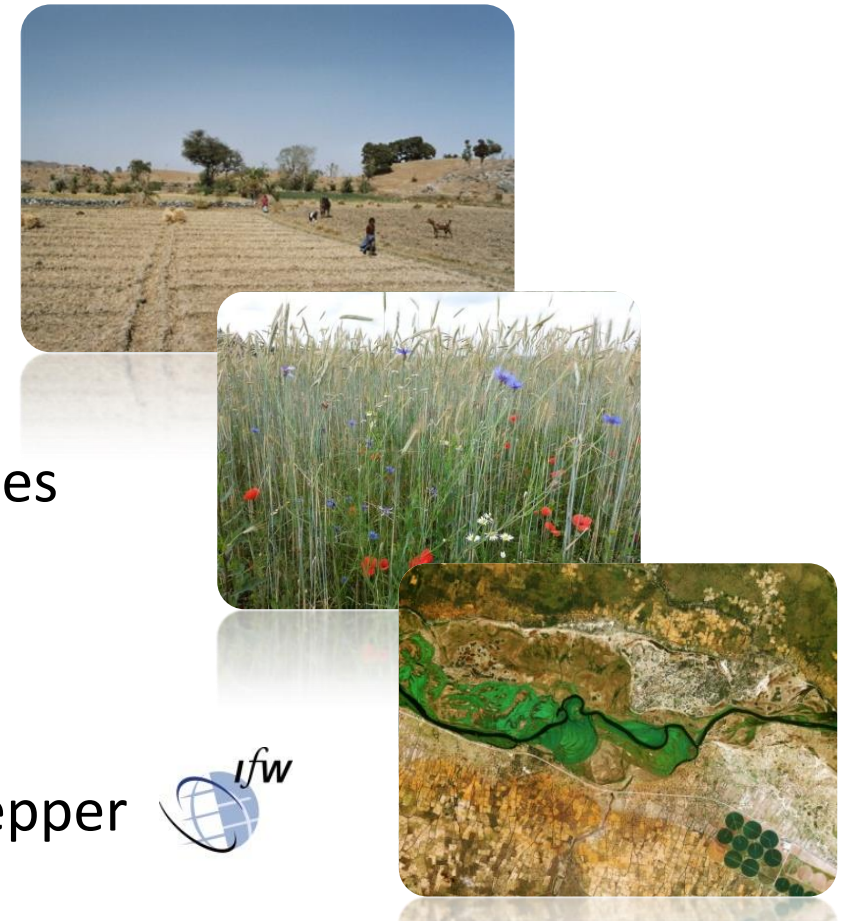
Food Security and Production



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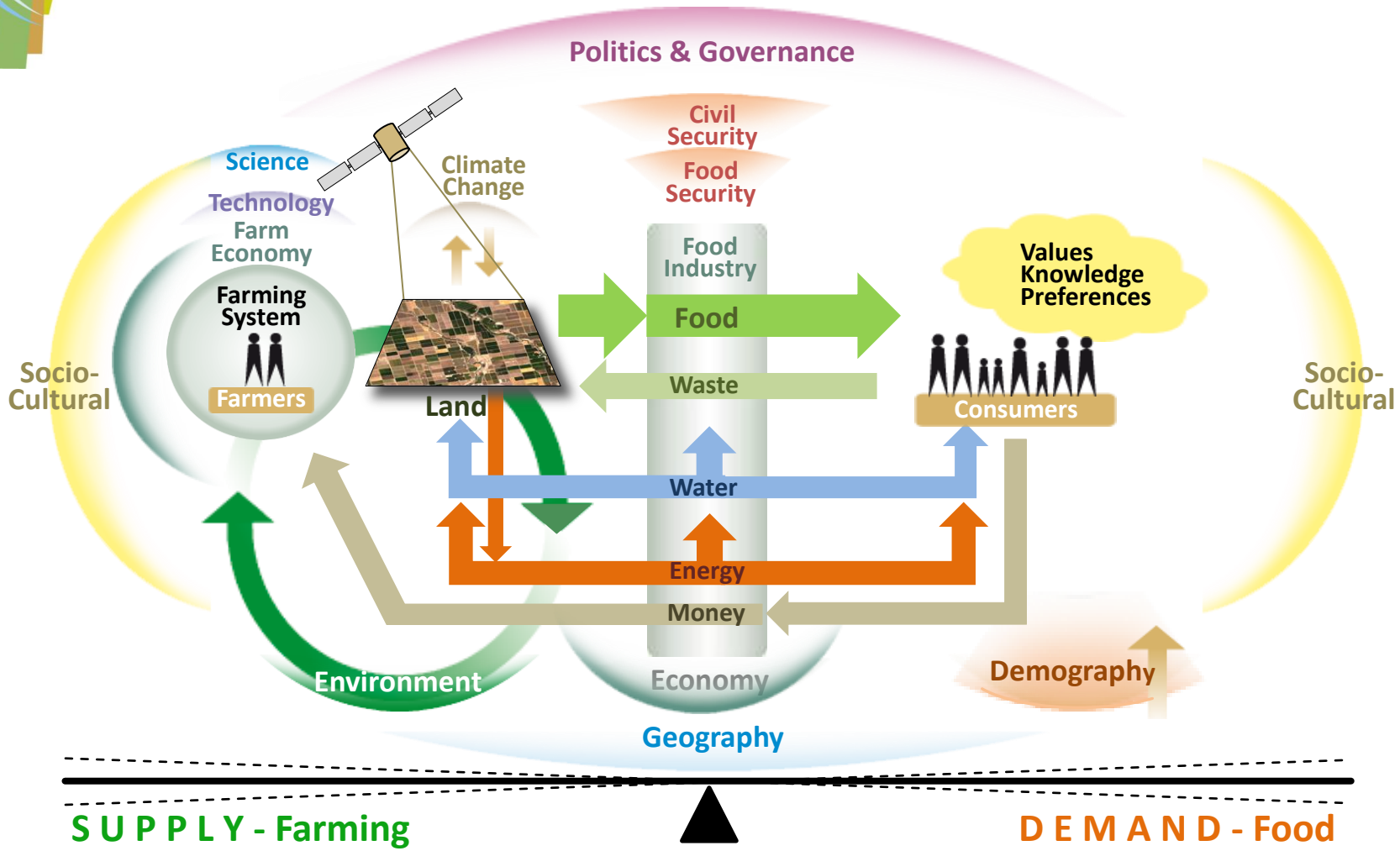
Wolfram Mauser

G. Klepper

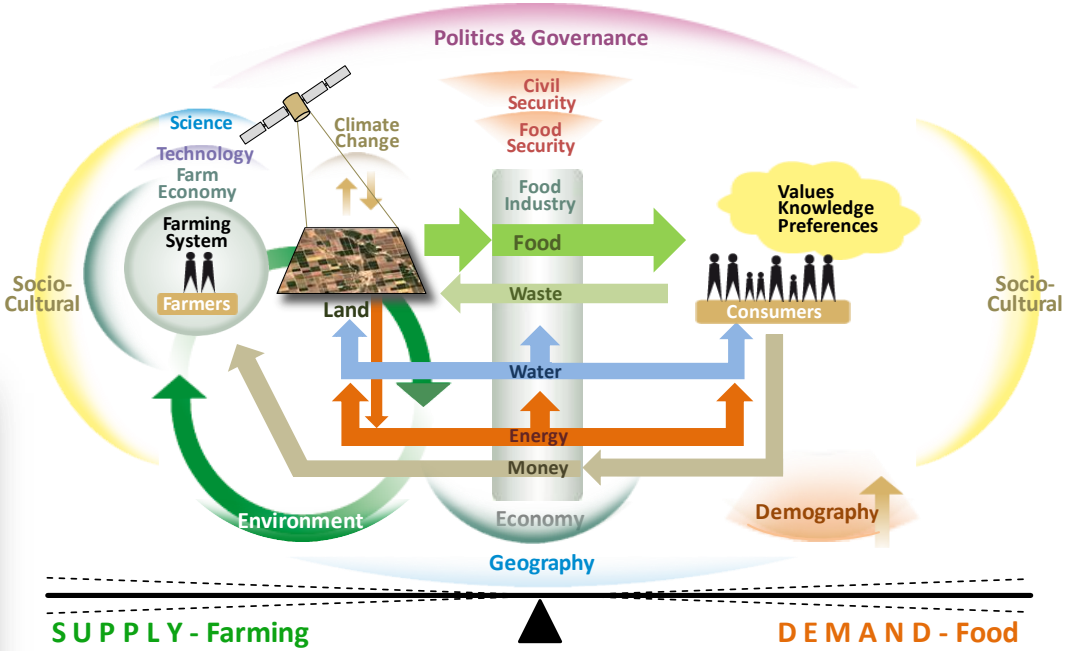
The Global Food System



Modified after Shiftn

Today's Global Farm

All farmers connected to the Global Food System represent today's Global Farm



On today's Global Farm different farming systems contribute to ensure food supply

