Global Burden of Crop Loss

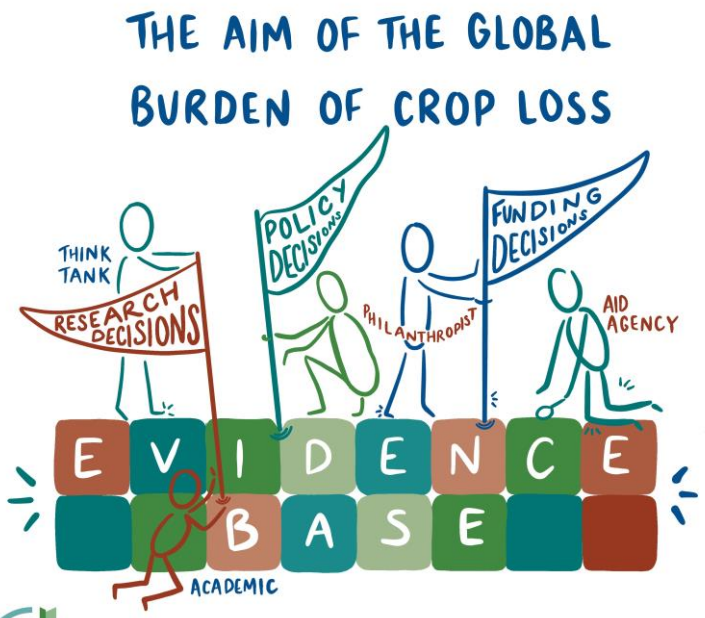
An introduction

July 2021

KNOWLEDGE FOR LIFE

CABI

The Global Burden of Crop Loss



The Global Burden of Crop Loss initiative aims to provide rigorous, authoritative evidence on **impacts**, **causes**, and **risk factors** of crop loss.

We are driving an innovative program that will bring together **people**, **data**, and **ideas** to **work collaboratively** on developing a data-driven system to help answer pressing questions on the scale, scope and impact of crop loss.

Evidence on the drivers and impacts of crop loss will help **direct funding**, **policy**, and **research** efforts to reduce crop loss at the farm level.

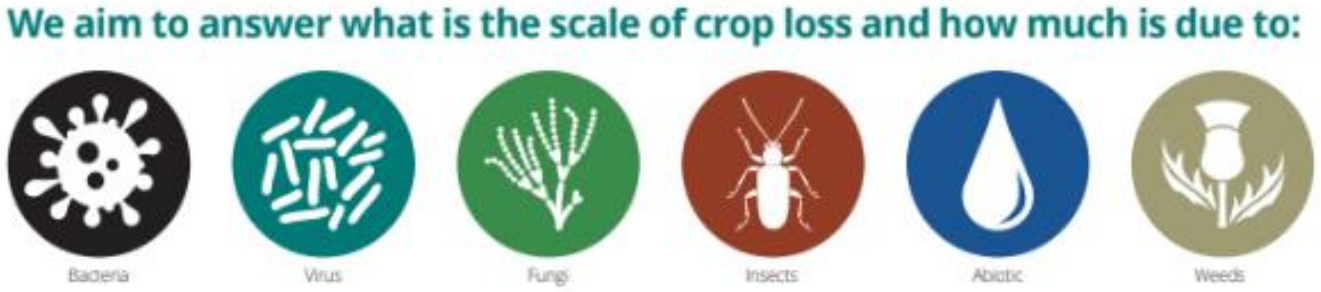
Our vision and mission

The **vision** for GBCL is that reduction and prevention of crop losses, achieved through the implementation of data-driven decision-making, improves food security and leads to more resilient agricultural value chains.

The **mission** for GBCL is to produce estimates of crop losses by establishing a community of collaborators who share data, conduct analyses, publish findings, and communicate results in order to inform decision making locally, nationally, and globally.

