

## Annex B. Quick reference to CropWatch indicators, spatial units and methodologies

The following sections give a brief overview of CropWatch indicators and spatial units, along with a description of the CropWatch production estimation methodology. For more information about CropWatch methodologies, visit CropWatch online at [www.cropwatch.com.cn](http://www.cropwatch.com.cn).

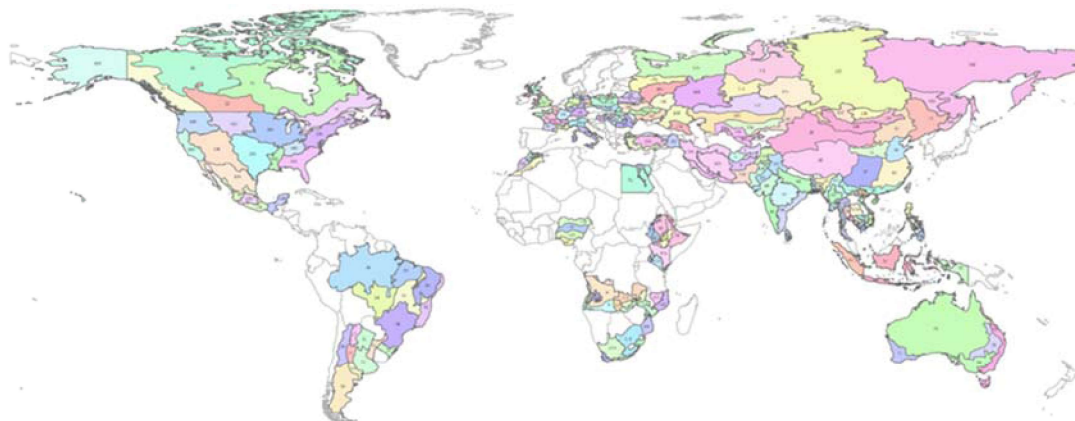
### **Agroecological zones for 43 key countries**

#### ***Overview***

217 agroecological zones for the 43 key countries across the globe

#### ***Description***

43 key agricultural countries are divided into 217 agro-ecological zones based on cropping systems, climatic zones, and topographic conditions. Each country is considered separately. A limited number of regions (e.g., region 001, region 027, and region 127) are not relevant for the crops currently monitored by CropWatch but are included to allow for more complete coverage of the 42 key countries. Some regions are more relevant for rangeland and livestock monitoring, which is also essential for food security.



