	IPC Mean (SD)	CARI Mean (SD)	Mean difference	p-value
Overall (1,044)	0.287 (0.155)	0.423 (0.239)	-0.137	<0.001
Afghanistan (136)	0.383 (0.132)	0.700 (0.199)	-0.317	<0.001
Burundi (40)	0.100 (0.042)	0.234 (0.079)	-0.134	<0.001
Central African Republic (115)	0.422 (0.113)	0.493 (0.212)	-0.071	0.001
Djibouti (22)	0.216 (0.099)	0.231 (0.187)	-0.015	0.660
Ethiopia (74)	0.266 (0.097)	0.362 (0.101)	-0.095	<0.001
Guatemala (22)	0.223 (0.055)	0.230 (0.122)	-0.007	0.686
Lesotho (20)	0.180 (0.094)	0.312 (0.116)	-0.132	0.0014
Pakistan (57)	0.258 (0.072)	0.579 (0.199)	-0.321	<0.001
South Sudan (78)	0.548 (0.170)	0.723 (0.171)	-0.175	<0.001
Sudan (360)	0.203 (0.092)	0.356 (0.165)	-0.153	<0.001
Zimbabwe (120)	0.256 (0.097)	0.168 (0.053)	0.088	<0.001

As was done for the pooled data, we developed regression models to assess the association of the prevalence of those in IPC high-risk phases (IPC ≥ 3) with CARI prevalence in these categories. Models were significant in most countries, but not in the Central African Republic, Ethiopia, and Lesotho. For Afghanistan, Djibouti, Guatemala, Pakistan, and Sudan, the adjusted R^2 was greater than 0.25. See **Table 10** for additional details about these analyses.

Table 10. Regression analysis of area-level prevalence in IPC high-risk categories (dependent variable) using CARI high-risk prevalence

Country (n=)	Coef.	p-value	95% CI	Adjusted R^2
All sites (1,044)	0.397	<0.001	(0.366, 0.428)	0.376
Afghanistan (136)	0.420	<0.001	(0.332, 0.507)	0.396
Burundi (40)	0.200	0.018	(0.036, 0.363)	0.115
Central African Republic (115)	0.081	0.105	(-0.017, 0.180)	0.014
Djibouti (22)	0.288	0.009	(0.080, 0.496)	0.259
Ethiopia (74)	-0.004	0.973	(-0.230, 0.222)	-0.014
Guatemala (22)	0.396	<0.001	(0.294, 0.498)	0.754
Lesotho (20)	-0.107	0.578	(-0.504, 0.290)	-0.037
Pakistan (57)	0.215	<0.001	(0.137, 0.294)	0.344
South Sudan (78)	0.358	0.001	(0.147, 0.568)	0.118
Sudan (360)	0.339	<0.001	(0.293, 0.386)	0.365
Zimbabwe (120)	0.602	<0.001	(0.286, 0.919)	0.100

Table 11. Summary of strength of alignment of CARI with IPC by country

Country (n=)	Percent in each phase or class	Ranking of areas in high-risk prevalence	Mean difference in area high-risk prevalence	Strength of Assoc	Sum of scores, Strength of Alignment
Overall (1,044)	1	1	0	2	4, Moderate
Afghanistan (136)	1	2	0	2	5, Strong
Burundi (40)	0	1	0	1	2, Weak
Central African Republic (115)	0	0	1	0	1, Weak
Djibouti (22)	1	2	2	2	7, Strong
Ethiopia (296)	0	0	1	0	1, Weak
Guatemala (22)	1	2	2	2	7, Strong
Lesotho (20)	0	0	0	0	0, Weak
Pakistan (57)	0	1	0	2	3, Moderate
South Sudan (78)	1	0	0	1	2, Weak
Sudan (360)	1	1	0	2	4, Moderate
Zimbabwe (120)	1	0	1	1	3, Moderate

Finally, we calculated a simple overall index of alignment using each of the indicators described above and the approach outlined in Table 6. We found strong alignment of CARI with IPC in Afghanistan, Djibouti, and Guatemala (**Table 11**). We also found moderate alignment of the two assessment approaches for Pakistan, Sudan, and Zimbabwe, as well as for the overall pooled data. Data from five of the countries showed weak alignment.

We also repeated the main analyses presented above in tables 8-11, but this time considering prevalence in IPC Phase 4 or CARI Class 4. Overall results were similar, though not identical. Using the pooled dataset still showed a moderate alignment, and, as before, 6 countries were strongly or moderately aligned, while 5 were weakly aligned. There were changes for specific countries. Alignment dropped in Afghanistan from strong to moderate and in Djibouti from strong to weak. It improved in South Sudan from weak to moderate. See additional details about these results in Appendix Tables 5-8.

4.3. Results from sensitivity tests

To test the robustness of our results to different approaches, we examined three sets of alternatives to our basic approach by modifying our indicators of alignment for the:

1. Correlation of IPC and CARI on the ranking of areas with high-risk populations;
2. Mean difference in high-risk populations between IPC and CARI; and
3. Regression models of IPC with CARI, using alternative functional forms.

These sensitivity tests are described in the following sections.

4.3.1. Alternative scoring of the correlation of the ranking of areas

In our main analysis, we examined how each approach – IPC or CARI – ranked the areas within a country by their prevalence of those in the high-risk groups (Phase 3 and above). We used a Spearman correlation between those two rankings (see Table 8) and assessed the strength of that correlation using an established scoring criterion.[14] Specifically, a strong correlation was one with a Spearman's Rho that was significant and ≥ 0.61, while moderate and weak correlations were those between 0.41 and 0.60, and ≤ 0.40 or not significant, respectively (Table 6). To test the sensitivity of our results to a different criterion, we increased the thresholds between moderate and strong to 0.71 and that between weak and moderate to 0.51. This only affected the scoring on alignment for two countries and overall category of alignment for just one country, specifically, the alignment of CARI with IPC changed from strong to moderate in Afghanistan. See **Table 12** for additional details.

[14] Prion S, Haerling KA. "Making sense of methods and measurement: Spearman-Rho ranked-order correlation coefficient," *Clinical Sim Nurs* 2014;10:535-536.

Table 12. Sensitivity Analysis 1: Summary of changes in alignment of CARI with IPC using a different threshold for rating the correlation of the ranking of areas on prevalence in high-risk categories

	Strength of correlation of ranking of areas in high-risk prevalence		Overall strength of alignment (Sum of scores, Strength category)	
Country (n=)	Original analysis	Alternate criterion	Original analysis	Alternate Criterion
Overall (1,044)	1	—	4, Moderate	—
Afghanistan (136)	2	1	5, Strong	4, Moderate
Burundi (40)	1	0	2, Weak	1, Weak
Central African Republic (115)	0	—	1, Weak	—
Djibouti (22)	2	—	7, Strong	—
Ethiopia (74)	0	—	1, Weak	—
Guatemala (22)	2	—	7, Strong	—
Lesotho (20)	0	—	0, Weak	—
Pakistan (57)	1	—	3, Moderate	—
South Sudan (78)	0	—	2, Weak	—
Sudan (360)	1	—	4, Moderate	—
Zimbabwe (120)	0	—	3, Moderate	—

Table Notes: Scoring the strength of correlation: 2 = a significant Spearman's Rho ≥ 0.61; 1 = a Spearman's Rho of 0.41 – 0.60; 0 = a Spearman's Rho < 0.40 or not significant (same as Table 11, 2nd data column). Alternative criterion for strength of correlation adjusts to 0.51 and 0.71 instead of 0.41 and 0.61. "—" means there was no difference in the scoring with this adjustment. Sum of scores of 4 tests and categorical strength of alignment (same as Table 11, last data column).

4.3.2. Alternative scoring of the mean difference in prevalence

In our main analysis (Table 9), we examined the mean difference in area high-risk prevalence between the IPC and CARI approaches. If there was no significant difference between the two, we scored that a strong alignment, (2 points), if there was a significant difference, but the mean difference was <10 percentage points, we considered that a moderate alignment (1 point). If it was ≥10 percentage points, we considered it a weak alignment (0 points).

In our second set of sensitivity analyses (**Table 13**), we tested this threshold between moderate and weak alignment, either relaxing it to 15 percentage points or tightening it to 5 percentage points. With a more relaxed threshold, the scoring on this test "improved" for the overall sample and in 2 specific countries (Burundi and Lesotho). With a tighter threshold, the scoring on this test weakened in 3 countries (CAR, Ethiopia, and Zimbabwe). When aggregating the results from the revisions to this test with all our other tests, we found that the categorical strength of alignment – i.e., strong, moderate, or weak – changed only for two countries. With a more relaxed threshold on this mean difference test, the overall strength of alignment for Burundi changed from weak to moderate and the pooled sample changed from moderate to strong. With a tighter threshold, it changed Zimbabwe's alignment from moderate to weak.

Table 13. Sensitivity Analysis 2: Summary of changes in alignment of CARI with IPC using different thresholds for rating the mean difference

	Rating of mean difference in area high-risk prevalence based on different thresholds			Overall strength of alignment (Sum of scores, Strength category)		
Country (n=)	15%	Main analysis (10%)	5%	Alternate criterion 1	Main analysis	Alternate criterion 2
Overall (1,044)	1	0	—	5, Strong	4, Moderate	—
Afghanistan (136)	—	0	—	—	5, Strong	—
Burundi (40)	1	0	—	3, Moderate	2, Weak	—
Central African Republic (115)	—	1	0	—	1, Weak	0, Weak
Djibouti (22)	—	2	—	—	7, Strong	—
Ethiopia (74)	—	1	0	—	1, Weak	0, Weak
Guatemala (22)	—	2	—	—	7, Strong	—
Lesotho (20)	1	0	—	1, Weak	0, Weak	—
Pakistan (57)	—	0	—	—	3, Moderate	—
South Sudan (78)	—	0	—	—	2, Weak	—
Sudan (360)	—	0	—	—	4, Moderate	—
Zimbabwe (120)	—	1	0	—	3, Moderate	2, Weak

Table Notes: Scoring: 2 = no significant difference in area high-risk prevalence; 1 = mean difference < 10 percentage points; 0 = mean difference ≥ 10 percentage points. Alternate criterion 1, 2: thresholds between moderate and weak ratings were tested at 15% (data column 1) and 5% (data column 3) respectively.

4.3.3. Alternative models for regression analysis

Our main results for Table 10, testing the association of IPC with CARI on the proportion of the population in the high-risk groups were based on simple linear regression models. Country-level scatterplots of prevalence of households in IPC phase 3+ and CARI class 3+ are presented in Appendix Figures 13-23. To test whether a different functional form might show a stronger association, we examined two other functional forms – log-log and semi-log. We had assessed these models using two measures, whether the beta-coefficient on CARI was significantly different than zero, and whether the adjusted-R squared was greater than 0.25. Using this same approach, we did not find that alignment improved for any of the alternative models for any of the countries we examined. R-squared values improved for some countries with some models – for example in Djibouti, Guatemala, and Pakistan with the log-log specification (see Appendix Tables 9-12 for details) – but the R-squared values for these countries were already above our threshold to get maximum points on this test, so this did not change their evaluation.

Table 14. Sensitivity Analysis 3: Summary of changes in alignment of CARI with IPC using regression models with alternative functional forms

	Model rating			Overall strength of alignment		
Country (n=)	Original	Log-Log	Semi-log	Orig-inal	Log-Log	Semi-log
Overall (1,044)	2	—	—	4, M	—	—
Afghanistan (136)	2	—	—	5, S	—	—
Burundi (39)	1	—	—	2, W	—	—
Central African Republic (115)	0	—	—	1, W	—	—
Djibouti (22)	2	—	—	7, S	—	—
Ethiopia (74)	0	—	—	1, W	—	—
Guatemala (22)	2	—	—	7, S	—	—
Lesotho (20)	0	—	—	0, W	—	—
Pakistan (57)	2	—	—	3, M	—	—
South Sudan (78)	1	—	—	2, W	—	—
Sudan (360)	2	—	—	4, M	—	—
Zimbabwe (120)	1	—	—	3, M	—	—

W=Weak alignment, M=Moderate alignment, S=Strong alignment

4.3.4. Summary of results from sensitivity analyses

In sum, we did sensitivity testing with:

- One alternative to the correlation between CARI and IPC on the ranking of high-risk areas within a country (Tables 8 and 12),
- Two alternatives to the mean difference in area high-risk prevalence between the two systems (Tables 9 and 13), and
- Two alternative model types to assess association of high-risk prevalence in IPC with CARI data (Tables 10 and 14).

This amounts to five different sensitivity tests in 11 different countries plus the overall sample. Of these 60 tests, changes in our overall rating of alignment – strong, medium, or weak – deviated only four times from our original approach. Thus, our original results on evaluation of the alignment between CARI and IPC appear to be robust.

4.4. Results from examining alternative CARI approaches

CARI provides a composite assessment of food insecurity that is based on a household's current status and its coping capacity to withstand future shocks. According to current guidance from WFP,[2] four food insecurity indicators are used in this composite assessment: the Food Consumption Score (FCS), the reduced Coping Strategies Index (rCSI), the Food Expenditure Share (FES), and the Livelihood Coping Strategies (LCS). This is the main CARI indicator that we used in testing alignment with IPC, the results of which are described in Tables 7-11 above.

We wanted to know whether potential changes to the set of indicators in this basic CARI might influence CARI's alignment with IPC. For this work we examined two alternative specifications:

1. CARI without rCSI
2. CARI without FES

The first alternative, which is essentially the 2015 version of CARI, allowed us to evaluate whether the 2021 guidance might have modified alignment with IPC, specifically by including rCSI. It also provides a bridge to earlier work that was done with CARI-2015.

The second alternative allowed us to compare the current version of CARI with one that does not include FES. Some have argued for exclusion of this indicator because of challenges in collecting it, and because it may not be sensitive to acute changes in food security.

For these experiments, we used data from six countries: Burundi, Central African Republic, Guatemala, Lesotho, Sudan, and Zimbabwe. This includes one country in which CARI alignment with IPC was considered strong, two in which it was moderate, and three in which it was weak. We ran our four tests of alignment of IPC in each country with each of the two alternative specifications listed above.

The specific results of our analyses, which mirror Tables 7-11 above, can be found in Appendix Tables 13-19. **Table 15** below presents the summary of these results. Overall, we found very few changes with these alternative indicators. CARI without rCSI improved the alignment with IPC in only one country, Central African Republic, where it moved from a weak to a moderate alignment. This owed to improved alignment on two of our four tests, though no change on the other two (see Appendix Tables 17-19). In Guatemala, CARI without FES worsened the rating of alignment with IPC from strong to weak, with changes on three of our four tests.

Table 15. Summary of strength of alignment of CARI with IPC for different versions of CARI

	Sum of test scores, Overall strength of alignment		
Country (n=)	CARI	CARI w/o rCSI	CARI w/o FES
Burundi (40)	1, Weak	2, Weak	1, Weak
Central African Republic (114)	1, Weak	3, Moderate	1, Weak
Guatemala (22)	7, Strong	6, Strong	2, Weak
Lesotho (30)	0, Weak	0, Weak	0, Weak
Sudan (54)	3, Moderate	4, Moderate	3, Moderate
Zimbabwe (120)	3, Moderate	3, Moderate	3, Moderate

4.5. Comparisons with other studies

It is useful to discuss our results in light of other related studies. Two are particularly relevant for our work, the IPC Accuracy Study[15] and a study on the politics of information and analysis in food security crises.[16] We discuss both below.

4.5.1. The IPC Accuracy Study

Among other things, the IPC Accuracy Study compared IPC outcomes to an average of food insecurity indicators that are typically used individually by the Technical Working Groups as inputs for the IPC process. Although IPC cautions against using simple averages of food security indicators, the authors employed this strategy to examine the role that the IPC consensus process itself plays in food security assessment.

To make these comparisons, the authors took a simple average of the share of the population classified in phase 3 or above from each of four indicators: FCS, rCSI, LCS, and the Household Hunger Scale (HHS). Then they compared this to the share of the population assigned to these phases by the consensus process. For each specific area within a country, they evaluated whether the consensus process was more conservative (i.e. a lower percentage of the population in these high-risk groups) than the average of food security indicators would otherwise indicate, and calculated the overall frequency in a country in which this occurred.

This study suggests an opportunity to triangulate our results. Since we are assessing the alignment of IPC results to CARI, which is an average of food security indicators, we can evaluate whether IPC is more or less conservative than CARI. Thus, we employed a similar analysis as that of the IPC accuracy study to examine this question.

In the eight countries which were common to both studies, we found directionally similar results in seven of them. Specifically, the frequency of IPC consensus estimates being more conservative than their calculated approach (mean of food security indicators) was higher in the same six countries where we found IPC estimates to be more frequently conservative than CARI estimates, namely Afghanistan, Central African Republic, Ethiopia, Pakistan, South Sudan and Sudan. Both our studies found that Djibouti IPC estimates were more often <u>less</u> conservative than the calculated approach. Only in Guatemala did our results differ in direction, where we found the IPC estimates to be less conservative than our calculated approach (CARI), the opposite of what the IPC Accuracy Study found.

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[15] Lentz E, Baylis K, Michelson H, Kim C, "IPC Accuracy Study: Analyzing the internal consistency of the IPC AFI and AMN analyses, IPC, 2024
[16] Maxwell D, Hailey P. "Analyzing Famine: The Politics of Information and Analysis in Food Security Crises," Journal of Humanitarian Affairs 2021;3:16-27.