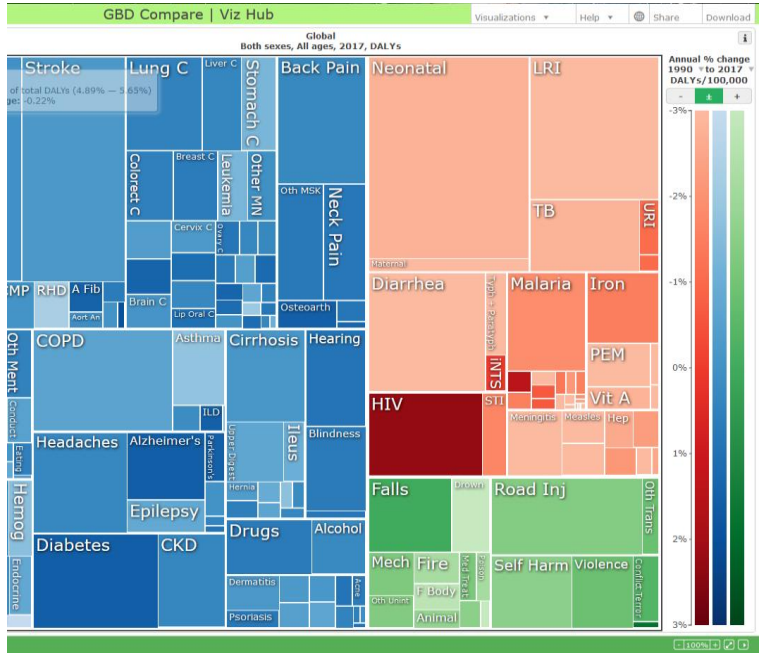
We are trying to answer...

- How much of the world's crops are lost to insects, disease, weeds or abiotic factors?
- How does this vary by geography, or by crop?
- What is the economic impact of crop loss, and where is it most damaging?



Improved statistics and indicators to answer these questions would put us in a much clearer position to address the most damaging causes of crop loss.

Learning from human health systems

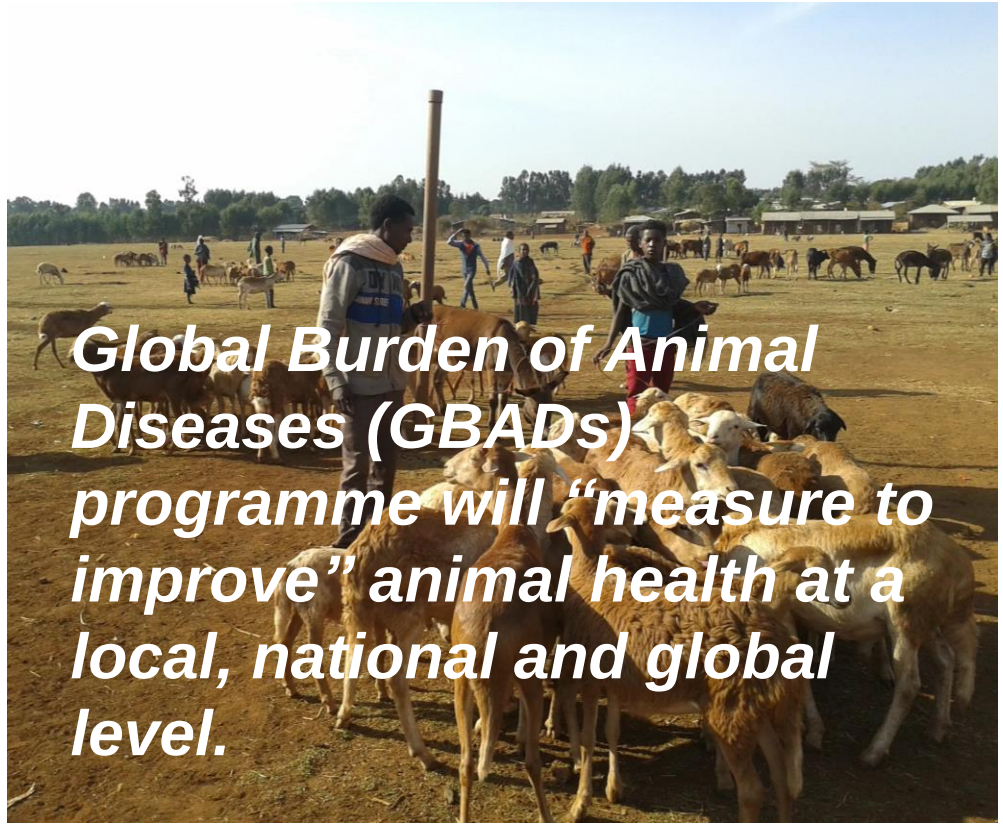


The Global Burden of Disease initiative, led by the Institute for Health Metrics and Evaluation (IHME), has transformed the human health agenda over the past 30 years.

The system provides comprehensive, authoritative data on the impact of hundreds of health problems and risk factors.

Inspired by the Global Burden of Disease, the Global Burden of Crop Loss initiative requires high-quality data gathering mechanisms, analytical methods that “crosswalk” data from different sources and the creation of new metrics that are globally recognised.