- 001. Central region with sparse vegetation
- 002. Dry region
- 003. Wind dry farming and irrigated cultivation region
- 004. Wind dry farming and grazing region
- 005. Arid zone
- 006. Central Plateau
- 007. Humid zone
- 008. Semi-arid zone
- 009. Sub-humid zone
- 010. Andes
- 011. Chaco
- 012. Mesopotamia
- 013. Humid Pampas
- 014. Pampas hills
- 015. Arid part of Patagonia
- 016. Dry Pampas
- 017. Subtropical highlands
- 018. Arid and semiarid zone
- 019. Southeastern wheat area
- 020. Subhumid subtropical zone
- 021. Southwestern wheat area
- 022. Wet temperate and subtropical zone
- 023. Coastal region
- 024. Gaugetic plain
- 025. Hills
- 026. Striped basin
- 027. Center
- 028. North
- 029. South-west
- 030. Amazon
- 031. Central Savanna
- 032. Coast
- 033. Northwestern mixed forest and farmland
- 034. Mato Grosso
- 035. Nordeste
- 036. Parnaiba basin
- 037. Southern subtropical rangelands
- 038. Gaoze Xiajiang
- 039. Huiluan
- 040. Huang Huaihai
- 041. Inner Mongolia
- 042. Loess region
- 043. Lower Yangtze region
- 044. North East China
- 045. Qinghai-Tibet
- 046. Southern China
- 047. South West China
- 048. China Eiaison
- 049. Soviet Lawrence basin
- 050. Arctic
- 051. Hudson Bay
- 052. Western Canada
- 053. Prairies
- 054. East German lake and Heathland sparse crop area
- 055. Central wheat zone of Saxony and Thuringia
- 056. Wheat zone of Schleswig-Holstein and the Baltic coast
- 057. Wind wheat and sugarbeets zone of the north-west
- 058. Bavarian Plateau
- 059. Western sparse crop area of the Rhinisch massif
- 060. Nile Delta and Mediterranean coastal strip
- 061. Nile Valley
- 062. Desert
- 063. Central-northern maize-teff highlands
- 064. Eastern arid area
- 065. Great Rift region
- 066. Northern Arid zone
- 067. North-western cereal-root-tubers lowlands
- 068. North-western semi-irrigated lowlands
- 069. North-western semi-arid lowlands
- 070. South-western mixed maize zone
- 071. South-eastern Waddoo highlands
- 072. Semi-arid pastures area
- 073. South-western coffee-cocoa highlands
- 074. Western mixed maize zone
- 075. Mixed Central dry zone
- 076. Alps region
- 077. Mediterranean zone
- 078. Northern barley zone
- 079. Maize, barley and livestock zone along the English Channel
- 080. Improved zone of eastern France
- 081. Southwest maize zone
- 082. Mixed maize, barley and rye zone from the Centre to the Atlantic Ocean
- 083. North England, Wales and North Ireland sparse crop area
- 084. Barley area in Scotland
- 085. South English mixed wheat and barley zone
- 086. Central Hungary
- 087. Pannia
- 088. North Hungary
- 089. Transylvania
- 090. Java
- 091. Kalimantan and Sulawesi
- 092. Sumatra
- 093. West Papua
- 094. Decan Plateau
- 095. Eastern coastal region
- 096. Gangetic plain
- 097. Assam and north-eastern regions
- 098. Agriculture areas in Rajasthan and Gujarat
- 099. Western coastal region
- 100. North western dry region
- 101. Western Himalayan region
- 102. Central and Eastern wasteland region
- 103. Arid Red Sea coastal low hills and plains
- 104. Semi-arid to sub-tropical western and northern hills
- 105. East coast
- 106. Po Valley
- 107. Islands
- 108. Northern Italy
- 109. Central semi-agriculture region
- 110. South zone
- 111. Eastern plateau and northeastern zone
- 112. Northern zone
- 113. Coast
- 114. Highland agriculture zone
- 115. Northern rangelands
- 116. South-west
- 117. Tropic step
- 118. Mekong valley between Laos-Vietnam border
- 119. Northern plain and northeast
- 120. Southwest Hilly region
- 121. Dry Zone
- 122. Intermediate Zone
- 123. Wet zone
- 124. Desert
- 125. Sub-humid northern highlands
- 126. Rare semiarid zones
- 127. Rare subhumid zones
- 128. Arid and semi-arid regions
- 129. Humid tropics with summer rainfall
- 130. Sub-humid temperate region with summer rains
- 131. Sub-humid low tropics with summer rains
- 132. Central plain
- 133. Delta and southern-coast
- 134. Hills
- 135. Alluvial
- 136. Gold Desert
- 137. Bengal Ganges Region
- 138. Sclero-therm Region
- 139. Central and Eastern Steppes
- 140. Bush basin
- 141. Northern high altitude areas
- 142. Low Zambesia River basin
- 143. Northern coast
- 144. Southern region
- 145. Derived savanna zone
- 146. Guinea savanna
- 147. Humid forest zone
- 148. Sudanese-Saharan zone
- 149. Baluchistan
- 150. Lower Indus basin in south Punjab and Sind
- 151. Northern highlands
- 152. Northern Punjab
- 153. Faroe Islands
- 154. Faroe and central Vinnar Islands
- 155. Northern lowlands of Wisconsin to western Vinnar
- 156. Central rice and potato area
- 157. Northern rice and potato area
- 158. Northern-central wheat and sugarbeet area
- 159. Southern wheat and sugarbeet area
- 160. Central mixed farming and pasture Carpathian hills
- 161. Eastern and southern maize wheat and sugarbeet plains
- 162. Western and central maize wheat and sugarbeet plateau
- 163. Amur and Priuralsky Krai
- 164. Central Russia
- 165. Central black soils area
- 166. Eastern Siberia
- 167. Middle Siberia
- 168. Middle Volga
- 169. Northern Caucasus
- 170. Northeast Region including Nizhny Novgorod
- 171. South Caucasian
- 172. Subarctic region
- 173. Ural and western Volga region
- 174. Western Siberia
- 175. West subarctic region
- 176. Central double and triple cropped rice lowlands
- 177. South-eastern horiculture area
- 178. Western and southern hill areas
- 179. Single-cropped rice north-eastern region
- 180. Black Sea region
- 181. Central Anatolia region
- 182. Eastern Anatolia region
- 183. Marasra Apam Mediterranean lowland region
- 184. Central wheat area
- 185. Eastern Carpathian hills
- 186. Northern wheat area
- 187. Southern wheat and maize area
- 188. Alaska and Hawaii
- 189. Blue Grass region
- 190. California
- 191. Corn Belt
- 192. Lower Mississippi
- 193. Northern Plains
- 194. North-eastern zones
- 195. Northwest
- 196. Southern Plains
- 197. Southeast
- 198. Southwest
- 199. Central region with sparse crops
- 200. Eastern hilly cereals zone
- 201. Arid Sea coast zone
- 202. North Central Coast
- 203. North East
- 204. Red River Delta
- 205. South East
- 206. South Central Coast
- 207. South West
- 208. Central highlands
- 209. Mekong River Delta
- 210. Arid and desert zones
- 211. Humid Cape Fold mountains
- 212. Mediterranean zone
- 213. Dry highland and subtropical maize areas
- 214. Loamless Zambesi rift valley
- 215. Northern high rainfall zone
- 216. Central-western and southern plateau
- 217. Western semi-arid plain

### CropWatch indicators

The CropWatch indicators are designed to assess the condition of crops and the environment in which they grow and develop; the indicators—RAIN (for rainfall), TEMP (temperature), and RADPAR (photosynthetically active radiation, PAR)—are not identical to the weather variables, but instead are value-added indicators computed only over crop growing areas (thus for example excluding deserts and rangelands) and spatially weighted according to the agricultural production potential, with marginal areas

receiving less weight than productive ones. The indicators are expressed using the usual physical units (e.g., mm for rainfall) and were thoroughly tested for their coherence over space and time. CWSU are the CropWatch Spatial Units, including MRUs, MPZ, and countries (including first-level administrative districts in select large countries). For all indicators, high values indicate "good" or "positive."

