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HarvestStat Africa – Harmonized Subnational Crop Statistics for Sub-Saharan Africa

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Abstract

Sub-Saharan Africa (SSA) faces severe agricultural data scarcity amidst high food insecurity and a large agricultural yield gap, making crop production data crucial for understanding and enhancing food systems. To address this gap, HarvestStat Africa presents the largest compilation of open-access subnational crop statistics and time-series across SSA. Based on agricultural statistics collated by USAID's Famine Early Warning Systems Network, the subnational crop statistics are standardized and calibrated across changing administrative units to produce consistent and continuous time-series. The dataset includes 546,605 records, primarily spanning from 1980 to 2022, detailing crop production, harvested areas, and yields for 33 countries and 90 crop types, including key cereals in SSA such as wheat, maize, rice, sorghum, barley, millet, and fonio. This new dataset enhances our understanding of how climate variability and change influence agricultural production, supports subnational food system analysis, and aids in operational yield forecasting. As an open-source resource, it sets an important precedent for sharing subnational crop statistics to inform decision-making and modeling efforts.

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Background & Summary

Crop production statistics are fundamental to analyzing yield gaps[1,2], production trends[3,4], and the effects of climate variability[5–8], climate extremes[9–11], and climate change[12–15] on food systems, as well as knock-on effects of how changes in crop production influence food insecurity and health outcomes. Crop production data is also required to develop operational crop yield monitoring[5,6] and forecasting systems that support early warning systems.[7,8,16–18]

National-scale crop statistics, such as the data from FAOSTAT[19], span multiple socioeconomic crop production systems and agroecological climate zones. While these data are an invaluable resource for information on global and regional food production, their coarse spatial resolution limits their utility for spatially detailed climate-crop analyses, crop-yield forecasting, or estimation of yield gaps because it fails to represent spatial variation of yields at not near the scales where yields respond to climate variability. For this reason, each of the aforementioned studies used either subnational crop yield statistics or national-scale statistics disaggregated to the subnational scale using various downscaling methods and remote sensing[20]. Indeed, there is broad agreement on the need for increased investment in gathering and managing subnational crop statistics to enhance decisions for food production systems[21] as demonstrated by the recent effort to harmonize European agricultural statistics and legally binding requirements for EU member states to report subnational data beginning in 2025[22].

While systematic collation of subnational crop production statistics is important everywhere, there are few places with as great a need as Sub-Saharan Africa (SSA)[21], which contains countries with some of the highest levels of food insecurity and greatest economic dependence on agriculture[23]. In 2022 alone, chronic malnutrition impacted nearly 282 million individuals in SSA, representing 20% of the region's population[23]. SSA also has the world's greatest prevalence of agricultural data scarcity due to technical, institutional, and policy barriers[21], even for key staple crops. The dearth of timely and reliable information on crop production volumes is costly - impeding timely responses to food crises and hampering public policy formulation. In this context, improved subnational crop production statistics are imperative for understanding African food systems, developing crop yield monitoring and forecasting systems, understanding the impacts of climate variability and change, and exploring resilience and adaptation policies to respond to climate change.

In this article, we present HarvestStat Africa, the largest and most comprehensive collection of open-access subnational crop statistics for SSA to date. HarvestStat Africa encompasses detailed information on specific crop types, growing seasons, and crop production systems, among other aspects. All crop statistics are harmonized and geolocated to produce consistent and continuous time-series of crop yield, harvested area, and production. HarvestStat Africa is an open-access, transparent, and standardized compilation of subnational data intended for use in both a research and operational context. The release of HarvestStat Africa represents the first step in a new generation of community-generated datasets and databases that promote open science through the free and public sharing of subnational crop statistics.

Methods

Beyond the subnational level of reporting, a key advance of the HarvestStat Africa dataset is the detail provided on the provenance of the data as well as the transparency of subsequent modifications needed to produce continuous time-series of crop production. Providing detailed information on the original source of data and subsequent modifications has been identified as a key barrier to improving the production and use of agricultural data for research and decision making[21]. By collating data in a complex, often data sparse environment, HarvestStat Africa provides information where it is most needed in a means that is both accessible to end users and suitably flexible for a variety of applications.

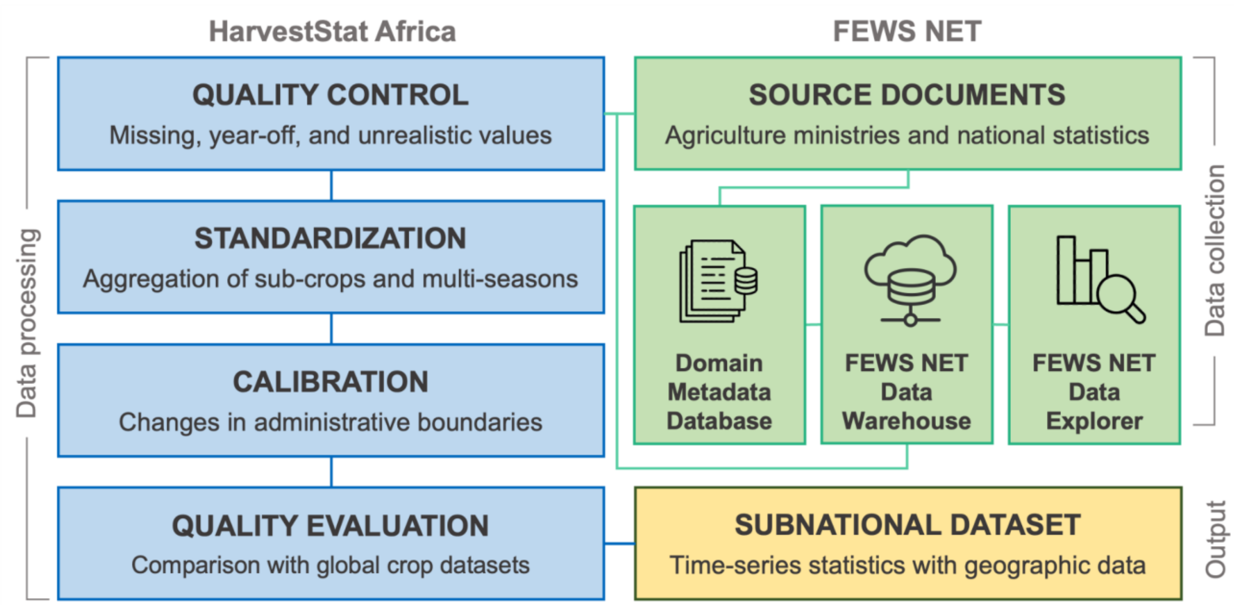


Figure 1. Flowchart illustrating the sequential workflow for data collection, processing, and output within the FEWS NET and HarvestStat Africa frameworks.

The workflow for data collection, processing, and output within HarvestStat Africa is illustrated in Figure 1, beginning with the FEWS NET Data Warehouse (FDW). Agricultural statistics are first loaded into the FDW, a centralized hub that facilitates data exploration and visualization via the FEWS NET Data Explorer (FDE). After the initial data collection phase, the process transitions to the HarvestStat Africa framework, where the data is processed to ensure quality and consistency. This begins with quality control to identify any erroneous or unrealistic values. The data are then standardized into aggregate statistics from various crop types and seasons and calibrated to reflect changes in administrative boundaries. The last step in the HarvestStat Africa process is validation, where the data are compared with other global crop datasets to ensure consistency and accuracy. The principal output is the subnational dataset, which provides time-series of crop statistics linked to geographical boundary data.

A. Data collection

The FDW (https://help.fews.net/fdw/) was developed to serve as the central repository for critical data essential to FEWS NET's efforts in food security and early warning analysis. The data includes statistics related to crop production, market prices, exchange rates, and trade. Data in the FDW can be accessed from the FDE (https://fdw.fews.net/data-explorer/). The FDW is designed to store subnational crop production statistics that are continuously updated from diverse sources, including annual government statistics, reports from agricultural ministries, and tabular data from relevant national agencies. This seamless integration is achieved through monitoring and the maintenance of an extensive database, which includes common metadata and geospatial references. For example, each administrative unit (e.g., state, province, district, etc.) is assigned a unique geocode (FNID) linked to the country's boundary at a specific point in time. FEWS NET has tracked changes in the names and geometry of administrative boundaries and created a database of historical and current subnational administrative boundaries for a select set of countries, including FEWS-monitored countries. The data and further details on FEWS NET's harmonization of geographic boundaries can be found at https://fews.net/data/geographic-boundaries. The FDW's crop statistics also reflect the changes in administrative boundaries in each country.

The metadata within the crop production data domain of the FDW includes an FNID, a code to identify the crop based on the UN's Central Product Classification v2 (CPCv2) code, a season name, the season date, information on the crop production system (e.g., irrigated or rainfed), geographic group, and more. Once this data undergoes internal review (e.g., source reference, tests for plausible accuracy, overlap with existing database) within FEWS NET, it is subsequently uploaded to the FDW. Users are provided with the flexibility to access the data directly from the web platform or through the Application Programming Interface (API). HarvestStat Africa primarily uses the API for data retrieval, except when it adds new data points while FEWS NET conducts internal reviews. Once this supplementary data becomes accessible on FDW, HarvestStat Africa seamlessly transitions back to utilizing the FDW database. This strategic approach effectively ensures the maintenance of an up-to-date database for each country.

While the FDW is dedicated to data storage, the FDE focuses on data access. Within the FDE, data is organized by humanitarian sectors, such as population demographics, market prices, agricultural production, nutrition, and livelihoods, among others, allowing for refined search and filtering capabilities. Additionally, it provides features for users to explore and validate potentially relevant data through a suite of visualization tools, including tables, graphs, and maps, facilitating the examination of data prior to its export for application.

B. Data processing

HarvestStat Africa provides information on yield, area, and production where available. However, not all source documents and countries provide comprehensive sets of area, production, and yield records, and these may not always be updated in the FDW database. Consequently, countries often exhibit variations in the number of data points related to harvest area, production, and yield. In such cases, we retain all available data points whenever feasible. Some countries report both "planted area" and "harvested area", and in such instances, we report "harvested area". When countries do not differentiate, we assume that the reported figures correspond to "harvested area". Data that are unreported or not collected are represented as missing values.

The data processing in HarvestStat Africa primarily focuses on four key processes: quality control, data standardization, calibration of administrative boundaries, and quality evaluation (Figure 1). We process all countries using the same procedure, with minor revisions tailored to specific issues in each country. For information on quality evaluation, please refer to the Technical Validation section.