…and animal health systems



Similarly, the Global Burden of Animal Diseases (GBADs) aims to measure and improve societal outcomes from livestock and have a positive impact on the Sustainable Development Goals.

They will deliver rigorous methods, data, and evidence on livestock health and the performance of animal health systems, in order to support better decision making.

Why is it in needed in plant health?

- Data on the scale and causes of crop loss are sparse and outdated
- Plant health data have significant challenges compared to human and animal health data
- There are no equivalents of doctors or official medical records
- The number of species covered and wide variety of data formats and types present additional challenges

From: https://twitter.com/FAOstatistics/status/780420534786031617

Target users

Policymakers
Investors
Donors

- Actors at the highest levels of the Plant Health System
- Their decisions shape incentives for the whole system – setting priorities and allocating resources

Major use cases

- Understand state of plant health globally; assess trends
- Make informed decisions about investments in plant health, directing funding to where it’s most needed
- Systematically develop investment in, and capacity of, plant health systems
- Prioritise efforts of extension services, researchers, and other actors to address the most pressing problems
- Support de-risking of agricultural investments and the development of innovative products

Defining the burden

Value of crops lost + **Cost of control**

- Need for simple, clear, metric comparable across crops, production systems, and time
- Similar to GBADs, we have chosen an economic metric, rather than measuring burden in yield, nutritional, or other terms
- This was based on strong user demand – stakeholders reported needing to justify their decisions in economic terms

Framework

1. Crop yields

Theoretical yield: Crop x's potential yield based on physiological growth under unstressed conditions.

Attainable yield in context (geographical and social): attainable yields that take into consideration local constraints (water, nutrient, social).

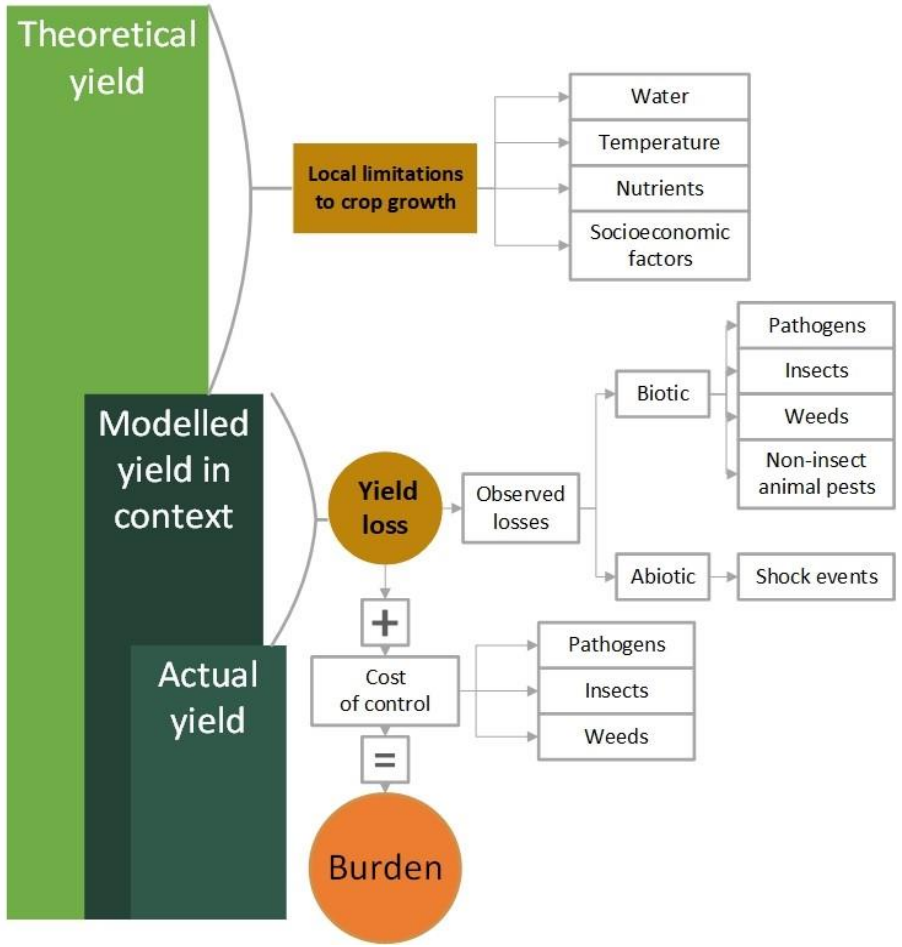
Actual yields: based on production stats, Earth Observation data & yield modelling