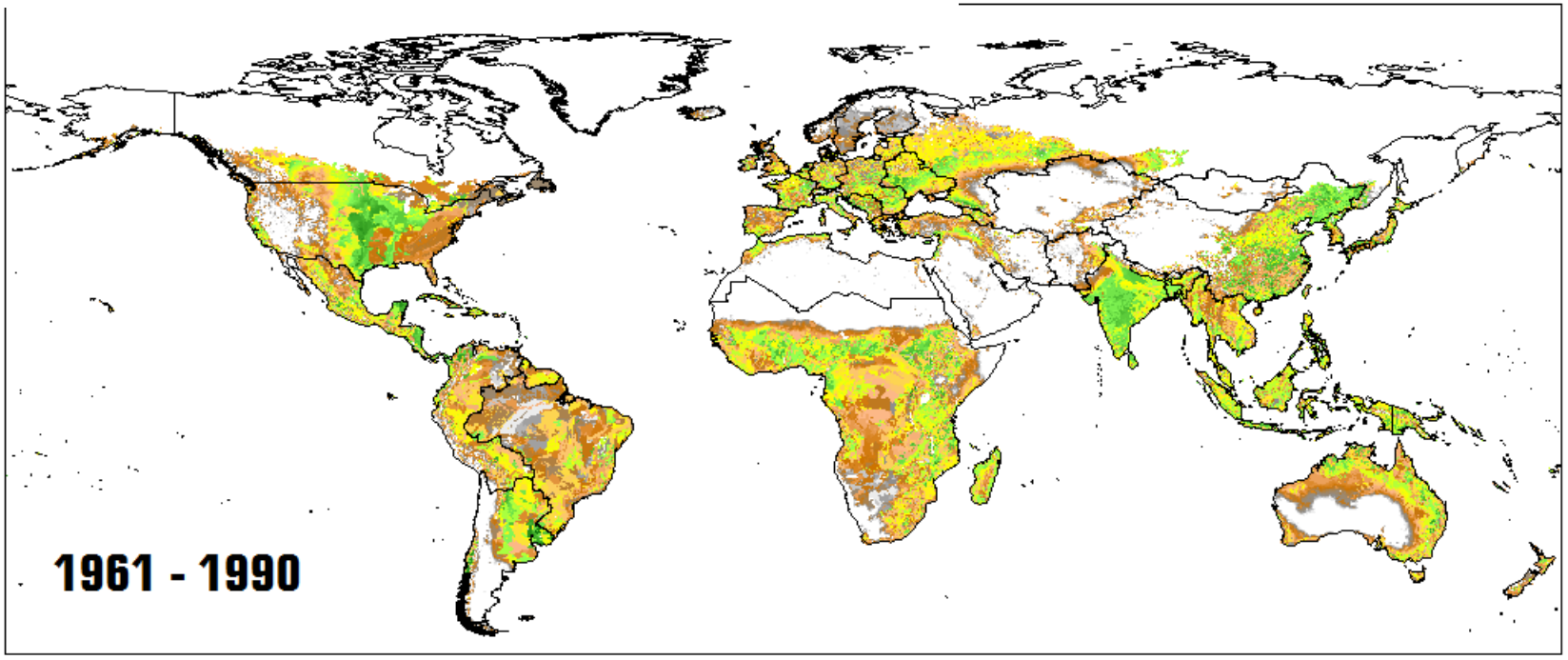
Today's Global Farm is:

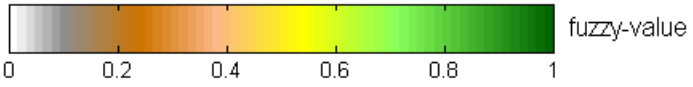
- ➢ not sustainable:
  - soil degradation
  - rural poverty
- ➢ not efficient through waste of water, energy, labor
- ➢ expanding and destroying natural ecosystems

Climate Change will cause Transition

Farmers must adapt their farm operations to temperature increase and changes of rainfall patterns.