Although the two studies give qualitatively similar results in seven of the eight countries, there are, of course, limitations to these comparisons. CARI assesses food security at the household level and then aggregates that assessment across a sample. The IPC Accuracy Study assessed population estimates of food insecurity for each indicator and then averaged those results. Although three of the indicators are common to both approaches, CARI's calculation includes the Food Expenditure Share, whereas the IPC Accuracy Study used the Household Hunger Scale. But despite these differences, both studies indicate that the consensus process of IPC affects results in a way that does not exactly align with an average of food security indicators. As is seen in both the IPC Accuracy Study and in ours, the IPC consensus process more frequently provides conservative results (i.e. a lower population at risk), than a calculated approach.

4.5.2. Study on the politics of information and analysis

Our results from Table 9, as well as the discussion from the previous section indicate that where IPC differs from CARI, it is most of the time more conservative in its estimate of acute food insecurity. If the IPC consensus process provides more conservative results than a calculation based on food security indicators, this suggests that there might be influence, political or otherwise, in the Technical Working Groups that form the backbone of the IPC approach. Maxwell and Hailey examined some of the factors that put pressure on the independent assessment and information collection of acute food insecurity or famine.[17] Specifically, they compared case studies in six countries on the quality of information and the independence of analysis. Two of the six countries – South Sudan and Ethiopia – overlap with our sample. Others have written about difficultuies in reaching consensus in South Sudan and Somalia.[18,19]

Based on hundreds of key informant interviews, Maxwell and Hailey identified 18 factors within each country that could contribute to constraints on data collection and analysis. In South Sudan, all 18 of these factors were present and in Ethiopia, 17 of the 18 were noted. See Appendix Table 20 for a summary of these factors.

The implications for this study are clear. There is previously documented evidence of constraints in data collection and analysis that could lead to a divergence of the consensus process with a calculation based on indicators of the prevalence of acute food security. We found CARI's alignment with IPC to be weak in five countries. Two of these – South Sudan and Ethiopia – were previously studied. Although we cannot know the mechanisms that might have caused the specific discrepancies between IPC and CARI in these countries, they both display a wide range of constraints, be they in

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[17] Maxwell D, Hailey P. "Analyzing Famine: The Politics of Information and Analysis in Food Security Crises," Journal of Humanitarian Affairs 2021;3:16-27.
[18] Buchanan-Smith M, Cocking J, Sharp S. Independent Review of the IPC South Sudan. HPG Report. London: ODI; 2021. Available at: www.odi.org/en/publications/independent-review-ofthe-ipc-south-sudan.
[19] Buchanan-Smith M, Cocking J, Moallin Z. Independent review of the Integrated Food Security Phase Classification (IPC) Somalia. HPG commissioned report. London: ODI; 2023. Available at: www.odi.org/en/publications/independent-review-of-the-ipc-in-somalia.

data collection, analysis, or in stakeholder influence, which could account for this divergence.

4.6 A Country-Level Measure of Alignment

Given the difference in results found in algorithm- and consensus-based measures of food insecurity, both in our study and in the IPC Accuracy Study, we examined a rough country-level indicator of alignment that might be useful to trigger a country-level response in situations where IPC may not be available. For this indicator we analysed 22 separate country-year datasets and calculated the percent of areas which would be classified by IPC or CARI as high-risk, that is, in phase/class 3 and above.

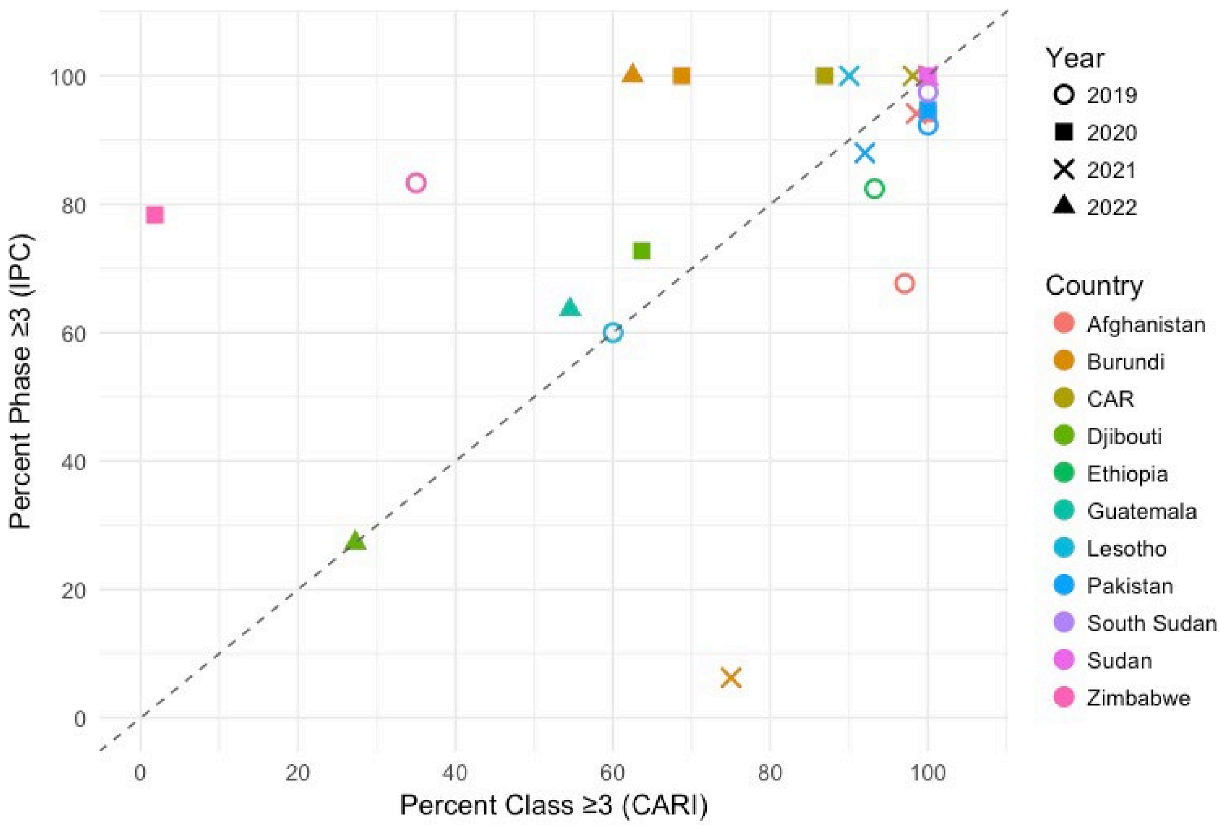

Figure 3. Scatterplot of percent of areas classified by IPC and CARI in phase/class 3+ by country and year

Figure 3 provides a scatterplot of these data. The dotted line is a 45-degree equivalence line, where IPC and CARI show the same percent of high-risk areas How well could CARI classify according to IPC? For purposes of this indicator, we considered countries with 80% of their areas so classified as particularly vulnerable. Our results indicated that CARI had a high sensitivity rate (80%) for classifying vulnerable countries (i.e. those with a high percentage of high-risk areas as indicated by IPC). CARI also had a high specificity rate (86%) for classifying those countries that were not vulnerable. We consider this a rough indicator of alignment because it does not examine correlation of results at the area level within countries as did our other indicators. But if the concern is for the overall need for action in a country, and only CARI is available, our evidence suggests that it will align pretty well with IPC.

5. Summary of Findings

We examined the alignment of two important food security assessment approaches, the Integrated Food Security Phase Classification (IPC) and the Consolidated Approach to Reporting of Indicators of Food Security (CARI). IPC is considered the gold standard for food security assessment by the international humanitarian community. Area-wide assessments of food insecurity are derived from a consensus process that makes use of a wide variety of indicators from various sources with standardized cut-points for food insecurity severity. CARI was developed and is used internally by the World Food Programme (WFP). It calculates food insecurity severity at the household level using a standardized algorithm with a few indicators, typically obtained from one survey dataset.

Our document review and key informant interviews made clear that CARI is an approach that can support IPC, a conclusion based on four different findings. First, CARI was originally designed to be used alongside IPC. In part, because of this original design requirement, the conceptual approach to food security used by CARI is analogous to that of IPC. For CARI, food security is about both current consumption and the ability to maintain consumption in the face of future shocks. This idea is at the core of IPC, forming the basis of IPC’s color-coded table in which each phase describes these two dimensions.

Second, there is overlap in the actual indicators used for the two approaches, with the Food Consumption Score (FCS), the Reduced Coping Strategies Index (rCSI), and the Livelihood Coping Strategies indicator (LCS) being common to both. This overlap is not just in the analysis phase. WFP surveys are used to collect data on these and many other indicators. Datasets from these surveys provide key inputs to the IPC process. Moreover, WFP in-country analysts often serve on IPC consensus panels, providing not only data inputs, but also insights into the conditions in which such data were collected.

Third, CARI summary results, on the prevalence of households in different food security classes, are only made public in countries where there is no IPC process. This can provide coverage on food security assessments for the dozens of countries without an IPC.

Fourth, because CARI is calculated at the household level, it allows for targeting and prioritization of needed assistance to specific areas or population groups identified in survey-collected variables, such as within refugee camps, or specific occupational groups that have suffered a livelihood breakdown (e.g., pastoralists, farmers). CARI’s algorithmic approach allows an analyst to produce results quickly. This makes the tool invaluable for internal monitoring and operational decision-making within WFP.

Our quantitative analysis of CARI and IPC was based on data from contemporaneous assessments in 11 countries. We developed and tested four indicators: (1) overall assignment of areas to IPC phases and CARI classes; (2) ranking of areas in their prevalence of those in high-risk (phases/classes ≥ 3); (3) difference between CARI and IPC in the mean area prevalence of those in high-risk groups; and (4) model results on the association of IPC with CARI area-level high-risk prevalence. We rated alignment using these indicators for the overall pooled dataset of 1,044 areas, as well as for each of the 11 countries. For each indicator, alignment was rated as either strong, moderate, or weak. We also developed a summary measure of alignment.

Our analyses of the overall pooled dataset revealed a moderate alignment of results from the two systems. CARI results on assignment of areas to different food security classes were significantly associated with assignment to IPC phases. The ranking of areas by CARI in terms of their prevalence in high-risk groups was moderately correlated with IPC rankings (rho = 0.58, $p < 0.001$). The CARI mean area prevalence in high-risk groups was significantly higher than IPC, overestimating it by about 14 percentage points. Modelling of IPC with CARI, showed a relatively strong association of the two approaches in five countries.

Our pooled dataset came from a collection of distinct countries: eight in sub-Saharan Africa, two in Asia, and one in Latin America. Country-level results provide insights into why CARI was only moderately aligned at the overall pooled dataset level. Specifically, we found strong alignment in three countries (Afghanistan, Djibouti, and Guatemala), moderate alignment in three countries (Pakistan, Sudan, and Zimbabwe), and weak alignment in five others (Burundi, Central African Republic, Ethiopia, Lesotho, and South Sudan). Thus, alignment using the overall dataset is influenced by countries where CARI aligns well and countries where it does not.

Our analysis of the mean difference in area prevalence for high-risk groups indicated significant differences between CARI and IPC for nine of the 11 countries, with eight of those nine showing an overestimate by CARI.

We conducted sensitivity analysis to examine whether our results were robust to modification of our tests of alignment. We examined changes to these tests in which we altered our thresholds for rating alignment either: (1) on the correlation of the ranking of areas in their high-risk prevalence; or (2) on the difference between CARI and IPC in the mean area prevalence of those in high-risk groups. We also conducted a third set of sensitivity tests by varying the functional form of our regression models. This amounted to seven different sensitivity tests in 11 different countries plus the overall sample. Of these 84 tests, changes in our overall rating of alignment – strong, medium, or weak – deviated only four times from our original approach. Thus, our original results on evaluation of the alignment between CARI and IPC appear to be robust to modifications of our alignment approach.

We also examined modifications to the CARI approach to see whether this might influence alignment. We tested two alternate specifications of CARI, one without rCSI and one without the Food Expenditure Share (FES). We studied this in six countries and ran the same four alignment tests that we used in our main analysis. Overall, we found very few changes with these alternative indicators. CARI without rCSI improved the alignment with IPC in only one country, Central African Republic, where it moved from a weak to a moderate alignment. In Guatemala, CARI without FES worsened the rating of alignment with IPC from strong to weak. These results alone do not provide sufficient justification to modify CARI's current specification.

It is not surprising that CARI overestimates IPC prevalence of high-risk groups, given similar results of the IPC Accuracy Study.[20] This study sought to examine the difference between assessments made with IPC input data tables and the IPC consensus process. It found that analysis of a suite of indicators (including FCS, rCSI, and LCS), using assigned cut-offs, overestimated food security prevalence compared to the consensus process. In most cases, the consensus process appears to dampen estimates of acute food insecurity, providing a more conservative approach. Case study work in six countries on the politics of information and analysis in food security crises provides a set of factors explaining why this might occur.[21] Almost all of these factors were present in the two countries which overlapped with our study, and in both, CARI's alignment with IPC was weak.

Given the difference in results found in algorithm- and consensus-based measures of food insecurity, both in our study and in the IPC Accuracy Study, we examined a rough indicator of alignment that might be useful to trigger a country-level response in situations where IPC may not be available. For this indicator we analysed 22 separate country-year datasets and calculated the percent of areas which would be classified by IPC or CARI as high-risk, that is, in phase/class 3 and above. Our results indicated that CARI had a high sensitivity rate (80%) for classifying vulnerable countries (i.e. those with a high percentage of high-risk areas as indicated by IPC). CARI also had a high specificity rate (86%) for classifying those countries that were not vulnerable. We consider this a rough indicator of alignment because it does not examine correlation of results at the area level within countries as did our other indicators. But if the concern is for the overall need for action in a country, and only CARI is available, our evidence suggests that it will align well with IPC.

In sum, using a suite of rigorous alignment indicators based on different tests of association at the area-level, the alignment of CARI with IPC is only moderate. It varies considerably by country, in some cases strong or moderate, but in about as many cases the alignment is weak. However, using a rough indicator of alignment at the country-level, CARI aligns pretty well with IPC, suggesting that it could be used as a proxy for a first-order of response, that is, choosing vulnerable countries in need of humanitarian assistance.

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[20] Lentz E, Baylis K, Michelson H, Kim C, "IPC Accuracy Study: Analyzing the internal consistency of the IPC AFI and AMN analyses, IPC, 2024.
[21] Maxwell D, Hailey P. "Analyzing Famine: The Politics of Information and Analysis in Food Security Crises," Journal of Humanitarian Affairs 2021;3:16-27.

6. Recommendations for Next Steps

These results raise a number of questions about future planning for the CARI system: Is it feasible or advisable to better align CARI with IPC? If the two approaches do not align, which one provides assessments closer to the true prevalence of food insecurity? Can CARI be improved, and, if so, how? Should CARI be sunsetted in favour of IPC? How should stakeholders in the humanitarian sector respond to classification differences between IPC and CARI? These questions are addressed in the following sections.

6.1. Feasibility or advisability of rigorous alignment

Is it feasible or advisable to better align CARI with IPC? No, it is not feasible to rigorously align CARI with IPC. We modified CARI, testing two alternate versions with different indicators in six countries, and did not get better alignment. We modified our tests of alignment, varying thresholds and other criteria and alignment did not improve. The IPC Accuracy Study found that the IPC consensus results did not align with an average of the food security indicators used for IPC in the 15 countries that it studied. In 12 of the countries, the consensus process most frequently gave results that were more conservative (i.e. with a lower prevalence of those in high-risk groups) than an average of food insecurity indicators.

For area-level assignment of food security status, an algorithm-based approach will not consistently produce the same results as a Technical Working Group (TWG) that operates based on consensus. Some of the same data are used by both TWGs during consensus and in CARI analysis, but how these and other indicators are weighted in the process to provide a food insecurity rate for a given area is a matter of discussion among human actors. TWG members may be influenced by their own work or that of others, including those employed by government or international agencies.

There are lags, typically months, between when data are collected and when an IPC process produces a report. To account for "current" conditions, TWG members make a number of assumptions about how conditions may have worsened or improved since data collection. These assumptions might address increases in market prices, exchange rate fluctuations, changes in humanitarian assistance, religious holidays (e.g. Ramadan), or updates on armed conflicts in particular areas. These factors are used to adjust prevalence rates from the original data, not based on weighting or modelling, but rather on individual perspective and discussion.

Technical working groups can be large, perhaps with even dozens of members. Their consensus results are not only influenced by all the above factors that might condition each member's individual perspective, but also by group dynamics. As with any multi-stakeholder process, group dynamics can shape consensus outcomes. Some members may have more authority, talk louder, or be more persistent in arguing their case.[22] To address this, IPC processes are guided by clear protocols for evidence inclusion, decision documentation, and facilitation. Independent reviews by the IPC Global Support Unit help mitigate undue influence and ensure methodological integrity. Even so, the myriad factors described above are multiplied by the group dynamics that influence the discussions that resolve those factors.

No algorithm can capture the complexity of differing human perspectives, discussions and group dynamics. Nor should it try. CARI provides one approach to food security assessment and IPC a different. Both are important and can be used together. See Section 6.5 below for continued discussion of this.

6.2. True prevalence of food insecurity

If the two approaches do not align, which one provides assessments closer to the true prevalence of food insecurity? This cannot be known. Food insecurity is a theoretical construct that cannot be observed directly. It is a latent variable that must be assessed by measuring other variables. As such, we can never know whether IPC or CARI gives a closer approximation to the true prevalence of food insecurity, because that prevalence cannot be known. This was also the case for the IPC Accuracy Study, in which the authors could not say whether the results from the IPC consensus were closer to true food insecurity rates than those of an average of indicators used in the IPC process. They could only assess which provided more conservative results than the other.