2. Burden

Observed losses: attribute to shock abiotic events and biotic stresses

Costs of control measures to avert losses: include costs of control & labour

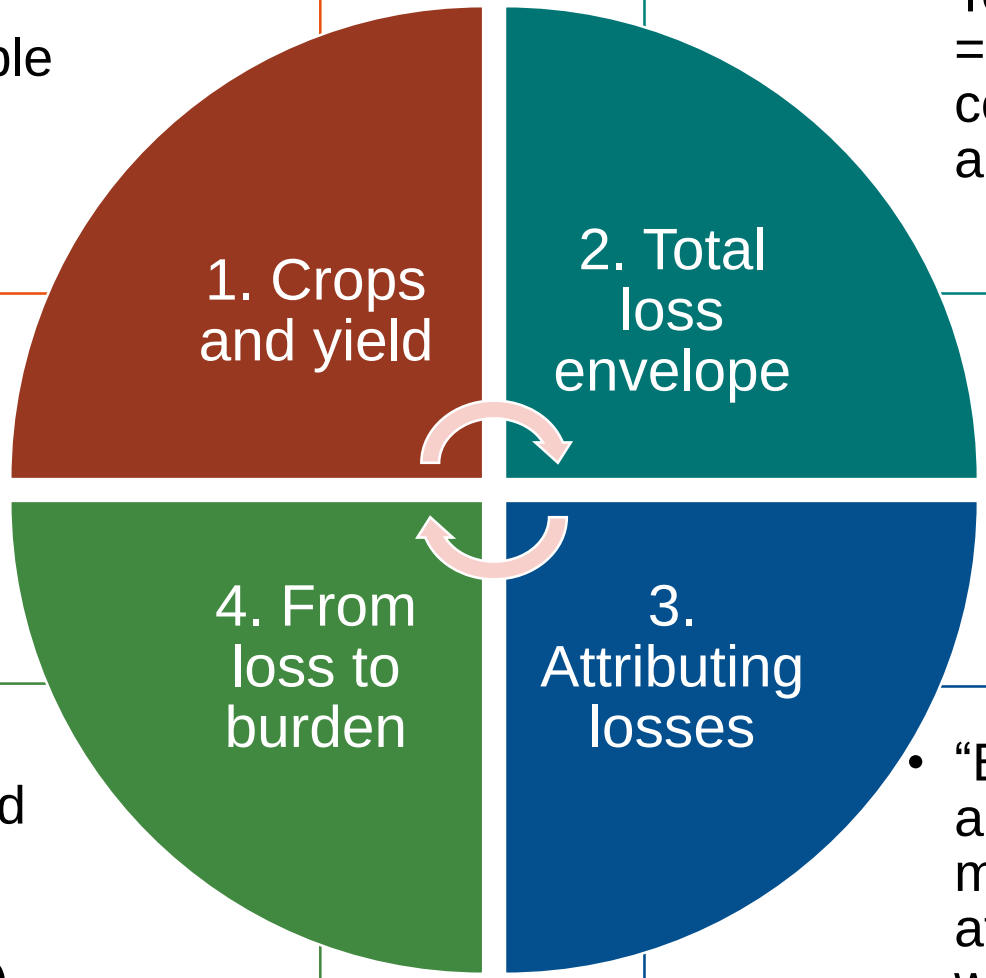
Total burden = economic loss due to observed losses + cost of control (incl. labour)



Estimating the burden

- Map crop areas
- Estimate attainable yield in context
- Estimate actual yields

- Total loss envelope = attainable yield in context minus actual yields



- Economic metric
- Value of observed losses +
- Cost of control (including labour)