Quality control of data

During the quality control process, we identify unrealistic and misreported values. While extreme yield shortfalls due to abiotic or biotic stresses are plausible, years with significantly higher yields than the surrounding years are likely outliers. We compute Z-scores for the yield data for each region, crop, and season combination by subtracting the mean and dividing by the standard deviation. The Z-scores are based on a rolling window of length seven years, centered on the current year. We first identify potential outliers as those with a Z-score of greater than 2. We similarly identify any crop with a yield of greater than 10 as a potential outlier. We next inspect each time-series containing potential outliers to determine whether the observation should be flagged as an outlier in the final dataset (see Figure S1). This final step is necessary because some crops in some countries would be expected to have large yield values, and in low-yielding production systems a high degree of variance may be normal.

We do not remove, but instead clearly identify these values using the “QC_flag” column so that users can decide how best to process these outliers for their own applications. We furthermore clearly identify where such a process has occurred in the country-specific processing scripts, which are publicly available accompanying this dataset. In this way, we provide both our own post-processing analysis of the crop statistics as well as the tools and information needed for users to make alternative decisions about data in a post-processing workflow.

Beyond flagging outliers, we are often unable to judge the accuracy of collected data because the data collected are usually the only data available at the subnational level. We do, however, provide comparison to alternative datasets, such as FAOSTAT, to ensure the accuracy of particularly questionable data (see Technical Validation for details). In conjunction with these comparisons, we collaborate closely with FDW to verify specific metadata.

Standardization of data

The FDW data may include information on crop production systems, population groups, and sub-crops for each crop and country. A sub-crop may refer to different crop varieties or to non-genetic distinctions made on the basis of taste, color, smell, mouth-feel, health benefits, preparation practices, market preferences, etc. For example, a sub-crop could be a distinction between white and yellow maize or between rice and `broken’ rice. For our analysis, we either choose between key sub-crops or aggregate sub-crops as necessary to create a time-series product. In some countries, including Angola, Malawi, and Tanzania, the thematic detail at which certain crop types are reported has changed over time. For example, whereas earlier reports refer to a single category "millet", this has later been disaggregated into more specific varieties, including "pearl millet" and "finger millet". To maintain consistency and create a continuous time-series, we have re-aggregated these varieties into the general "millet" category in our dataset. In instances where a sub-crop becomes predominant, less common sub-crops may be omitted. For example, while we report both white and yellow maize in the South Africa data, when combined with all-Africa data we report only white maize as this is the variety used for human consumption. Similar decisions are made, depending on data availability, for the number of seasons to report and the number of production systems to report. All such decisions are made transparent in our Github repository: https://github.com/HarvestStat/HarvestStat. Users of the data are free to fork the GitHub repository and make changes to the cleaning and harmonization workflow as they see fit.

In the FDW, the spatial resolution of data at times changes, as in Somalia, Madagascar, Benin, and Tanzania, among other countries. In these cases, producing a continuous time-series often requires aggregation of finer-scale crop statistics to a coarser resolution. In the case of Madagascar, for example, administrative level 3 (district) data was aggregated to administrative level 2 (region) to create a continuous time-series of data. We aggregate production and harvested area within the administrative level 2 units and then recalculate yield accordingly. When aggregating data, we only aggregate data when data are available for at least 50% of production within the coarser resolution administrative unit, which is estimated using a low-frequency Gaussian filter with a kernel standard deviation of three years. We otherwise mark the observation as missing.

Time-series of reported crop statistics may contain changes not only in spatial resolution but also in temporal resolution in areas with multiple crop seasons. In Kenya, for example, the FDW data are reported for a single “annual” season in some years and separately for “short rains” or “long rains” seasons in other years. Here, we maintain this heterogeneity in our product.

<u>Spatial calibration</u>

In SSA, administrative boundaries have undergone changes over time. These changes within or between countries include splitting, merging, aggregating, and even renaming or changing the administrative levels. Subnational crop statistics often reflect these changes, necessitating the calibration of crop statistics for old administrative units to align with the current administrative units, to ensure their suitability for time-series analysis. We adjust crop statistics (i.e., time-series of crop production and harvested area) using the ratio of production or cropland in each old administrative unit to that of the new administrative units, and then re-calculate crop yield. Two distinct cases are considered:

Case A: This scenario occurs when administrative boundaries change while maintaining their boundary areas. For example, a single district splits into two districts, maintaining equivalent boundary areas (see Figure S2a,b). In such cases, we use the ratios of the mean crop production of the new units to calibrate the crop statistics of the old unit, as defined by Eq (1):

$$X_i = X_{old}\left(\frac{P_i}{\sum_j^n P_j}\right) \quad (1)$$

where X_i is the crop statistic (i.e., time-series of production and area) in the new administrative unit *i*, X_{old} is the crop statistics of the old administrative unit, P_i is the mean crop production of the new administrative unit *i*, and $\sum_j^n P_j$ is the sum of crop production values in each of the *n* new administrative units. As these ratios apply uniformly to both crop production and harvested area, the re-calculated crop yield remains consistent among the new administrative units. This method is implemented for each crop type to realistically reflect the distinct production characteristics prevalent among various districts.

Case B: This scenario arises when changes in administrative boundaries result in alterations to their respective boundary areas. For instance, an existing district expands to encompass multiple old districts (see Figure S2c,d). Since the ratio of mean crop production is not applicable in this case, we employ the ratio of cropland area to partially transfer crop productivity from the associated old administrative units to the new administrative unit, as defined by Eq (2):

$$X_{new} = \sum_j^n (X_j \times \frac{A_{new,j}}{A_j}) \quad (2)$$

where A_j is the cropland area of the old district *j*, $A_{new,j}$ is the common cropland area between the old and new districts, X_{new} is the crop statistics of the new administrative unit, and X_j is the crop statistics of the associated old administrative unit *j.* These ratios are calculated for each of the *n* intersections between the new and the old administrative units. In this case, these ratios are consistently applied to all crop types. The cropland area is extracted from the global cropland map[24]. A similar approach, such as using the arable land class from the land cover map, has been applied to calculate weights for the European subnational crop dataset[25].

To optimize the calibration process, we focus on significant administrative boundary changes, recognizing that not all changes necessitate calibration. Specifically, we apply calibration when an administrative unit changes its area by at least 10%. It is important to note that, although the calibration is executed automatically, we conduct a visual inspection of all boundary changes in each country. Based on this inspection, we manually modify decisions regarding the type of calibration employed, and all such determinations are documented in the country processing scripts. Finally, we compare the total production and areas before and after calibration to verify the calibration process.

Output products

The HarvestStat Africa v1.0 dataset is available on Dryad (https://doi.org/10.5061/dryad.vq83bk42wY). It encompasses harmonized crop statistics in tabular format and the administrative boundaries aligned with these statistics, as detailed in Table 1.

Table 1. Overview of HarvestStat Africa v1.0 dataset including filenames and descriptions.

Dataset	Filename	Description
Subnational crop statistics	hvstat_africa_data_v1.0.csv	A CSV file containing subnational crop statistics
Administrative boundary data	hvstat_africa_boundary_v1.0.gpkg	A GeoPackage file compiling FEWS NET's administrative boundaries, aligned with crop statistics via FNID.

The tabular subnational dataset consists of 16 columns, including FNID, country name, country code (ISO 3166-1 alpha-2), administrative level 1 name, administrative level 2 name, product name, season name, planting year, planting month, harvest year, harvest month, crop production system, QC_flag, and crop statistic values for area, production, and yield. The administrative boundaries data is synthesized from individual country boundary files and are linked to the tabular data via the FNID.

Data Records

Figure 2 and Table 2 provide details on the countries processed (see Table S1 for additional details on the number of years recorded for each crop). In total, 33 countries have been included, comprising 18 with data at administrative level 1 and 15 at administrative level 2. Spatial calibration has been implemented in 19 countries. Although administrative boundaries in these countries typically underwent 1-2 changes, some, like Ethiopia, have required up to 6 boundary calibrations over a span of 25 years. HarvestStat Africa v1.0 includes data on 90 crop types. Although several crop types belong to the same crop classes, we retain the specific crop types as reported. Data on multiple growing seasons and multiple crop production systems are reported in 21 and 10 countries, respectively.

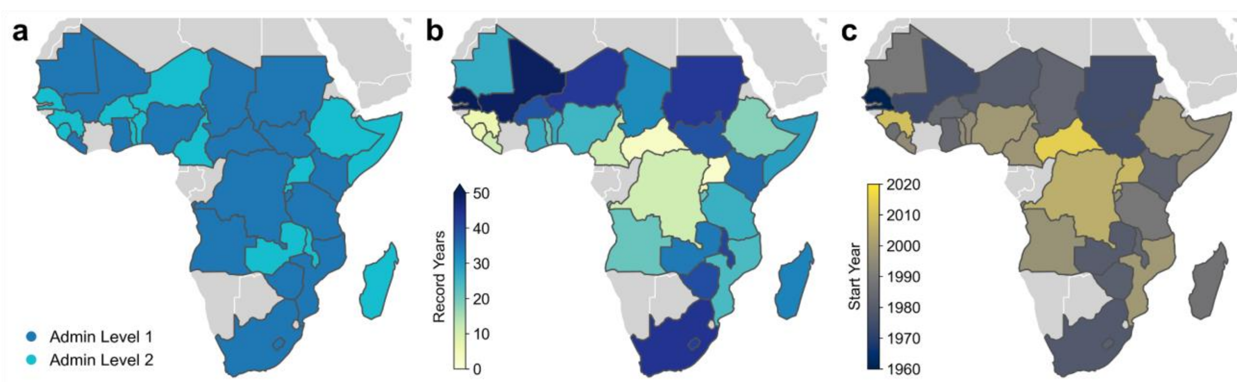


Figure 2. (a) Administrative levels, (b) number of recorded years, and (c) first year covered by processed crop statistics in HarvestStat Africa v1.0. The data for (b) and (c) encompass all available crop types.

Table 2. Overview of countries and processed subnational crop data in HarvestStat Africa v1.0. The 'CPS' stands for crop production systems.

