GEOGLAM:

Science-driven information supporting decisions in agricultural markets and food security through use of earth observations

Inbal Becker-Reshef

Program Scientist | GEOGLAM Secretariat
Co-Director | Center for Global Agricultural Monitoring Research, University of Maryland

A Group on Earth Observations (GEO) Global Agricultural Monitoring Initiative

5th Meeting of the Agricultural Chief Scientists, Xi'an, May 30-31

A GEO Initiative on Global Agricultural Monitoring through the use of earth observations

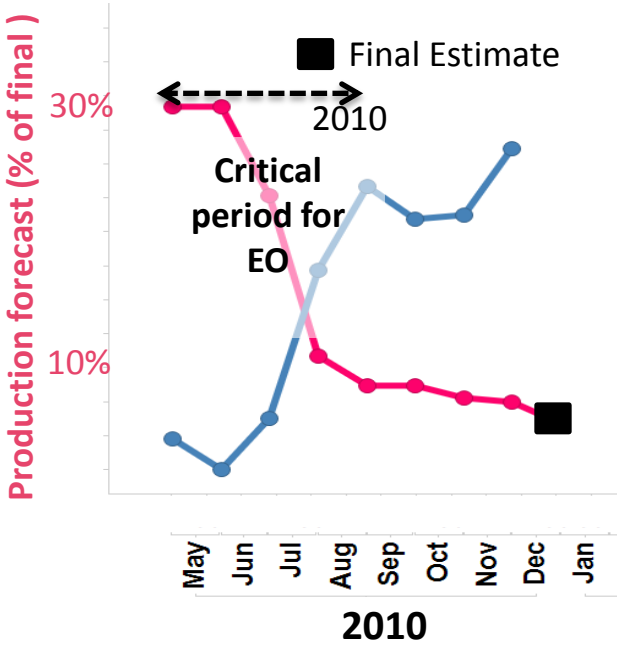
- Launched by G20 in 2011 (French Presidency), under Action Plan on Food Price Volatility and Agriculture
  - Alongside the Agricultural Market Information System (AMIS)
- Vision: Strengthen the international community's capacity to provide actionable, science-driven, open, information at sub-national to global scales, in support of policies, investments and decisions, in food security, and agricultural markets.
  - Through use of coordinated, multi-sensor, Earth Observations (EO)
  - Building on existing systems

www.geoglam.org

Context

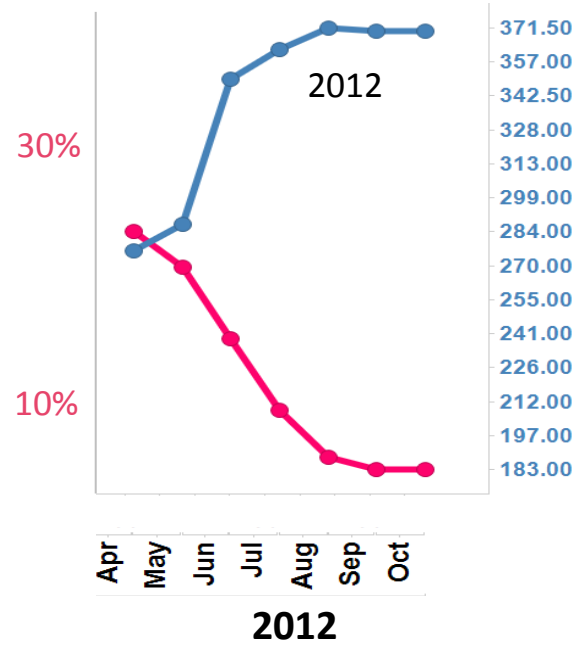
Wheat Production Forecasts vs. International Market Price: 2010, 2012

Production Forecasts (% of final estimate)



Need for improved timely, production forecasts

Price ($/Ton)



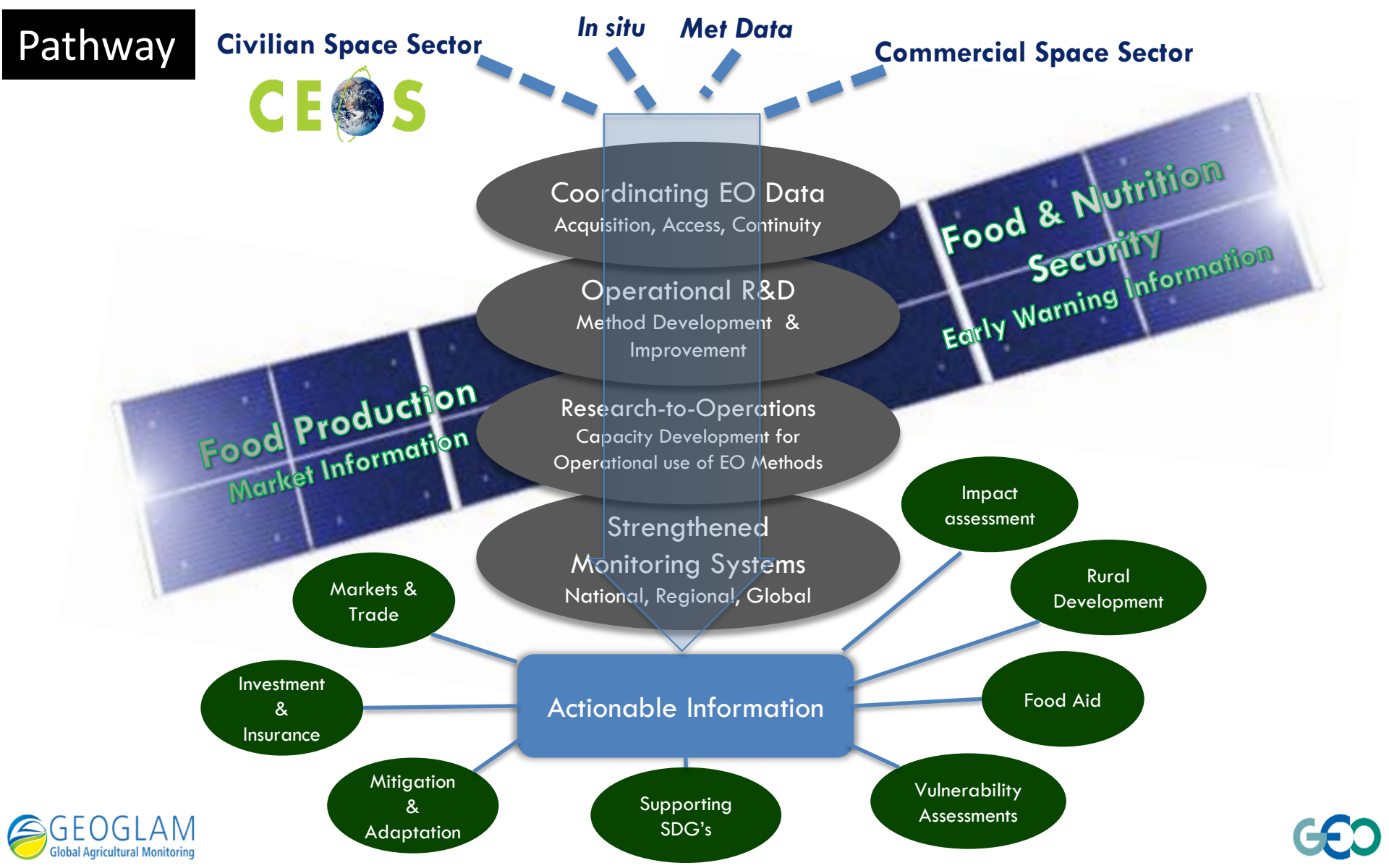
An International Collaborative Initiative

- Based on common interests and challenges
- Building on existing systems， leveraging domestic and international activities
- Foundation in user-driven operational R&D
- Emphasis on transitioning research to operations & capacity building

Structure

- Advisory Committee representing user community (Ag Departments)
  - Chaired by USA (Ann Bartuska) and China (He Changchui)
  - Members include: EC , Canada, South Africa, Japan, Greece, Australia/CEOS, African Union, WMO, AMIS, IFPRI, BMGF)
- Secretariat
- Distributed implementation team and projects leads

Pathway


Civilian Space Sector
CEOS
In situ
Met Data
Commercial Space Sector
Coordinating EO Data
Acquisition, Access, Continuity
Operational R&D
Method Development & Improvement
Research-to-Operations
Capacity Development for Operational use of EO Methods
Strengthened Monitoring Systems
National, Regional, Global
Food & Nutrition Security
Early Warning Information
Food Production
Market Information
Actionable Information
Markets & Trade
Investment & Insurance
Mitigation & Adaptation
Supporting SDG's
Vulnerability Assessments
Food Aid
Rural Development
Impact assessment
GEOGLAM
Global Agricultural Monitoring
GEO

GROUP ON EARTH OBSERVATIONS

GEOGLAM Global Agricultural Monitoring

GEOGLAM is aligned with SDGs

2 ZERO HUNGER

End hunger, achieve food security and improved nutrition and promote sustainable agriculture

TARGETS

2.1
By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round

2.2
By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons

2.3
By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment

MONITORING FOR EARLY WARNING IN SMALLHOLDER SYSTEMS

2.4
By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality

R&D EFFORTS ON SUSTAINABLE AGRICULTURE

2.5
By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed

2.a
Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries

INTERNATIONAL COORDINATION FOR R&D

2.b
Correct and prevent trade restrictions and distortions in world agricultural markets, including through the parallel elimination of all forms of agricultural export subsidies and all export measures with equivalent effect, in accordance with the mandate of the Doha Development Round

2.c
Adopt measures to ensure the proper functioning of food commodity markets and their derivatives and facilitate timely access to market information, including on food reserves, in order to help limit extreme food price volatility

CROP MONITOR => TIMELY ACCESS TO MARKET INFORMATION TO REDUCE PRICE VOLATILITY

RELEVANT TOPICS

Food security and nutrition and sustainable agriculture

Rural Development

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GEOGLAM Global Agricultural Monitoring

The GEOGLAM Community

Open Community made up of international and national agencies concerned with agricultural monitoring including Ministries of Ag, Space agencies, Universities, & Industry

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GEOGLAM Global Agricultural Monitoring

Our Broad Challenge:

- Development of robust, operationally viable methods for agricultural monitoring, forecasting, and assessments of global food production applicable at field to global scales across diverse agricultural systems
  - Ensuring coordinated, sustained and accessible EO data
  - Access to training data (in-situ and stats) building linkages with relevant platforms and networks
  - Linking with the climate modeling community

- Technology transfer- transition into operational systems
  - Capacity building and sustained relationship between R&D community & operational end users
  - Ultimately improve global assessments by improving national monitoring

- Broad and effective communication to decision makers (farmers, extension, markets, private sector, insurance, food relief, policy & economics communities)

Too big for one country or agency – need for international coordination and collaboration

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GEOGLAM Global Agricultural Monitoring

Opportunity: Big Data, Technological Innovation & international collaboration platform

- Unprecedented volumes of (free/cheap) data, super-computing/cloud compute, innovative analysis tools, mobile and gps technologies, social media, etc.