INDICATOR			
<b>BIOMSS</b>			
<b>Biomass accumulation potential</b>			
Crop/ Ground and satellite	Grams dry matter/m <sup>2</sup> , pixel or CWSU	An estimate of biomass that could potentially be accumulated over the reference period given the prevailing rainfall and temperature conditions.	Biomass is presented as maps by pixels, maps showing average pixels values over CropWatch spatial units (CWSU), or tables giving average values for the CWSU. Values are compared to the average value for the last five years (2014-2018), with departures expressed in percentage.
<b>CALF</b>			
<b>Cropped arable land and cropped arable land fraction</b>			
Crop/ Satellite	[0,1] number, pixel or CWSU average	The area of cropped arable land as fraction of total (cropped and uncropped) arable land. Whether a pixel is cropped or not is decided based on NDVI twice a month. (For each four-month reporting period, each pixel thus has 8 cropped/ uncropped values).	The value shown in tables is the maximum value of the 8 values available for each pixel; maps show an area as cropped if at least one of the 8 observations is categorized as "cropped." Uncropped means that no crops were detected over the whole reporting period. Values are compared to the average value for the last five years (2014-2018), with departures expressed in percentage.
<b>CROPPING INTENSITY</b>			
<b>Cropping intensity Index</b>			
Crop/ Satellite	0, 1, 2, or 3; Number of crops growing over a year for each pixel	Cropping intensity index describes the extent to which arable land is used over a year. It is the ratio of the total crop area of all planting seasons in a year to the total area of arable land.	Cropping intensity is presented as maps by pixels or spatial average pixels values for MPZs, 42 countries, and 7 regions for China. Values are compared to the average of the previous five years, with departures expressed in percentage.
<b>NDVI</b>			
<b>Normalized Difference Vegetation Index</b>			
Crop/ Satellite	[0.12-0.90] number, pixel or CWSU average	An estimate of the density of living green biomass.	NDVI is shown as average profiles over time at the national level (cropland only) in crop condition development graphs, compared with previous year and recent five-year average (2014- 2018), and as spatial patterns compared to the average showing the time profiles, where they occur, and the percentage of pixels concerned by each profile.
<b>RADPAR</b>			
<b>CropWatch indicator for Photosynthetically Active Radiation (PAR), based on pixel based PAR</b>			
Weather /Satellite	W/m <sup>2</sup> , CWSU	The spatial average (for a CWSU) of PAR accumulation over agricultural pixels, weighted by the production potential.	RADPAR is shown as the percent departure of the RADPAR value for the reporting period compared to the recent fifteen-year average (2004-2018), per CWSU. For the MPZs, regular PAR is shown as typical time profiles over the spatial unit, with a map showing where the profiles occur and the percentage of pixels concerned by each profile.
<b>RAIN</b>			
<b>CropWatch indicator for rainfall, based on pixel-based rainfall</b>			
Weather /Ground	Liters/m <sup>2</sup> , CWSU	The spatial average (for a CWSU) of rainfall accumulation over agricultural	RAIN is shown as the percent departure of the RAIN value for the reporting period, compared to

INDICATOR			
and satellite		pixels, weighted by the production potential.	the recent fifteen-year average (2004-18), per CWSU. For the MPZs, regular rainfall is shown as typical time profiles over the spatial unit, with a map showing where the profiles occur and the percentage of pixels concerned by each profile.
<b>TEMP</b>			
<b>CropWatch indicator for air temperature, based on pixel-based temperature</b>			
Weather /Ground	°C, CWSU	The spatial average (for a CWSU) of the temperature time average over agricultural pixels, weighted by the production potential.	TEMP is shown as the departure of the average TEMP value (in degrees Centigrade) over the reporting period compared with the average of the recent fifteen years (2004-18), per CWSU. For the MPZs, regular temperature is illustrated as typical time profiles over the spatial unit, with a map showing where the profiles occur and the percentage of pixels concerned by each profile.
<b>VCIx</b>			
<b>Maximum vegetation condition index</b>			
Crop/ Satellite	Number, pixel to CWSU	Vegetation condition of the current season compared with historical data. Values usually are [0, 1], where 0 is "NDVI as bad as the worst recent year" and 1 is "NDVI as good as the best recent year." Values can exceed the range if the current year is the best or the worst.	VCIx is based on NDVI and two VCI values are computed every month. VCIx is the highest VCI value recorded for every pixel over the reporting period. A low value of VCIx means that no VCI value was high over the reporting period. A high value means that at least one VCI value was high. VCI is shown as pixel-based maps and as average value by CWSU.
<b>VHI</b>			
<b>Vegetation health index</b>			
Crop/ Satellite	Number, pixel to CWSU	The average of VCI and the temperature condition index (TCI), with TCI defined like VCI but for temperature. VHI is based on the assumption that "high temperature is bad" (due to moisture stress), but ignores the fact that low temperature may be equally "bad" (crops develop and grow slowly, or even suffer from frost).	Low VHI values indicate unusually poor crop condition, but high values, when due to low temperature, may be difficult to interpret. VHI is shown as typical time profiles over Major Production Zones (MPZ), where they occur, and the percentage of pixels concerned by each profile.
<b>VHIn</b>			
<b>Minimum Vegetation health index</b>			
Crop/ Satellite	Number, pixel to CWSU	VHIn is the lowest VHI value for every pixel over the reporting period. Values usually are [0, 100]. Normally, values lower than 35 indicate poor crop condition.	Low VHIn values indicate the occurrence of water stress in the monitoring period, often combined with lower than average rainfall. The spatial/time resolution of CropWatch VHIn is 16km/week for MPZs and 1km/dekad for China.