Country	Administrative level (Local name)	Spatial calibration	# of seasons	# of crops	# of CPS	Main source organization(s)
Angola	Level 1 (Province)	No	1	26	1	Ministry of Agriculture and Forestry, Angola
Benin	Level 2 (Commune)	Yes	2	30	1	Ministere de l'Agriculture, Direction de la Statistique Agricole, Benin
Burkina Faso	Level 2 (Province)	Yes	2	15	4	Ministère de l'Agriculture, des Ressources animales et halieutiques, Burkina Faso
Burundi	Level 1 (Province)	Yes	3	20	1	Institut de Statistiques et d'Etudes Economiques du Burundi
CAF	Level 1 (Prefecture)	No	1	5	1	FAO/WFP, Central African Republic
Cameroon	Level 2 (Division)	No	5	23	1	Ministere de l'agriculture, DEPA/CES, Cameroun
Chad	Level 1 (Region)	Yes	2	13	1	Ministry of Agriculture and Irrigation, Chad
DRC	Level 1 (Province)	Yes	1	5	1	Ministère de l'agriculture pêche et élevage, DRC
Ethiopia	Level 2 (Zone)	Yes	1	46	1	Ministry of Agriculture, Ethiopia
Ghana	Level 1 (Region)	Yes	2	12	1	Ministry of Food and Agriculture, Ghana
Guinea	Level 2 (Prefecture)	No	1	4	1	L'Agence Nationale des Statistiques Agricoles et Alimentaires, Guinea
Kenya	Level 1 (County)	Yes	3	18	1	Ministry of Agricultural and Livestock Development, Kenya
Lesotho	Level 1 (District)	No	2	6	2	Lesotho Bureau of Statistics, Lesotho
Liberia	Level 1 (County)	Yes	1	2	1	Ministry of Agriculture, Liberia
Madagascar	Level 2 (Region)	Yes	1	38	1	Ministry of Agriculture, Madagascar
Malawi	Level 2 (District)	Yes	3	29	3	Ministry of Agriculture, Irrigation and Water Development, Malawi
Mali	Level 1 (Region)	Yes	1	18	1	Ministere De L'agriculture, Mali

Mauritania	Level 1 (Region)	No	8	7	6	Ministry of Rural Development, Mauritania
Mozambique	Level 1 (Province)	No	4	28	1	Ministério da Agricultura e Segurança Alimentar, Mozambique
Niger	Level 2 (Department)	Yes	2	35	3	Ministere de l'Agriculture, Niger
Nigeria	Level 1 (State)	No	2	20	1	National Agricultural Extension and Research Liaison Services, Nigeria
Rwanda	Level 2 (District)	No	3	30	1	Ministry of Agriculture and Animal Resources, Rwanda
Senegal	Level 2 (Department)	Yes	2	10	3	Agence Nationale de la Statistique et de la Demographie, Senegal
Sierra Leone	Level 2 (District)	No	1	12	1	Ministry of Agriculture, Forestry and Food Security, Sierra Leone
Somalia	Level 2 (District)	No	4	10	3	Food Security and Nutrition Analysis Unit, Somalia
South Africa	Level 1 (Province)	No	2	9	1	Crop Estimates Committee, Department of Agriculture, Forest and Fisheries, South Africa
South Sudan	Level 1 (State)	Yes	1	8	4	FAO/WFP, Government of South Sudan
Sudan	Level 1 (State)	Yes	2	9	4	Federal Ministry of Agriculture and Forestry (FMoA&F), Sudan
Tanzania	Level 1 (Region)	Yes	4	25	1	Ministry of Agriculture, Food Security and Cooperatives, Tanzania
Togo	Level 2 (Prefecture)	Yes	2	12	1	Direction des Statistiques Agricoles, de l'Informatique et de la Documentation, Togo
Uganda	Level 2 (District)	No	3	15	1	Ministry of Agriculture, Animal Industry and Fisheries, Uganda
Zambia	Level 2 (District)	Yes	1	19	1	Ministry of Agriculture and The Central Statistics Office, Zambia
Zimbabwe	Level 1 (Province)	No	1	14	8	FAO/WFP, Ministry of Lands, Agriculture, Fisheries, Water and Rural Development, Zimbabwe

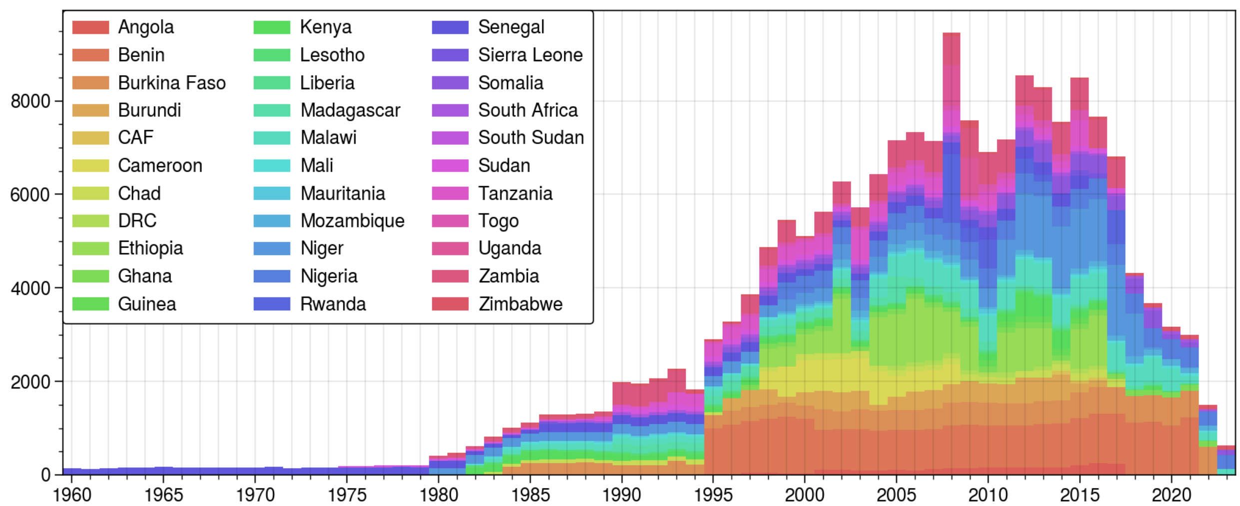


Figure 3. Temporal distribution of production records by country in HarvestStat Africa v1.0, including all available crop types.

Figure 3 illustrates the temporal trends in the number of crop production records across 32 countries as processed in HarvestStat Africa v1.0, covering the period from 1960 to 2022. The dataset encompasses a total of 546,605 records, comprising 189,095 records for production, 181,060 for area, and 176,450 for yield. Notably, production records are considered more reliable than area and yield records[26]. Temporal trends of crop production records for individual countries are represented in Figure S3.

The data exhibit a progressive increase in record volume over the decades, with a marked escalation from the early 2000s. This uptick is attributed to the broader availability of crop statistics and a reduction in missing data during this period. Specifically, countries such as Burkina Faso and Zambia have shown significant growth in record numbers. The decline in data collection post-2015 reflects the typical delays associated with reporting, collecting, and updating data from national agencies to the FDW database, along with a reporting shortfall in some countries in recent years.

Overall, we observed a considerable expansion in the documentation of crop production, with Burkina Faso, Ethiopia, and Zambia emerging as significant contributors to the database over recent decades. This trend may reflect advancements in agricultural technologies, survey methodologies, and data management systems, as well as increased and sustained funding, underscoring the evolving landscape of agricultural development and statistics in these regions.

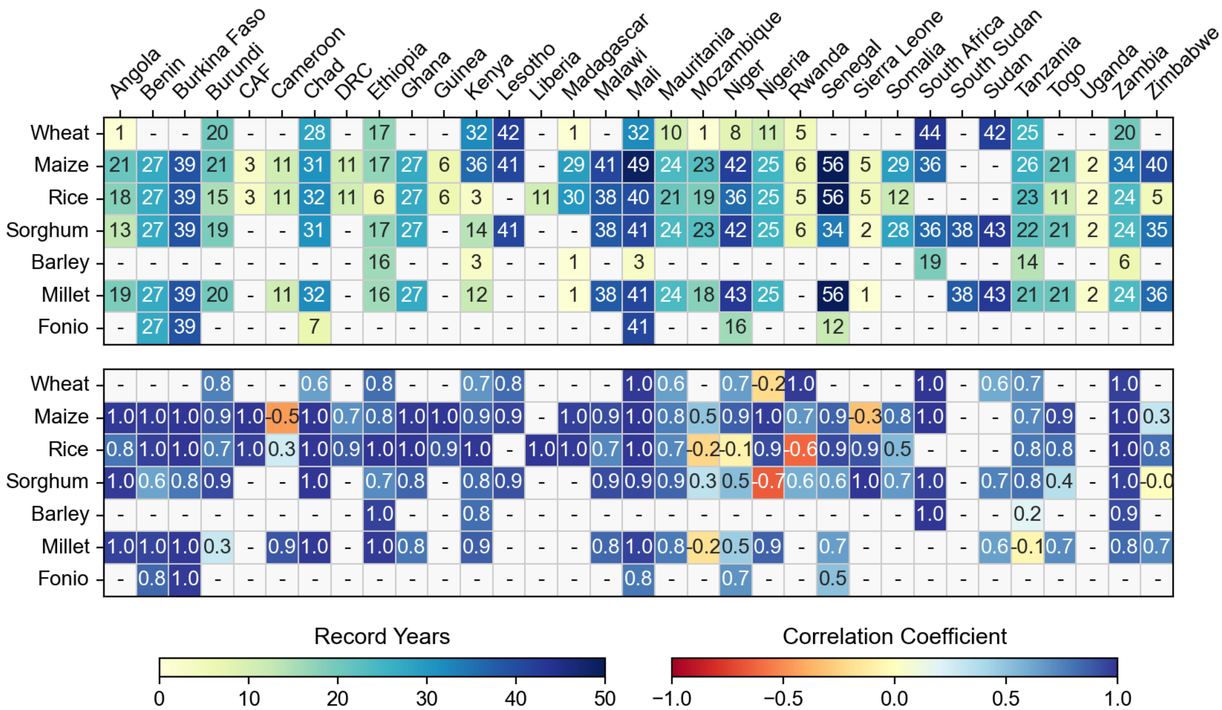


Figure 4. (a) Number of years with production records and (b) correlation coefficient of national crop productions between HarvestStat Africa v1.0 and FAOSTAT for seven grain types. The record years do not necessarily represent consecutive years.

Figure 4a depicts the number of recorded years with production records for seven grain types. The same figure for other crop types are presented in Figures S4. On average, grain crops, such as wheat, maize, rice, sorghum, barley, millet, and fonio, demonstrate a more extensive record presence, with 23 years of records across all countries, highlighting their significant role in diverse agricultural assessments.

In contrast, vegetables and fruits exhibit the lowest average record span, ranging from 6 to 9 years. Other crop groups show varying number of years of reliable records: oilseeds and oleaginous fruits (18 years), edible roots and tubers (13 years), pulses (17 years), and sugar crops (14 years) (Figure S4). While certain countries, including Burkina Faso, Burundi, Cameroon, Ethiopia, Madagascar, Malawi, Mali, Niger, and Nigeria, have comprehensive records spanning most crop types, countries such as the Central African Republic, Guinea, and Uganda present limited recorded years. According to the current FDW database, countries in Western Africa tend to have more reliable data records for grain crops, followed by Southern Africa and Eastern Africa.