- Specifically in EO- rapidly changing landscape
  - Transformational for the agricultural monitoring community
  - Promise for sustained observations in the future (Canada, India, China, EU, US, Belgium…)

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Traditionally relied on 1km to 250m resolution data

Punjab, Pakistan, 250m MODIS

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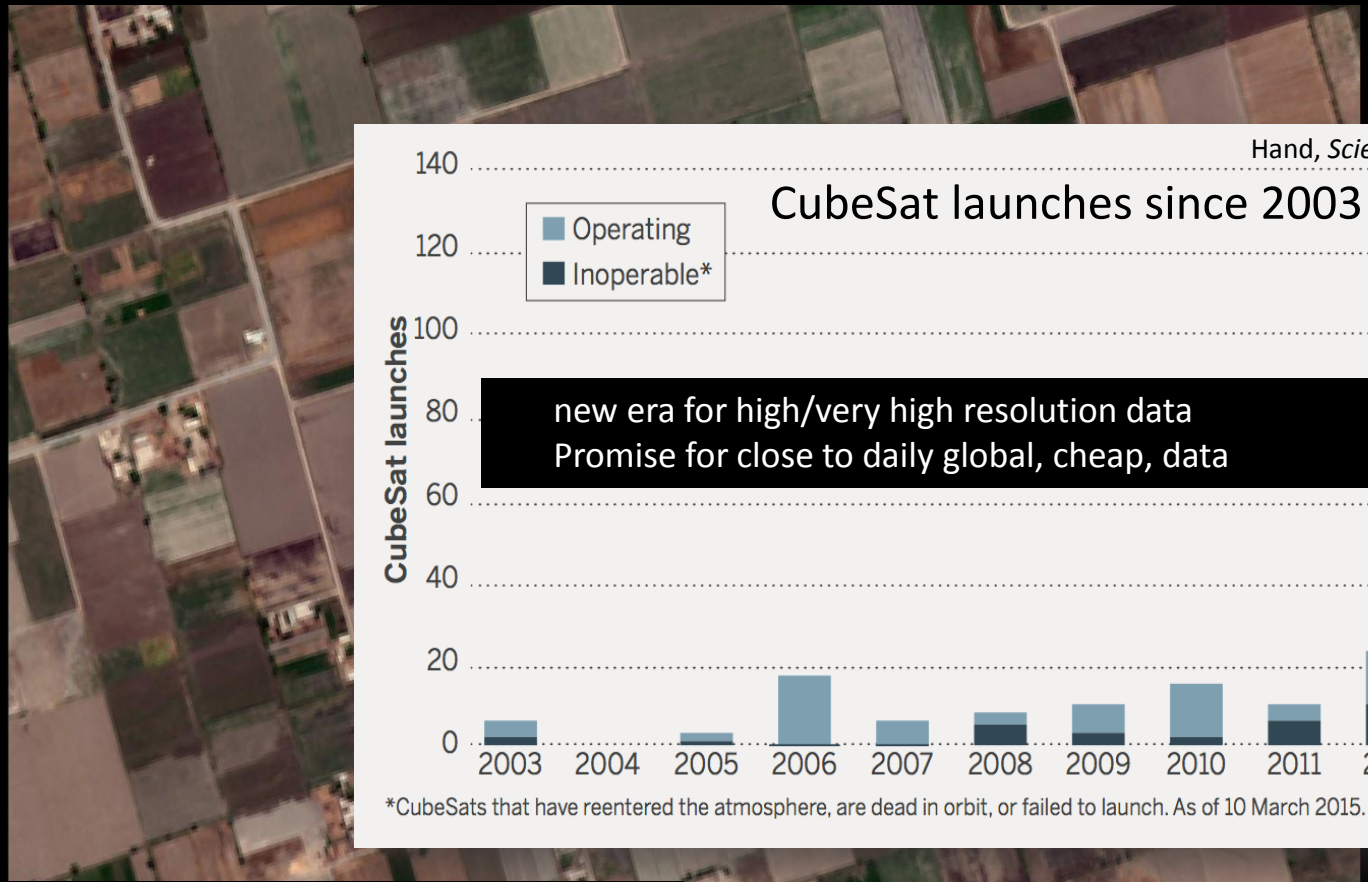
GEOGLAM Global Agricultural Monitoring

Now we have 30 - 10m resolution data

Punjab, Pakistan, 30m Landsat 8

In near future 1 to 5 meter will be routine!



Punjab, Pakistan, 0.5 meter, Worldview2

Hand, *Science* News, 2015

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GEOGLAM
Global Agricultural Monitoring

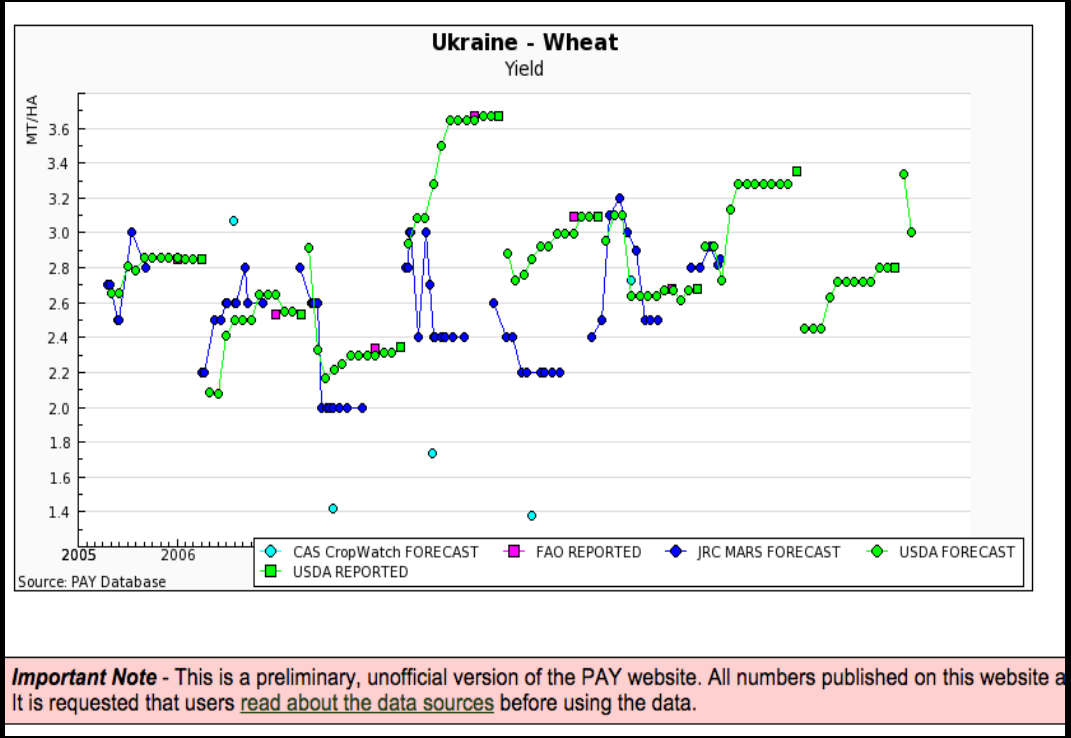
EXAMPLES OF GEOGLAM ACHIEVEMENTS

GEOGLAM Crop Monitor for AMIS

- Response to AMIS request
- Objective: transparent, timely, crop condition assessments in primary agricultural production areas
- Reflecting an international consensus, building on existing systems
- 4 Crops: Wheat, maize, soybean, rice
- Focus: main production/export countries (G20)

www.geoglam-cropmonitor.org

Context: need for improved production forecasts & transparency



Colors indicate different agencies

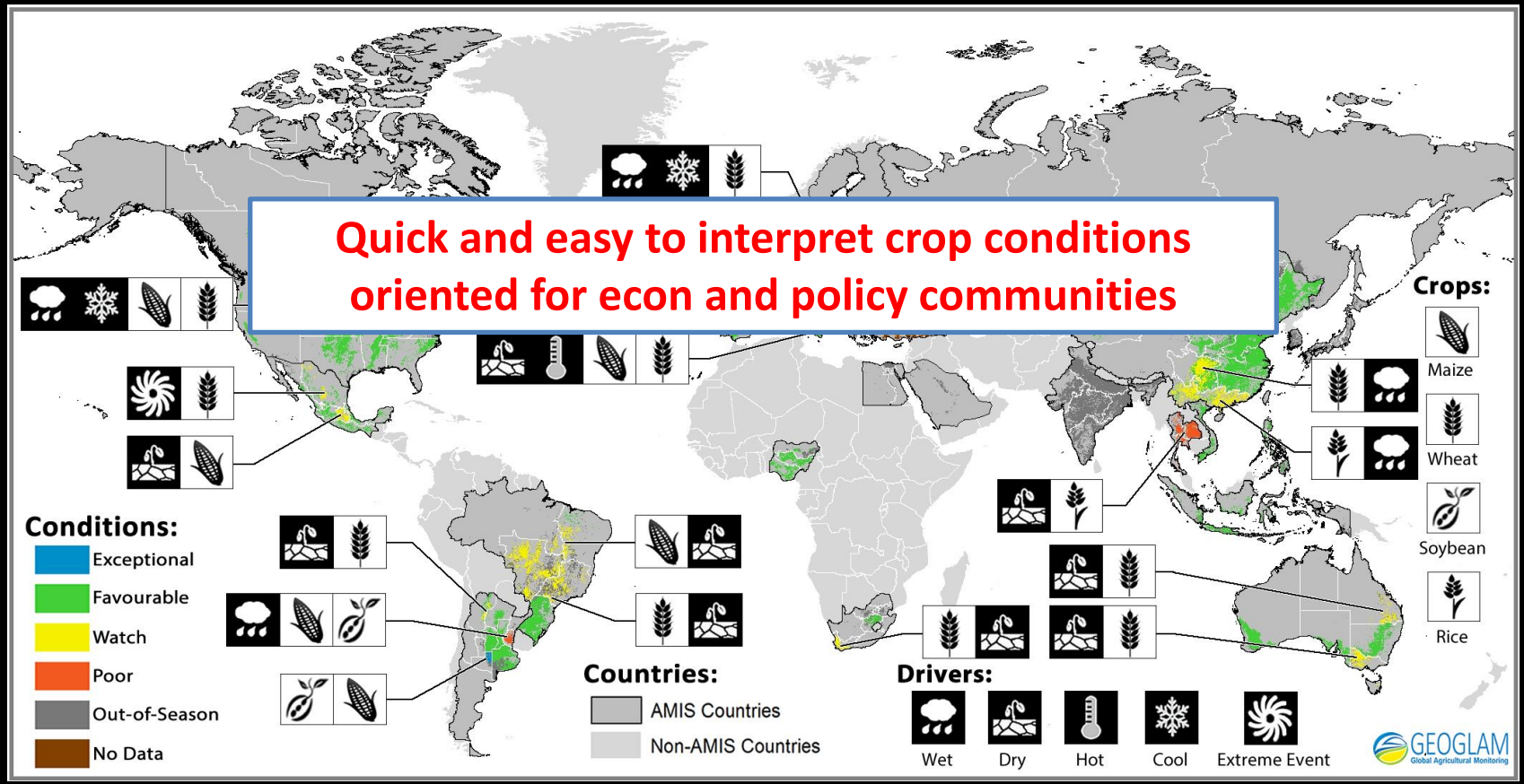
■ Squares indicate reported end of season estimates