6.3. Potential sunsetting of CARI

If CARI does not rigorously align with IPC, and IPC is accepted by the international community, should CARI be ended? No, CARI was never designed as a substitute for IPC. Rather, it was set up as a quick, standard, and transparent way for WFP to analyse household data that provides an indicator of food insecurity for internal use, such as for targeting of resources within a country. In most cases when assistance is delivered, one cannot outwardly tell who are the most vulnerable. CARI provides an indicator on a household survey that can be used to model the demographics of the most vulnerable population. This allows for targeting using identifiable characteristics (e.g. household size or households headed by single women) along with community consultation.

Moreover, CARI, as the name implies, is an approach to reporting indicators. It is not just one indicator of food insecurity. In order to do a CARI assessment, one needs a household survey which gathers data on various indicators of food insecurity. Those indicators, such as the Food Consumption Score, reduced Coping Strategies Index, and Livelihood Coping Strategies index are used in the IPC process. WFP sponsors this

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[22] Daniel Maxwell and Peter Hailey. “The Politics of Information and Analysis in Famines and Extreme Emergencies: Synthesis of Findings from Six Case Studies.” Boston: Feinstein International Center, Tufts University, 2020.

work and is the main contributor of these data to the IPC process. The extra analytical work to generate a final CARI food security classification is trivial compared to collecting, cleaning, and analysing the data for the food security indicators. And these food insecurity indicators are vitally needed by IPC. In essence, without the WFP CARI apparatus (e.g., collection, cleaning, and distribution of indicator data that feeds into IPC analyses), an IPC process would not be as robust.

6.4. Future improvements to CARI

Can CARI be improved, and, if so, how? Yes, additional work could be done to improve CARI. But, the goal should not be alignment with IPC, per se, but rather creating a lighter, more nimble approach with higher quality data. Efforts in these directions are already being taken by WFP. A remotely-administered CARI (rCARI) has been developed and is undergoing validation work. Guidelines for improving data quality have also been developed.[23]

As part of this effort, WFP should consider removing FES and even ECMEN. Although these indicators cover an important economic dimension of food security, they are too cumbersome to be included on rapid surveys and too challenging for participants to answer accurately. If WFP ultimately drops FES and ECMEN because of respondent burden and survey cost, they should consider experimenting with a less intensive substitute. IPC documentation signals possible problems with the LCS because less vulnerable households may be more capable of changing livelihood strategies and asset levels, and thus may have a higher score.[24] A simple to collect checklist of assets has been used in many areas of the world as an indicator of wealth.[25] Although this needs to be tailored to specific areas, it could be used in combination with the LCS to provide another dimension to livelihoods. Combining indicators that address different dimensions of food insecurity is useful to having a well-rounded assessment approach, and this might accomplish this in a lower cost and less burdensome way than CARI's current economic indicator choices (FES or ECMEN).

Even in the absence of a new indicator tool to substitute for FES or ECMEN, it is still advisable to drop these indicators. In our six country study, dropping of FES made a difference to overall assessment in only one of the countries. It did make CARI results less aligned with those of IPC in this country, but this might be adjusted in the future with experiments on indicator weighting, i.e. weighting FCS, rCSI, and LCS equally. In the end, FCS, rCSI, and LCS are relatively simple tools that are well accepted and can

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[23] World Food Programme, WFP Data Quality Guidance Note for Food Security & Essential Needs Assessment and Monitoring, January 2025. Available at: resources.vam.wfp.org/planning/guidelines/data-quality-guidance

[24] IPC Global Partners, "Integrated Food Security Phase Classification (IPC) Technical Manual Version 3.1: Evidence and Standards for Better Food Security and Nutrition Decisions," 2021, https://www.ipcinfo.org/ipcinfo-website/resources/ipc-manual/en/.

[25] Rutstein SO. "Steps to constructing the new DHS Wealth Index," DHS Program. Available at: https://dhsprogram.com/programming/wealth%20index/Steps_to_constructing_the_new_DHS_Wealth_Index.pdf.

be added to different types of surveys, whether conducted by WFP or others. This gives additional opportunities for low-cost monitoring and learning from additional experience.

6.5. Stakeholder response to classification differences by the two approaches

How should stakeholders in the humanitarian sector respond to classification differences between IPC and CARI? Differing results from the two systems are likely to occur. Using rigorous area-level correlation indicators, we saw strong alignment between the two systems in only three of 11 countries. The IPC Accuracy Study only found one country out of 15, where results from the consensus process and those from an average of indicators aligned more frequently than not. The international humanitarian community needs to accept that results from the two systems will differ. Just as doctors base a medical diagnosis on many indicators that don't always align, so too must agencies when considering food insecurity. Food insecurity is a multi-dimensional concept, and indicators often capture different dimensions of the problem, so the correlation of food insecurity indicators is often moderate or even weak. It should be no surprise that the alignment of an aggregation of such indicators is no different.

Combining indicators for use in decisive action was a key motivation for creating both the IPC and CARI approaches. But the divergence in the methods used by these approaches – one by algorithm, one by human consensus – leads to divergence in results. But it also facilitates action. Consensus allows the donor community to be united on the need for an action. An algorithm provides quick results and the potential to target resources to those in greatest need within defined geographic areas.

Going forward, CARI results, not just CARI inputs, could be shared more frequently in the IPC process itself. To date, WFP has not consistently shared CARI results in countries where an IPC process is underway. In the past, this has made sense because it allowed the international community to get behind one set of results. Not sharing the results showed the agency's support for the IPC process and for not confusing communications about the results of this process. But CARI results have an important role to play in the IPC discussion. CARI sets an analytical benchmark for the core IPC approach of considering two "first-level" constructs – current food consumption AND livelihood change. It does it simply, equally weighting these concepts, with some of the same indicators used by IPC. This sort of information could be helpful in the consensus process itself to provide an additional reference point or baseline indicator for discussion. Although technical guidance suggests this possibility,[26] it does not appear to be implemented on a widescale.

Indeed, the IPC Accuracy Study authors used a simple average of indicators with which to compare IPC consensus results. Given there were typically five indicators available to them (FCS, rCSI, HHS, HDDS, and LCS), this approach implicitly weighted current

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[26] World Food Programme, "The CARI and the IPC," factsheet available at: https://library.ipcinfo.org/Acute%20Food%20Insecurity/IPC%20Thematic%20Material/6.%20Indicators%20for%20IPC/IPC%20vs%20ind.%20indicators/WFP_CARI%20and%20IPC.pdf

consumption four times more than livelihood change. CARI's advantage over a simple average of five indicators is a more balanced one-to-one weighting between consumption and livelihoods.

In situations where IPC is not available and not possible, then it clearly makes sense to use CARI. There is a longstanding history with the use of the CARI indicators as well as support in the scientific and programmatic literature for them. They are combined in a simple manner that reflects the key concepts of current consumption and livelihood coping capacity that are central to the IPC process and important to the international community. Moreover, CARI aligns well with IPC in classifying vulnerable countries – those with a high percentage of areas classified as high risk.

CARI plays an important role in the international community's efforts to assess and ultimately reduce food insecurity. It supports the functioning of IPC, providing needed inputs in countries where IPC operates, and needed summary assessments in countries where it does not. Use of CARI results in the ways suggested above, as an input to the IPC process where there is one, and as a standalone tool when there is not, will require additional communication and training about what CARI is and how it can support the work of IPC. In countries where an IPC process is active, it should not be seen as a substitute, but rather as an additional element to be used in consensus building. In countries where there is no IPC, CARI should be used with confidence. The indicators that make up the tool are strong, their combination is simple and transparent, it roughly corresponds to IPC on a country-level basis, and absent other comprehensive indicators, there is no other choice.

Appendix

Appendix Table 1. Comparison of CARI and IPC indicators and thresholds for food security classification

Tool	Domains	Indicator	Phase 1 (None/minimal)	Phase 2 (Stressed)	Phase 3 (Crisis)	Phase 4 (Emergency)	Phase 5 (Catastrophe/Famine)
			Food secure	Marginally food insecure	Moderately food insecure	Severely food insecure	NA
CARI	Current status	Food Consumption Score (FCS)[1]	>35 (Acceptable)	>35 (Acceptable)	21.5-35 (Borderline)	0-21 (Poor)	N/A
		Reduced Coping Strategies Index (rCSI)[1]	rCSI <4	rCSI ≥4	rCSI ≥4	rCSI ≥4	N/A
	Coping Capacity	Economic capacity to meet essential needs (ECMEN)*[2]	Total expenditure > Minimum Expenditure Basket (MEB)		Survival Minimum Expenditure Basket (SMEB) ≥Economic Capacity ≤Minimum Expenditure Basket (MEB)	Economic capacity ≤ Survival Minimum Expenditure Basket (SMEB)	N/A
		Food expenditure share (FES)*[2]	<50%	50-65%	65-75%	≥75%	N/A
		Livelihood Coping Strategies (LCS)[1]	None	Applied stress strategies	Applied crisis strategies	Applied emergency strategies	N/A
IPC	Food security first-level outcomes	Energy Intake	2,350 kcal/pp/day	2,100 kcal/pp/day	<2,100 kcal/pp/day	<2,100 kcal/pp/day	<2,100 kcal/pp/day
		Household Dietary Diversity Score (HDDS)	5-12 food groups (stable)	5 food groups, deterioration of ≥1 food group rom typical	3-4 food groups	0-2 food groups	0-2 food groups
		Food Consumption Score (FCS)[1]	>35 (Acceptable and stable)	>35 (Acceptable but deteriorating)	21.5-35 (Borderline)	0-21 (Poor)	0-21 (Poor)
	Second-level outcomes	Household Hunger Scale (HHS)	0 (None)	1 (Slight)	2-3 (Moderate)	4 (Severe)	5-6 (Severe)
		Reduced Coping Strategies Index (rCSI)[1]	0-3	4-18	≥19(NDC)	≥19 (NDC)	≥19 (NDC)
		Household Economy Analysis (HEA)	No livelihood protection deficit	Small or moderate	Livelihood protection deficit	Survival deficit ≥20% but <50%	Survival deficit ≥50%

				livelihood protection deficit <80%	≥80% or survival deficit <20%		
		Food Insecurity Experience Scale (FIES)	<-0.58	Between -0.58 to 0.36	>0.36 (NDC)	>0.36 (NDC)	>0.36 (NDC)
		Livelihood change	Sustainable livelihood strategies and assets	Stressed strategies and/or assets; reduced ability to invest in livelihoods	Accelerated depletion/erosion of strategies/assets	Extreme depletion/liquidation of strategies/assets	Near complete collapse of strategies and assets
		Livelihood Coping Strategies (LCS)[1]	No stress, crisis, or emergency coping observed	Stress strategies are the most severe strategies used by the HH in the past 30 days	Crisis strategies are the most severe strategies used by the HH in the past 30 days	Emergency strategies are the most severe strategies used by the HH in the past 30 days	Near exhaustion of coping capacity
		Global Acute Malnutrition (GAM) based on WHZ	<5% (acceptable)	5-9.9% (alert)	10-14.99% or > than usual	15-29.9% or >much greater than usual	≥30%
		Global Acute Malnutrition (GAM) based on MUAC	<5% (acceptable)	5-9.9%	10-14.9%	≥15%	≥15%
		BMI <18.5 kg/m2	<5%	5-9.9%	10-19.9%, 1.5x greater than baseline	20-39.99%	≥40%
	Second-level outcomes Contributing factors	**Crude death rate**	<0.5/10,000/day	<0.5/10,000/day	0.99/10,000	1-1.99/10,000/day or >2x reference	≥2/10,000/day
		Under-5 death rate	<1/10,000/day	<1/10,000/day	1-1.99/10,000/day	2-3.99/10,000/day	≥4/10,000/day
		Food availability, access, utilization, and stability	Adequate to meet short-term food consumption needs	Borderline adequate to meet food consumption requirements	Inadequate to meet food consumption requirements	Very inadequate to meet food consumption requirements	Extremely inadequate to meet food consumption requirements
		Water	≥15L/person/day	Safe water marginally ≥15L/person/day	Safe water > 7.5 to 15L/person/day	Safe water >3 to <7.5L/person/day	Safe water ≤3L/person/day

		Hazards and vulnerability[2]	None or minimal effects of hazards and vulnerability on livelihoods and food consumption	Effects of hazards and vulnerability stress livelihoods and food consumption	Effects of hazards and vulnerability result in a loss of assets and/or significant food consumption deficits	Effects of hazards and vulnerability result in large loss of livelihood assets and/or extreme food consumption deficits	Effects of hazards and vulnerability result in near complete collapse of livelihood assets and/or near complete food consumption deficits
*Either FES (used with ECMEN is unavailable) or ECMEN should be used to calculate CARI, not both **Non-defining characteristic (NDC) [1]Indicators used by both CARI and IPC [2]Adjacent/similar indicators used by CARI and IPC							

Appendix 2. Sample Interview Guide for CARI-IPC Alignment Study

Name of Interviewee:

Position titles:

Date:

We're conducting a CARI-IPC alignment student, and I wanted to get your insight on the two assessment systems. Can I record this?

1. Describe your involvement with the IPC or CARI?

2. Which one are you familiar with, or are you familiar with both?

3. What's been your experience in using CARI? In using IPC?

4. Have you looked at both IPC and CARI results for a particular country or region?

   (If the respondent answers no, then skip the next questions).

5. When you have, how do results on CARI classifications and IPC phases compare with each other across different countries?

6. Are there identifiable factors, either based on country context or measurement methodology, which affect their divergence?

7. Have the results from both systems been useful for governments or the donor community?

8. How does WFP use CARI results?

9. Do all indicators in CARI and IPC reflect short-term changes in food insecurity status associated with an acute condition.

10. What is the meaning of IPC-compatible, and what are the other IPC-compatible measurements in use today?

11. Is CARI, as currently used, IPC-compatible, or is there another adjective that applies to its interface with this system?

12. What is the importance of these distinctions?

13. What are the implications of there being 4 categories of food security in CARI and 5 in IPC? (Reasons for this?)

14. Is it advantageous to have two systems with different approaches, consensus vs algorithm, that use different units of analysis, (area-level (IPC) versus household-level (CARI)), etc.? (If so, what are they?)

15. How can communications be improved regarding the respective strengths of these approaches, or the synergies between them?

16. Do you have any recommendations for improvement for either of these? For IPC? For CARI?

17. Do you have recommendations for other people I should talk with….who…why

18. Can you recommend a country or region in which in-depth investigation should be conducted to examine the two systems in greater detail.

Appendix Table 3. Hypothetical CARI food security outcomes for different indicator combinations[1]

Indicator Combo	Current Status (CS)	Coping Capacity (CC)			Formula	Final food security outcome for household *Overall WFP Food Security Group*
	Food Consumption Score and rCSI	ECMEN	Food Exp. Share	Livelihood Coping Strategies Categories		
Scenario 1	Poor food consumption *(CARI scale 4)*	SMEB ≥ Economic capacity ≤ MEB *(CARI scale 3)*		Stress coping strategy *(CARI scale 2)*	$CS = 4$ $CC = \frac{3+2}{2} = 2.5$	(4 + 2.5)/2 = 3.25 *Moderately food insecure*
Scenario 2	Poor food consumption *(CARI scale 4)*		65% - <75% *(CARI scale 3)*	Crisis coping strategy *(CARI scale 3)*	$CS = 4$ $CC = \frac{3+3}{2} = 3$	(4 + 3)/2 = 3.5 *Severely food insecure*

(example indicator results in parentheses)

Appendix Table 4. Example of a completed CARI food security console[1]

Domain		Indicator	Food Secure (1)	Marginally Food Secure (2)	Moderately Food Insecure (3)	Severely Food Insecure (4)
Current Status	Food Consumption	*Food consumption groups and rCSI*	Acceptable 21.1%	Acceptable and rCSI>=4 30.3%	Borderline 36.2%	Poor 13.4%
Coping Capacity	Economic Vulnerability	*Economic capacity to meet essential needs*	Economic capacity > MEB 10.1%		SMEB ≥ Economic capacity ≤ MEB 18.4%	Economic capacity ≤ SMEB 71.5%
Coping Capacity	Livelihood coping strategies	*Livelihood coping strategies - food security*	No coping 66.0%	Stress 19.0%	Crisis 3.6%	Emergency 11.4%
CARI			30.1%	27.0%	25.3%	17.6%

[1] Tables taken from WFP, "Technical Guidance for WFP: Consolidated Approach for Reporting Indicators of Food Security (CARI) Guidelines," December 2021. https://docs.wfp.org/api/documents/WFP-0000134704/download/?_ga=2.82456470.1845913047.1729131304-1467195517.1667912790

Appendix Table 5. Correlation of area rankings based on prevalence in IPC Phase Class 4 and CARI Class 4

Country (n=)	Spearman's Rho	p-value
Overall (n=1,044)	0.451	<0.001
Afghanistan (n=136)	0.607	<0.001
Burundi (n=40)	-0.047	0.780
CAR (n=115)	0.071	0.448
Djibouti (n=22)	0.285	0.198
Ethiopia (n=74)	0.272	0.019
Guatemala (n=22)	0.778	0.0001
Lesotho (n=20)	-0.087	0.711
Pakistan (n=57)	0.348	0.008
South Sudan (n=79)	0.441	0.0001
Sudan (n=360)	0.303	<0.001
Zimbabwe (n=120)	0.287	0.002

Appendix Table 6. Mean area prevalence in IPC Phase Class 4 and CARI Class 4 and mean difference between IPC and CARI