As a dynamic dataset, HarvestStat Africa will be further curated to ensure it remains up-to-date and reliable. These updates will include additions of new data and revisions of existing data from FDW, as well as further data corrections within the FDW/HarvestStat Africa framework. To facilitate transparency and user access to these modifications, both the source scripts and the updated output dataset will be maintained in a dedicated GitHub repository (https://github.com/HarvestStat/HarvestStat). This approach guarantees that users can easily track and identify any changes between versions, enhancing the dataset's utility and reliability.

Technical Validation

Evaluation approach for plausibility

In this section, we describe how we assessed the data quality, consistency, and unique advantages of HarvestStat Africa by comparing its outputs with other comparable global datasets. For HarvestStat Africa's tabular data, we correlate the national crop production figures with FAOSTAT's national statistics. Although HarvestStat Africa's source documents are considered direct observations, verifying its consistency with FAOSTAT is essential to identify and rectify any potential discrepancies. Moreover, we conduct a spatial analysis of HarvestStat Africa data by comparing it with Earthstat, Global Data of Historical Yields (GDHY), and IFPRI's Spatial Production Allocation Model (SPAM). This analysis highlights HarvestStat Africa's ability to represent the reported spatial patterns of crop yield and its trends on a subnational scale, demonstrating a significant enhancement over the national-scale approaches typically employed in other datasets.

Comparison to FAOSTAT

Figure 4b shows the Pearson correlations of national annual crop production time-series between HarvestStat Africa and FAOSTAT, with HarvestStat Africa data entries spanning less than five years being omitted for clarity. The same figure for other crop types are presented in Figure S5. In instances of multiple growing seasons and crop production systems, as identified for countries like Burundi, Kenya, and Somalia (see Table 2), seasonal crop productions are aggregated into annual figures for direct comparison with FAOSTAT's annual production data. Note that HarvestStat Africa's spatial calibration and standardization processes do not influence the comparison of national annual production figures. The analysis predominantly reveals positive correlations, suggesting a high level of consistency between HarvestStat Africa and FAOSTAT. Specifically, grain crops exhibit an average correlation coefficient of 0.8, indicating substantial agreement. Notably, primary staple crops in each country demonstrate strong correlations (ranging from 0.9 to 1.0). Several countries, including Burkina Faso, Lesotho, Malawi, Chad, South Africa, Zambia, and Yemen, show high levels of agreement with FAOSTAT across most crop categories, with correlation coefficients exceeding 0.8 (Figure 4b and Figure S5).

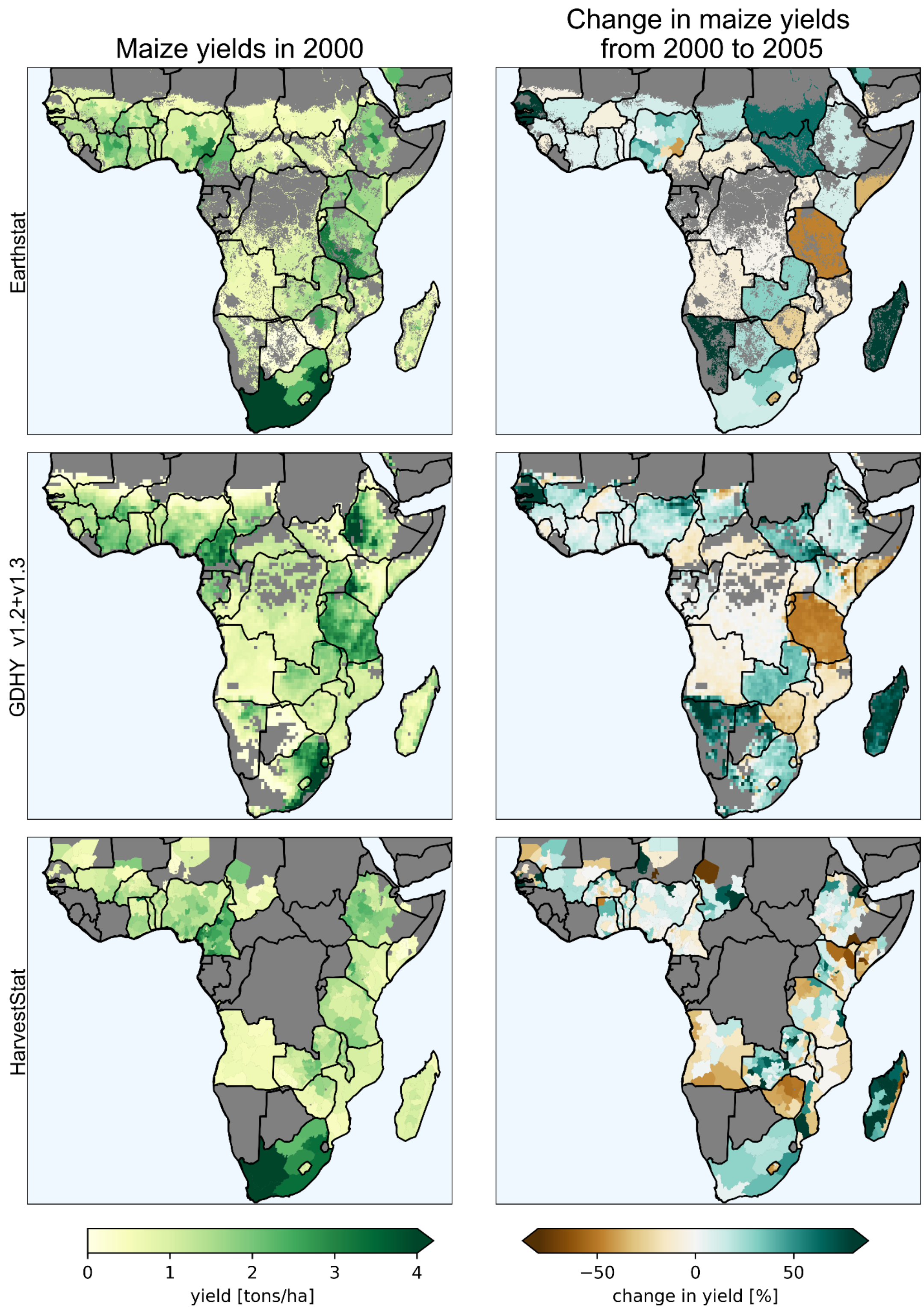
In contrast, non-grain crops exhibit a wider range of correlation levels with FAOSTAT. The source of these variations is difficult to identify without an independent dataset, but they may arise from data quality issues with either the subnational data in HarvestStat Africa or FAOSTAT. Direct comparisons may be challenging for certain crops, given FAOSTAT's aggregation of multiple crops within a single category (e.g., carrots/turnips and onions/shallots), and instances where HarvestStat Africa categorizes crops more granularly or broadly than FAOSTAT. Despite FAOSTAT being regarded as the foremost global dataset for crop production, approximately 30% of its entries are flagged as estimated, imputed, or unofficial figures (as illustrated in Figure S6). Hence, discrepancies do not always imply inaccuracies inHarvestStat Africa data. Overall, the predominantly high positive correlations underscore the consistency and reliability of agricultural data across a broad spectrum of crops and countries within the HarvestStat Africa framework, as benchmarked against FAOSTAT.

Comparison to gridded data products on yield datasets

While HarvestStat Africa is not the only publicly available subnational crop yield dataset, it is the only dataset that consists exclusively of subnational data in the African domain, giving it a subnational resolution in both time and space. To understand how HarvestStat Africa v1.0 compares to other datasets, we compare HarvestStat Africa v1.0 maize yields around the year 2000 to Earthstat[27], and the GDHY v1.3[28].

Each of the aforementioned subnational datasets takes a different approach to producing subnational crop yield estimates. The GDHY v1.3 dataset begins with FAO country-level statistics before disaggregating crop yields to the pixel-level using the fraction of photosynthetically available radiation (fPAR) and leaf area index (LAI) during the growing season as an indication of subnational vegetative health[28]. Ray et al. (2012) also blends FAO country-level data with subnational data by using FAO data to fill missing gaps in the collected subnational statistics and by scaling subnational data to FAO estimates. Portions of the data used in Ray et al. (2012) are available from the EarthStat website (http://www.earthstat.org; accessed Mar 21, 2024). A final product that we do not compare against is the SPAM dataset, which combines subnational crop statistics with information on cropland extent, climate, and socioeconomic development to produce distributions of crop yields, harvested areas, and production at a pixel scale[29]. We do not compare against the SPAM datasets because they are not designed to be used in a time-series analysis.

Each of the existing subnational crop yield datasets produces data that have a subnational resolution in space but have only quasi-subnational resolutions in time. Figure 5 illustrates the temporal resolution of the data using the change in yields from around the year 2000 (1998-2002) to around the year 2005 (2003-2007). Uniform national-level yield differences from FAOSTAT dominate the interannual variability of both EarthStat and GDHY, even in countries that appear to have subnational data in space. Because GDHY starts with the time-series of FAOSTAT yields, the spatial variability follows the vegetative health indices while the interannual variability of the data is dominated by the underlying FAOSTAT data. The authors clearly acknowledge this point, stating that “the spatial variation in modelled yields in a country followed that in the [net primary productivity], whereas the temporal variation in modelled yields basically followed those in the FAO data”[3]. In the Ray et al. (2012) data, the country-level temporal resolution is likely a result of subnational data scarcity in Africa in the dataset, which would necessitate gap-filling missing years with pattern-scaled FAO data. Both the Ray et al. (2012) data and GDHY data do demonstrate temporal subnational resolution in some locations. Ray et al. (2012) shows subnational temporal resolutions over Nigeria, for example, and GDHY well differentiates yield levels that vary across Kenya as is present also in the subnational data of HarvestStat Africa. Subnational HarvestStat Africa data is presented without in-filling of years and areas where subnational data is unavailable to allow for the most appropriate down-stream use of the data in, e.g., panel regression models.



397

398 **Figure 5.** Comparison of the Ray et al. (2012; EarthStat), GDHY v1.3, and HarvestStat Africa
399 data for maize yields around the year 2000 (1998-2002) and in the change of maize yields from
400 2000 (1998-2002) to 2005 (2003-2007).

Usage Notes

The subnational crop statistics in SSA may exhibit inherent uncertainty due to technical errors, such as sampling, processing, and coverage errors in agricultural census statistics[21,26]. While certain source documents explain their sampling methods for crop production reporting, others lack such information entirely. The uncertainty associated with harvested area measurement is generally considered greater than that of production figures[26]. Measuring harvested area accurately is challenging without advanced techniques[30], which are often not available in various regions, especially in past decades[26]. It is common for one indicator, such as harvested area, to be inferred from the other indicators.