● Circles indicate in-season forecasts

- Within season forecasts vary between agencies & years
- Critical particularly in anomalous years

Crop Condition Maps Covering AMIS Crops

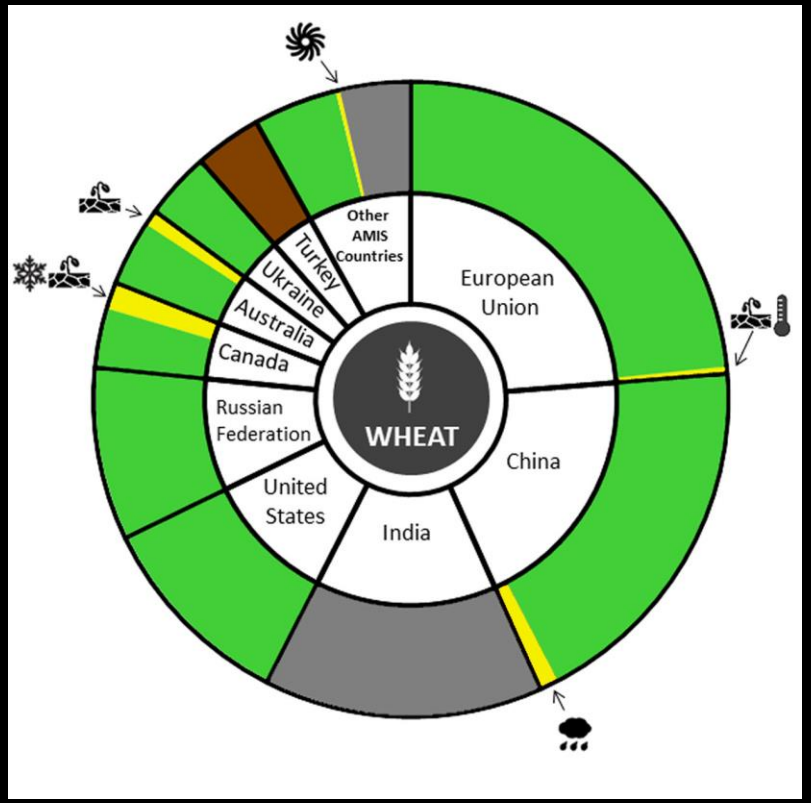
Conditions as of May 28th

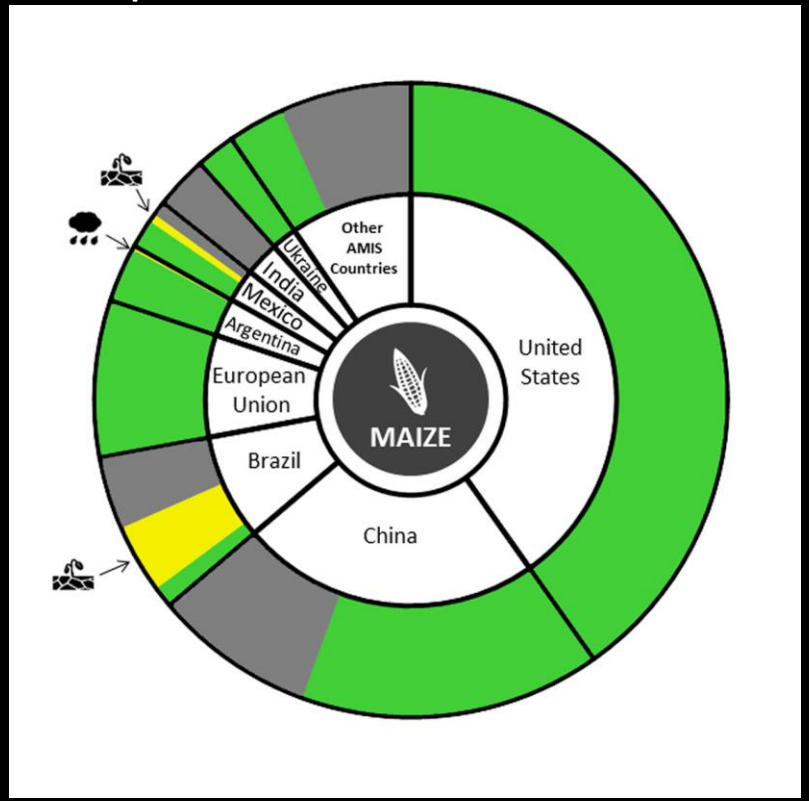


Crops that are in other than favorable conditions are displayed on the map with their crop symbol & driver.

Crop Conditions Pie Charts by Crop

as share of AMIS total production





Crop Conditions as of May 28th, 2015

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Global Agricultural Monitoring

GEOGLAM Crop Monitor Partners

> 35 Partners and Growing

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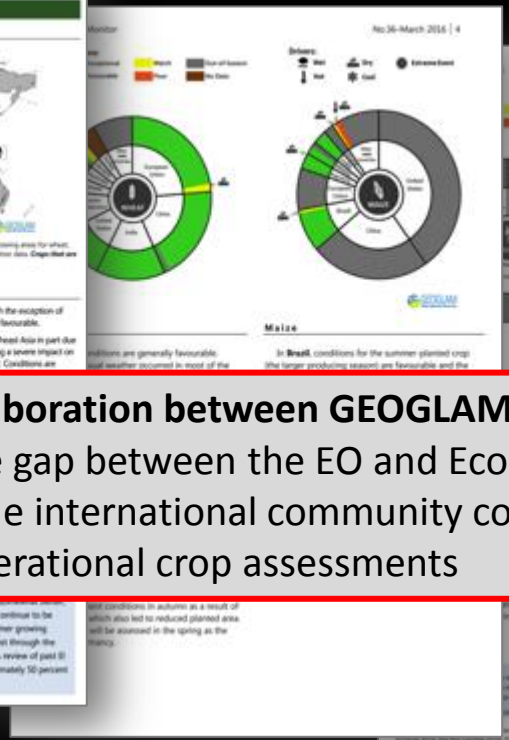
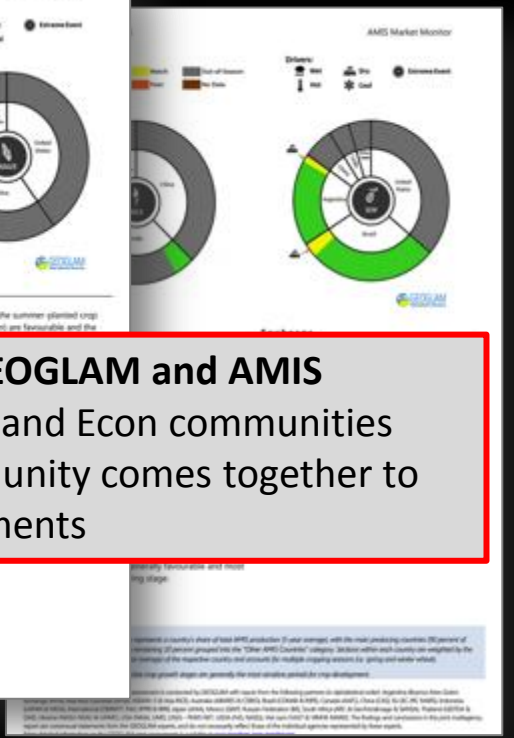
GEOGLAM Global Agricultural Monitoring

Operational Monthly Bulletin Since 2013 Published in the AMIS Market Monitor

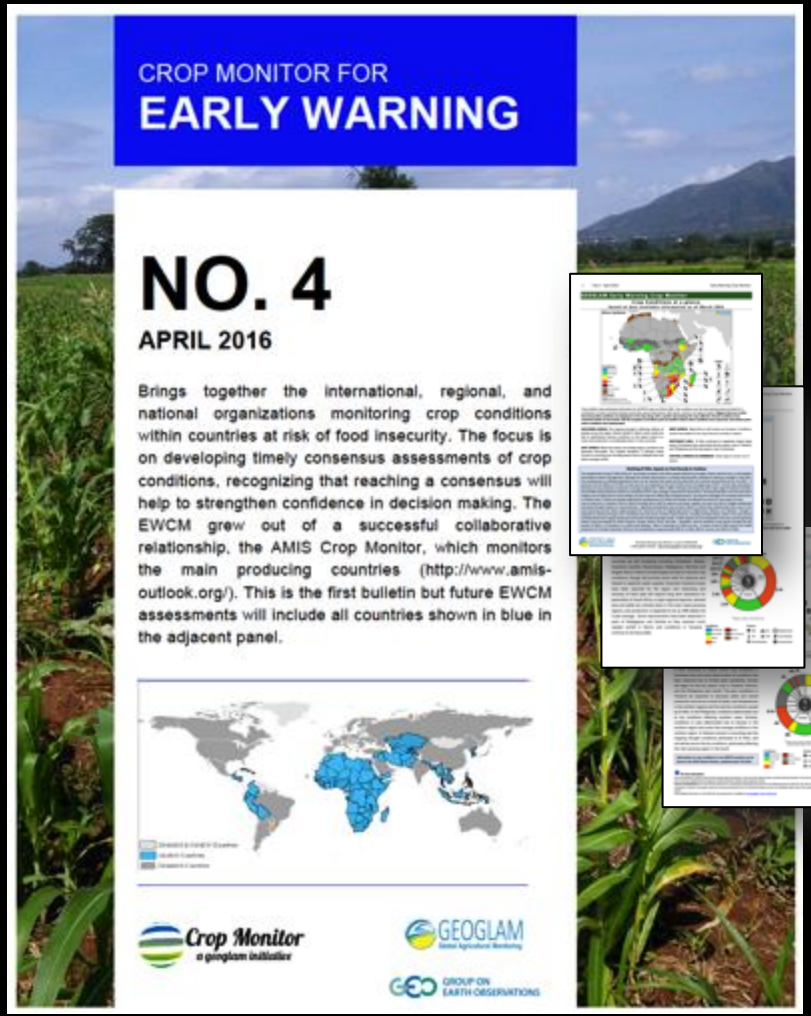




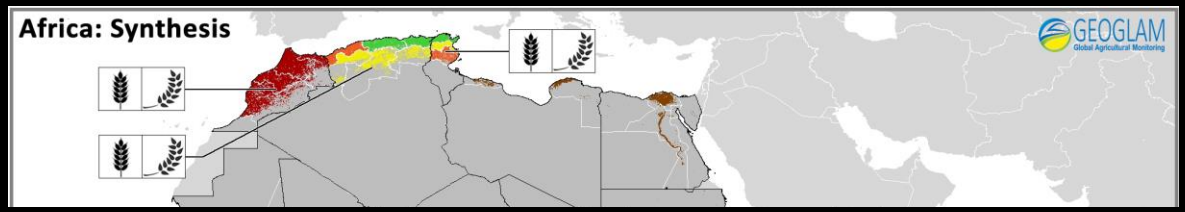
- **Strong collaboration between GEOGLAM and AMIS**
- Bridging the gap between the EO and Econ communities
- First time the international community comes together to produce operational crop assessments