*Note:* Type is either "Weather" or "Crop"; source specifies if the indicator is obtained from ground data, satellite readings, or a combination; units: in the case of ratios, no unit is used; scale is either pixels or large scale CropWatch spatial units (CWSU). Many indicators are computed for pixels but represented in the CropWatch bulletin at the CWSU scale.

### CropWatch spatial units (CWSU)

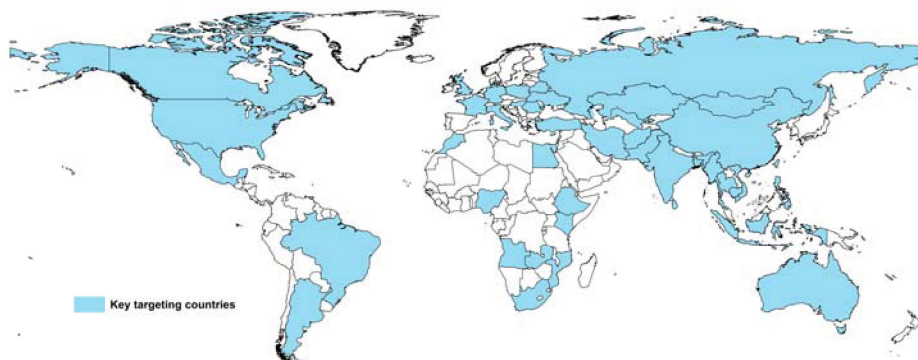
CropWatch analyses are applied to four kinds of CropWatch spatial units (CWSU): Countries, China, Major Production Zones (MPZ), and global crop Monitoring and Reporting Units (MRU). The tables below

summarize the key aspects of each spatial unit and show their relation to each other. For more details about these spatial units and their boundaries, see the CropWatch bulletin online resources.

SPATIAL LUNITS	
CHINA	
Overview	Description
Seven monitoring regions	The seven regions in China are agro-economic/agro-ecological regions that together cover the bulk of national maize, rice, wheat, and soybean production. Provinces that are entirely or partially included in one of the monitoring regions are indicated in color on the map below.
<p>The map displays the seven monitoring regions in China, each color-coded: North East China (orange), Inner Mongolia (green), Loess region (yellow), South-West China (light green), Lower Yangtze (light orange), and Southern China (light yellow). Major provinces are labeled, including Heilongjiang, Jilin, Liaoning, Inner Mongolia, Gansu, Ningxia, Shaanxi, Shanxi, Shandong, Henan, Anhui, Jiangsu, Zhejiang, Jiangxi, Hunan, Hubei, Sichuan, Chongqing, Guizhou, Yunnan, Guangxi, Guangdong, and Fujian. The Huang Huaihai plain is also indicated.</p>	

**Countries (and first-level administrative districts, e.g., states and provinces)**

Overview	Description
43 countries to represent main producers/exporters and other key countries.	CropWatch monitored countries together represent more than 80% of the production of maize, rice, wheat and soybean, as well as 80% of exports. Some countries were included in the list based on criteria of proximity to China (Uzbekistan, Cambodia), regional importance, or global geopolitical relevance (e.g., four of five most populous countries in Africa). The total number of countries monitored is "42 + 1," referring to 42 and China itself. For the nine largest countries—, United States, Brazil, Argentina, Russia, Kazakhstan, India, China, and Australia, maps and analyses may also present results for the first-level administrative subdivision. The CropWatch agroclimatic indicators are computed for all countries and included in the analyses when abnormal conditions occur. Background information about the countries' agriculture and trade is available on the CropWatch Website, <a href="http://www.cropwatch.com.cn">www.cropwatch.com.cn</a> .