- “Bottom up” approach – pest modelling to attribute losses within the envelope

1. Crops and yield

Key questions

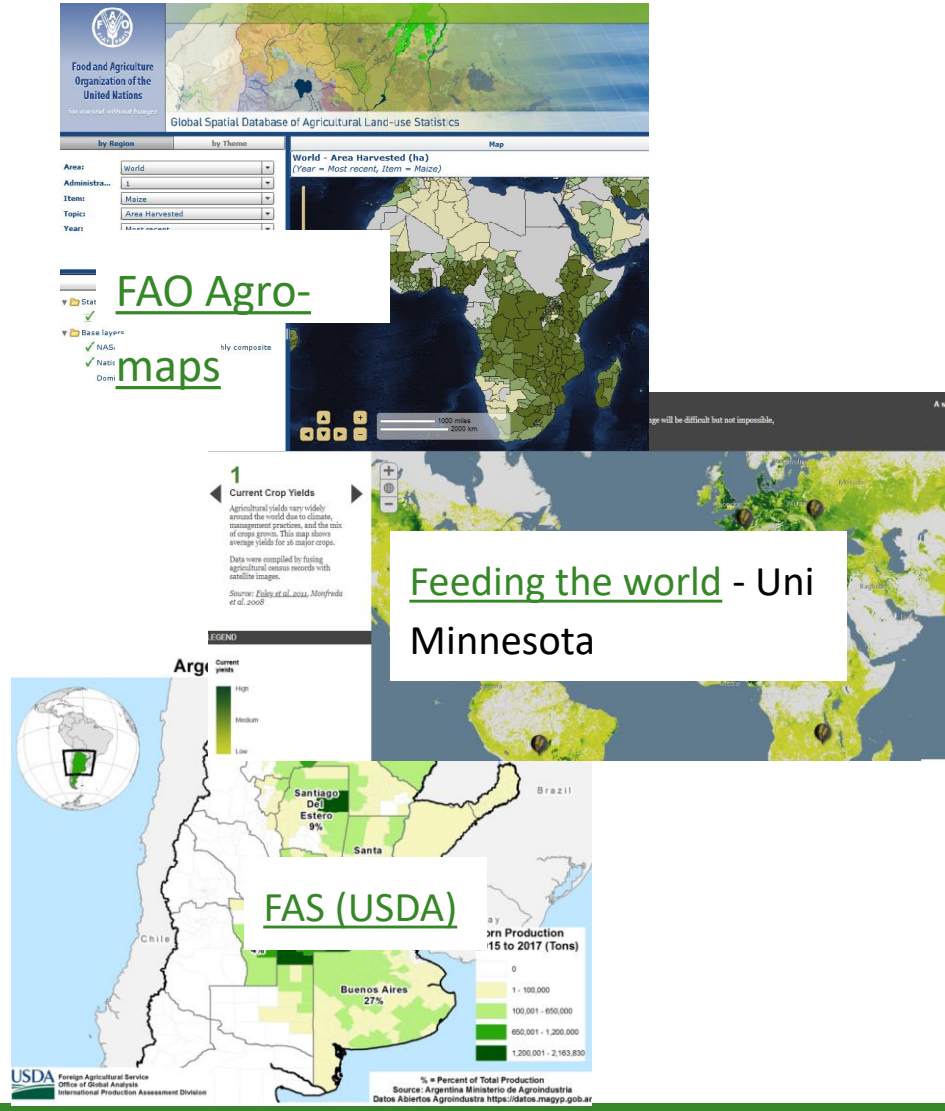
- Where (globally) is the crop grown?
- How much land is cultivated for this crop?
- Given the local climatic, soil, and agronomic context, what is the attainable yield in context for each local area?
- What is our best estimate for actual yield, in each local area?

Photo credit: CIMMYT.

1. Crops and yield: crop mapping

Approach:

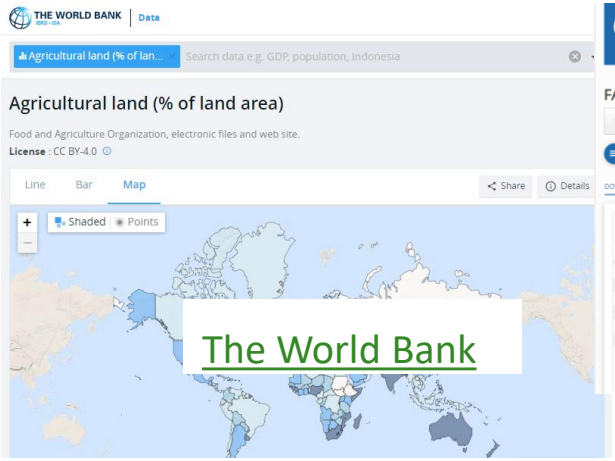
- Harness existing datasets, methods and initiatives
- Develop methods to combine and analyse existing data, use modelling to fill gaps to produce global estimates.
- Earth Observation (EO) provides the opportunity to map the extent of crop area and to distinguish irrigated from non-irrigated cropland. Methods have been developed to differentiate crop types and to map the temporal behaviour of crop production.