The Crop Monitor for Early Warning

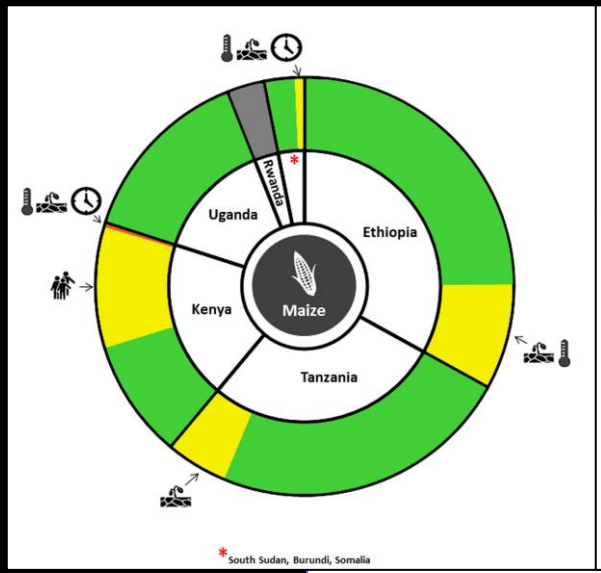
- Focus on countries at risk of food insecurity
- Response to Early Warning Community
- Objective: build consensus & reduce uncertainty
- Current partners: USAID FEWS NET, WFP, JRC, FAO, ARC, ASIA RiCE, UMD
  - Expanding to regional & national partners
- First bulletin published in Feb 2016
- Already informing agricultural decisions
  - News, press releases and official reports including joint press release by FEWS NET, JRC, WFP and FAO on current crisis in southern Africa



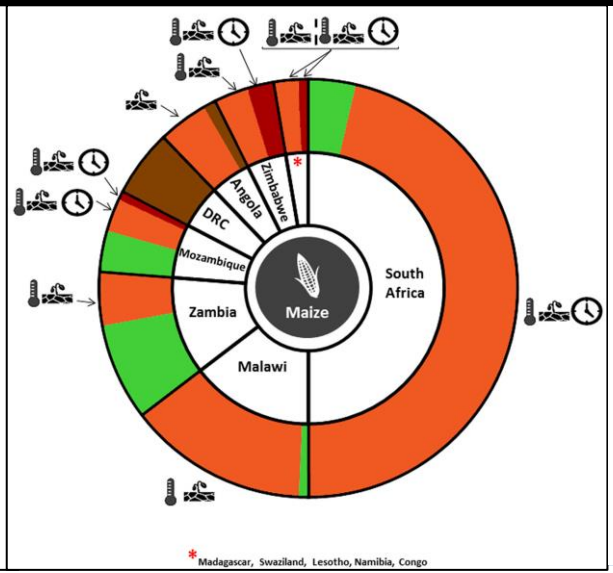
Africa May Assessment



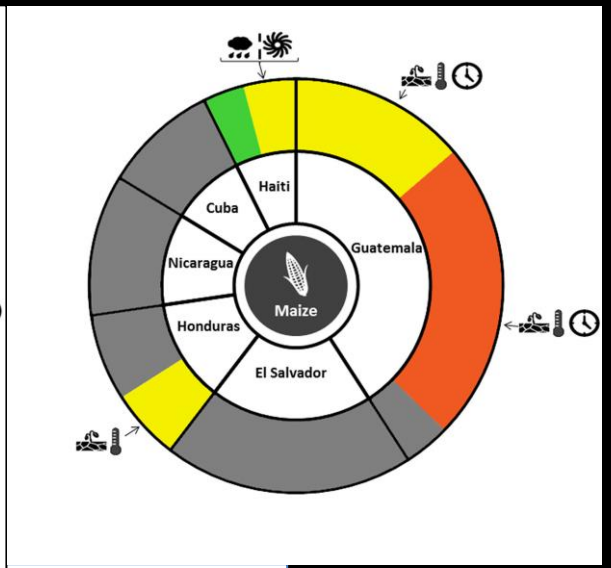
Maize East Africa

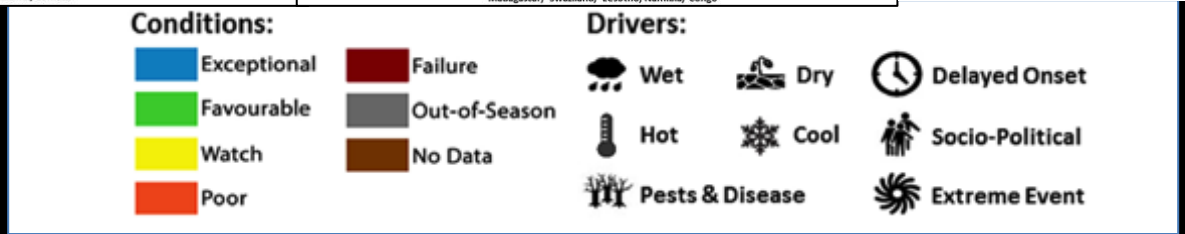


Maize Southern Africa



Maize Central America





Business / Land & Agriculture

Dry and brown Southern Africa will need food aid

BY EMIKO TERAZONO AND ANDREW ENGLAND, FEBRUARY 15 2016, 05:52

Related articles

- Escalating costs hammer Pioneer
- Food prices to soar as drought bites
- High red meat prices could mean a crash in the market

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Southern Africa: A Season of Regional Drought

Southern Africa Growing Season 2015-2016:

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Southern Africa warned of severe ood crisis

Thursday 24 March 2016 - 4:04pm

Agricultural Commodities

South African corn withers amid worst drought on record

Impact of extreme weather on food prices set to remain serious

Joint Statement

World Food Programme | FEWS NET | Food and Agriculture Organization of the United Nations

El Niño Set to Have a Devastating Impact on Southern Africa's Harvests and Food Security

GEO Announces Launch of Early Warning Crop Monitor: A New Tool to Fight Food Insecurity

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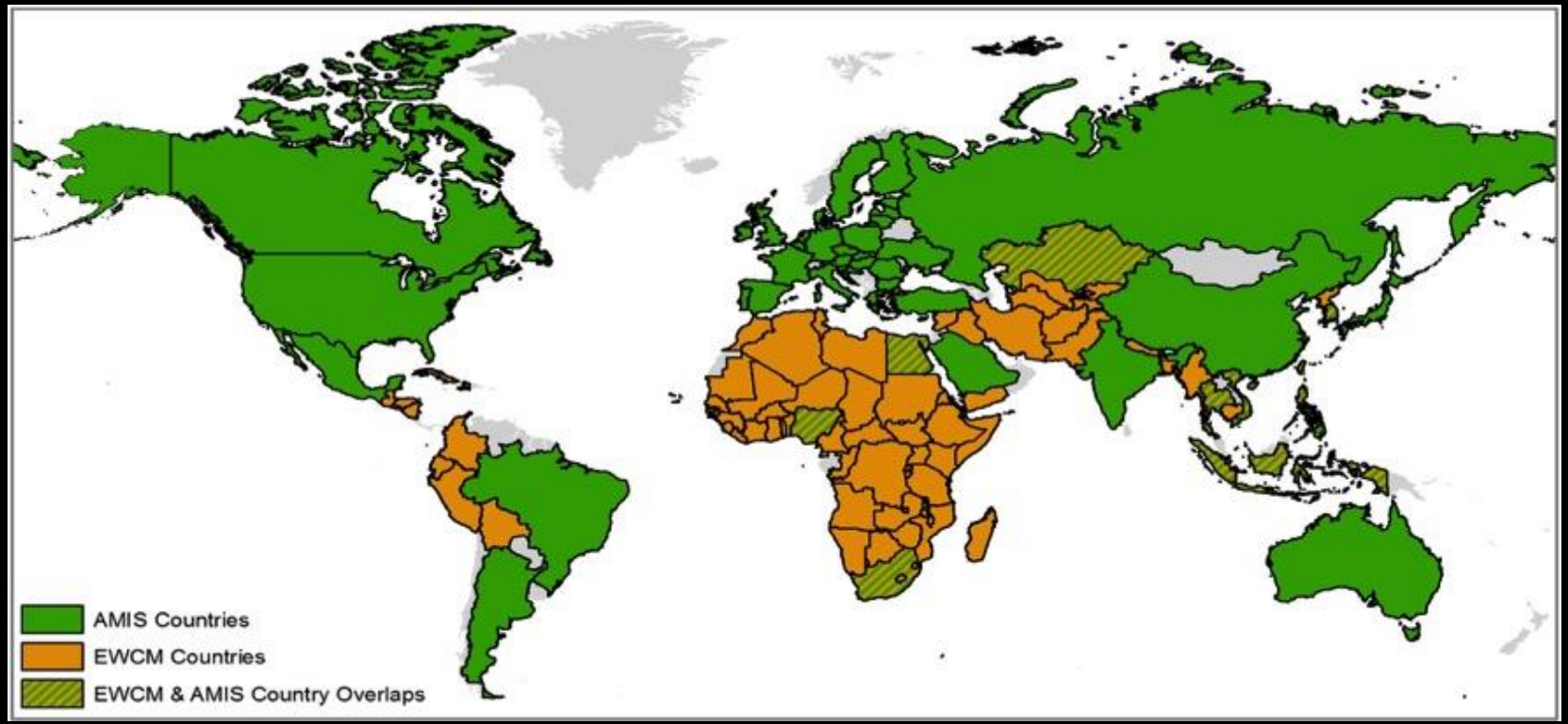
GEOGLAM Global Agricultural Monitoring

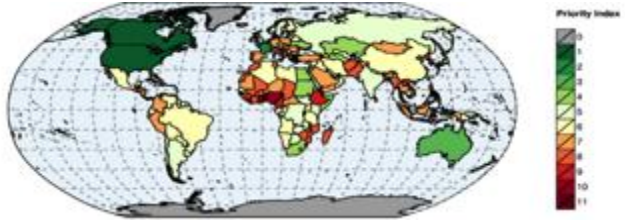
Countries Covered by Crop Monitors



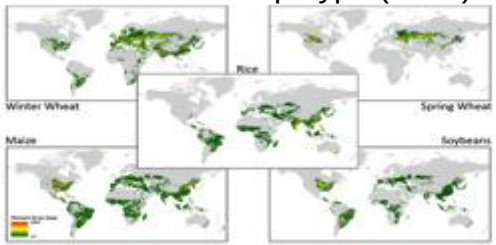
about 94% of world agricultural area…

New and Improved Global Data Sets

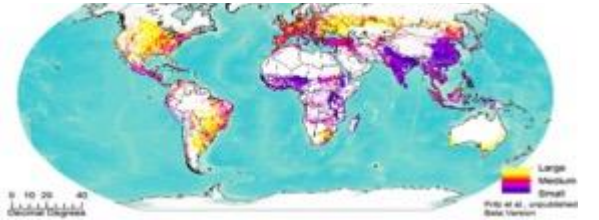
Priorities for Cropland Mapping (EC SIGMA)



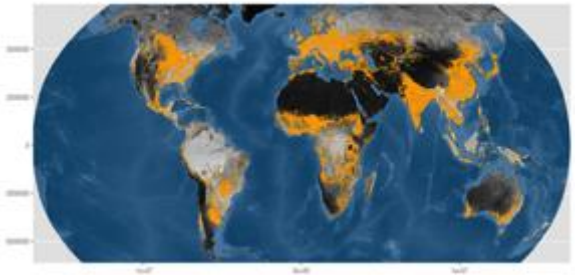
Best Available Crop Type (UMD)