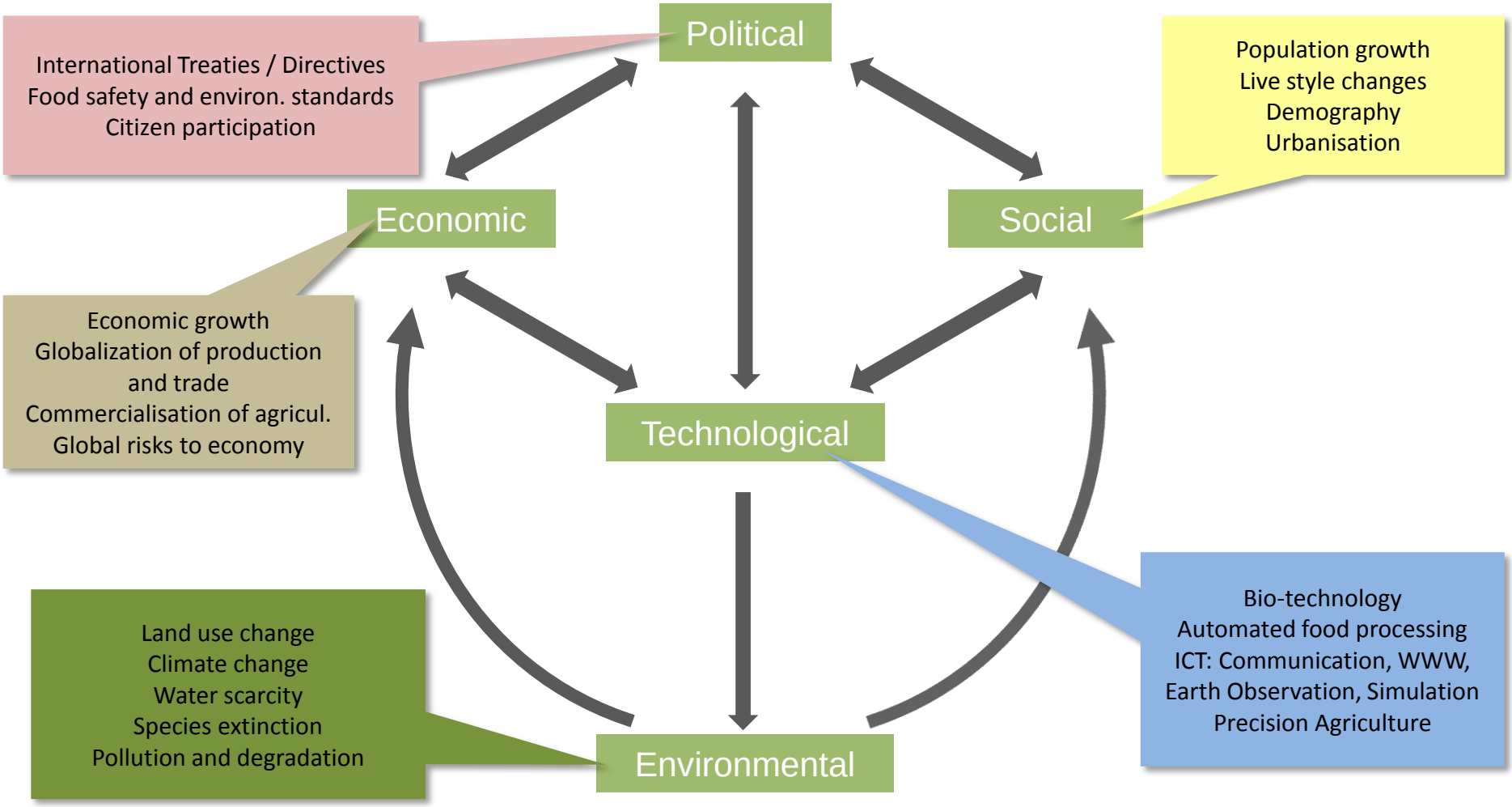
Crop Suitability and its transition





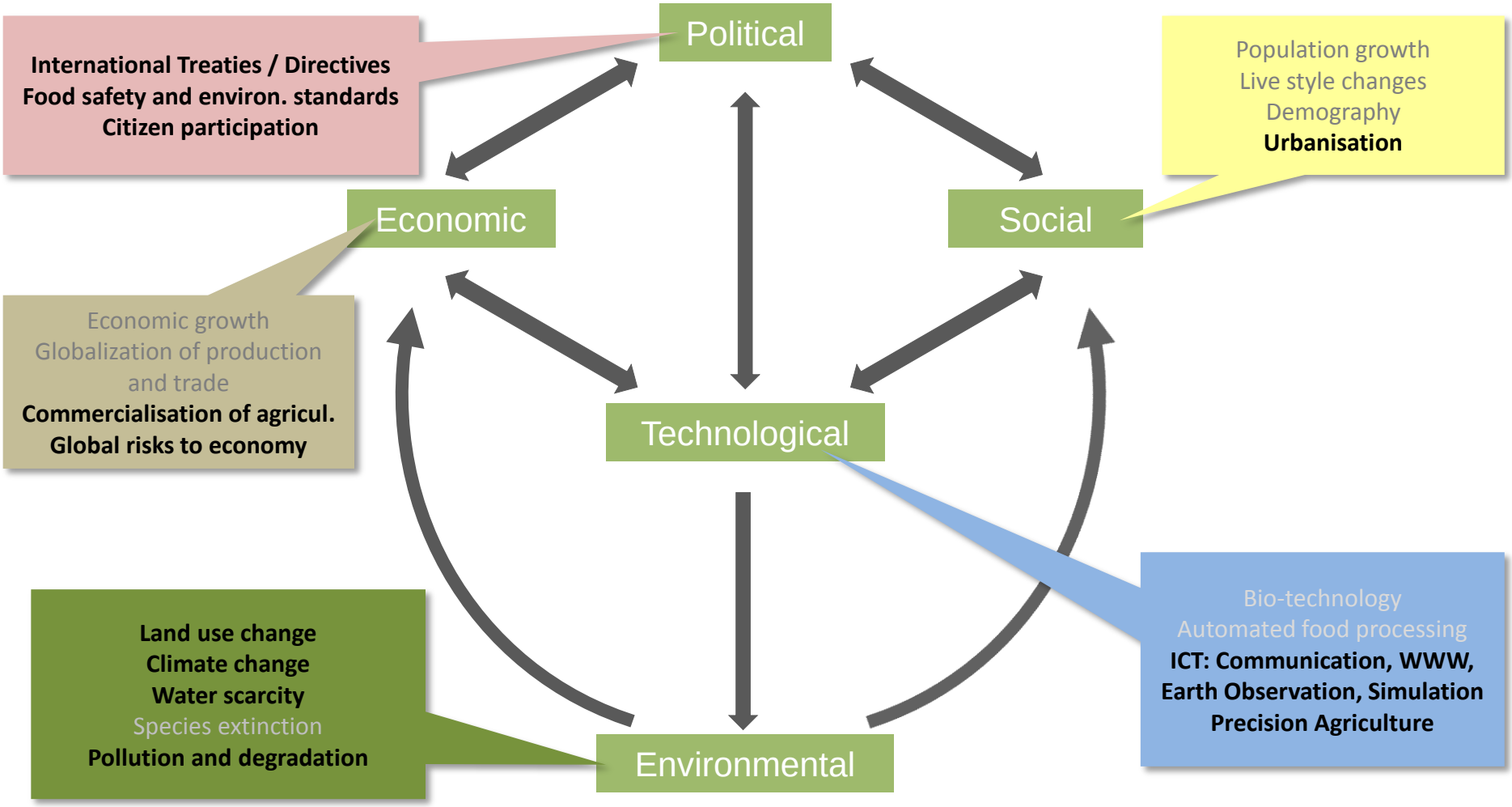
Development of Crop suitability 1961-2100. Climate data based on the bias-corrected and down-scaled output of the ECHAM-5 climate model, terrain data derived from SRTM data, soil information from the Harmonized World Soil Database (ZABEL & MAUSER, 2014).