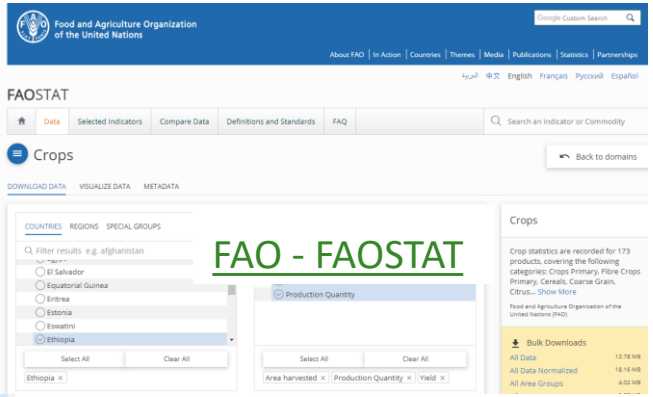


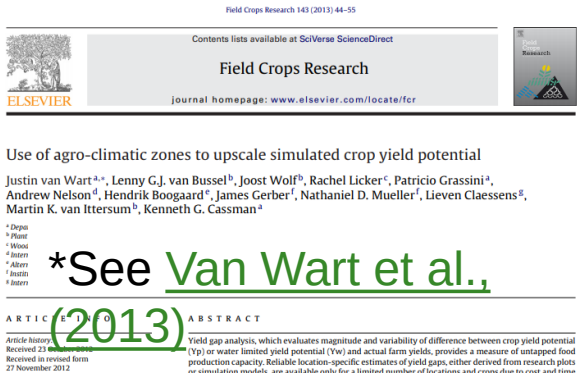
1. Crops and yield: actual yields

Approach

- Utilise national production statistics as validation of outputs.
- Use spatially explicit datasets to train models and extrapolations to calculate the total amount produced and ensure global coverage - we will not leave gaps.
- Where data are not available, estimates will be extrapolated from other areas with similar eco-climatic conditions (e.g using the global agro ecological zone (GAEZ) classifications to determine similarity between locations*)



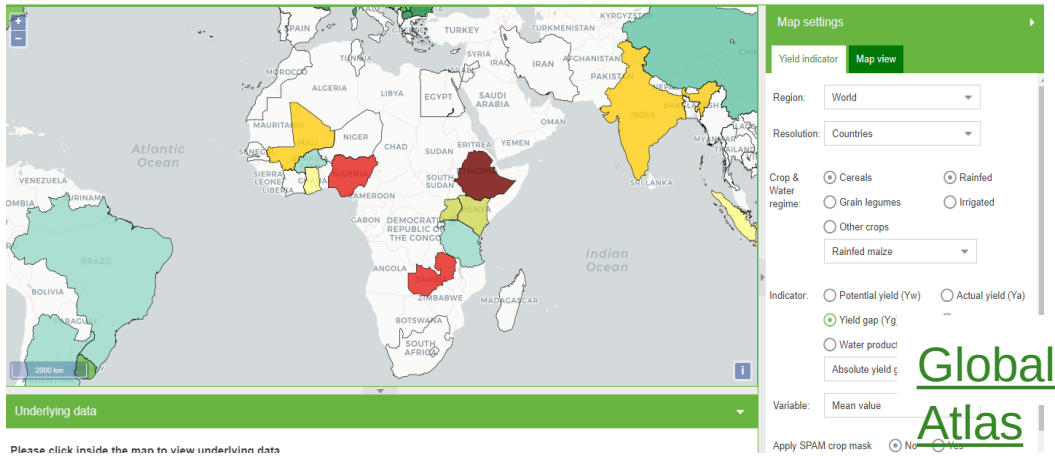




2. Total loss envelope

Approach

- Use existing data and methods to calculate attainable yield in different geographies
- Use earth observation, national statistics, crop modelling and trade data to determine the total loss envelope and to produce national estimates of loss.
- Where data are not adequate or available we will extrapolate based on geographic similarity
- Develop a clear method for indicating gaps we have filled and how we have filled them



Global Yield Gap Atlas

3. Attributing losses

Approach

- Work top down - attribute losses to the total loss envelope to ensure the amount attributed does not exceed 100% of losses.
- Develop a species prioritisation method to identify key species
- Group species where needed (e.g. taxonomic; by injury mechanism)
- Use existing data to build crop specific multi-species analyses
- Where possible report to species level, but we expect that we will have a significant ‘other’ category that will shrink over time as data improves
- Be open about methodologies and uncertainty in all outputs

3. Attributing losses – pest modelling

Examples of approaches

- Species distribution modelling: Map and predict species distribution based known distributions e.g Ecological niche modelling, Maximum entropy (MaxEnt)
- Climate based risk modelling (e.g: CLIMEX)
- Population models (e.g DYMEX)
- Phenology models - define the seasonality and duration of growth and reproduction and pace ecological interactions
- Integrate genomic, crop production and environmental data to conduct multi-peril biotic risk assessment at varying spatial and temporal scales (e.g multi-peril risk analysis, GEMS)