The availability of crop statistics in SSA are often discontinuous in both space and time. Data may not be collected in every administrative unit in every year and subnational estimates are often not available for every year. The limited resources available for data collection of crop production and yield in some countries may also affect data quantity and quality in subnational statistics. This may manifest in data being estimated based on sparse samples taken from, e.g., farmer estimates or crop cut methods, or in limited or infrequent collection of subnational data. An additional systematic bias in some countries is that during particular years (e.g., poor crop-growing conditions) surveyors are not sent to areas of crop failure to save time and money on petrol, resulting in a value of “not collected” rather than a zero or near-zero production value. Additionally, figures from previous years are sometimes used to replace unobserved statistics. An example of this is the 2021/2022 statistics for the Tigray region in Ethiopia, which were impacted by the Tigray conflict starting in 2020.

As with many other regions, SSA countries frequently modify their administrative boundaries. This challenge has been addressed by FEWS NET through the identification of these changes and the subsequent reconstruction of proper administrative boundaries over time, which are then linked to crop statistics via the FNID. The lack of crop-specific harvested area maps for each year further introduces uncertainty into the harmonization process, as does the fact that the cropland map is static over time. Nevertheless, the harmonization process we employ represents a parsimonious and transparent set of assumptions in a data-scarce environment.

HarvestStat Africa offers the largest collection of reported subnational data available publicly and provides a harmonization of those data over changing subnational units. Our methods correct very few values, focusing primarily on reporting errors that can be verified with other sources of information or implausible values reported, such as single-year production values differing from values in neighboring years by an order of magnitude. All such changes are made in the public GitHub repository so as to maintain 100% transparency. By taking this approach, we defer to the officially reported statistics in each country, choosing to impose few modifications to the original data.

Finally, our approach represents a new, collaborative and entirely transparent model for collating, processing, and harmonizing subnational statistics. Our dataset is drawn from a database that is free and publicly available (the FEWS Data Warehouse), we process the data in a public and collaborative GitHub repository, and we immediately make the resulting analysis-ready dataset publicly available. The FEWS Data Warehouse already holds data submitted by a number of partners, and, moving forward, welcomes further data submissions that contain appropriate metadata. By making both the database of crop production statistics and the harmonized dataset entirely open, we aim to eliminate the duplication of effort needed to find and digitize these records, which has been an unfortunate hallmark of efforts to collate subnational crop statistics to date. An open and transparent workflow enables equity of access to the data and will catalyze innovation in the field of food systems research. While HarvestStat Africa focuses on Africa, our approach is transferable to other regions and globally scalable.

Code availability

Our custom code is available in a GitHub repository: https://github.com/HarvestStat/HarvestStat. It comprises data preparation, individual country processing scripts, and an aggregation process for consolidating output files. This setup ensures transparent and replicable data handling from retrieval to final output generation.

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Author Contributions

DL and WA made equivalent contributions to this work and are recognized as co-first authors. DL, WA, and XC processed the FDW data. FD, SS, RS, MB, JR, JV, LY, MA, KD, EK, SE, CJ, and CM provided the manuscript with scientific insights and feedback.

Competing Interests

The authors declare no competing interests.

Supplementary Information for “MateHarvestStat Africa – Harmonized Subnational Crop Statistics for Sub-Saharan Africa”

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Summary:

This supplementary information includes one table (Table 1) and six figures (Figures S1–S6).

Table S1. Crop types and data records for each country and season in HarvestStat Africa v1.0.

Country	Season (Record period)	Data records (Number years)
Angola	Main (1997-2017)	Avocado (2), Banana (10), Beans (mixed) (16), Cabbage (3), Carrots (3), Cassava (17), Chili Pepper (3), Coffee (3), Cowpea (1), Garlic (4), Green Bean (1), Groundnuts (In Shell) (13), Lemon (2), Maize (21), Mango (1), Millet (9), Okras (3), Onions (3), Pineapple (3), Potato (12), Rice (8), Sorghum (6), Soybean (5), Sweet Potatoes (15), Tomato (2), Wheat (1)
Burkina Faso	Main (1984-2022)	Bambara groundnut (30), Cotton (23), Cowpea (30), Fonio (11), Groundnuts (In Shell) (32), Maize (32), Millet (33), Potato (3), Rice (34), Sesame Seed (26), Sorghum (33), Sorghum (Red) (13), Soybean (15), Sweet Potatoes (15), Yams (11)
	Annual (2015-2022)	Maize (4), Rice (7)
Burundi	Season A (1997-2016)	Banana (17), Beans (mixed) (15), Bush Bean (3), Cassava (17), Cowpea (1), Groundnuts (In Shell) (2), Maize (18), Millet (3), Pea (14), Pigeon Pea (0), Pole Bean (3), Potato (15), Rice (1), Sorghum (2), Soybean (1), Sunflower Seed (0), Sweet Potatoes (15), Taro (15), Wheat (2), Yams (5)
	Season B (1996-2014)	Banana (14), Beans (mixed) (14), Bush Bean (3), Cassava (17), Cowpea (2), Groundnuts (In Shell) (2), Maize (16), Millet (13), Pea (16), Pigeon Pea (2), Pole Bean (3), Potato (14), Rice (10), Sorghum (16), Soybean (2), Sunflower Seed (1), Sweet Potatoes (15), Taro (16), Wheat (10), Yams (8)
	Season C (1996-2014)	Banana (14), Beans (mixed) (13), Bush Bean (2), Cassava (17), Cowpea (0), Groundnuts (In Shell) (0), Maize (13), Millet (0), Pea (5), Pigeon Pea (1), Pole Bean (1), Potato (9), Rice (1), Sorghum (1), Soybean (0), Sunflower Seed (1), Sweet Potatoes (14), Taro (9), Wheat (1), Yams (0)
Benin	Main (1995-2021)	Bambara groundnut (23), Cowpea (26), Fonio (15), Geocarpa groundnut (18), Goussi (18), Groundnuts (In Shell) (26), Maize (26), Millet (19), Molokhia (5), Onions (7), Pigeon Pea (14), Potato (5), Sesame Seed (10), Sorghum (25), Soybean (18), Sugarcane (6), Sweet Potatoes (24), Taro (12), Watermelon (4), Yams (23)
	Annual (1995-2021)	Cabbage (4), Carrots (5), Cassava (26), Cucumber (4), Eggplant (11), Lettuce (8), Okras (20), Pineapple (10), Rice (22), Tomato (25)
DRC	Main (2005-2016)	Banana (10), Beans (mixed) (7), Cassava (10), Maize (10), Rice (10)

CAF	Main (2014-2016)	Cassava (3), Groundnuts (In Shell) (3), Maize (3), Rice (3), Sesame Seed (3)
Cameroon	Annual (1998-2008)	Bambara groundnut (3), Banana (8), Beans (mixed) (1), Cassava (8), Cowpea (4), Groundnuts (In Shell) (1), Maize (1), Melon (3), Millet (1), Okras (5), Onions (1), Pam Nut (7), Pineapple (5), Potato (1), Rice (2), Squash and Melon Seeds (1), Sweet Potatoes (1), Taro (10), Tomato (1), Watermelon (2), Yams (8)
	North 1st Season (1998-2008)	Beans (mixed) (9), Groundnuts (In Shell) (10), Maize (10), Millet (6), Potato (8), Rice (8), Sesame Seed (6), Soybean (8), Squash and Melon Seeds (8), Sweet Potatoes (9)
	North 2nd Season (1999-2008)	Beans (mixed) (7), Maize (6), Millet (5), Onions (10), Rice (6), Sweet Potatoes (6)
	1st Season (1998-2008)	Bambara groundnut (7), Beans (mixed) (6), Groundnuts (In Shell) (8), Maize (6), Melon (6), Millet (8), Potato (6), Rice (7), Sesame Seed (3), Soybean (6), Squash and Melon Seeds (7), Sweet Potatoes (7), Tomato (5), Watermelon (6)
	2nd Season (1998-2008)	Bambara groundnut (7), Beans (mixed) (6), Groundnuts (In Shell) (6), Maize (6), Melon (6), Millet (6), Potato (6), Rice (7), Soybean (6), Squash and Melon Seeds (5), Sweet Potatoes (7), Tomato (5), Watermelon (6)
Ethiopia	Meher (1998-2016)	Avocado (5), Banana (7), Barley (12), Beans (White) (9), Beet (3), Cabbage (4), Carrots (1), Chick Peas (8), Chili Pepper (3), Coffee (7), Ethiopian Cabbage (4), Fava Bean (13), Fenugreek (7), Field Peas (12), Garlic (4), Green Peppers (3), Groundnuts (In Shell) (5), Guava (2), Hops (7), Lemon (2), Lentils (9), Linseed (9), Maize (14), Mango (5), Millet (8), Mung bean (3), Neug (10), Oats (5), Onions (3), Orange (4), Papaya (5), Pineapple (1), Potato (6), Rape (6), Rice (1), Sesame Seed (6), Sorghum (12), Soybean (3), Sugarcane (6), Sunflower Seed (3), Sweet Potatoes (7), Taro (4), Teff (15), Tomato (1), Wheat (13), Yams (1)
Ghana	Annual (1997-2018)	Banana (22), Cassava (22), Taro (21)
	Main (1984-2022)	Banana (3), Cassava (4), Cowpea (18), Groundnuts (In Shell) (17), Maize (26), Millet (26), Rice (25), Sorghum (22), Soybean (17), Sweet Potatoes (8), Taro (4), Yams (23)
Guinea	Main (2010-2015)	Cassava (6), Groundnuts (In Shell) (6), Maize (6), Rice (6)
Kenya	Annual (1982-2014)	Banana (2), Barley (3), Beans (mixed) (24), Cassava (2), Coffee (7), Cowpea (2), Maize (21), Millet (6), Mung bean (2), Pigeon Pea (1), Potato (4), Rice (2), Sorghum (6), Sweet Potatoes (3), Taro (1), Tea (6), Wheat (23), Yams (1)