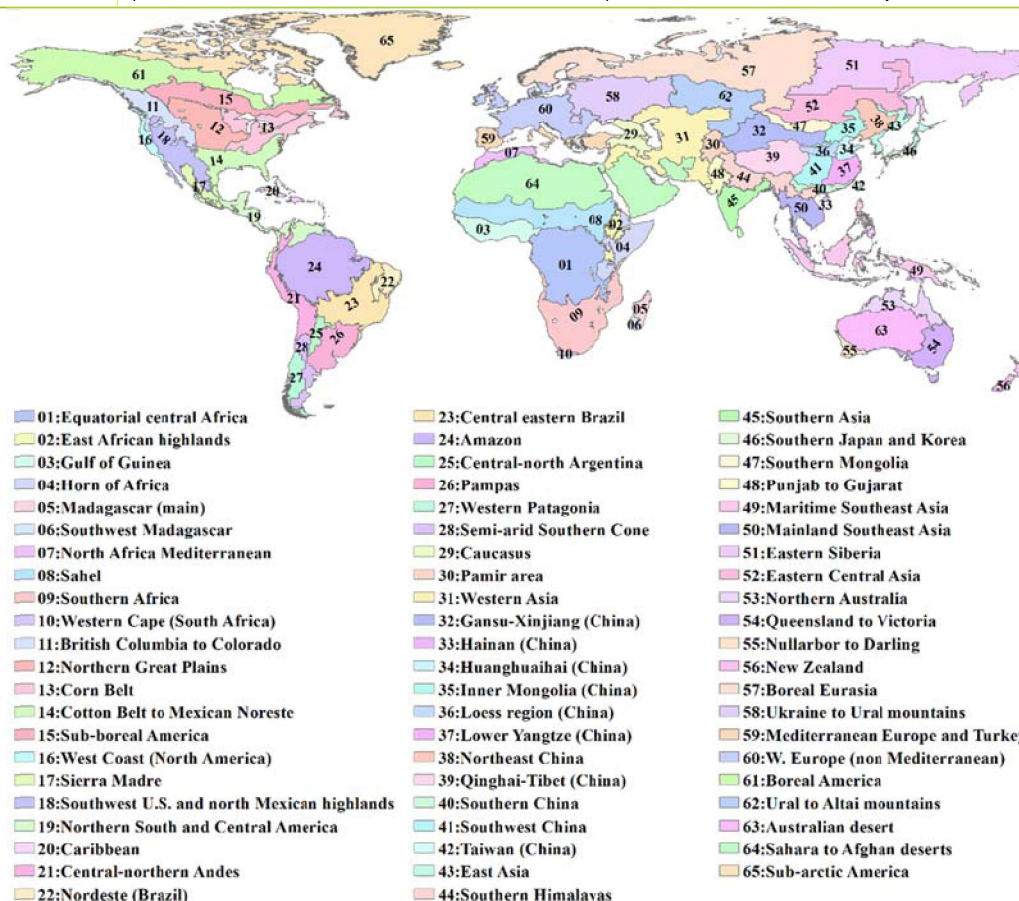
**Major Production Zones (MPZ)**

Overview	Description
Seven globally important areas of agricultural production	The six MPZs include West Africa, South America, North America, South and Southeast Asia, Western Europe and Central Europe to Western Russia. The MPZs are not necessarily the main production zones for the four crops (maize, rice, soybean, wheat) currently monitored by CropWatch, but they are globally or regionally important areas of agricultural production. The seven zones were identified based mainly on production statistics and distribution of the combined cultivation area of maize, rice, wheat and soybean.



## Global Monitoring and Reporting Unit (MRU)

Overview	Description
65 agro-ecological/agro-economic units across the world	MRUs are reasonably homogeneous agro-ecological/agro-economic units spanning the globe, selected to capture major variations in worldwide farming and crops patterns while at the same time providing a manageable (limited) number of spatial units to be used as the basis for the analysis of environmental factors affecting crops. Unit numbers and names are shown in the figure below. A limited number of units (e.g., MRU-63 to 65) are not relevant for the crops currently monitored by CropWatch but are included to allow for more complete coverage of global production. Additional information about the MRUs is provided online under <a href="http://www.cropwatch.com.cn">www.cropwatch.com.cn</a> .



## Production estimation methodology

The main concept of the CropWatch methodology for estimating production is the calculation of current year production based on information about last year's production and the variations in crop yield and cultivated area compared with the previous year. The equation for production estimation is as follows:

$$Production_i = Production_{i-1} * (1 + \Delta Yield_i) * (1 + \Delta Area_i)$$

Where  $i$  is the current year,  $\Delta Yield_i$  and  $\Delta Area_i$  are the variations in crop yield and cultivated area compared with the previous year; the values of  $\Delta Yield_i$  and  $\Delta Area_i$  can be above or below zero.

For the 42 countries monitored by CropWatch, yield variation for each crop is calibrated against NDVI time series, using the following equation:

$$\Delta Yield_i = f(NDVI_i, NDVI_{i-1})$$

Where  $NDVI_i$  and  $NDVI_{i-1}$  are taken from the time series of the spatial average of NDVI over the crop specific mask for the current year and the previous year. For NDVI values that correspond to periods after the current monitoring period, average NDVI values of the previous five years are used as an average expectation.  $\Delta Yield_i$  is calculated by regression against average or peak NDVI (whichever yields the best regression), considering the crop phenology of each crop for each individual country.