4. From loss to burden

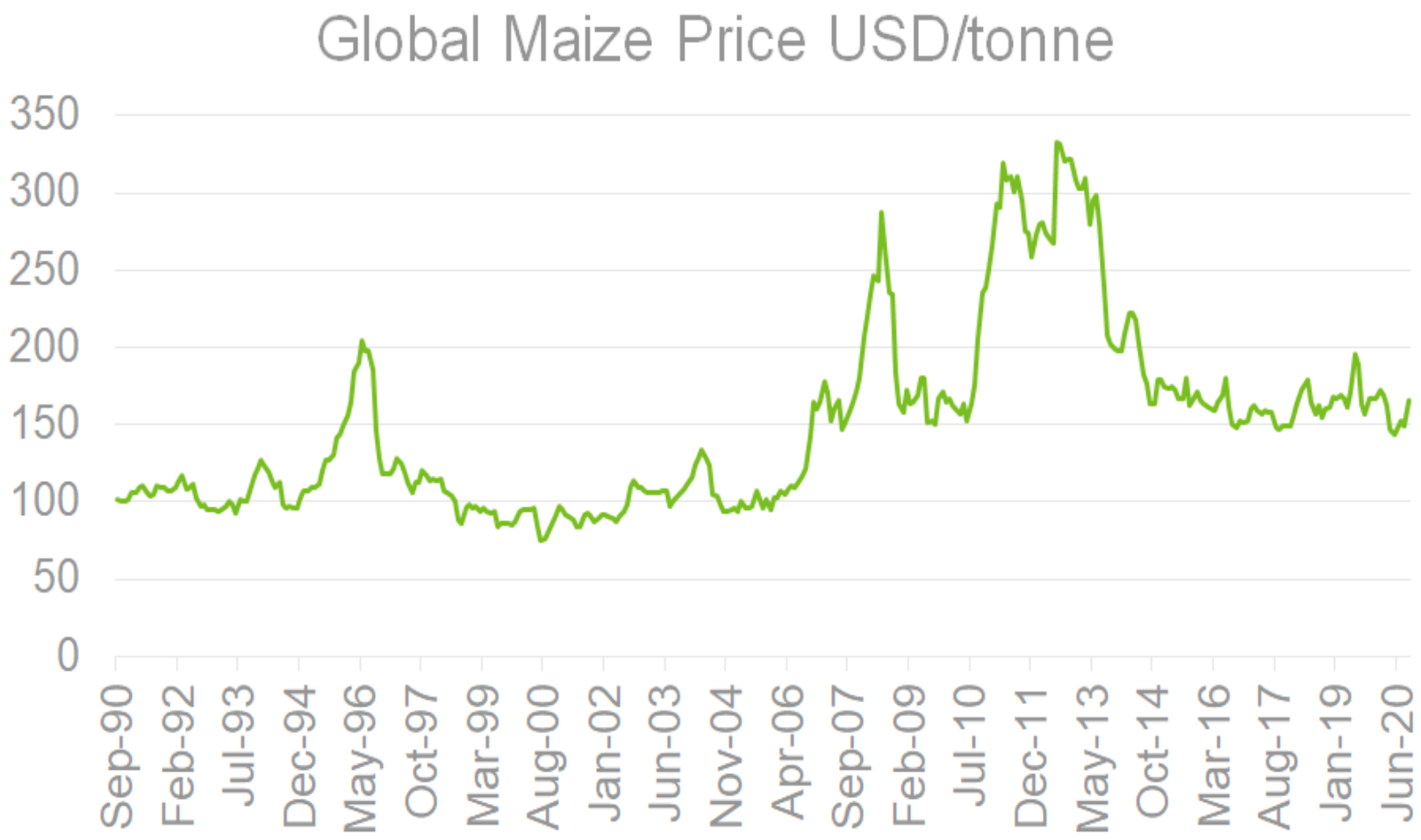
Value of crops lost + **Cost of control**

- To estimate the **value of crops lost**, we need to translate the losses from yield terms into economic terms.
- How to measure value?
  - Where in value chain? Farm gate prices, wholesale, export, etc
  - How to account for household consumption crops that would never have been sold?