	Long (1991-2019)	Maize (12), Sorghum (1)
	Short (1991-2019)	Maize (7), Sorghum (2)
Liberia	Main (1995-2015)	Cassava (7), Rice (10)
Lesotho	Summer (1981-2022)	Beans (mixed) (36), Maize (39), Oats (0), Pea (30), Sorghum (38), Wheat (34)
	Winter (2006-2022)	Beans (mixed) (0), Maize (1), Oats (0), Pea (9), Sorghum (0), Wheat (7)
Madagascar	Annual (1987-2019)	Bambara groundnut (1), Banana (1), Barley (1), Beans (mixed) (21), Beet (1), Broad Beans (1), Carrots (1), Cassava (28), Chili Pepper (1), Coffee (19), Cotton (1), Cowpea (1), Cucumber (1), Eggplant (1), Garlic (1), Ginger (1), Green Pea (1), Groundnuts (In Shell) (18), Jute (1), Lentils (1), Lettuce (1), Maize (28), Millet (1), Onions (1), Pepper (1), Pigeon Pea (18), Pineapple (1), Potato (11), Rice (30), Soybean (1), Squash (1), Sugarcane (21), Sweet Potatoes (23), Taro (1), Tobacco (1), Tomato (1), Wheat (1), Yams (1)
Mali	Main (1974-2022)	Bambara groundnut (32), Barley (2), Beans (mixed) (4), Cotton (35), Cowpea (28), Fonio (35), Groundnuts (In Shell) (34), Maize (36), Millet (37), Rice (36), Sesame Seed (16), Sorghum (37), Soybean (8), Sugarcane (26), Sweet Potatoes (4), Tomato (1), Wheat (11), Yams (6)
Mauritania	Annual (1989-2019)	Cowpea (4), Groundnuts (In Shell) (1), Maize (4), Millet (4), Rice (19), Sorghum (5)
	Bas-fond (1999-2016)	Cowpea (1), Maize (9), Rice (1), Sorghum (12), Wheat (3)
	Dam retention (1999-2016)	Cowpea (1), Maize (5), Rice (0), Sorghum (4), Wheat (2)
	Main (1999-2016)	Cowpea (1), Maize (7), Millet (12), Sorghum (14)
	Walo (1999-2016)	Cowpea (1), Maize (9), Sorghum (13)
	Decrue controlee (2000-2016)	Maize (5), Sorghum (7)

	Hot off-season (2005-2016)	Rice (7)
	Cold off-season (2010-2016)	Wheat (3)
Malawi	Main (1983-2020)	Bambara groundnut (15), Banana (3), Bean (Hyacinth) (13), Beans (mixed) (12), Cabbage (2), Cassava (31), Chick Peas (8), Chili Pepper (9), Coffee (8), Cotton (27), Cowpea (15), Field Peas (10), Garlic (1), Groundnuts (In Shell) (30), Maize (34), Millet (23), Onions (2), Paprika (9), Pigeon Pea (14), Potato (14), Rice (22), Sesame Seed (11), Sorghum (25), Soybean (14), Sunflower Seed (11), Sweet Potatoes (17), Tobacco (14), Tomato (2), Velvet Bean (12)
	Annual (2018-2023)	Beans (mixed) (3), Cassava (3), Groundnuts (In Shell) (3), Maize (3), Rice (3), Soybean (3)
	Winter (2006-2020)	Beans (mixed) (12), Cabbage (2), Cowpea (11), Field Peas (10), Garlic (1), Onions (2), Paprika (4), Pigeon Pea (1), Potato (11), Sweet Potatoes (13), Tomato (2)
Mozambique	Main (1999-2022)	Bambara groundnut (16), Beans (Rosecoco) (9), Beans (mixed) (14), Chili Pepper (1), Cowpea (16), Ginger (1), Green Bean (6), Groundnuts (In Shell) (13), Maize (21), Millet (15), Mung bean (1), Paprika (2), Pepper (2), Pigeon Pea (15), Sesame Seed (11), Sorghum (21), Soybean (1), Sugarcane (1), Sunflower Seed (8), Sweet Potatoes (5), Tobacco (11), Wheat (1)
	Annual (1999-2022)	Cassava (22), Jute (2), Sugarcane (1), Tea (2)
	Cotton season (1999-2020)	Cotton (14)
	Rice season (1999-2022)	Banana (1), Rice (15)
Niger	Dry (2011-2022)	Bean (Hyacinth) (2), Cabbage (7), Capsicum Chinense (6), Carrots (6), Cassava (5), Celery (2), Chili Pepper (4), Cowpea (5), Cucumber (1), Eggplant (3), Garlic (3), Groundnuts (In Shell) (2), Lettuce (7), Maize (6), Melon (3), Okras (4), Onions (7), Pea (2), Potato (6), Rape (3), Rice (3), Sorghum (3), Sorrel (1), Squash (6), Sugarcane (5), Sweet Potatoes (5), Tobacco (2), Tomato (7), Watermelon (3), Wheat (3)
	Main (1980-2022)	Bambara groundnut (10), Cabbage (1), Capsicum Chinense (1), Cassava (1), Chili Pepper (1), Cotton (2), Cowpea (32), Cucumber (1), Fonio (8), Groundnuts (In Shell) (22), Lettuce (1), Maize (12), Millet (36), Okras (8), Onions (5), Potato (0), Rice (11), Sesame Seed (14), Sorghum (36), Sorrel (9), Squash (1), Sugarcane (1), Sweet Potatoes (1), Tomato (2)

Nigeria	Wet (1999-2023)	Banana (2), Cassava (2), Cotton (16), Cowpea (23), Ginger (9), Groundnuts (In Shell) (21), Maize (24), Melon (8), Millet (19), Okras (10), Onions (11), Rice (24), Sesame Seed (12), Sorghum (19), Soybean (17), Sweet Potatoes (10), Tomato (12), Wheat (7)
	Annual (1999-2023)	Cassava (22), Taro (18), Yams (23)
Rwanda	Season A (2008-2017)	Avocado (1), Banana (4), Beans (mixed) (1), Beet (1), Bush Bean (2), Cabbage (1), Carrots (1), Cassava (3), Celery (1), Cereal Crops (0), Eggplant (1), Green Bean (1), Green Pea (1), Groundnuts (In Shell) (3), Maize (4), Okras (1), Pea (3), Pole Bean (3), Potato (4), Rice (2), Sorghum (2), Soybean (3), Squash (1), Sugarcane (1), Sunflower Seed (1), Sweet Potatoes (4), Taro (1), Tomato (1), Wheat (2), Yams (3)
	Season B (2008-2017)	Avocado (1), Banana (4), Beans (mixed) (1), Beet (1), Bush Bean (2), Cabbage (1), Carrots (1), Cassava (4), Celery (1), Cereal Crops (1), Eggplant (1), Green Bean (1), Green Pea (1), Groundnuts (In Shell) (3), Maize (4), Okras (1), Pea (3), Pole Bean (2), Potato (3), Rice (3), Sorghum (3), Soybean (3), Squash (1), Sugarcane (1), Sunflower Seed (1), Sweet Potatoes (4), Taro (1), Tomato (1), Wheat (2), Yams (3)
	Season C (2013-2013)	Bush Bean (0), Pea (1), Pole Bean (0), Potato (1), Soybean (1)
Sudan	Main (1975-2017)	Cotton (Acala) (14), Cotton (American) (9), Groundnuts (In Shell) (28), Millet (47), Pigeon Pea (1), Sesame Seed (37), Sorghum (65), Sunflower Seed (16), Wheat (7)
	Winter (1975-2016)	Wheat (24)
Sierra Leone	Main (1986-2016)	Banana (0), Cashew (unshelled) (0), Cassava (2), Groundnuts (In Shell) (2), Maize (2), Millet (0), Okras (2), Potato (0), Rice (2), Sesame Seed (2), Sorghum (2), Sweet Potatoes (2)
Senegal	Main (1960-2015)	Cassava (7), Cowpea (35), Fonio (6), Groundnuts (In Shell) (48), Maize (35), Millet (46), Rice (33), Sesame Seed (4), Sorghum (25), Sweet Potatoes (1)
	Main-off (2000-2011)	Groundnuts (In Shell) (3), Maize (6), Rice (8)
Somalia	Deyr (1996-2023)	Cowpea (8), Groundnuts (In Shell) (7), Maize (21), Onions (6), Pepper (9), Rice (5), Sesame Seed (10), Sorghum (17), Tomato (4), Watermelon (4)
	Gu (1995-2021)	Cowpea (9), Groundnuts (In Shell) (5), Maize (23), Onions (8), Pepper (9), Rice (11), Sesame Seed (8), Sorghum (18), Tomato (5), Watermelon (3)

	Deyr-off (2004-2021)	Cowpea (6), Maize (4), Sesame Seed (3), Sorghum (1)
	Gu-off (2005-2019)	Cowpea (4), Maize (5), Sesame Seed (5), Sorghum (2)
South Sudan	Main (1975-2013)	Cereal Crops (2), Cotton (Acala) (7), Cotton (American) (4), Groundnuts (In Shell) (23), Millet (30), Sesame Seed (23), Sorghum (48), Sunflower Seed (9)
Chad	Main (1983-2017)	Bambara groundnut (9), Cassava (14), Cowpea (17), Fonio (4), Groundnuts (In Shell) (24), Maize (25), Millet (31), Rice (21), Sesame Seed (21), Sorghum (29), Sweet Potatoes (6), Taro (6), Wheat (28)
	Cold-off (1983-2017)	Sorghum (19)
Togo	Main (1995-2015)	Beans (mixed) (5), Cassava (5), Cotton (4), Cowpea (5), Groundnuts (In Shell) (5), Maize (19), Millet (9), Sorghum (16), Soybean (1), Sweet Potatoes (0), Yams (4)
	Annual (2005-2015)	Rice (4)
Tanzania	Long (2003-2015)	Bambara groundnut (2), Barley (1), Beans (mixed) (1), Cassava (1), Chick Peas (1), Cowpea (1), Field Peas (1), Groundnuts (In Shell) (2), Maize (2), Millet (2), Mung bean (1), Pigeon Pea (1), Potato (1), Rice (2), Sesame Seed (1), Sorghum (2), Soybean (1), Sunflower Seed (1), Sweet Potatoes (1), Taro (1), Wheat (1), Yams (1)
	Annual (1989-2015)	Bambara groundnut (3), Banana (15), Barley (9), Beans (mixed) (12), Cassava (18), Chick Peas (2), Cowpea (4), Field Peas (6), Groundnuts (In Shell) (12), Maize (21), Millet (12), Mung bean (3), Pea (2), Pigeon Pea (1), Potato (10), Rice (19), Sesame Seed (9), Sorghum (18), Soybean (3), Sugarcane (0), Sunflower Seed (8), Sweet Potatoes (13), Taro (1), Wheat (11), Yams (1)
	Short (2003-2015)	Bambara groundnut (1), Barley (1), Beans (mixed) (1), Cassava (1), Chick Peas (1), Cowpea (1), Field Peas (1), Groundnuts (In Shell) (1), Maize (2), Millet (1), Mung bean (1), Pigeon Pea (1), Potato (1), Rice (2), Sesame Seed (1), Sorghum (1), Soybean (1), Sunflower Seed (1), Sweet Potatoes (1), Taro (1), Wheat (1), Yams (1)
	Long/Dry (2003-2003)	Cassava (1), Chick Peas (1), Maize (1), Mung bean (1), Soybean (1), Taro (1)
Uganda	First (2009-2009)	Banana (0), Beans (mixed) (0), Cassava (0), Cowpea (0), Field Peas (0), Groundnuts (In Shell) (0), Maize (1), Millet (0), Potato (0), Rice (0), Sesame Seed (0), Sorghum (0), Soybean (0), Sweet Potatoes (0)