A different method is used for areas. For China, CropWatch combines remote-sensing based estimates of the crop planting proportion (cropped area to arable land) with a crop type proportion (specific type area to total cropped area). The planting proportion is estimated based on an unsupervised classification of high resolution satellite images from HJ-1 CCD and GF-1 images. The crop-type proportion for China is obtained by the GVG instrument from field transects. The area of a specific crop is computed by multiplying farmland area, planting proportion, and crop-type proportion of the crop.

To estimate crop area for wheat, soybean, maize, and rice outside China, CropWatch relies on the regression of crop area against cropped arable land fraction of each individual country (paying due attention to phenology):

$$Area_i = a + b * CALF_i$$

where a and b are the coefficients generated by linear regression with area from FAOSTAT or national sources and CALF the Cropped Arable Land Fraction from CropWatch estimates.  $\Delta Area_i$  can then be calculated from the area of current and the previous years.

The production for "other countries" (outside the 43 CropWatch monitored countries) was estimated as the linear trend projection for 2020 of aggregated FAOSTAT data (using aggregated world production minus the sum of production by the 43 CropWatch monitored countries).

## Data notes and bibliography

### Notes

<https://www.arcgis.com/apps/dashboards/de4f7abc248545f6bb514c3d38f59f26>  
<http://www.fao.org/ag/locusts/common/ecg/1914/en/DL511e.pdf>  
<https://earthobservatory.nasa.gov/images/147866/eloise-floods-mozambique>  
<https://www.abc.net.au/news/rural/2021-03-22/nsw-farmers-assess-flood-damage/100020588>  
<https://international.thenewslens.com/article/149527>  
<https://droughtmonitor.unl.edu/>  
<https://www.nytimes.com/2020/12/04/world/asia/india-farmers-protest-pollution-coronavirus.html>  
<http://www.bom.gov.au/climate/current/soi2.shtml>  
[https://www.climate.gov/sites/default/files/Fig3\\_ENSOindices\\_SST\\_large.png](https://www.climate.gov/sites/default/files/Fig3_ENSOindices_SST_large.png)  
[http://www.bom.gov.au/climate/enso/wrapup/archive/20210511.ssta\\_pacific\\_monthly.png?popup](http://www.bom.gov.au/climate/enso/wrapup/archive/20210511.ssta_pacific_monthly.png?popup)  
<http://www.bom.gov.au/climate/enso/wrap-up/#tabs=Overview>  
<https://geoagro.users.earthengine.app/view/harvestfallowno2>  
<https://www.climate.gov/enso>

### References

ACT 2014 Condensed Papers of the First Africa Congress on Conservation Agriculture, 2014, Lusaka.  
[http://www.act-africa.org/lib.php?com=5&com2=20&com3=63&com4=30&res\\_id=219](http://www.act-africa.org/lib.php?com=5&com2=20&com3=63&com4=30&res_id=219)

Agada O O 2016 Agricultural Water Management in Sub – Sahara Africa: Options for Sustainable Crop Production. Greener Journal of Agricultural Sciences, 6 (4):151-158.  
[https://www.researchgate.net/publication/308208940\\_Agricultural\\_Water\\_Management\\_in\\_Sub\\_-\\_Sahara\\_Africa\\_Options\\_for\\_Sustainable\\_Crop\\_Production](https://www.researchgate.net/publication/308208940_Agricultural_Water_Management_in_Sub_-_Sahara_Africa_Options_for_Sustainable_Crop_Production)

Akroyd S, L Smith 2007 Public Spending to Agriculture A joint DFID / World Bank study. Main Study & Country Case-Studies. Oxford Policy Management, Oxford, UK.  
<http://www1.worldbank.org/publicsector/pe/pfma07/OPMReview.pdf>

ATV 2010 Recommendation report: food for all forever. Danish academy of technical sciences (ATV), Copenhagen,

Bloomberg 2018 South Africa Plans to Declare Drought a National Disaster  
<https://www.bloomberg.com/news/articles/2018-02-08/south-africa-plans-to-declare-drought-a-national-disaster>

Buckley L, Chen Ruijian, Yin Yanfei, Zhu Zidong 2017 Chinese agriculture in Africa, Perspectives of Chinese agronomists on agricultural aid. International Institute for Environment and Development IIED and Foreign Economic Cooperation Centre (FECC) of the of the Chinese Ministry of Agriculture,  
<http://pubs.iied.org/pdfs/17603IIED.pdf>

Christiaansen L, L Demery 2018 Agriculture in Africa : Telling Myths from Facts. Directions in Development—Agriculture and Rural Development;. Washington, DC: World Bank. © World Bank.  
<https://openknowledge.worldbank.org/handle/10986/28543> License: CC BY 3.0 IGO.