4. From loss to burden

Prices fluctuate…

And vary between farm gate, wholesale, retail, etc…



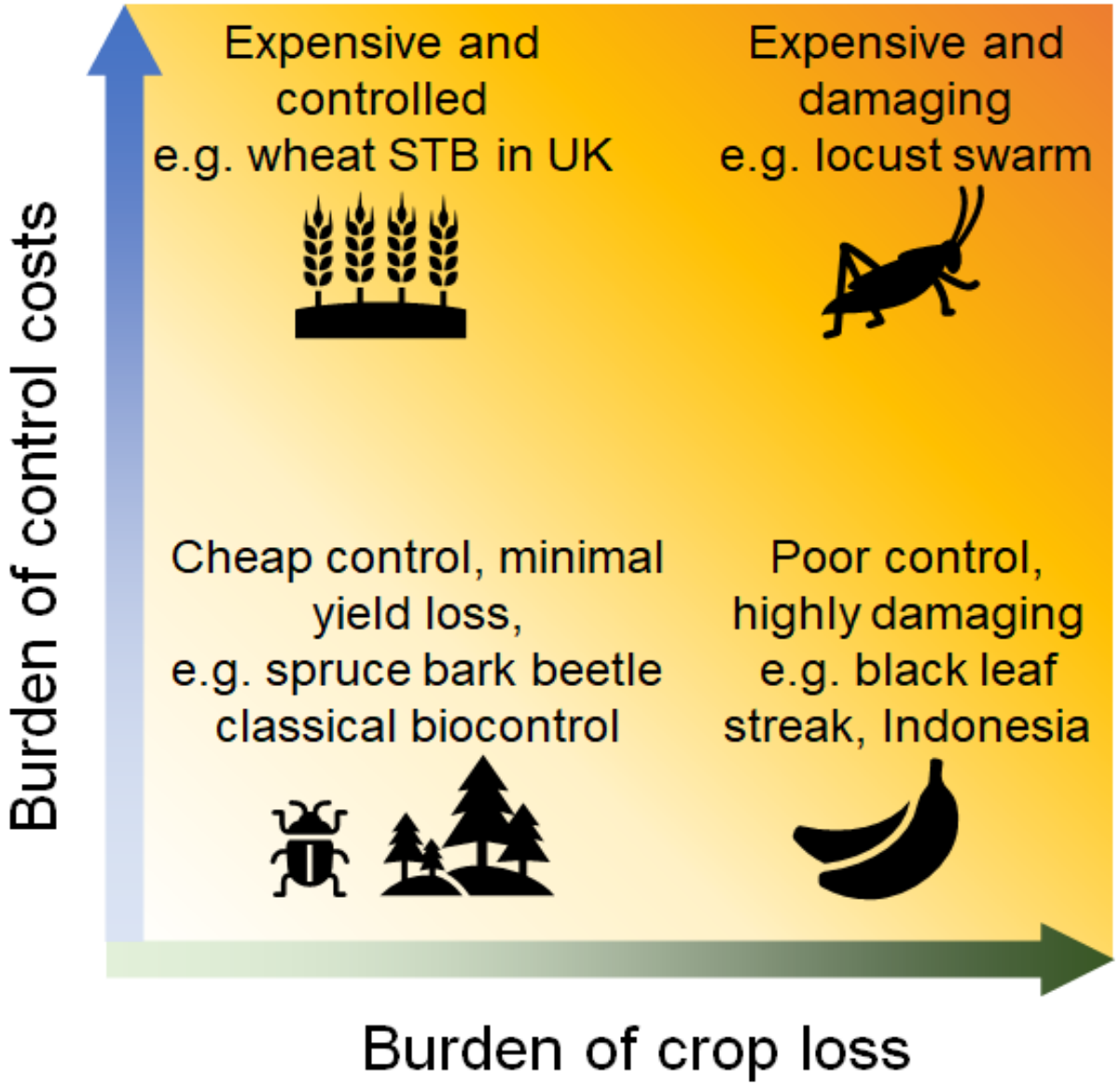
4. From loss to burden

Value of crops lost + Cost of control

- To estimate the **cost of control**, we need to account for **cash expenditure** on crop protection products, and the **labour** burden.
- Cash expenditure is relatively clear. But how to measure labour inputs?
  - Wage labour is the most straightforward to measure - but not always clear how to disaggregate between crop protection and other agricultural tasks
  - Family labour is more difficult to measure, and not clear how to represent in monetary terms

4. From loss to burden

Accounting for cost of control allows us to compare across production systems



Call for collaboration

Collaborators will be critical in both acquiring the necessary data and developing the analytical methods and metrics that will drive the Global Burden of Crop Loss. They will also play a vital role in ensuring the policy uptake and dissemination of outputs.

To find out more or to get involved:

Website: www.croploss.org

Contact: croploss@cabi.org

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Swiss Agency for Development and Cooperation SDC