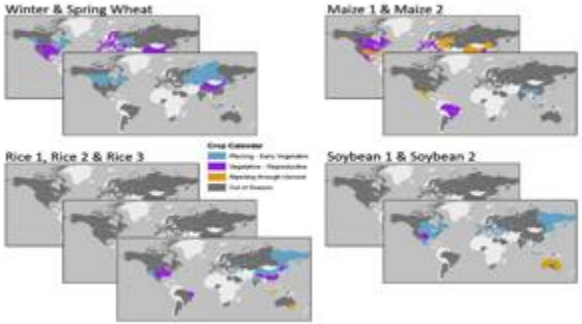
Field Size Distribution (IIASA)

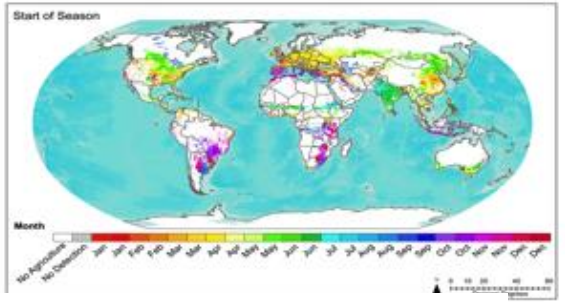


Best available cropland mask (EC SIGMA)

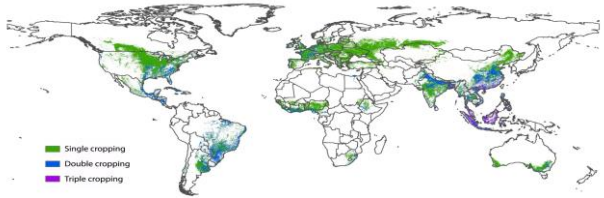


Growing Season & Crop Calendars (UMD)



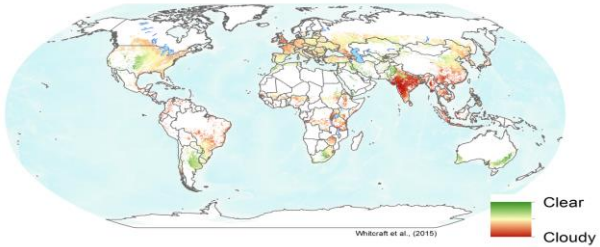


Global Cropping Intensity (China CropWatch)



Global cropping intensity, 2014

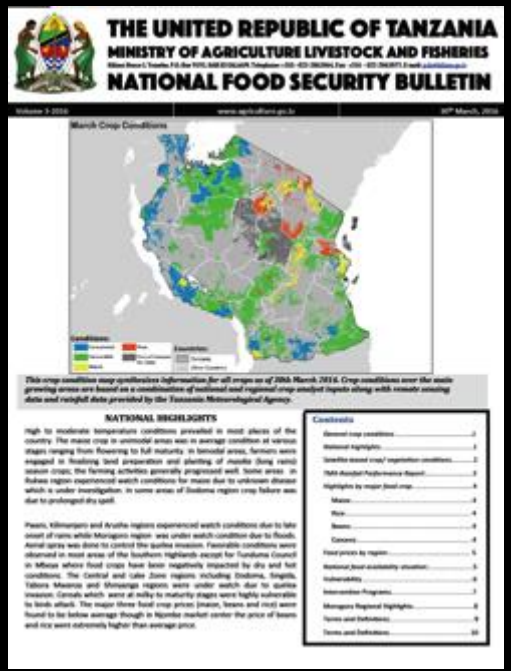
Cloud Cover (UMD)



Several Regional & Global Initiatives Launched

- Asia RiCE: focus on rice area and yield estimation in Asia
  - Led by Japan (JAXA) in collaboration with ASEAN +3 countries, India, France, IRRI, MRC AFSIS, UN-ESCAP and others *www.asia-rice.org*
- RAPP: Rangelands and Pasture Productivity Initiative: developing a global monitoring system
  - Led and supported by Australia (CSIRO) *www.geo-rapp.org*
- China CropWatch: Serve as a science-based Chinese voice on global food security perception
  - Led by China (CAS, RADI) *www.cropwatch.com.cn/htm/en/index.shtml*

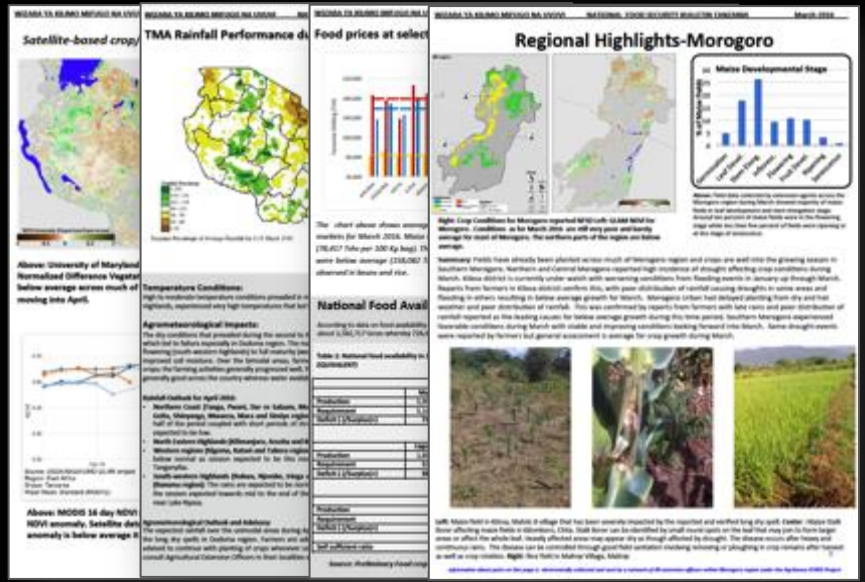
National Capacity Building: Tanzania Example


THE UNITED REPUBLIC OF TANZANIA
MINISTRY OF AGRICULTURE LIVESTOCK AND FISHERIES
NATIONAL FOOD SECURITY BULLETIN

March Crop Conditions

NATIONAL HIGHLIGHTS

Contents


Satellite-based crop

TMA Rainfall Performance du

Food prices at select

National Food Avail

Regional Highlights-Morogoro

Maize Developmental Stage

AgriSense

GEOGLAM R&D Component

- The implementation of any operational monitoring system requires an ongoing, user-driven, research component
  - Develop best practices
  - Incorporate new data streams and computing technology
  - Develop and enhance models
  - Linking with relevant communities

- Carried out through a number of large programs and projects including:
  - JECAM (led by Canada AAFC and UCL Belgium)
  - SIGMA (EC funded, VITO led consortium)
  - Sen 2 Agri- (ESA funded, UCL led)
  - MuSLI – (NASA & ESA funded- multiple projects)
  - STARS (BMGF funded, CIMMYT, ICRISAT, UMD, ITC led)
  - RAPP & Asia Rice
  - In collaboration with research and information initiatives
    - Including: LTAR, AgMIP, GYGA, GSARS

GEOGLAM Research Agenda and Priorities

- Robust & scalable algorithm development
  - In season area estimates
  - Yield forecasting
  - Early warning for countries at risk
  - Impacts of extreme events
- Land use change
  - planted crops, growing seasons, expansion & abandonment
- Yield gap
  - where, why & how to increase food production
- Production vulnerability under current /future climate
  - Successful resilience and adaptation strategies
- Innovation in data collection technologies
  - especially small-holder systems
- Integration with market early warning models and systems

Big (open) data, compute technologies –> game changer for agricultural monitoring

JECAM
Joint Experiment for Crop Assessment and Monitoring

GEOGLAM
Global Agricultural Monitoring

JECAM: Joint Experiment for Crop Assessment and Monitoring

A Global Research Platform for Agricultural Monitoring

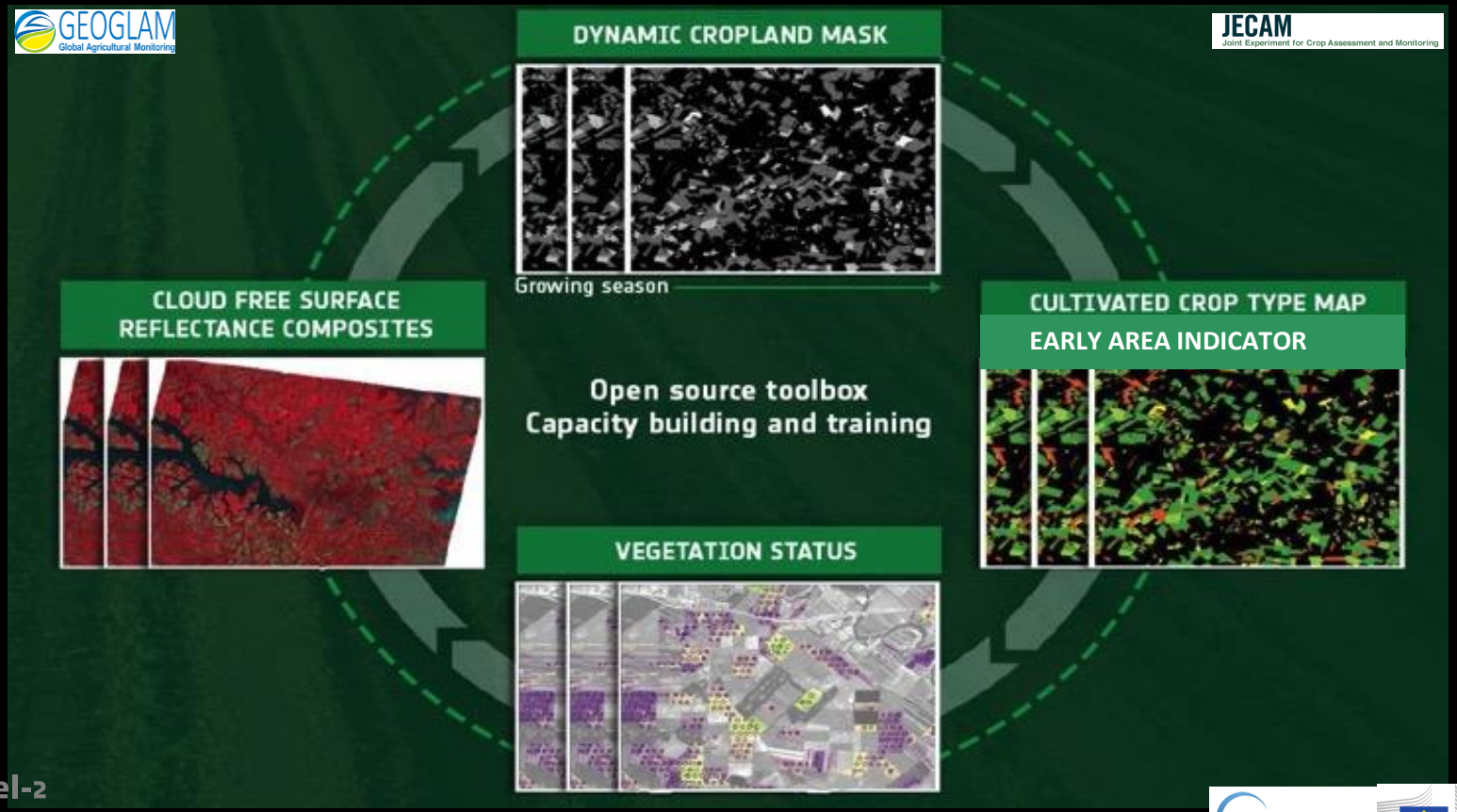
- R&D international network with over 30 sites, working on common research questions (*crop area, condition, yield, scaling up from field, regional to national*)
- Representing diversity of global agricultural systems
- Coordination with international space agencies CEOS & private sector
  - Developing data requirements, coordinating acquisitions and data sharing licenses (*DEIMOS, FenYung, Radarsat-2, Pleiades, SPOT 5, RapidEye, Sentinel-1&2, Landsat*…)
- Developing linkages with AgMIP, LTAR sites and other R&D networks
- **Program Office led by AAFC-Canada and UCL-Belgium**

www.jecam.org

Developing Automated User Ready Products:

Crop condition, type, & area

Sen2-Agri ESA Project



Project

UCL Université catholique de Louvain

CESBIO

ROMÂNIA

Key Users

FAO

WFP

IFAD

JRC EUROPEAN COMMISSION

cirad

FEWS NET

RCMRD

sentinel-2

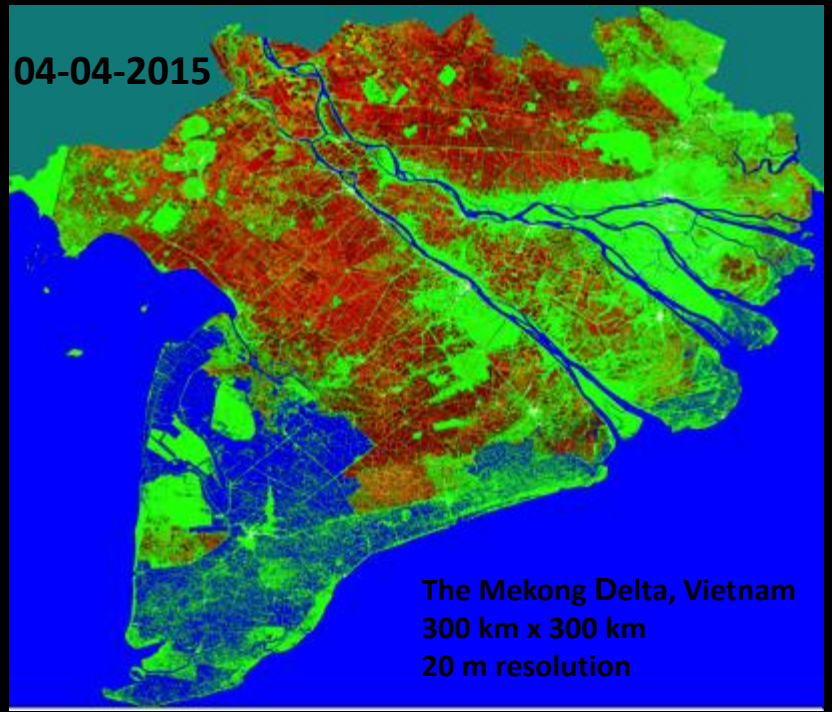
→ AGRICULTURE

copernicus Europe's eyes on Earth

European Commission

esa

Rice monitoring & Damage Assessments: Mekong Delta



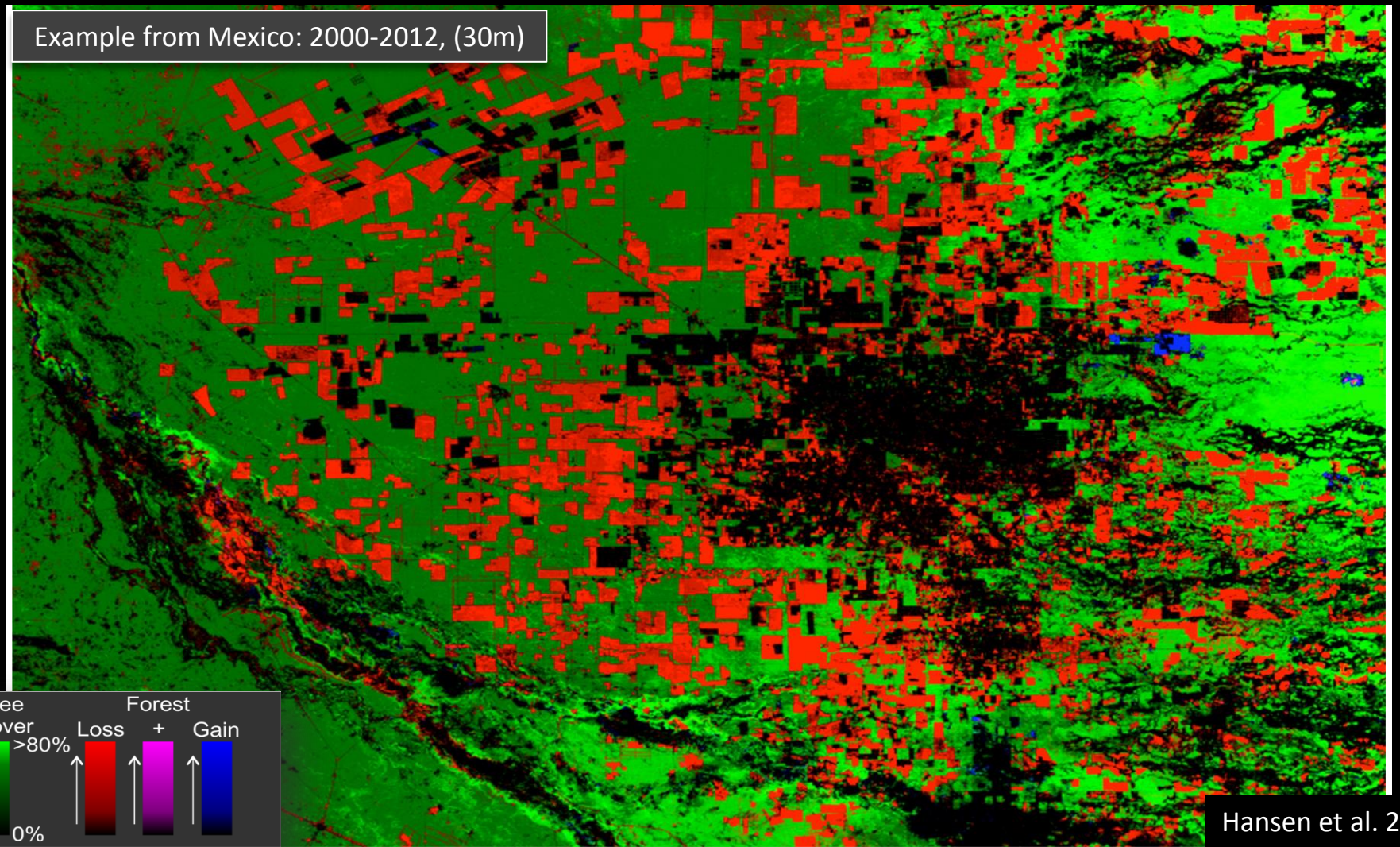
- Rice: early stage
- Rice: tillering stage
- Rice: reproductive stage
- Rice: maturity stage
- Non rice (forest, other LULC)
- Water (ocean, river, aquaculture)
- Land outside the Vietnam Mekong delta

Winter-Spring Rice 2015/16

- March 2016: 1.4 Million ha rice
- March 2015: 1.7 Million ha rice
- **16.5% loss in rice area** due drought and salt water intrusion caused by El Nino
- 976.000 people affected, 67 Mil. $ estimated damage

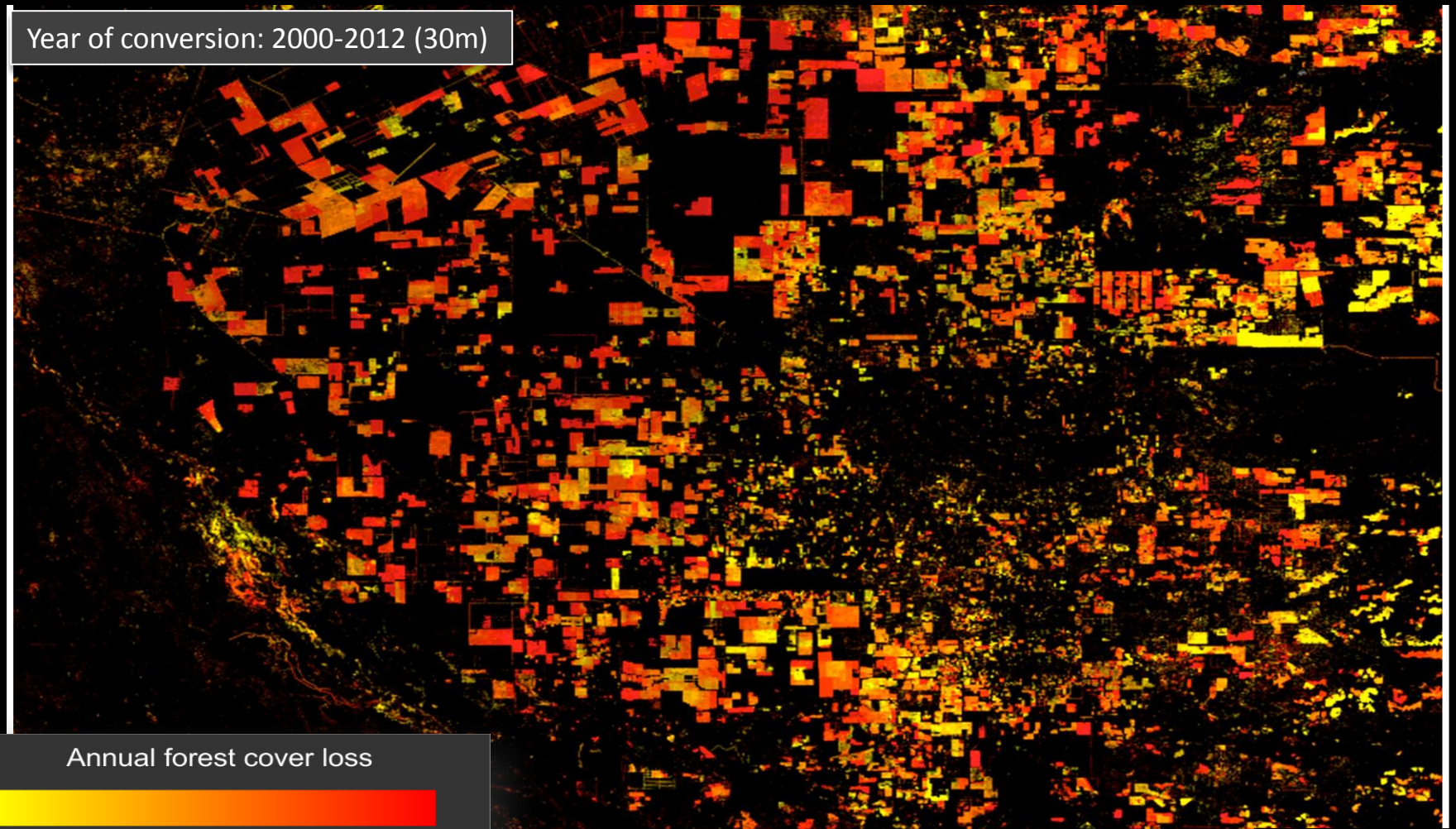
- Based on uprecedented ESA S1 timeseries (radar data)