	Second (2008-2008)	Banana (0), Beans (mixed) (1), Cassava (1), Cowpea (0), Field Peas (0), Groundnuts (In Shell) (1), Maize (1), Millet (0), Potato (0), Rice (0), Sesame Seed (0), Sorghum (0), Soybean (0), Sweet Potatoes (0)
	Annual (2008-2009)	Pigeon Pea (1)
South Africa	Winter (1979-2022)	Barley (11), Wheat (44)
	Summer (1981-2022)	Beans (mixed) (29), Groundnuts (In Shell) (36), Maize (35), Maize (Yellow) (35), Sorghum (25), Soybean (31), Sunflower Seed (26)
Zambia	Annual (1980-2017)	Bambara groundnut (8), Barley (2), Beans (mixed) (20), Cassava (0), Coffee (1), Cottonseed (11), Cowpea (9), Maize (33), Millet (16), Pineapple (1), Potato (6), Rice (14), Sorghum (18), Soybean (17), Sugarcane (1), Sunflower Seed (15), Sweet Potatoes (16), Velvet Bean (1), Wheat (6)
Zimbabwe	Main (1981-2023)	Bambara groundnut (1), Beans (Rosecoco) (11), Cassava (0), Cowpea (6), Groundnuts (In Shell) (31), Maize (52), Millet (41), Rape (7), Rice (3), Sesame Seed (4), Sorghum (34), Soybean (21), Sunflower Seed (24), Sweet Potatoes (8)

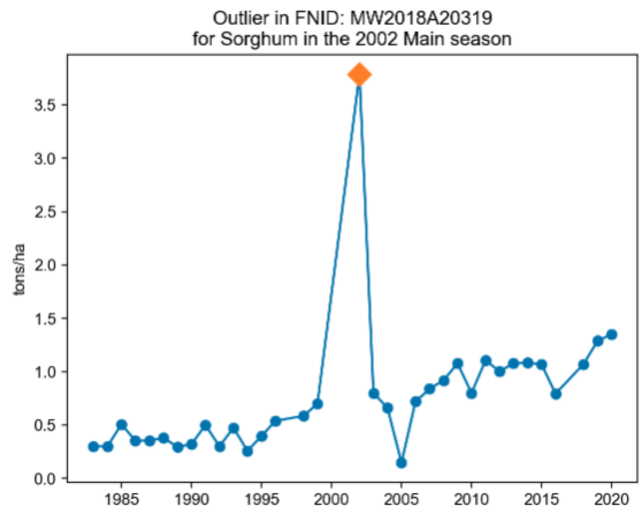

Figure S1: Example of crop yield outlier for Malawi sorghum, main season in FNID MW2018A20319

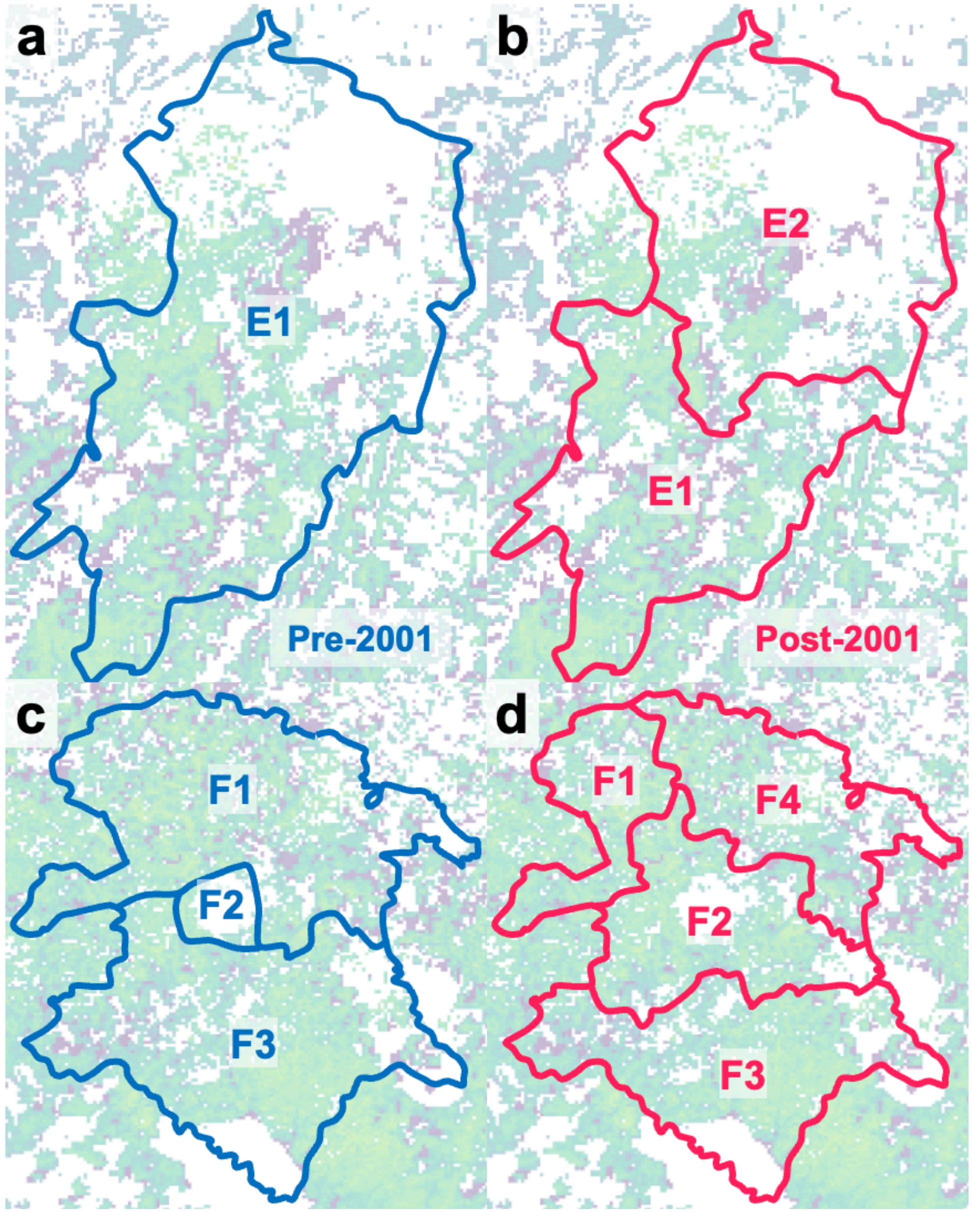

Figure S2. An illustrative example of changes in administrative boundaries from pre-2001 (left panels; blue lines) to post-2001 (right panels; red lines). The background color represents a crop mask, with green-to-blue colors indicating cropland areas. Top panels (a and b) illustrate Case A, where a single district (E1) splits into two districts (E1 and E2), maintaining equivalent boundary areas. Bottom panels (c and d) illustrate Case B, where three districts (F1, F2, and F3) are reorganized into four districts (F1, F2, F3, and F4), resulting in changes to their boundary areas.

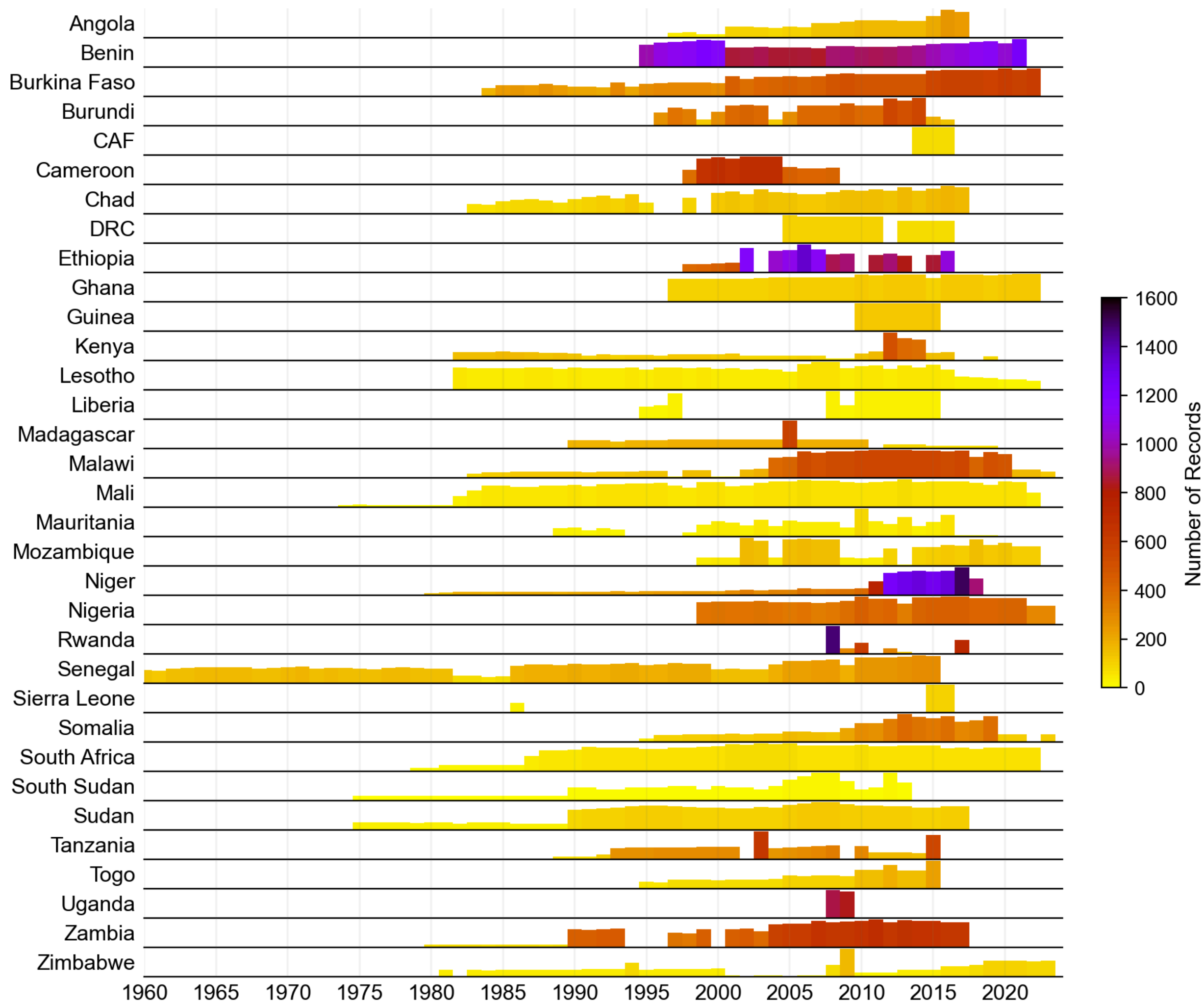

Figure S3. Temporal distribution of production records by country in HarvestStat Africa v1.0, including all available crop types. Note that the y-axis in each row is set by the maximum number of records in that country, while the colorbar applies across all countries.