CropWatch 2015 New optimism for African agriculture? February 2015 CropWatch bulletin available from  
<http://www.cropwatch.com.cn/htm/en/files/201531010955561.pdf>

- CropWatch 2017a The specter of famine is back in the Horn of Africa. August 2017 CropWatch bulletin available from <http://www.cropwatch.com.cn/htm/en/files/20170805en.pdf>
- CropWatch 2017b Rangeland management and issues in Africa. April 2017 CropWatch bulletin available from <http://www.cropwatch.com.cn/htm/en/files/20170405EN.pdf>
- Deininger K, D Byerlee 2011 Rising global interest in farmland. Can it yield sustainable equitable benefits. World Bank, Washington  
[http://siteresources.worldbank.org/INTARD/Resources/ESW\\_Sept7\\_final\\_final.pdf](http://siteresources.worldbank.org/INTARD/Resources/ESW_Sept7_final_final.pdf)
- ECA 2009 Agricultural Input Business Development in Africa: Opportunities, Issues and Challenges, Economic Commission for Africa, southern-Africa Office.  
<https://www.uneca.org/sites/default/files/PublicationFiles/sro-sa-agri-iputs-business-opportunities.pdf>
- FAO. 2011. The state of the world's land and water resources for food and agriculture (SOLAW) – Managing systems at risk. FAO Rome and Earthscan, London.  
<http://www.fao.org/docrep/017/i1688e/i1688e00.htm>
- Feed Africa 2016 Strategy for agricultural transformation in Africa. African development Bank, Tunis, Tunisia. [https://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/Feed\\_Africa-Strategy\\_for\\_Agricultural\\_Transformation\\_in\\_Africa\\_2016-2025.pdf](https://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/Feed_Africa-Strategy_for_Agricultural_Transformation_in_Africa_2016-2025.pdf)
- Ferguson, R., D. Krishna, Y. Mhango, A. Alexander, R. Kuzviwanza, A. Oliver, O. Mfunne, I. Pretorius & J. Lutzweiler. 2011. African agriculture, this other Eden. Renaissance, Moscow, Russia. 220 pp. [http://www.fastestbillion.com/res/Research/This\\_other\\_Eden-211111.pdf](http://www.fastestbillion.com/res/Research/This_other_Eden-211111.pdf)
- Fritz S, L See, I McCallum, Liangzhi You, A Bun and 42 others 2015 Mapping global cropland and field size Global Change Biology 21(5)1980-1992
- GrowAfrica 2018 <https://www.growafrica.com/>
- Hopkins R Agriculture in Africa <http://ruperthopkins.com/pdf/Agriculture%20in%20Africa%20002.pdf>
- IRI 2015 2015 El Niño: Notes for the East African Malaria Community.
- IFPRI 2016 El Niño and the Outlook for 2016. <http://www.foodsecurityportal.org/el-ni%C3%B1o-and-outlook-2016>
- Livingston G, S Schonberger, S Delaney 2011 Sub-Saharan Africa: The state of smallholders in agriculture, Paper presented at the IFAD Conference on New Directions for Smallholder Agriculture 24-25 January, 2011, IFAD, Rome
- Mittal A 2009 The 2008 Food price crisis: rethinking food security policies. G-24 Discussion Paper No. 56.
- Nakweya G 2017 Africa needs to invest in agricultural censuses. <https://www.scidev.net/sub-saharan-africa/agriculture/news/africa-invest-agricultural-censuses.html#>
- NEPAD 2013 Agriculture in Africa, Transformation and outlook.  
<https://www.un.org/en/africa/osaa/pdf/pubs/2013africanagricultures.pdf>
- OECD-FAO 2016 Agricultural Outlook 2016-2025. INCOMPLETE
- Peel M C, B L Finlayson, T A McMahon 2007 Updated world map of the Köppen-Geiger climate classification. Hydrol. Earth Syst. Sci., 11, 1633-1644.
- Reuters 2018 Commentary: In drought-hit South Africa, the politics of water.  
<https://www.reuters.com/article/us-saundersonmeyer-drought-commentary/commentary-in-drought-hit-south-africa-the-politics-of-water-idUSKBN1FP226>
- RISCURA 2015 The high-level impact and ongoing effects of El Niño  
<http://www.riscura.com/brightafrica/el-nino/impact-effects/>
- Siebert S, V Henrich, K Frenken, J Burke 2013 GMIA version 5, Global map of irrigated agriculture. FAO and University of Bonn. [http://www.fao.org/nr/water/aquastat/irrigationmap/gmia\\_v5\\_highres.pdf](http://www.fao.org/nr/water/aquastat/irrigationmap/gmia_v5_highres.pdf)
- SOLAW 2011. The state of the world's land and water resources for food and agriculture. Managing systems at risk. FAO, Rome. <http://www.fao.org/docrep/015/i1688e/i1688e00.pdf>