Country (n=)	IPC Phase 4 Mean (SD)	CARI Class 4 Mean (SD)	Mean difference	p-value
Overall (n=1,044)	0.075 (0.071)	0.065 (0.086)	0.102	<0.001
Afghanistan (n=136)	0.121 (0.066)	0.165 (0.136)	-0.043	<0.001
Burundi (n=40)	0.005 (0.015)	0.014 (0.022)	-0.009	0.051
Central African Republic (n=115)	0.109 (0.059)	0.043 (0.064)	0.066	<0.001
Djibouti (n=22)	0.038 (0.043)	0.016 (0.026)	0.023	0.016
Ethiopia (n=74)	0.049 (0.037)	0.116 (0.058)	-0.067	<0.001
Guatemala (n=22)	0.023 (0.015)	0.011 (0.013)	0.012	<0.001
Lesotho (n=20)	0.023 (0.026)	0.026 (0.027)	-0.003	0.719
Pakistan (n=57)	0.065 (0.028)	0.058 (0.051)	0.007	0.275
South Sudan (n=79)	0.192 (0.119)	0.142 (0.110)	0.051	0.0005
Sudan (n=360)	0.047 (0.042)	0.032 (0.036)	0.016	<0.001
Zimbabwe (n=120)	0.064 (0.039)	0.034 (0.026)	0.029	<0.001

Appendix Table 7. Regression analysis to assess association of area-wide prevalence of households in IPC Phase 4 with CARI class 4

Country (n=)	Coef.	p-value	95% CI	Adjusted R^2
Pooled with country-level fixed effects[1]	0.285	<0.001	0.240–0.331	0.484
Afghanistan (n=136)	0.253	<0.001	(0.183, 0.323)	0.269
Burundi (n=40)	-0.042	0.702	(-0.264, 0.180)	-0.022
Central African Republic (n=115)	-0.018	0.841	(-0.191, 0.156)	-0.008
Djibouti (n=22)	0.642	0.076	(-0.073, 1.358)	0.107
Ethiopia (n=74)	0.167	0.025	(0.021, 0.314)	0.055
Guatemala (n=22)	0.910	<0.001	(0.559, 1.261)	0.574
Lesotho (n=20)	-0.058	0.801	(-0.531, 0.416)	-0.052
Pakistan (n=57)	0.221	0.002	(0.085, 0.357)	0.147
South Sudan (n=79)	0.453	<0.001	(0.231, 0.676)	0.166
Sudan (n=360)	0.487	<0.001	(0.377, 0.597)	0.172
Zimbabwe (n=120)	0.481	<0.001	(0.220, 0.743)	0.094

[1]Afghanistan, Burundi, Central African Republic, Djibouti, Ethiopia, Guatemala, Lesotho, Pakistan, South Sudan, Zimbabwe

Appendix Table 8. Summary of strength of alignment of CARI with IPC by country (IPC and CARI Phase/Class 4)

Country (n=)	Association of percent of areas assigned to IPC phases and CARI classes[1]	Correlation of rankings of areas by prevalence in Phase/Class 4[2]	Mean difference in area prevalence in Phase/Class 4[3]	Association of IPC prevalence in Phase/Class 4 with CARI[4]	Sum of scores, Strength of Alignment[5]
Overall (n=1,044)	1	1	0	1	3, Moderate
Afghanistan (n=136)	1	1	1	1	4, Moderate
Burundi (n=40)	0	0	2	0	2, Weak
Central African Republic (n=115)	0	0	1	0	1, Weak
Djibouti (n=22)	1	0	1	0	2, Weak
Ethiopia (n=74)	0	0	1	1	2, Weak
Guatemala (n=22)	1	2	1	2	6, Strong
Lesotho (n=20)	0	0	2	0	2, Weak
Pakistan (n=57)	0	0	2	1	3, Moderate
South Sudan (n=79)	1	1	1	1	4, Moderate
Sudan (n=360)	1	0	1	1	3, Moderate
Zimbabwe (n=120)	1	0	1	1	3, Moderate

[1]Significant chi^2 test (1 point), insignificant (0 points)
[2]Spearman's Rho ≥0.61 (2 points), 0.41-0.60 (1 point), ≤0.40 or non-significant (0 points)
[3]Mean difference not significant (2 points), significantly different by <10 percentage points (1 point), significantly different by ≥10 percentage points (0 points)
[4]Beta coefficient significant and R^2 >25 (2 points), Beta coefficient significant and R^2 ≤25 (1 point), Beta-coefficient not significant (0 points)
[5]Strong alignment (5-7 points), Moderate alignment (3-4 points), Weak alignment (1-2 points)

FUNCTIONAL FORMS

Appendix Table 9. Log-log regression analysis to of prevalence of IPC high risk categories from CARI high risk prevalence (Phase/Class ≥ 3)

Country (n=)	Coef.	p-value	95% CI	Adjusted R^2
All sites (1,044)	0.445	<0.001	(0.399, 0.490)	0.257
Afghanistan (136)	0.690	<0.001	(0.541, 0.839)	0.382
Burundi (40)	0.551	0.009	(0.145, 0.956)	0.147
Central African Republic (115)	0.037	0.306	(-0.035, 0.108)	0.001
Djibouti (22)	0.319	0.002	(0.135, 0.504)	0.377
Ethiopia (74)	-0.024	0.897	(-0.396, 0.348)	-0.013
Guatemala (22)	0.420	<0.001	(0.325, 0.516)	0.799
Lesotho (20)	-0.154	0.633	(-0.819, 0.511)	-0.042
Pakistan (57)	0.487	<0.001	(0.348, 0.627)	0.462
South Sudan (78)	0.405	0.004	(0.133, 0.677)	0.090
Sudan (360)	0.458	<0.001	(0.377, 0.538)	0.257
Zimbabwe (120)	0.472	0.001	(0.215, 0.729)	0.093

Appendix Table 10. Semi-log regression analysis of prevalence of IPC high risk categories from CARI high risk prevalence (Phase/Class ≥ 3)

Country (n=)	Coef.	p-value	95% CI	Adjusted R^2
All sites (1,044)	0.120	<0.001	(0.107, 0.132)	0.265
Afghanistan (136)	0.211	<0.001	(0.161, 0.261)	0.342
Burundi (40)	0.045	0.025	(0.006, 0.084)	0.105
Central African Republic (115)	0.013	0.338	(-0.014, 0.041)	-0.001
Djibouti (22)	0.065	0.007	(0.020, 0.110)	0.292
Ethiopia (74)	0.004	0.910	(-0.071, 0.080)	-0.014
Guatemala (22)	0.090	<0.001	(0.070, 0.111)	0.801
Lesotho (20)	-0.049	0.375	(-0.161, 0.064)	-0.009
Pakistan (57)	0.092	<0.001	(0.058, 0.125)	0.343
South Sudan (78)	0.199	0.002	(0.077, 0.320)	0.110
Sudan (360)	0.089	<0.001	(0.074, 0.104)	0.272
Zimbabwe (120)	0.111	<0.001	(0.051, 0.172)	0.095

Appendix Table 11. Regression of area-wide prevalence of IPC Phase 4 on CARI Class 4, overall and by country (natural log transformation)

Country (n=)	Coef.	p-value	95% CI	Adjusted R^2
All sites (n=1,044)	0.252	<0.001	(0.220, 0.284)	0.234
Afghanistan (n=136)	0.297	<0.001	(0.223, 0.371)	0.318
Burundi (n=40)[1]	–	–	–	–
Central African Republic (n=115)	-0.024	0.649	(-0.128, 0.080)	-0.010
Djibouti (n=22)	0.045	0.866	(-0.653, 0.744)	-0.240
Ethiopia (n=74)	0.082	0.303	(-0.076, 0.239)	0.002
Guatemala (n=22)	0.444	<0.001	(0.242, 0.645)	0.568
Lesotho (n=20)[1]	–	–	–	–
Pakistan (n=57)	0.092	0.075	(-0.009, 0.193)	0.043
South Sudan (n=79)	0.339	<0.001	(0.197, 0.481)	0.232
Sudan (n=360)	0.144	<0.001	(0.096, 0.193)	0.128
Zimbabwe (n=120)	0.155	0.009	(0.038, 0.271)	0.051
[1]Insufficient data available at IPC Phase 4 and CARI Class 4 levels for analyses				

Appendix Table 12. Regression of area-wide prevalence of IPC Phase 4 on CARI Class 4, overall and by country (semi-log transformation)

Country (n=)	Coef.	p-value	95% CI	Adjusted R^2
All sites (n=1,044)	0.029	<0.001	(0.025, 0.032)	0.212
Afghanistan (n=136)	0.034	<0.001	(0.025, 0.043)	0.300
Burundi (n=40)	-0.003	0.405	(-0.011, 0.005)	-0.009
Central African Republic (n=115)	-0.005	0.476	(-0.019, 0.009)	-0.006
Djibouti (n=22)	0.021	0.292	(-0.021, 0.062)	0.030
Ethiopia (n=74)	0.013	0.019	(0.002, 0.024)	0.061
Guatemala (n=22)	0.011	<0.001	(0.006, 0.017)	0.554
Lesotho (n=20)	-0.003	0.694	(-0.017, 0.011)	-0.052
Pakistan (n=57)	0.007	0.064	(0.000, 0.015)	0.047
South Sudan (n=79)	0.051	0.001	(0.023, 0.079)	0.139
Sudan (n=360)	0.015	<0.001	(0.010, 0.019)	0.107
Zimbabwe (n=120)	0.015	0.002	(0.005, 0.024)	0.070

CARI COMPARISON TESTS

Appendix Table 13. CARI Comparison Tests: Association between IPC and CARI on percent of areas assigned to each phase/class[1], for pooled and country-level data

Country (n=)	CARI		CARI without rCSI		CARI without FES	
	χ^2	p-value	χ^2	p-value	χ^2	p-value
Burundi (n=40)	4.912	0.086	0.526	0.769	3.158	0.206
Central African Republic (n=114)	1.304	0.521	2.417	0.491	3.918	0.141
Guatemala (n=22)	15.086	<0.001	10.476	0.001	2.337	0.311
Lesotho (n=30)	0.938	0.333	2.329	0.127	3.606	0.058
Sudan (n=54)	8.438	0.015	9.681	0.008	6.589	0.037
Zimbabwe (n=120)	16.749	<0.001	15.797	<0.001	19.248	0.001
[1]Class assigned based on 25% area-level threshold						

Appendix Table 14. CARI Comparison Tests: Spearman Correlation of Area Ranking Based on Prevalence in High-Risk Categories Between IPC and CARI, by Country

Country (n=)	CARI		CARI without rCSI		CARI without FES	
	Spearman's Rho	p-value	Spearman's Rho	p-value	Spearman's Rho	p-value
Burundi (n=40)	0.000	1.000	0.000	1.000	0.000	1.000
Central African Republic (n=114)	0.021	0.821	0.075	0.433	-0.112	0.232
Guatemala (n=22)	0.828	0.001	0.690	0.008	0.313	0.171
Lesotho (n=30)	-0.177	0.351	-0.279	0.146	-0.347	0.079
Sudan (n=54)	0.335	0.011	0.405	0.003	0.349	0.011
Zimbabwe (n=120)	0.371	<0.001	0.359	<0.001	0.294	0.001

Appendix Table 15. CARI Comparison Tests: Mean area prevalence in high risk categories (IPC/CARI ≥3) for IPC and CARI

Country (n=)	CARI				CARI without rCSI				CARI without FES			
	IPC Mean (SD)	CARI Mean (SD)	Dif.	p-value	IPC Mean (SD)	CARI Mean (SD)	Dif.	p-value	IPC Mean (SD)	CARI Mean (SD)	Dif.	p-value
Burundi (n=40)	0.100 (0.042)	0.234 (0.078)	-0.134	<0.001	0.100 (0.042)	0.149 (0.086)	-0.049	0.0004	0.100 (0.042)	0.232 (0.087)	-0.132	<0.001
Central African Republic (n=114)	0.422 (0.113)	0.493 (0.212)	-0.071	0.0010	0.422 (0.113)	0.413 (0.207)	0.009	0.647	0.422 (0.113)	0.581 (0.200)	-0.158	<0.001
Guatemala (n=22)	0.223 (0.012)	0.230 (0.122)	-0.007	0.686	0.223 (0.055)	0.184 (0.131)	0.039	0.047	0.223 (0.055)	0.431 (0.137)	-0.208	<0.001
Lesotho (n=30)	0.173 (0.079)	0.317 (0.112)	-0.143	<0.001	0.173 (0.079)	0.305 (0.116)	-0.132	<0.001	0.173 (0.079)	0.332 (0.117)	-0.158	<0.001
Sudan (n=54)	0.189 (0.085)	0.368 (0.133)	-0.178	<0.001	0.189 (0.085)	0.284 (0.145)	-0.095	<0.001	0.189 (0.085)	0.309 (0.123)	-0.119	<0.001
Zimbabwe (n=120)	0.256 (0.097)	0.190 (0.063)	0.066	<0.001	0.256 (0.097)	0.179 (0.062)	0.077	<0.001	0.256 (0.097)	0.108 (0.058)	0.147	<0.001

Appendix Table 16. CARI Comparison Tests: Linear Regression of IPC High Risk (Phase ≥3) Area Prevalence on CARI High Risk Area Prevalence

Country (n=)	CARI				CARI without rCSI				CARI without FES			
	Coef.	p-value	95% CI	Adjusted R^2	Coef.	p-value	95% CI	Adjusted R^2	Coef.	p-value	95% CI	Adjusted R^2
Burundi (n=40)	0.163	0.047	(0.002, 0.323)	0.078	0.158	0.031	(0.015, 0.301)	0.096	0.163	0.026	(0.020, 0.306)	0.103
Central African Republic (n=114)	0.081	0.105	(-0.017, 0.180)	0.014	0.118	0.021	(0.018, 0.217)	0.038	0.068	0.202	(-0.037, 0.173)	0.006
Guatemala (n=22)	0.396	0.000	(0.294, 0.498)	0.754	0.366	0.000	(0.267, 0.465)	0.735	0.311	0.000	(0.192, 0.429)	0.579
Lesotho (n=30)	-0.042	0.754	(-0.317, 0.233)	-0.032	-0.027	0.833	(-0.292, 0.237)	-0.034	-0.050	0.701	(-0.313, 0.213)	-0.030
Sudan (n=54)	0.398	0.000	(0.257, 0.538)	0.371	0.365	0.000	(0.236, 0.494)	0.371	0.420	0.000	(0.265, 0.575)	0.351
Zimbabwe (n=120)	0.758	0.000	(0.515, 1.001)	0.238	0.731	0.000	(0.477, 0.984)	0.210	0.938	0.000	(0.689, 1.187)	0.314

Appendix Table 17. Summary of strength of alignment of CARI with IPC by country

Country	Association of percent of areas assigned to IPC phases and CARI classes[1]	Correlation of rankings of areas by prevalence in Phase/Class ≥3[2]	Mean difference in area prevalence in Phase/Class ≥3[3]	Association of IPC with CARI on area prevalence in Phase/Class ≥3[4]	Sum of scores, Strength of Alignment[5]
Burundi	0	0	0	1	1, Weak
Central African Republic	0	0	1	0	1, Weak
Guatemala	1	2	2	2	7, Strong
Lesotho	0	0	0	0	0, Weak
Sudan	1	0	0	2	3, Moderate
Zimbabwe	1	0	1	1	3, Moderate

[1]Significant chi^2 test (1 point), insignificant (0 points)
[2]Spearman's Rho ≥0.61 (2 points), 0.41-0.60 (1 point), ≤0.40 or non-significant (0 points)
[3]Mean difference not significant (2 points), significantly different by <10 percentage points (1 point), significantly different by ≥10 percentage points (0 points)
[4]Beta coefficient significant and R^2 >25 (2 points), Beta coefficient significant and R^2 ≤25 (1 point), Beta-coefficient not significant (0 points)
[5]Strong alignment (5-7 points), Moderate alignment (3-4 points), Weak alignment (1-2 points)

Appendix Table 18. Summary of strength of alignment of CARI with IPC by country (CARI without rCSI)

Country	CARI without rCSI				
	Association of percent of areas assigned to IPC phases and CARI classes[1]	Correlation of rankings of areas by prevalence in Phase/Class ≥3[2]	Mean difference in area prevalence in Phase/Class ≥3[3]	Association of IPC with CARI on area prevalence in Phase/Class ≥3[4]	Sum of scores, Strength of Alignment[5]
Burundi	0	0	1	1	2, Weak
Central African Republic	0	0	2	1	3, Moderate
Guatemala	1	2	1	2	6, Strong
Lesotho	0	0	0	0	0, Weak
Sudan	1	0	1	2	4, Moderate
Zimbabwe	1	0	1	1	3, Moderate

[1]Significant chi^2 test (1 point), insignificant (0 points)
[2]Spearman's Rho ≥0.61 (2 points), 0.41-0.60 (1 point), ≤0.40 or non-significant (0 points)
[3]Mean difference not significant (2 points), significantly different by <10 percentage points (1 point), significantly different by ≥10 percentage points (0 points)
[4]Beta coefficient significant and R^2 >25 (2 points), Beta coefficient significant and R^2 ≤25 (1 point), Beta-coefficient not significant (0 points)
[5]Strong alignment (5-7 points), Moderate alignment (3-4 points), Weak alignment (1-2 points)

Appendix Table 19. Summary of strength of alignment of CARI with IPC by country (CARI without FES)

Country	CARI without FES				
	Association of percent of areas assigned to IPC phases and CARI classes[1]	Correlation of rankings of areas by prevalence in Phase/Class ≥3[2]	Mean difference in area prevalence in Phase/Class ≥3[3]	Association of IPC with CARI on area prevalence in Phase/Class ≥3[4]	Sum of scores, Strength of Alignment[5]
Burundi	0	0	0	1	1, Weak
Central African Republic	0	0	0	0	0, Weak
Guatemala	0	0	0	2	2, Weak
Lesotho	0	0	0	0	0, Weak
Sudan	1	0	0	2	3, Moderate
Zimbabwe	1	0	0	1	2, Weak

[1]Significant chi^2 test (1 point), insignificant (0 points)
[2]Spearman's Rho ≥0.61 (2 points), 0.41-0.60 (1 point), ≤0.40 or non-significant (0 points)
[3]Mean difference not significant (2 points), significantly different by <10 percentage points (1 point), significantly different by ≥10 percentage points (0 points)
[4]Beta coefficient significant and R^2 >25 (2 points), Beta coefficient significant and R^2 ≤25 (1 point), Beta-coefficient not significant (0 points)
[5]Strong alignment (5-7 points), Moderate alignment (3-4 points), Weak alignment (1-2 points)

Appendix Table 20. Data quality and consensus issues previously identified in two countries where IPC and CARI alignment is weak

Issues identified	South Sudan	Ethiopia
Data collection constraints		
Missing data	X	X
Uneven data quality	X	X
Timing, frequency, and coordination issues	X	X
Lack of data sharing between stakeholders	X	X
Constraints on collection and use of qualitative data	X	X
Analysis issues		
Limited participation/transparency	X	X
Consensus-based analysis	X	X
Loudest voice in the room	X	X
Goldilocks problem	X	X
Risk of false negatives	X	X
Politics of numbers (inflating number of people in need)	X	X
Political constraints and influences		
Political interference	X	X
Access issues	X	X
Missing information (especially mortality)	X	X
Numbers in need	X	X
Self-censorship	X	X
Right-skewed but truncated population distributions	X	

Table Notes: Table adapted from Tables 1-3 of Maxwell D, Hailey P. “Analyzing Famine: The Politics of Information and Analysis in Food Security Crises,” Journal of Humanitarian Affairs 2021;3:16-27.