Megatrends with Impacts on Food Security and Production



Megatrends with Impacts on Food Security and Production

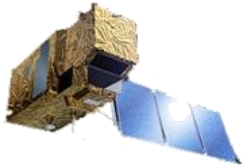
Accessable with Earth Observation



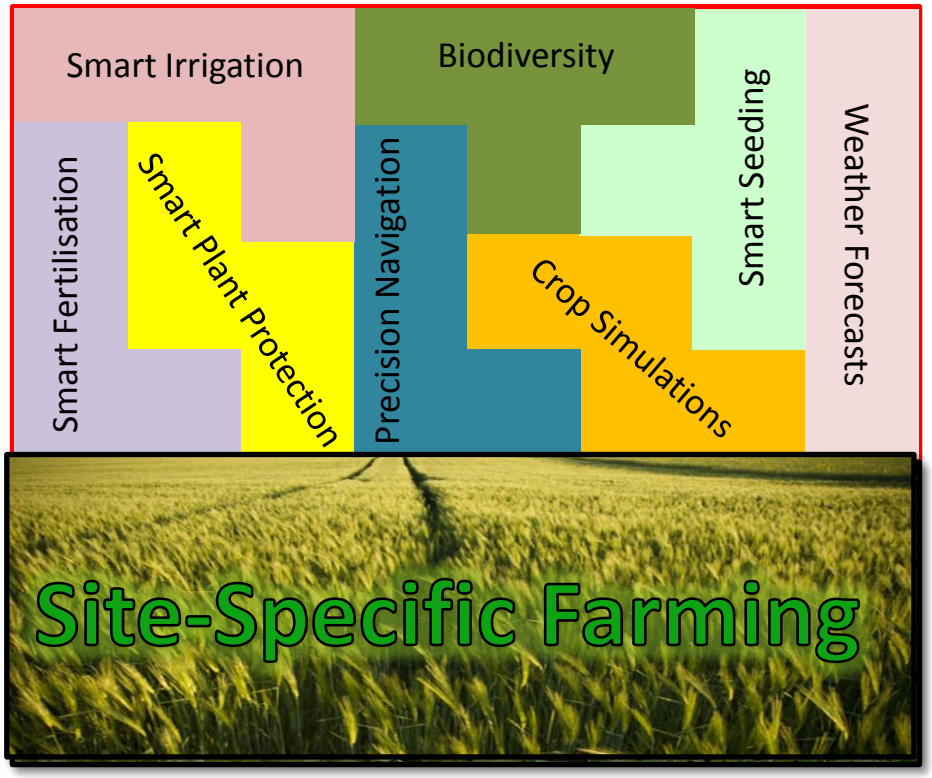
Challenge „feeding9billion“

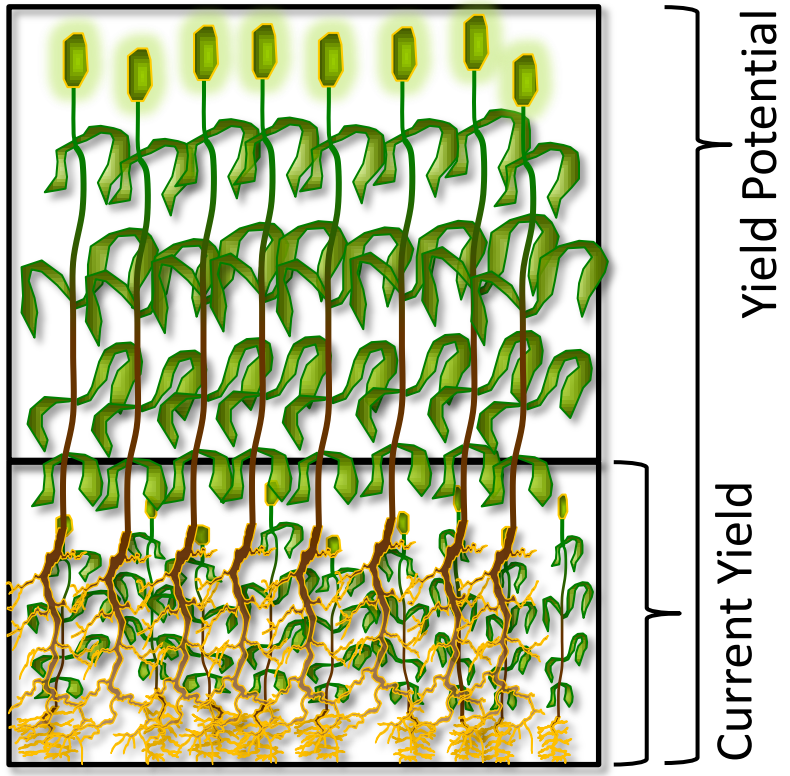
- Food supply needs to be doubled until 2050
- Further expansion of agriculture would eat up natural ecosystems
- Climate change will intensify imbalance in food supply
- Food Security critically depends on water availability
- Agricultural production must be intensified in a sustainable way