Land-use Change: Forest to Agriculture



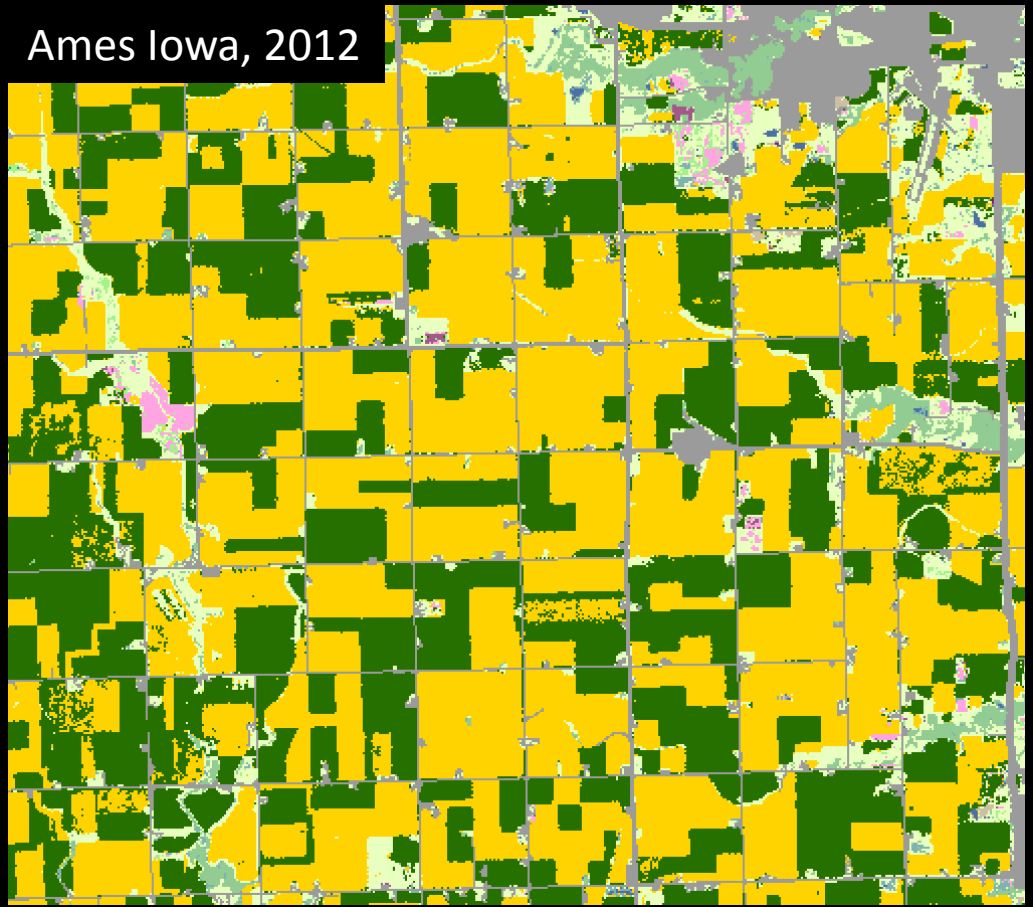
Hansen et al. 2014

Land-use Change: Forest to Agriculture



Hansen et al. 2014

Crop Type Identification, 30 meter resolution



USDA National Agricultural Statistical Service (NASS)

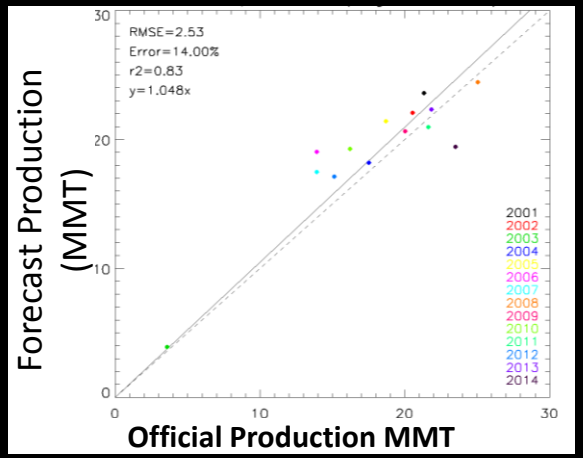
National level, annual product

Example from Ames Iowa- US Corn Belt
Critical for:

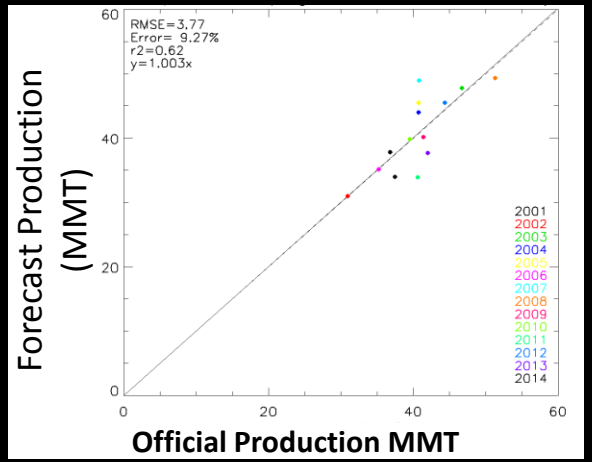
- Crop Area Estimation
- Crop Rotations
- Yield assessments and forecasting
- Yield gap
- Insurance
- Interventions and impact assessments