Appendix Table 21. Cross-Tab Phase Class and CARI Class, Pooled Sample

phaseclass	cariclass 1	2	3	4	Total
1	0	1	0	0	1
	0.00	100.00	0.00	0.00	100.00
	0.00	0.68	0.00	0.00	0.10
	0.00	0.10	0.00	0.00	0.10
2	2	52	76	1	131
	1.53	39.69	58.02	0.76	100.00
	25.00	35.14	9.35	1.32	12.54
	0.19	4.98	7.27	0.10	12.54
3	6	95	694	41	836
	0.72	11.36	83.01	4.90	100.00
	75.00	64.19	85.36	53.95	80.00
	0.57	9.09	66.41	3.92	80.00
4	0	0	43	34	77
	0.00	0.00	55.84	44.16	100.00
	0.00	0.00	5.29	44.74	7.37
	0.00	0.00	4.11	3.25	7.37
Total	8	148	813	76	1,044
	0.77	14.16	77.80	7.27	100.00
	100.00	100.00	100.00	100.00	100.00
	0.77	14.16	77.80	7.27	100.00

Appendix Table 22. Cross-Tab Phase Class and CARI Class, Afghanistan

phaseclass	cariclass 2	3	4	Total
2	1	16	0	17
	5.88	94.12	0.00	100.00
	50.00	17.58	0.00	12.50
	0.74	11.76	0.00	12.50
3	1	67	24	92
	1.09	72.83	26.09	100.00
	50.00	73.63	55.81	67.65
	0.74	49.26	17.65	67.65
4	0	8	19	27
	0.00	29.63	70.37	100.00
	0.00	8.79	44.19	19.85
	0.00	5.88	13.97	19.85
Total	2	91	43	136
	1.47	66.91	31.62	100.00
	100.00	100.00	100.00	100.00
	1.47	66.91	31.62	100.00

Appendix Table 23. Cross-Tab Phase Class and CARI Class, Burundi

phaseclass	cariclass 2	3	Total
1	1	0	1
	100.00	0.00	100.00
	8.33	0.00	2.50
	2.50	0.00	2.50
2	10	28	38
	26.32	73.68	100.00
	83.33	100.00	95.00
	25.00	70.00	95.00
3	1	0	1
	100.00	0.00	100.00
	8.33	0.00	2.50
	2.50	0.00	2.50
Total	12	28	40
	30.00	70.00	100.00
	100.00	100.00	100.00
	30.00	70.00	100.00

Appendix Table 24. Cross-Tab Phase Class and CARI Class, Central African Republic

phaseclass	cariclass 1	2	3	4	Total
3	1	9	91	6	107
	0.93	8.41	85.05	5.61	100.00
	100.00	100.00	91.92	100.00	93.04
	0.87	7.83	79.13	5.22	93.04
4	0	0	8	0	8
	0.00	0.00	100.00	0.00	100.00
	0.00	0.00	8.08	0.00	6.96
	0.00	0.00	6.96	0.00	6.96
Total	1	9	99	6	115
	0.87	7.83	86.09	5.22	100.00
	100.00	100.00	100.00	100.00	100.00
	0.87	7.83	86.09	5.22	100.00

Appendix Table 25. Cross-Tab Phase Class and CARI Class, Djibouti

phaseclass	cariclass 2	cariclass 3	Total
2	9	2	11
	81.82	18.18	100.00
	75.00	20.00	50.00
	40.91	9.09	50.00
3	3	8	11
	27.27	72.73	100.00
	25.00	80.00	50.00
	13.64	36.36	50.00
Total	12	10	22
	54.55	45.45	100.00
	100.00	100.00	100.00
	54.55	45.45	100.00

Appendix Table 26. Cross-Tab Phase Class and CARI Class, Ethiopia

phaseclass	cariclass 2	cariclass 3	cariclass 4	Total
2	0	12	1	13
	0.00	92.31	7.69	100.00
	0.00	19.35	14.29	17.57
	0.00	16.22	1.35	17.57
3	5	50	6	61
	8.20	81.97	9.84	100.00
	100.00	80.65	85.71	82.43
	6.76	67.57	8.11	82.43
Total	5	62	7	74
	6.76	83.78	9.46	100.00
	100.00	100.00	100.00	100.00
	6.76	83.78	9.46	100.00

Appendix Table 27. Cross-Tab Phase Class and CARI Class, Guatemala

phaseclass	cariclass 2	cariclass 3	Total
2	8	0	8
	100.00	0.00	100.00
	80.00	0.00	36.36
	36.36	0.00	36.36
3	2	12	14
	14.29	85.71	100.00
	20.00	100.00	63.64
	9.09	54.55	63.64
Total	10	12	22
	45.45	54.55	100.00
	100.00	100.00	100.00
	45.45	54.55	100.00

Appendix Table 28. Cross-Tab Phase Class and CARI Class, Lesotho

phaseclass	cariclass 2	cariclass 3	Total
2	2	12	14
	14.29	85.71	100.00
	40.00	80.00	70.00
	10.00	60.00	70.00
3	3	3	6
	50.00	50.00	100.00
	60.00	20.00	30.00
	15.00	15.00	30.00
Total	5	15	20
	25.00	75.00	100.00
	100.00	100.00	100.00
	25.00	75.00	100.00

Appendix Table 29. Cross-Tab Phase Class and CARI Class, Pakistan

phaseclass	cariclass 2	3	4	Total
2	1	4	0	5
	20.00	80.00	0.00	100.00
	50.00	7.41	0.00	8.77
	1.75	7.02	0.00	8.77
3	1	50	1	52
	1.92	96.15	1.92	100.00
	50.00	92.59	100.00	91.23
	1.75	87.72	1.75	91.23
Total	2	54	1	57
	3.51	94.74	1.75	100.00
	100.00	100.00	100.00	100.00
	3.51	94.74	1.75	100.00

Appendix Table 30. Cross-Tab Phase Class and CARI Class, South Sudan

phaseclass	cariclass 3	4	Total
2	2	0	2
	100.00	0.00	100.00
	3.28	0.00	2.53
	2.53	0.00	2.53
3	36	4	40
	90.00	10.00	100.00
	59.02	22.22	50.63
	45.57	5.06	50.63
4	23	14	37
	62.16	37.84	100.00
	37.70	77.78	46.84
	29.11	17.72	46.84
Total	61	18	79
	77.22	22.78	100.00
	100.00	100.00	100.00
	77.22	22.78	100.00

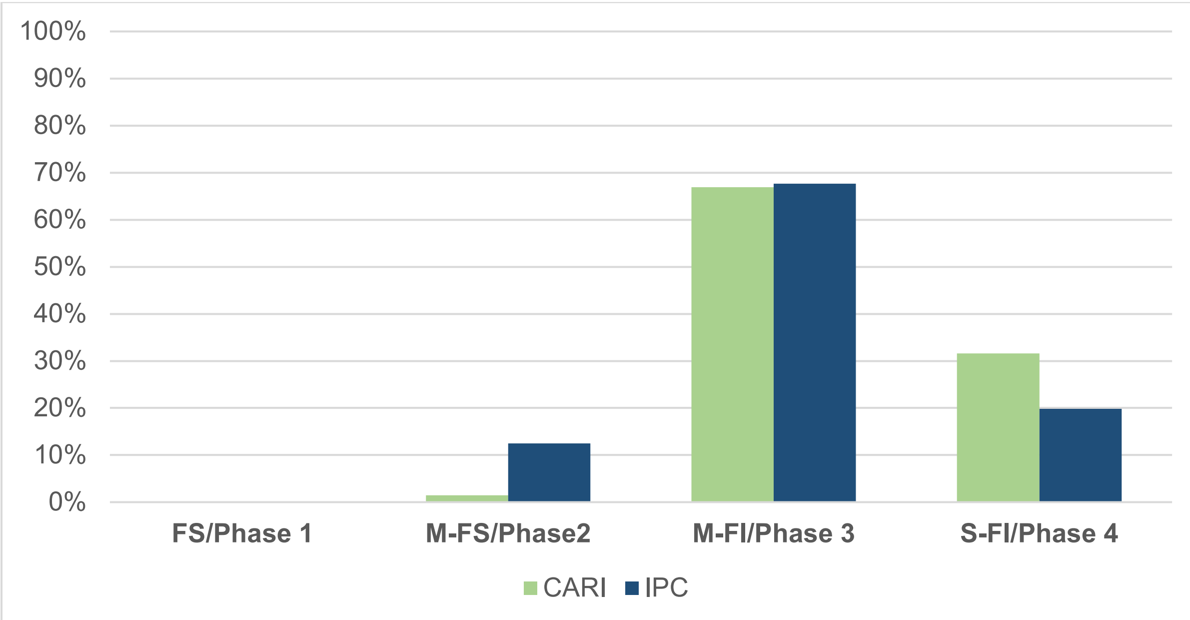
Appendix Table 31. Cross-Tab Phase Class and CARI Class, Sudan

phaseclass	cariclass 3	cariclass 4	Total
3	356	0	356
	100.00	0.00	100.00
	99.16	0.00	98.89
	98.89	0.00	98.89
4	3	1	4
	75.00	25.00	100.00
	0.84	100.00	1.11
	0.83	0.28	1.11
Total	359	1	360
	99.72	0.28	100.00
	100.00	100.00	100.00
	99.72	0.28	100.00

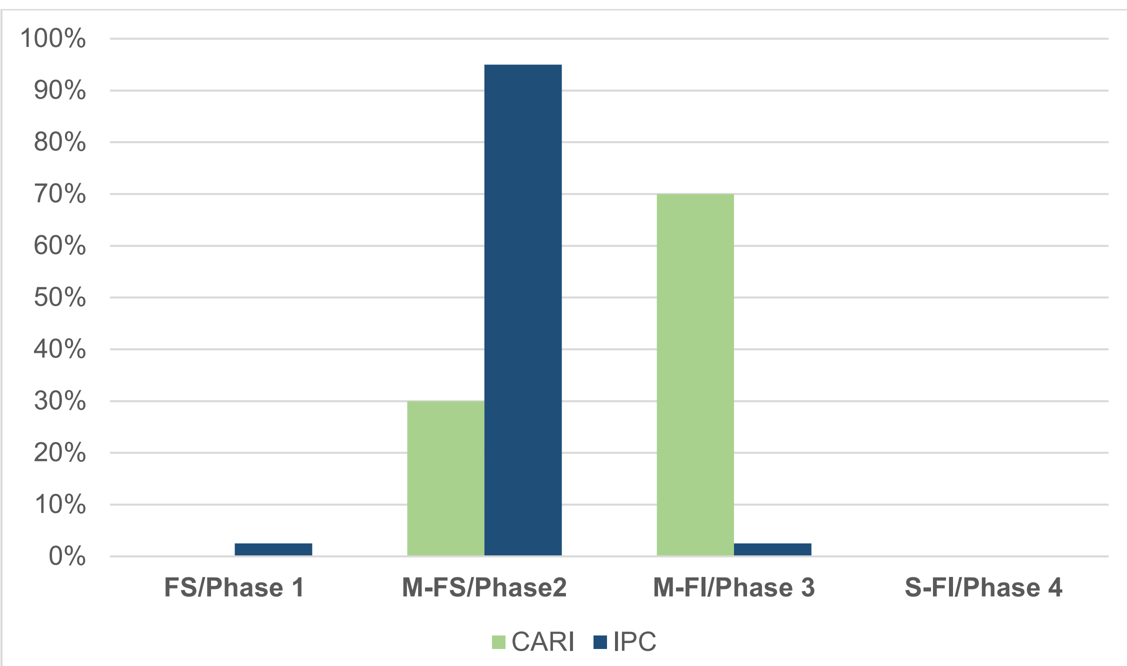
Appendix Table 32. Cross-Tab Phase Class and CARI Class, Zimbabwe

phaseclass	cariclass 1	cariclass 2	cariclass 3	Total
2	2	21	0	23
	8.70	91.30	0.00	100.00
	28.57	23.08	0.00	19.17
	1.67	17.50	0.00	19.17
3	5	70	21	96
	5.21	72.92	21.88	100.00
	71.43	76.92	95.45	80.00
	4.17	58.33	17.50	80.00
4	0	0	1	1
	0.00	0.00	100.00	100.00
	0.00	0.00	4.55	0.83
	0.00	0.00	0.83	0.83
Total	7	91	22	120
	5.83	75.83	18.33	100.00
	100.00	100.00	100.00	100.00
	5.83	75.83	18.33	100.00

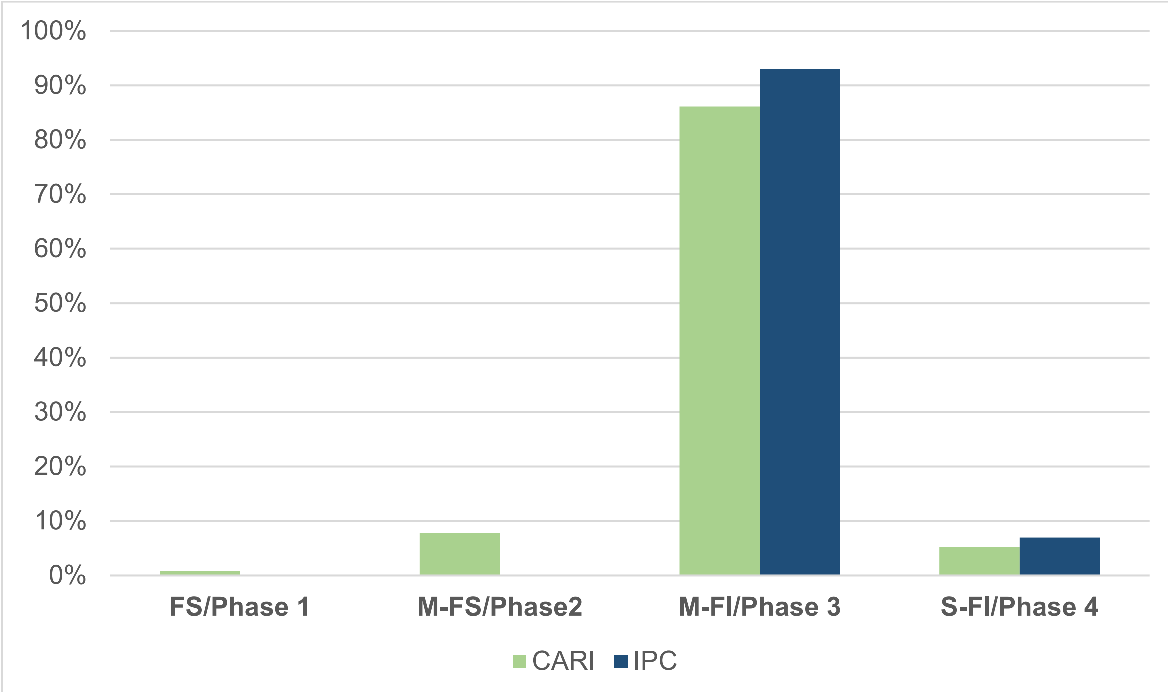
FIGURES



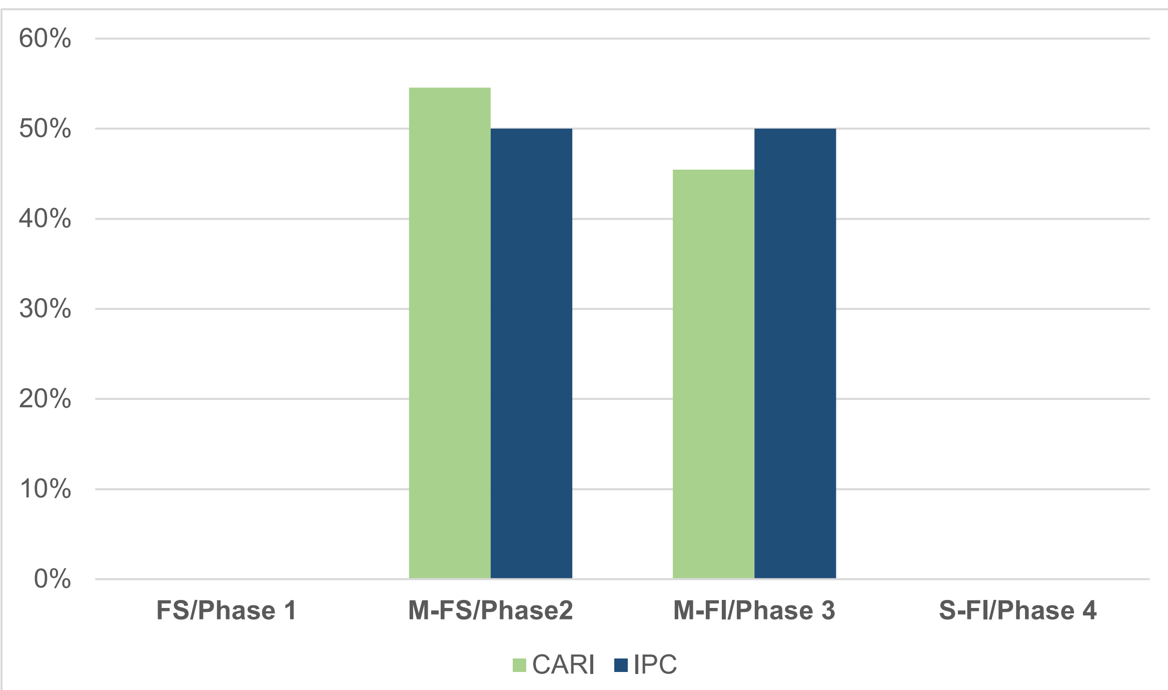
Appendix Figure 1. Distribution of areas by IPC phase/CARI class, Afghanistan (n=136)