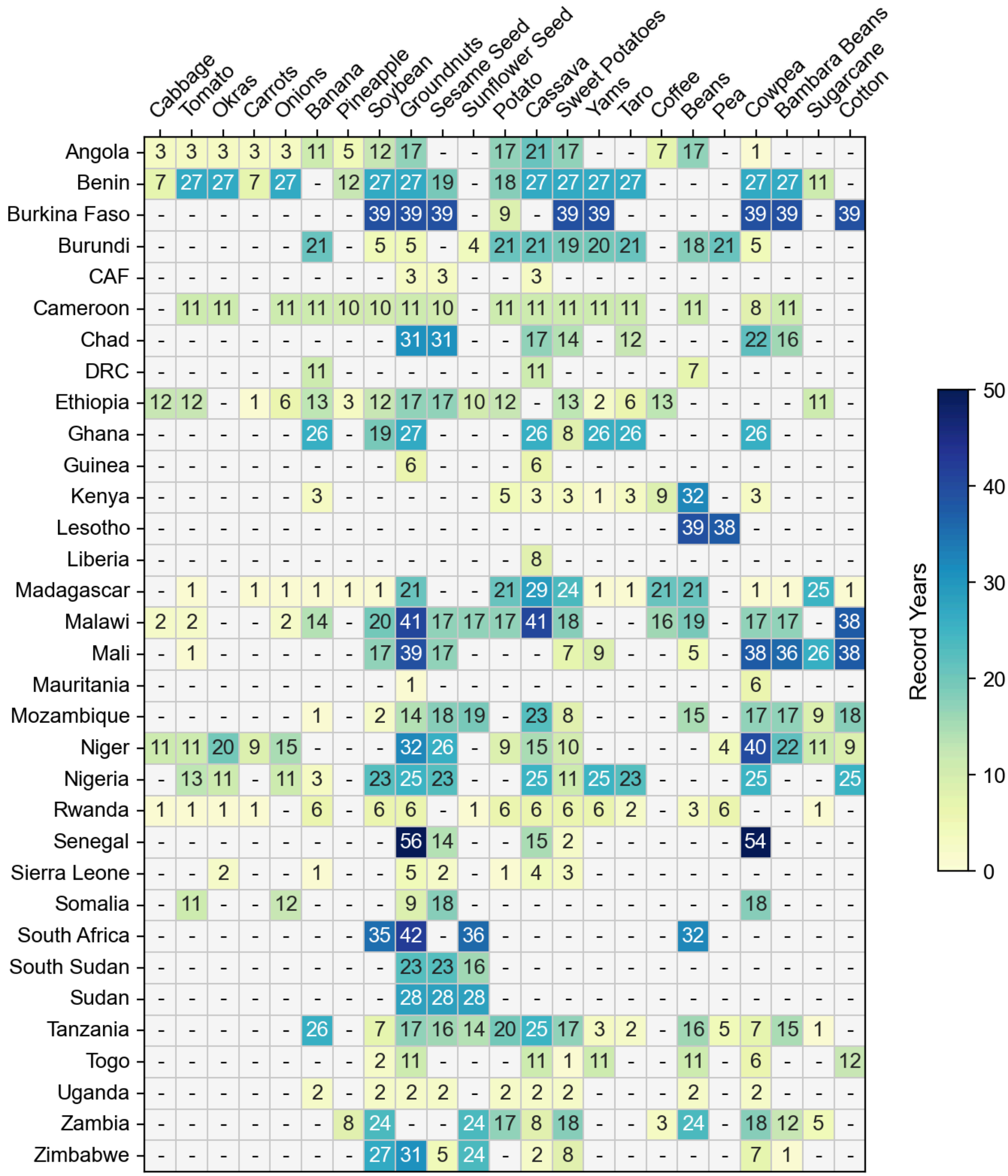

Figure S4. Number of years with production records for various crop types observed in at least five countries. The record years do not necessarily represent consecutive years.

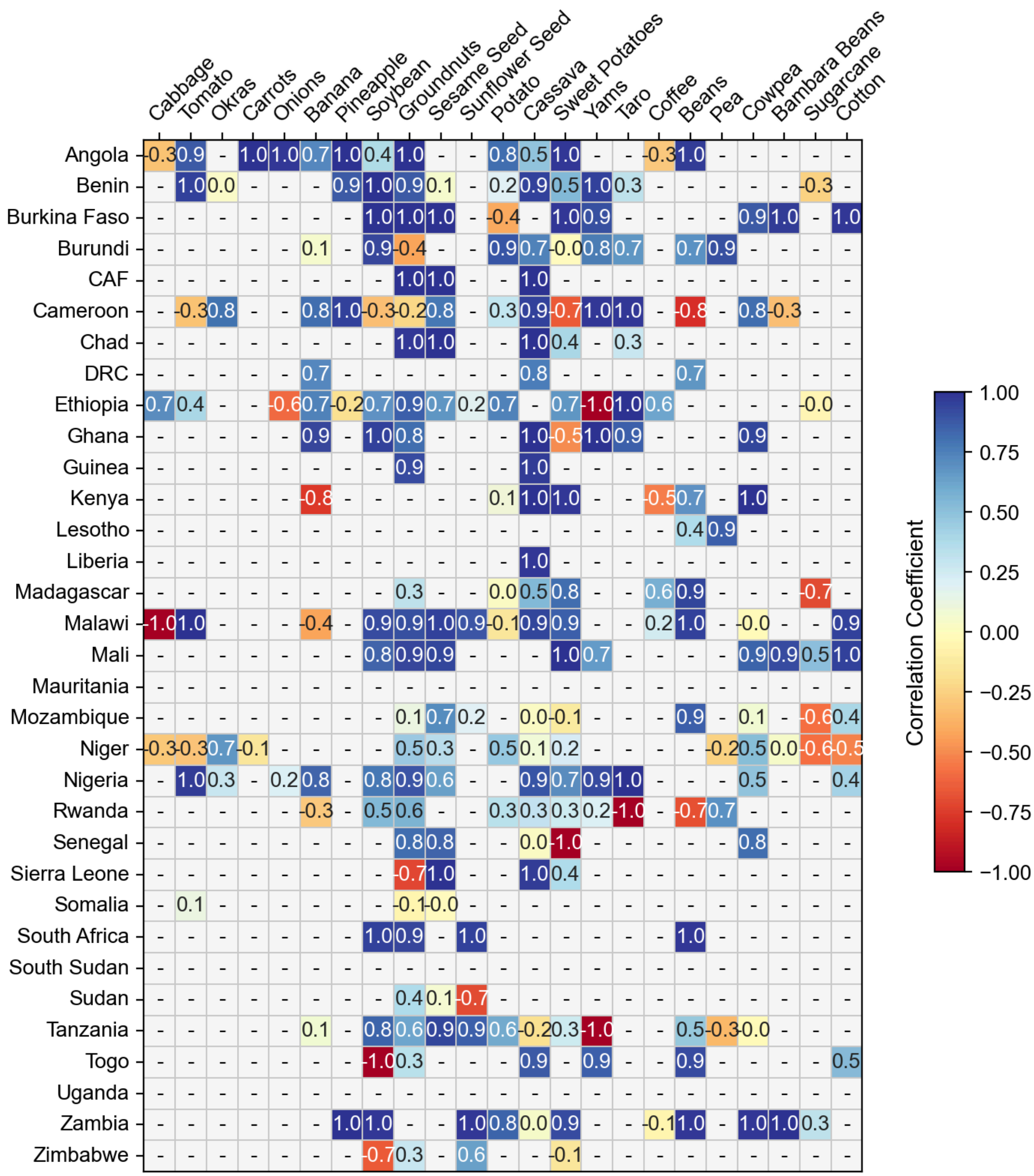

Figure S5. Correlation coefficient of national crop productions between HarvestStat v1.0 and FAOSTAT for various crop types observed in at least five countries.

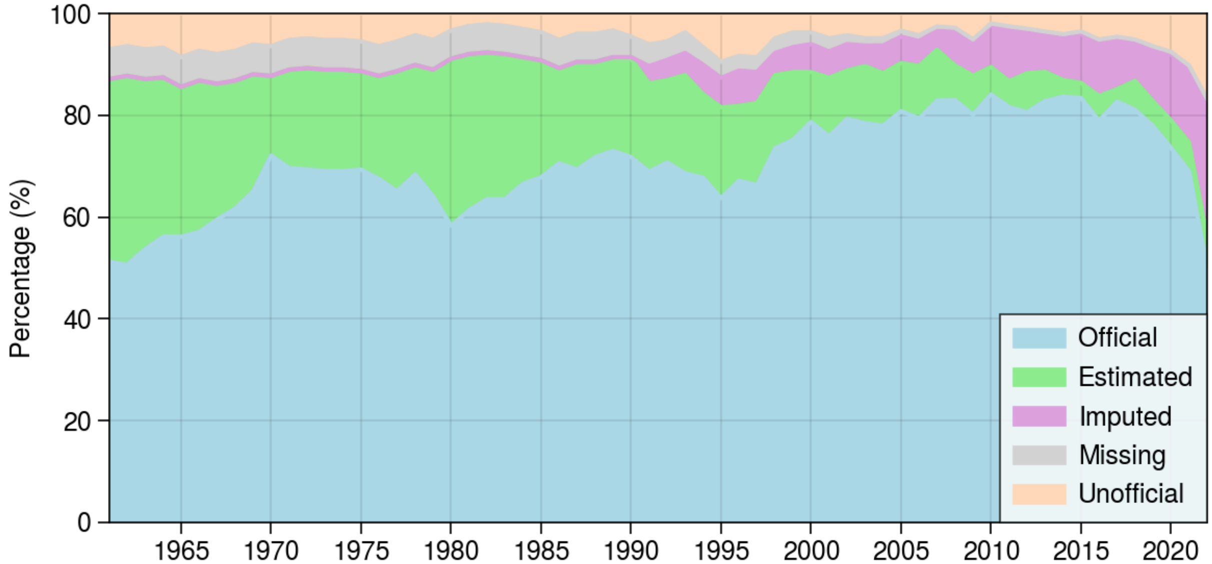

Figure S6. Percentage of data flags reported in FAOSTAT for 30 crop types (7 grain types and 23 other types) and 32 countries processed in HarvestStat v1.0.