- UNEP-UNCTAD 2008 Organic Agriculture and Food Security in Africa, UN New-York and Geneva  
[http://www3.weforum.org/docs/WEF\\_ACR\\_2015/Africa\\_Competitiveness\\_Report\\_2015.pdf](http://www3.weforum.org/docs/WEF_ACR_2015/Africa_Competitiveness_Report_2015.pdf)
- Vargas-Hill R 2010 Agricultural insurance in Sub-Saharan Africa: can it work? Paper prepared for the Fourth African Agricultural Markets Program (AAMP) policy symposium, Agricultural Risks Management in Africa: Taking Stock of What Has and Hasn't Worked, organized by the Alliance for Commodity Trade in Eastern and Southern Africa (ACTESA) and by the Common Market for Eastern and Southern Africa (COMESA). Lilongwe, Malawi, September 6-10, 2010.  
[http://www.fsg.afre.msu.edu/aamp/sept\\_2010/aamp\\_lilongwe-vargas\\_hill-agricultural\\_insurance.pdf](http://www.fsg.afre.msu.edu/aamp/sept_2010/aamp_lilongwe-vargas_hill-agricultural_insurance.pdf)
- Ward Christopher, R Torquebiau, Hua Xie 2016 Improved Agricultural Water Management for Africa's Drylands. World Bank Studies. Washington, DC: World Bank. doi: 10.1596/978-1-4648-0832-6. License: Creative Commons Attribution CC BY 3.0 IGO
- WEC 2015 "Africa competitiveness Report 2015, chapter 2.1 Africa" WEC, Geneva Switzerland  
[http://www3.weforum.org/docs/WEF\\_ACR\\_2015/Africa\\_Competitiveness\\_Report\\_2015.pdf](http://www3.weforum.org/docs/WEF_ACR_2015/Africa_Competitiveness_Report_2015.pdf)
- WB 2018 <https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS>,  
<https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS>
- WEF 2016 African farmers need investment – but these 6 factors stand in the way.  
<https://www.weforum.org/agenda/2016/05/6-challenges-to-investing-in-african-farmers>
- WHO 2016 El Niño and health, Global overview. [http://www.who.int/hac/crises/el-nino/who\\_el\\_nino\\_and\\_health\\_global\\_report\\_21jan2016.pdf](http://www.who.int/hac/crises/el-nino/who_el_nino_and_health_global_report_21jan2016.pdf)
- World Bank 2009. Awakening Africa's Sleeping Giant. Prospects for Commercial Agriculture in the Guinea Savannah Zone and Beyond. Directions in development, Agriculture and Rural Development. World Bank, Italian Ministry fo Foreign Affairs and FAO, Rome. 219 pp

## Acknowledgments

This bulletin is produced by the CropWatch research team at the Aerospace Information Research Institute (AIR), at the Chinese Academy of Sciences in Beijing, China. The team gratefully acknowledges the active support of a range of organizations and individuals, both in China and elsewhere.

Financial and programmatic support is provided by the Ministry of Science and Technology of the People's Republic of China, National Natural Science Foundation of China, and the Chinese Academy of Sciences. We specifically would like to acknowledge the financial support through The National Key Research and Development Program of China, Grant No:2016YFA0600300; National Natural Science Foundation, Grant No: 41561144013; the Strategic Priority Research Program of Chinese Academy of Sciences Grant No: XDA1903020.

The following contributions by national organizations and individuals are greatly appreciated: China Center for Resources Satellite Data and Application for providing the HJ-1 CCD data; China Meteorological Satellite Center for providing FY-2/3 data; China Meteorological Data Sharing Service System for providing the agro-meteorological data; and Chia Tai Group (China) for providing GVG (GPS, Video, and GIS) field sampling data.

The following contributions by international organizations and individuals are also recognized: François Kayitakire at FOODSEC/JRC for making available and allowing use of their crop masks; Ferdinando Urbano also at FOODSEC/JRC for his help with data; Herman Eerens, Dominique Haesen, and Antoine Royer at VITO, for providing the JRC/MARS SPIRITS software, Spot Vegetation imagery and growing season masks, together with generous advice; Patrizia Monteduro and Pasquale Steduto for providing technical details on GeoNetwork products; and IIASA and Steffen Fritz for their land use map; The cover photo (Photographer: Carl Wyatt) from <https://www.pexels.com/zh-cn/>.

## Online resources

---



Online Resources posted on [www.cropwatch.com.cn](http://www.cropwatch.com.cn) ,  
<http://cloud.cropwatch.com.cn/>

This bulletin is only part of the CropWatch resources available. Visit [www.cropwatch.com.cn](http://www.cropwatch.com.cn) for access to additional resources, including the methods behind CropWatch, country profiles, and other CropWatch publications. For additional information or to access specific data or high-resolution graphs, simply contact the CropWatch team at [cropwatch@radi.ac.cn](mailto:cropwatch@radi.ac.cn).

---

---

CropWatch bulletins introduce the use of several new and experimental indicators. We would be very interested in receiving feedback about their performance in other countries. With feedback on the contents of this report and the applicability of the new indicators to global areas, please contact:

**Professor Bingfang Wu**

Aerospace Information Research Institute  
Chinese Academy of Sciences, Beijing, China  
E-mail: [cropwatch@radi.ac.cn](mailto:cropwatch@radi.ac.cn), [wubf@radi.ac.cn](mailto:wubf@radi.ac.cn)

---