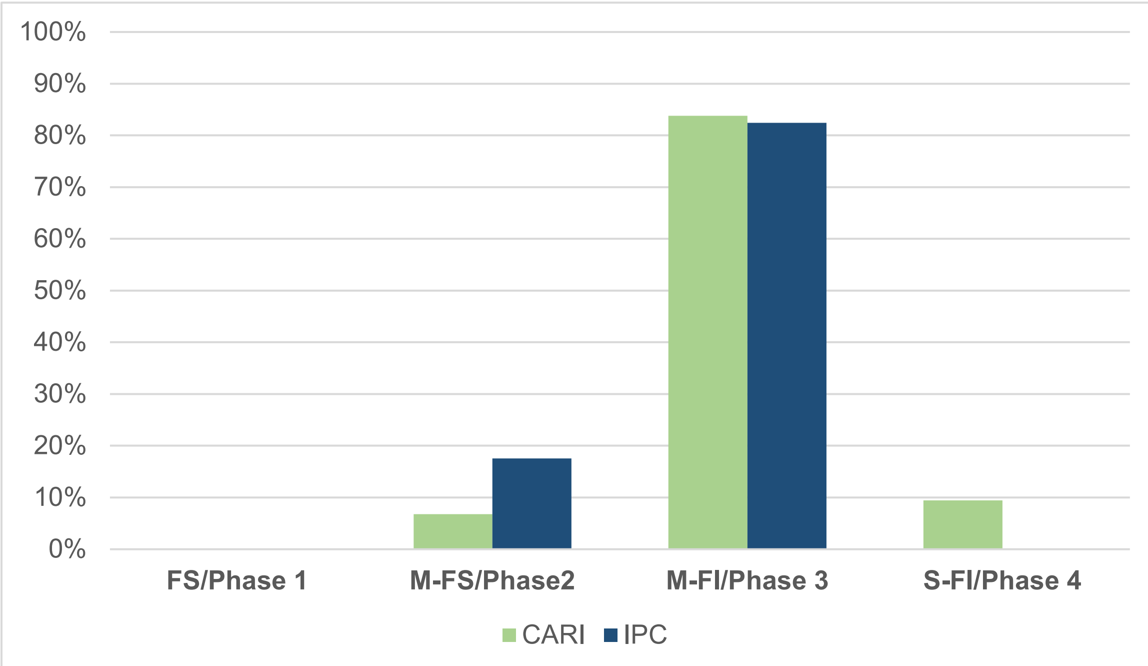
Appendix Figure 2. Distribution of areas by IPC phase/CARI class, Burundi (n=40)



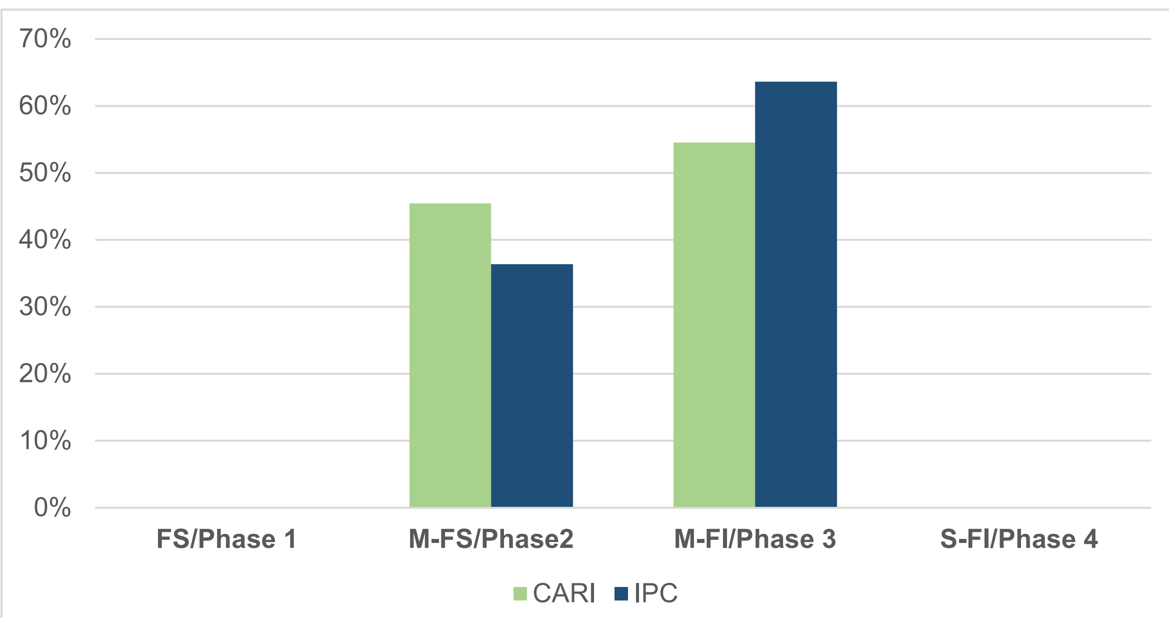
Appendix Figure 3. Distribution of areas by IPC phase/CARI class, CAR (n=115)



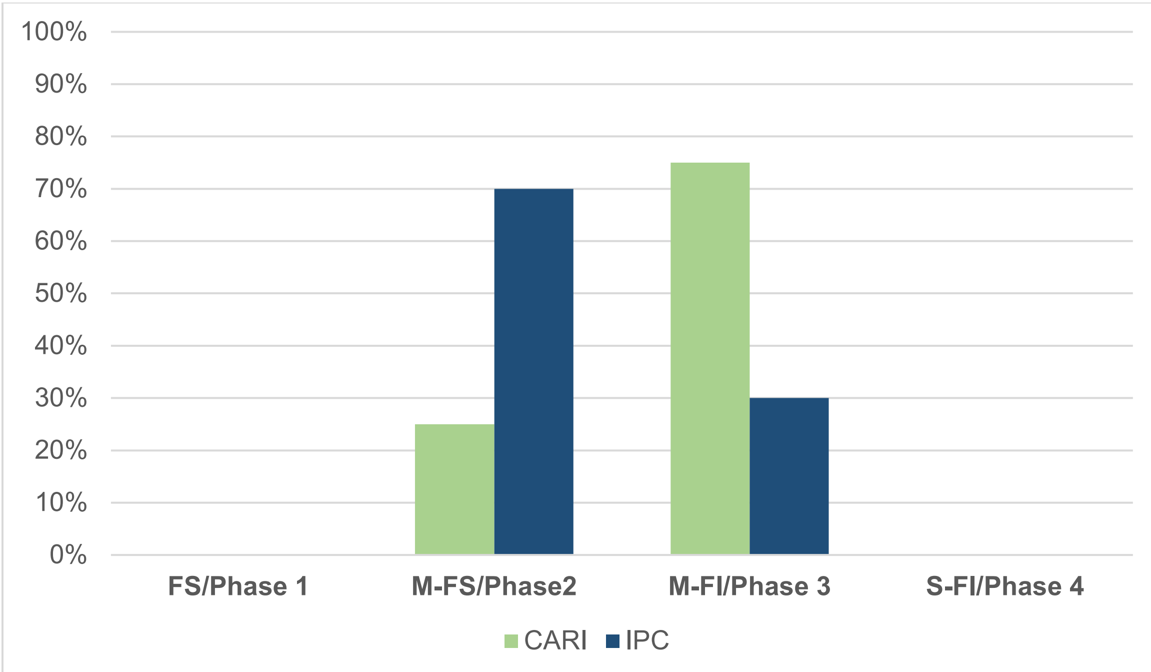
Appendix Figure 4. Distribution of areas by IPC phase/CARI class, Djibouti (n=22)



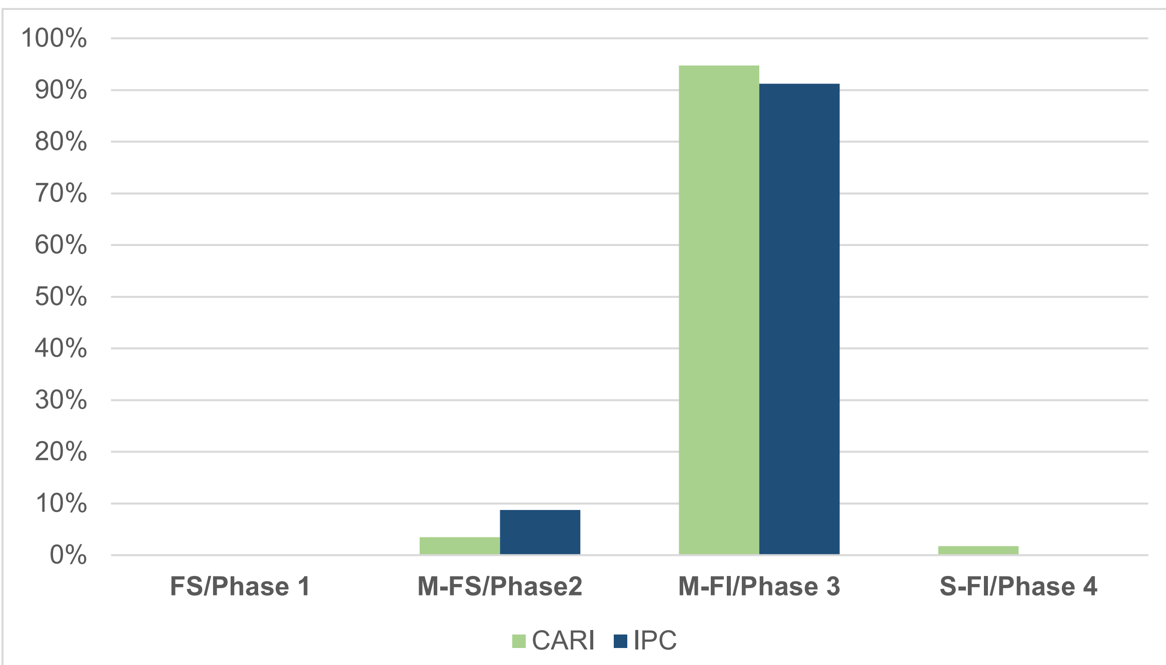
Appendix Figure 5. Distribution of areas by IPC phase/CARI class, Ethiopia (n=74)



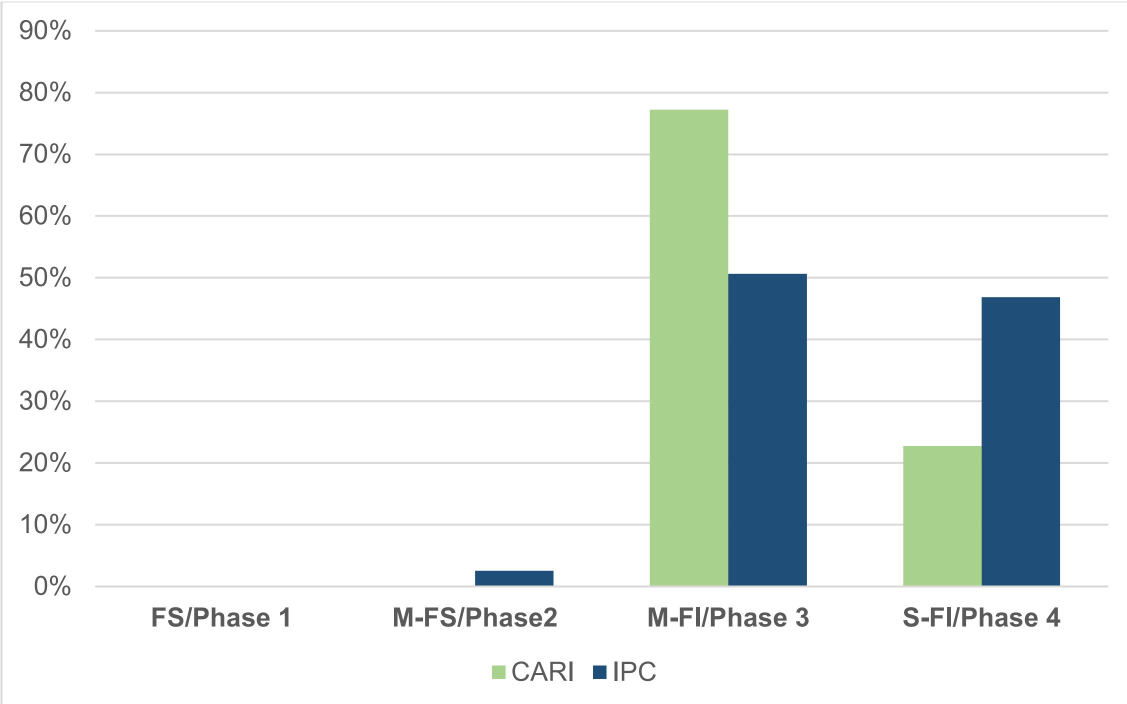
Appendix Figure 6. Distribution of areas by IPC phase/CARI class, Guatemala (n=22)



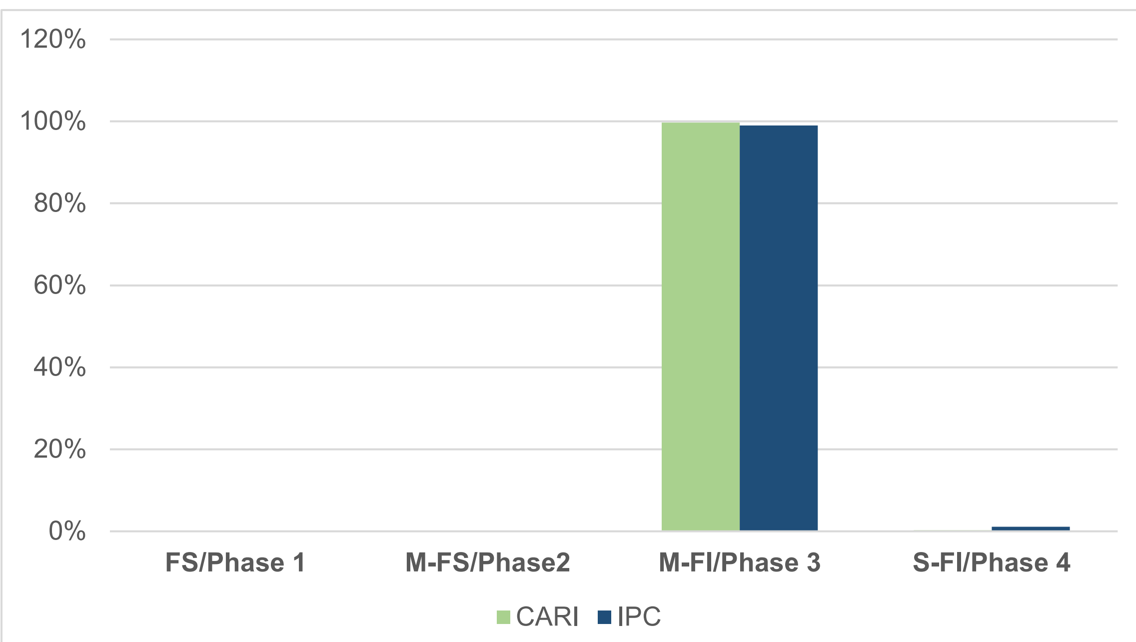
Appendix Figure 7. Distribution of areas by IPC phase/CARI class, Lesotho (n=20)