Yield Forecasting at National Scale

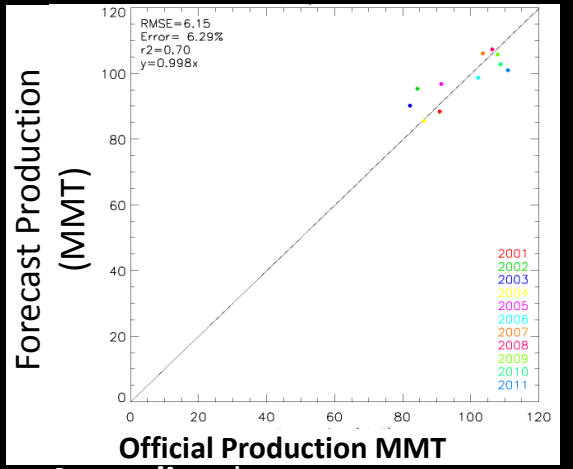
Ukraine winter wheat



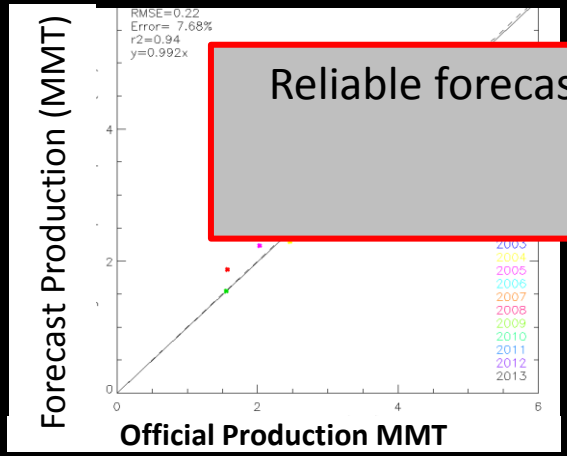
US winter wheat production



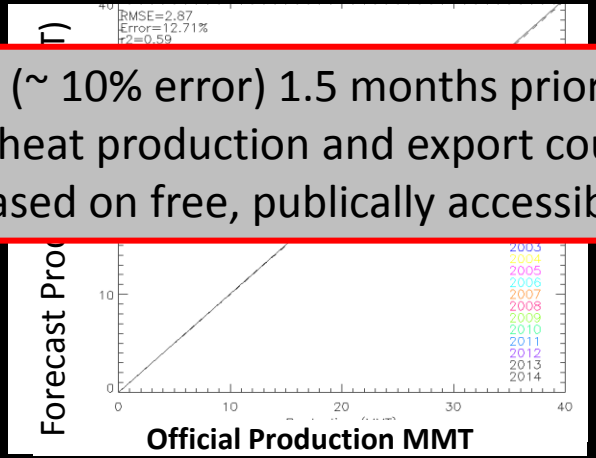
China winter wheat



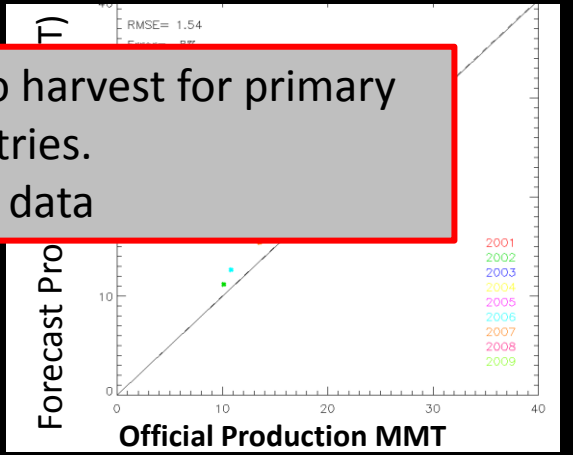
Canada winter wheat



Canada spring wheat



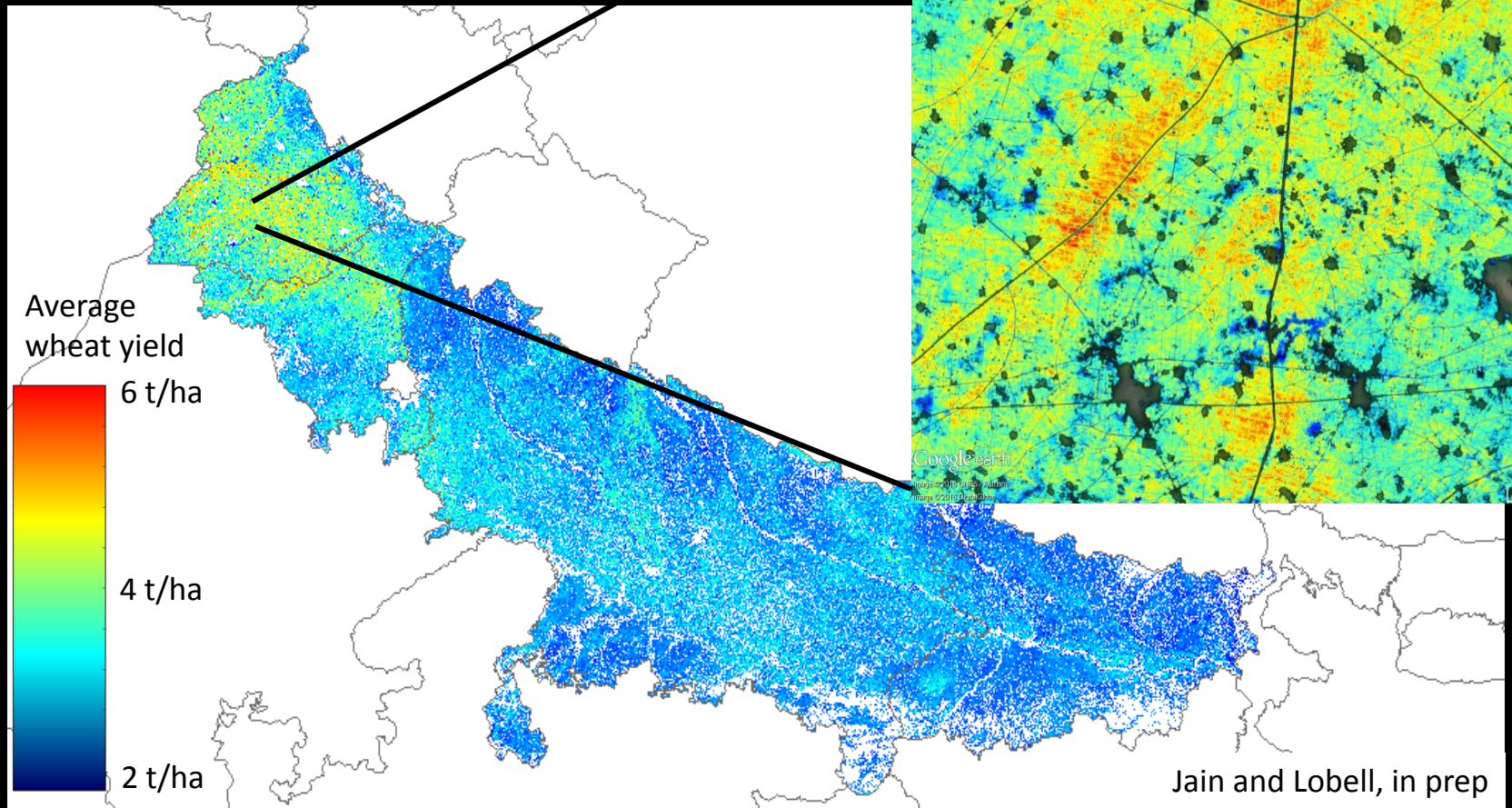
Australia wheat



Reliable forecasts (~ 10% error) 1.5 months prior to harvest for primary wheat production and export countries.
Based on free, publically accessible data

Becker-Reshef , & Franch

Yield Forecasting at Field Scale
Example: Indo-Gangetic Plains

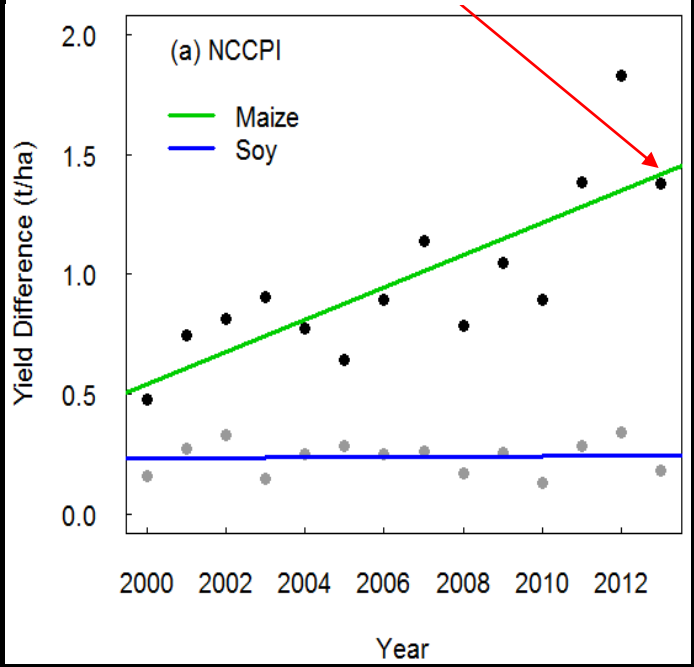


Jain and Lobell, in prep

With new field-scale yield data, can ask…

- How does yield vary through space & time? (leading to improved crop specific risk assessment)
- How big are yield gaps?
- What causes yield losses?
- What are sources of recent yield gains?
- Which interventions are working best?
- When should insurance be triggered?

Average within-county difference between corn yields on “best” and “worst” soils in U.S., based on SCYM yields



Lobell and Azzari, in review

In Summary

- Bottom- up & top down, open initiative
  - Platform for multi-lateral and bilateral cooperation
- Strong G-20 countries' support
- Major contributions from many countries and international agencies – Thank you!
  - In-kind, secondments, large project funding and R&D calls
- Producing relevant information for food security and market stability
- Focus on user driven R&D & technology transfer
  - Methods testing and inter-comparisons- developing best practices
  - Strengthening national systems
- Developing linkages with relevant research platforms and initiatives

Final Thoughts

- International recognition need for more reliable, timely, transparent production information from field to the global scale to inform local to global decisions, interventions and policies
  - informing & stabilizing markets, early warning of potential food shortages, damage assessments
  - monitoring progress towards needed agricultural intensification to meet global food needs sustainably
- Science, data, and technology are rapidly advancing
  - Revolution in cost and availability of satellite data and technology transforming our monitoring, forecasting and assessment capabilities
  - Clearly geospatial EO one piece of puzzle- strengthen partnerships with relevant initiatives and programs
- Global challenge that can only be addressed through
  - International collaboration and partnerships, across countries, organizations, sectors, and disciplines
  - Innovation in science and technology
  - Open sharing of data, information, methods and experiences
- Look forward to advancing and growing participation in this international initiative to deliver science-driven, actionable information
  - further exchanges and a mutually beneficial relationship with the broader G-20 science community

www.geoglam.org
www.geoglam-crop-monitor.org

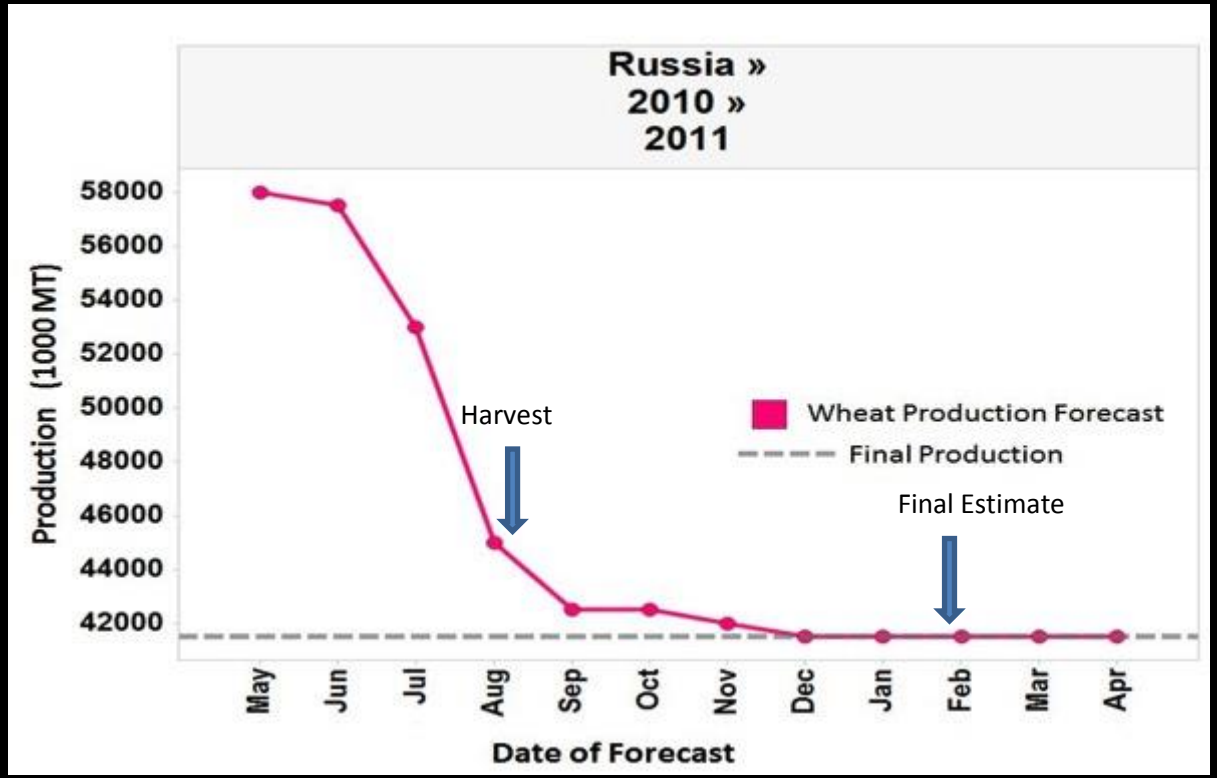
Contact: Inbal Becker-Reshef
ireshef@geoglam.org

Russia Forecast Example:

case for more timely information needed

Year of major Drought in Russia

resulted in 30% grain loss → ~80% increase in price



High Value for Crop Condition Monitoring

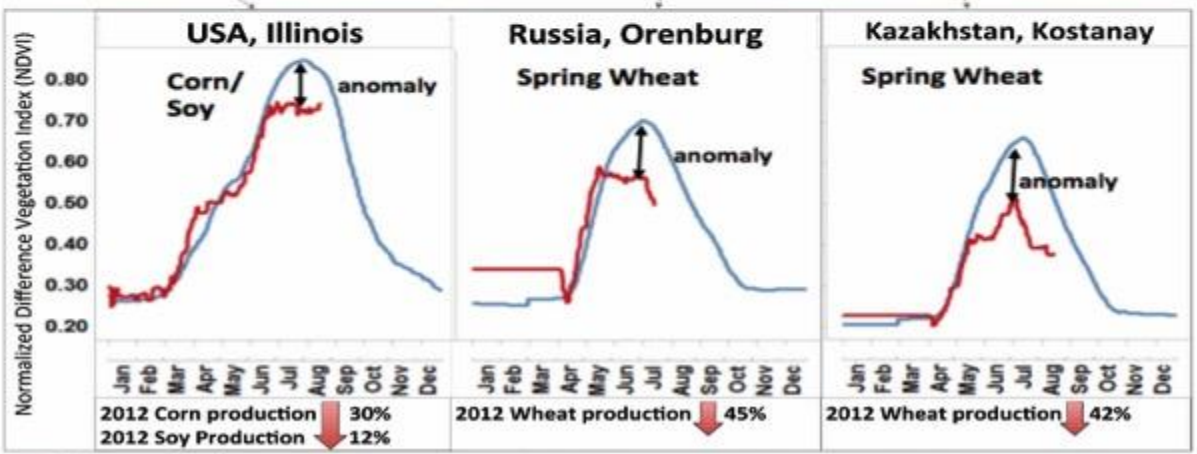
Example 2012 Droughts: Crop NDVI Anomaly relative to Average (2000-2011)

July 15th, 2012

Crop Condition
NDVI Departure from Mean (2000-2011)

-0.4 Worse than average | 0 average | 0.4 Better than average

Non Cropland
Not shown



2012 crop development
Average season development (2000-2011)

Statistics sources: USA- USDA NASS, Russia- Rosstat , Kazakhstan- SSA. 2012 decrease in prodcution is computed as percentage relative to average (2000-2011)

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