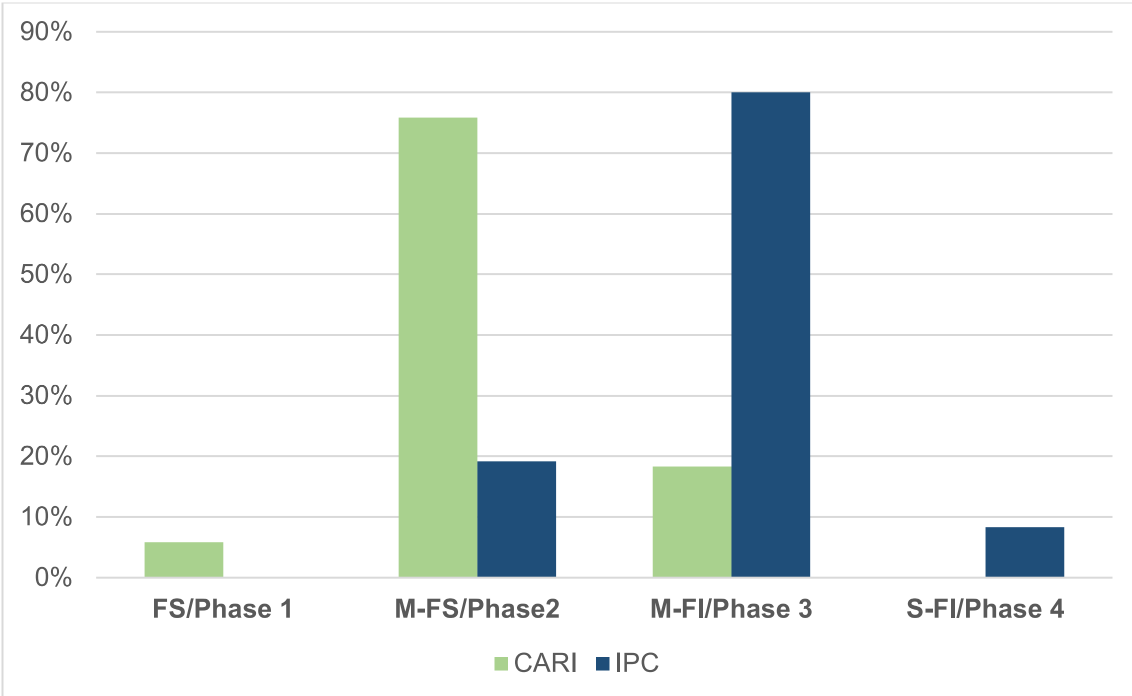
Appendix Figure 8. Distribution of areas by IPC phase/CARI class, Pakistan (n=57)



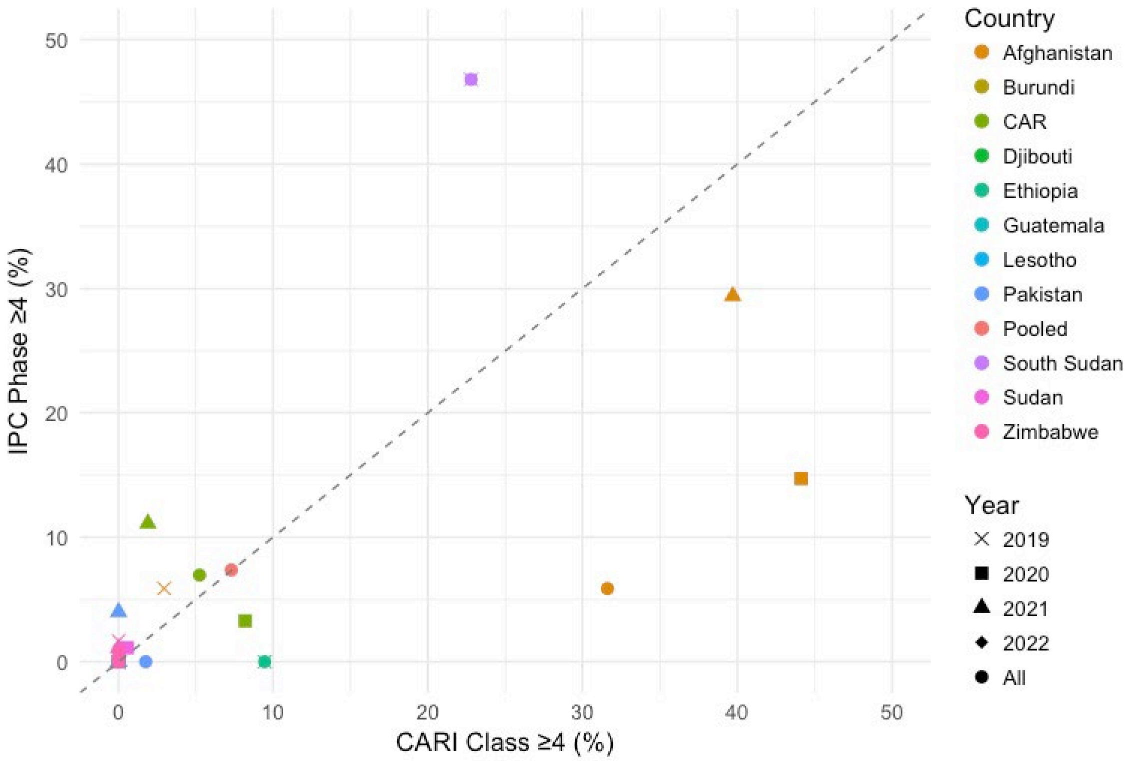
Appendix Figure 9. Distribution of areas by IPC phase/CARI class, South Sudan (n=79)



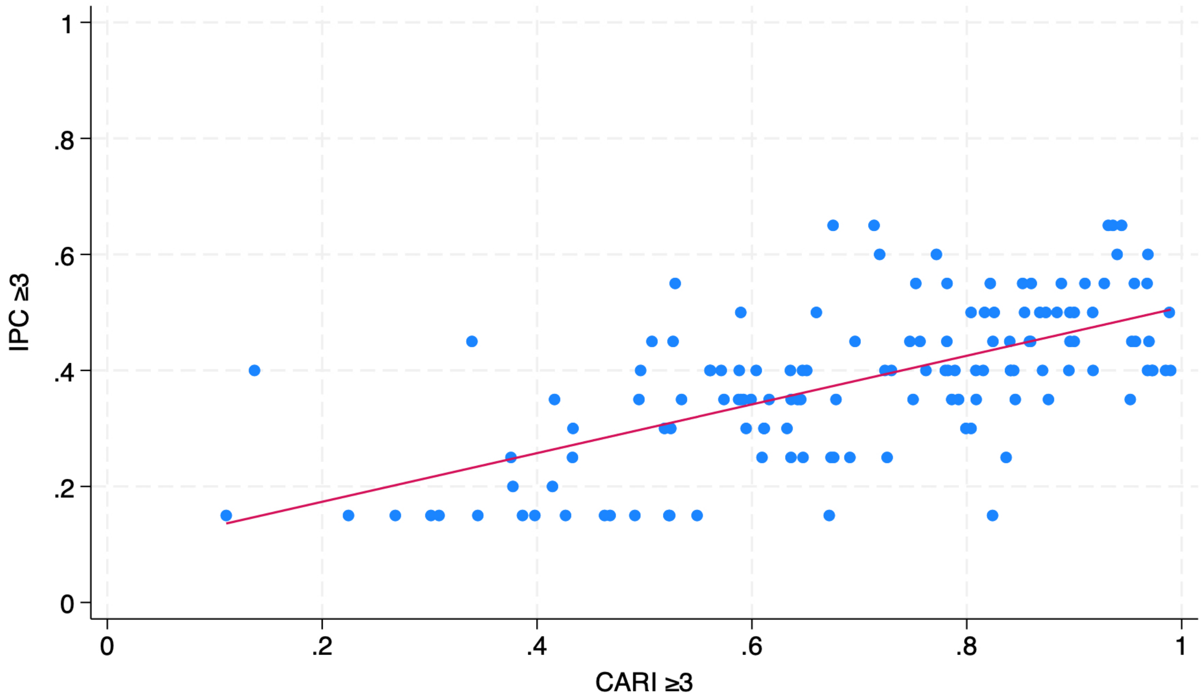
Appendix Figure 10. Distribution of areas by IPC phase/CARI class, Sudan (n=360)



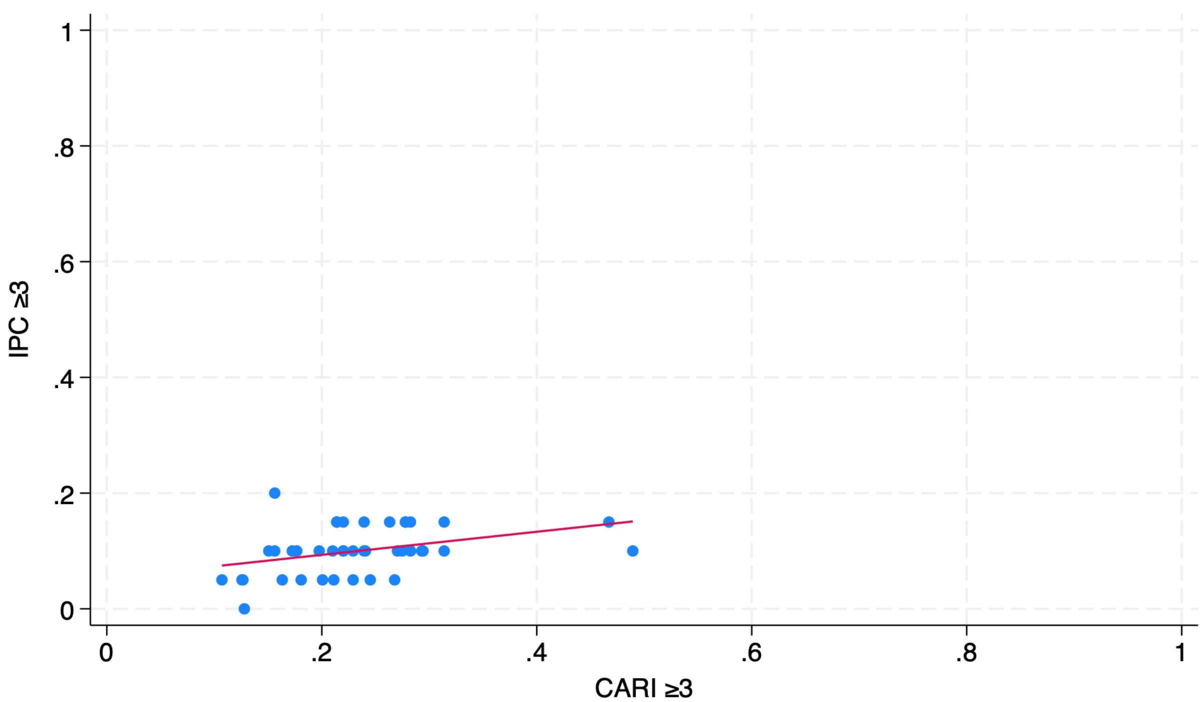
Appendix Figure 11. Distribution of areas by IPC phase/CARI class, Zimbabwe (n=120)



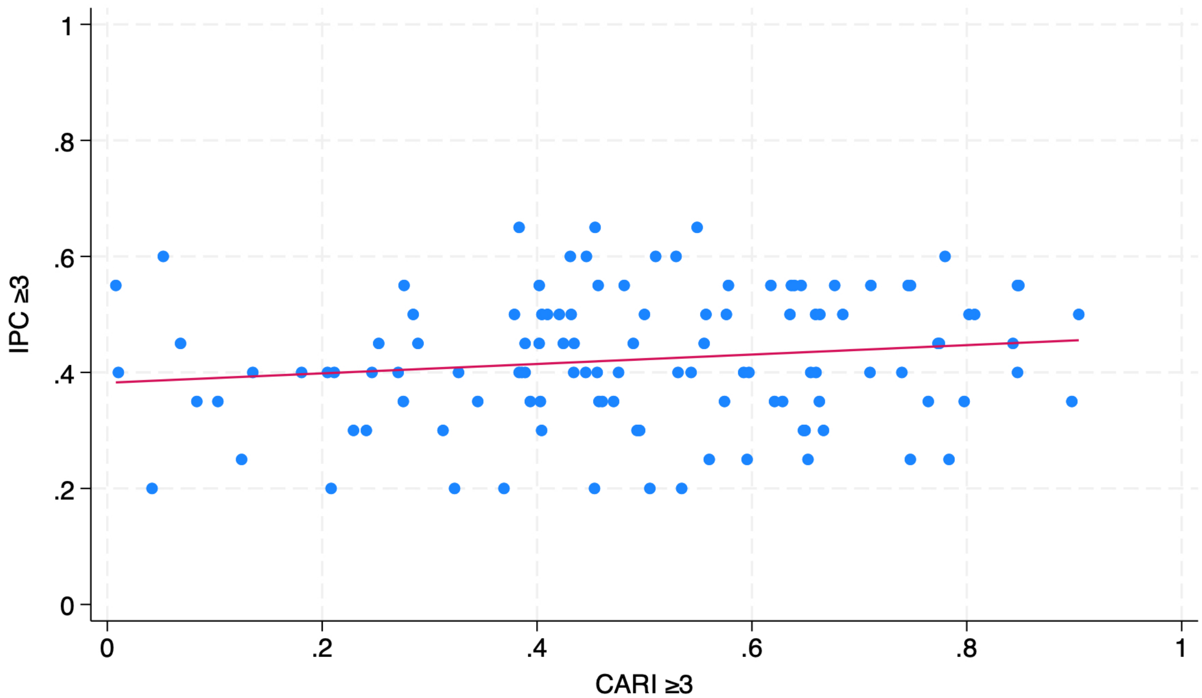
Appendix Figure 12: Scatterplot of proportion of areas in IPC 4 and CARI 4, by country and year (n=22)



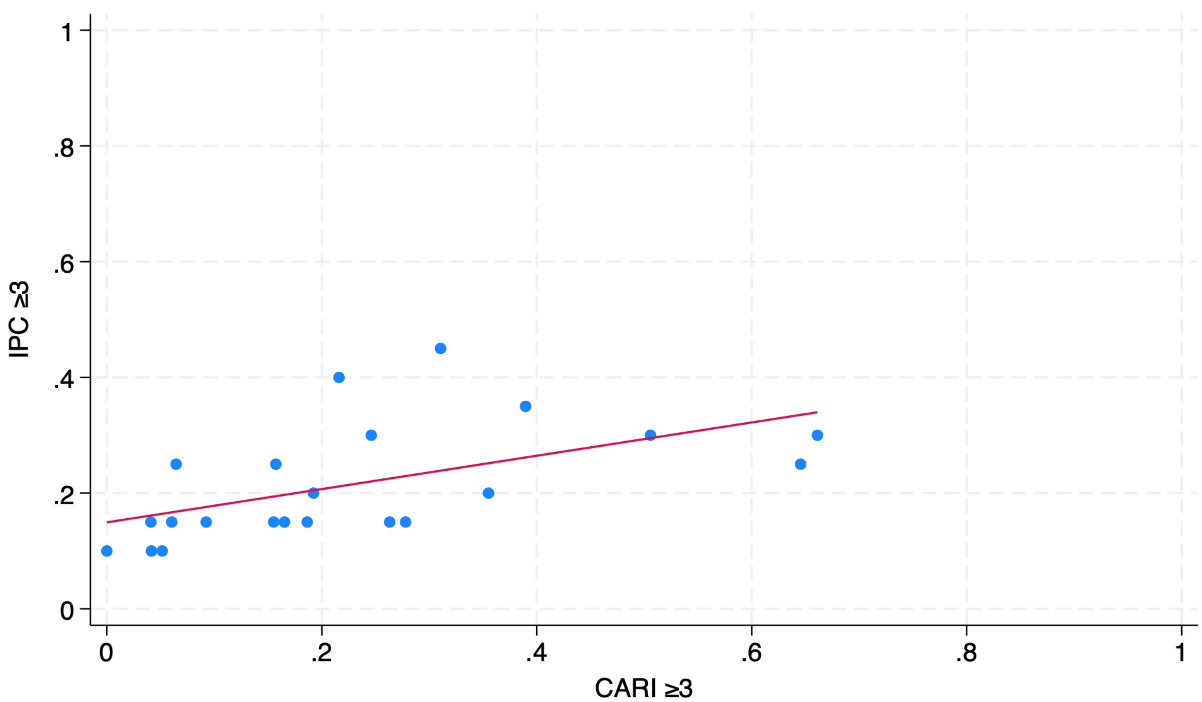
Appendix Figure 13: Area-level prevalence of households in IPC ≥3 and CARI ≥3, Afghanistan



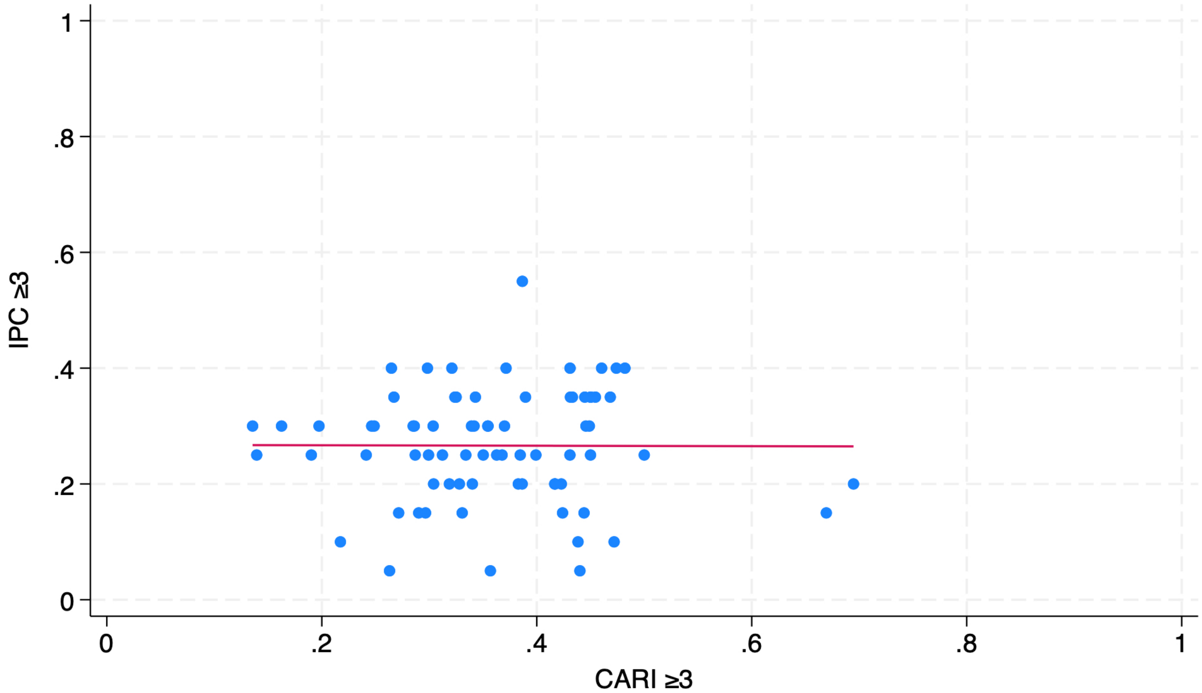
Appendix Figure 14: Area-level prevalence of households in IPC ≥3 and CARI ≥3, Burundi



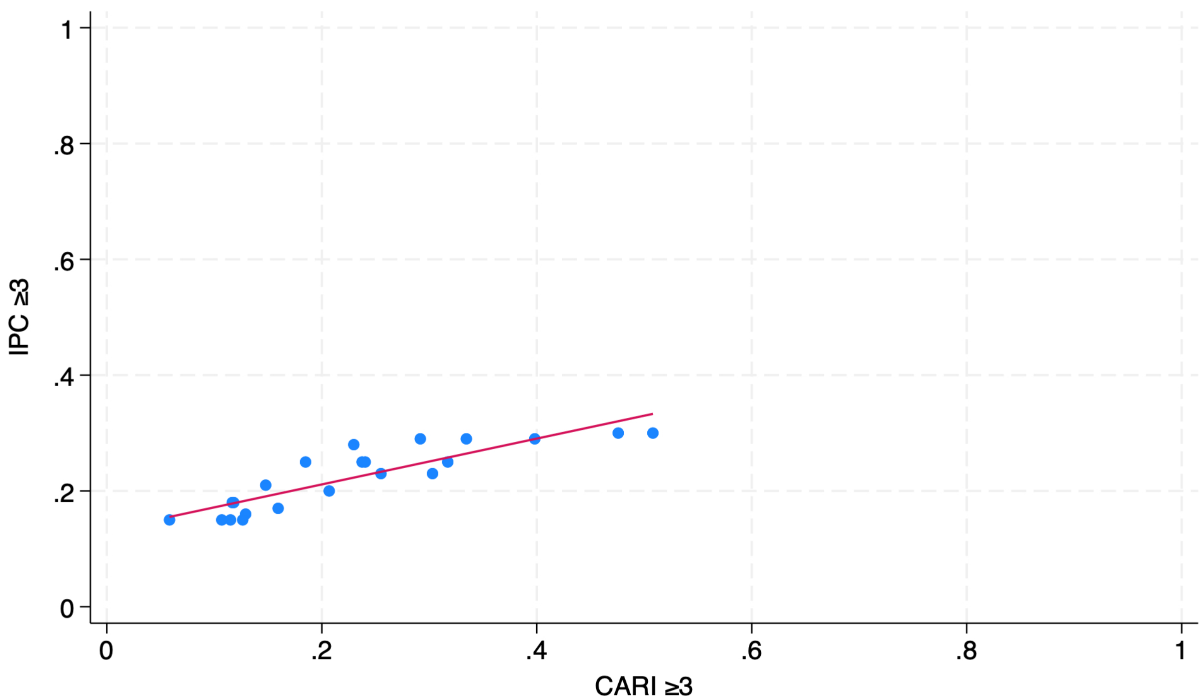
Appendix Figure 15: Area-level prevalence of households in IPC ≥3 and CARI ≥3, CAR



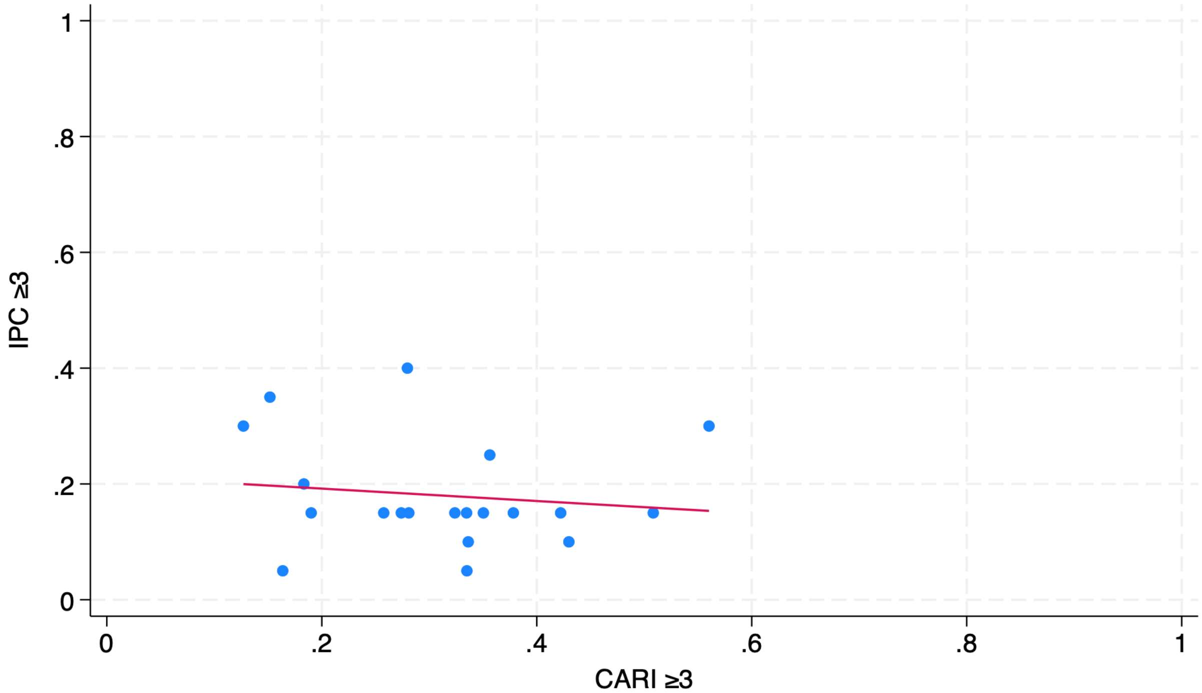
Appendix Figure 16: Area-level prevalence of households in IPC ≥3 and CARI ≥3, Djibouti



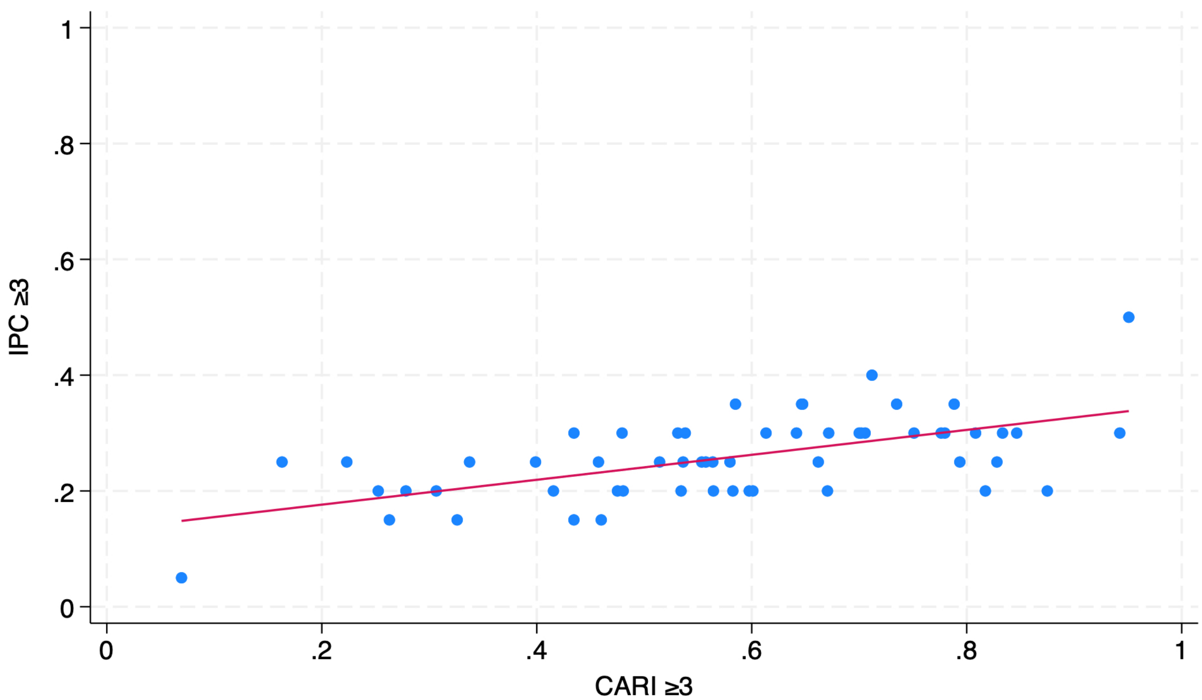
Appendix Figure 17: Area-level prevalence of households in IPC ≥3 and CARI ≥3, Ethiopia



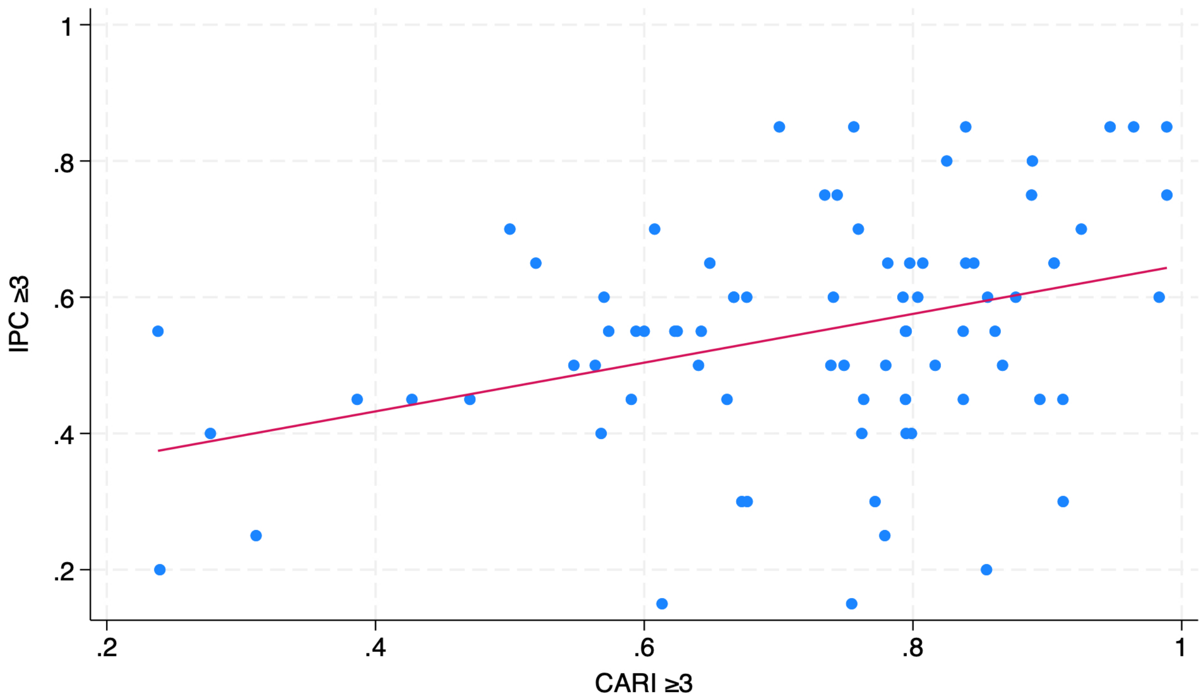
Appendix Figure 18: Area-level prevalence of households in IPC ≥3 and CARI ≥3, Guatemala



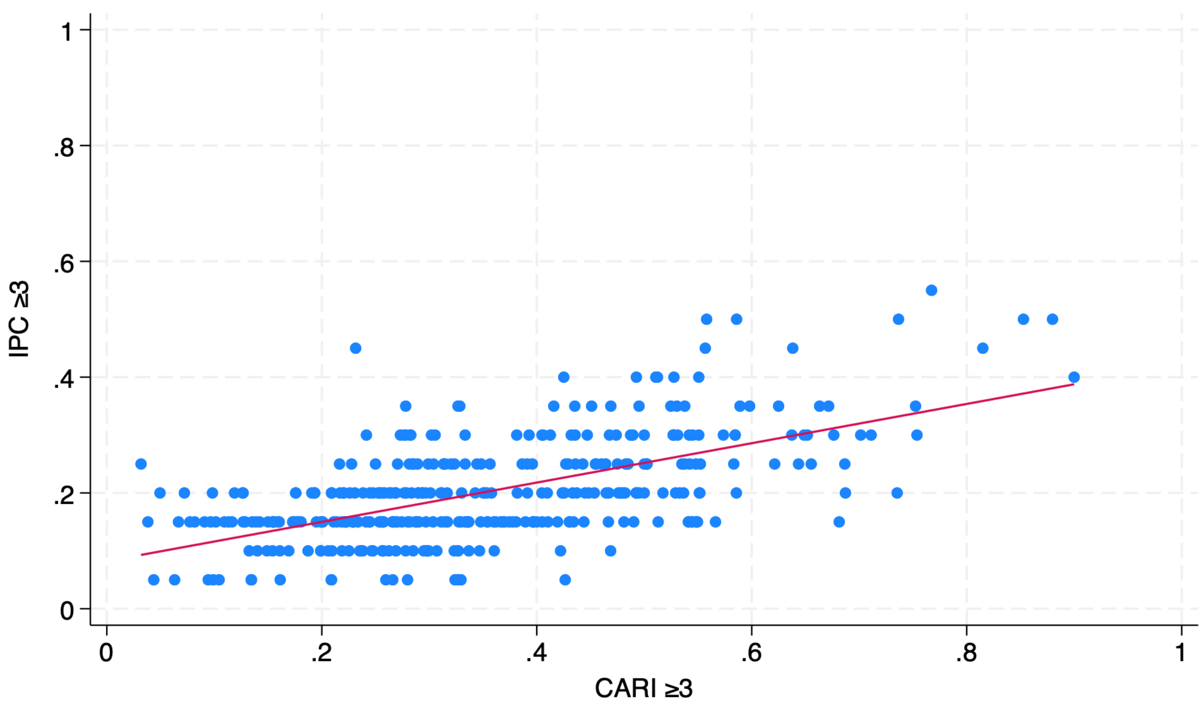
Appendix Figure 19: Area-level prevalence of households in IPC ≥3 and CARI ≥3, Lesotho



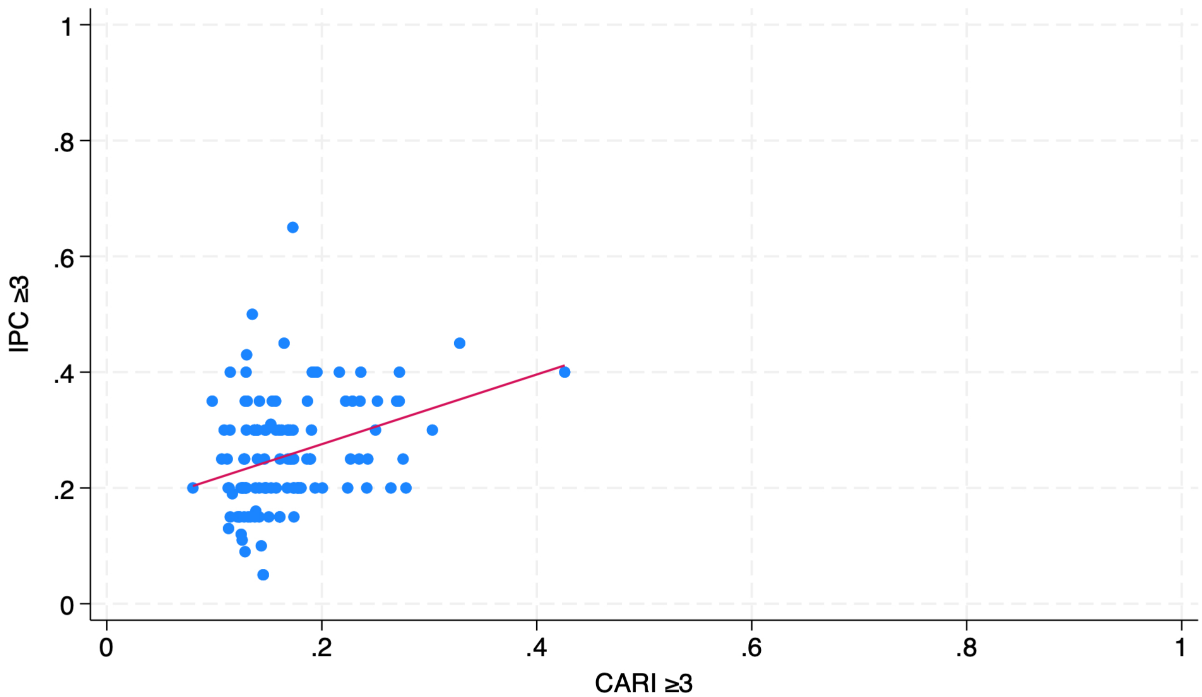
Appendix Figure 20: Area-level prevalence of households in IPC ≥3 and CARI ≥3, Pakistan



Appendix Figure 21: Area-level prevalence of households in IPC ≥3 and CARI ≥3, South Sudan



Appendix Figure 22: Area-level prevalence of households in IPC ≥3 and CARI ≥3, Sudan



Appendix Figure 23: Area-level prevalence of households in IPC in IPC ≥3 and CARI ≥3, Zimbabwe