Smart Farming to close the Yield Gap

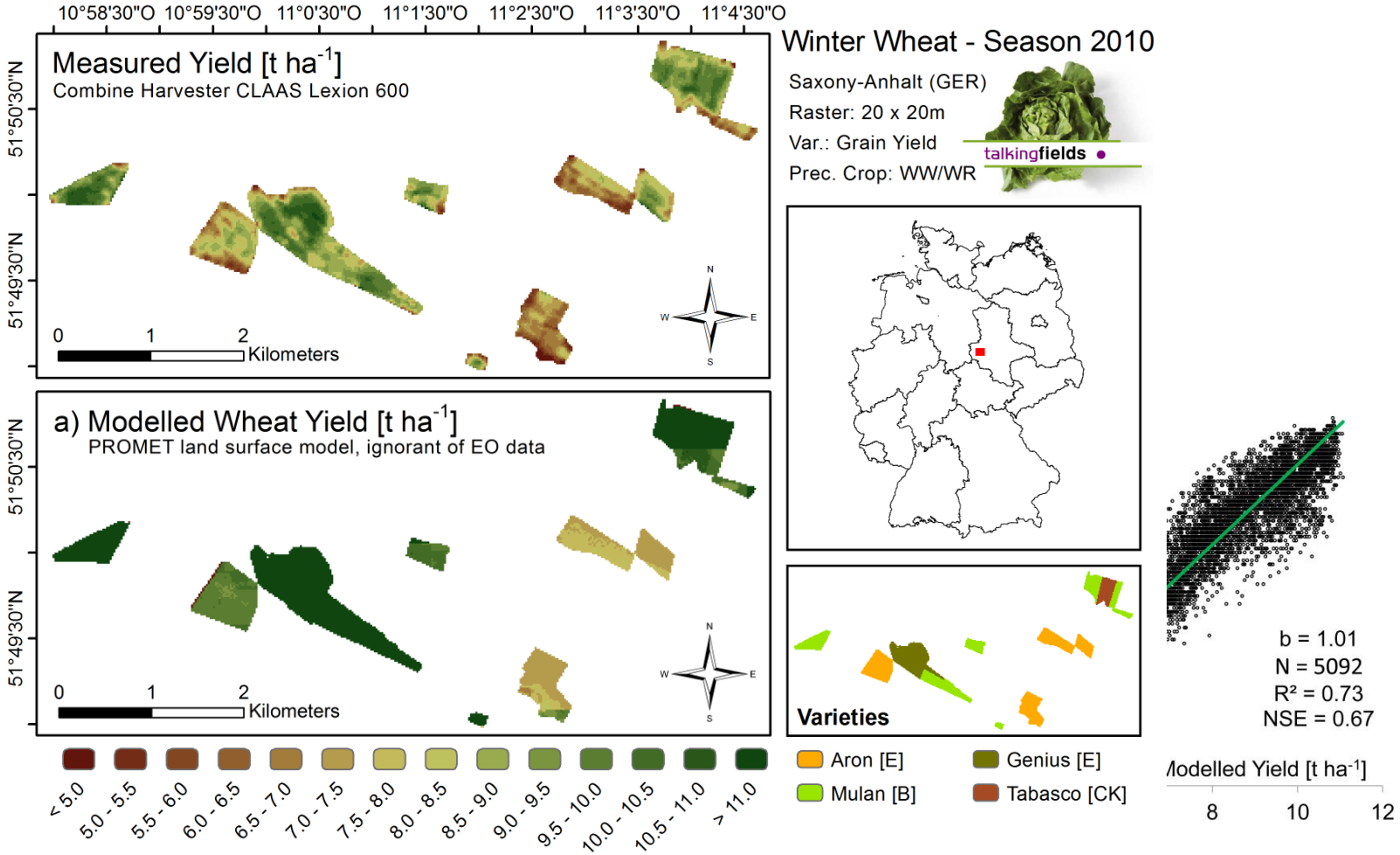


With central contributions of satellite technology and EO





Smart Farming: Contribution from EO



Information Needs

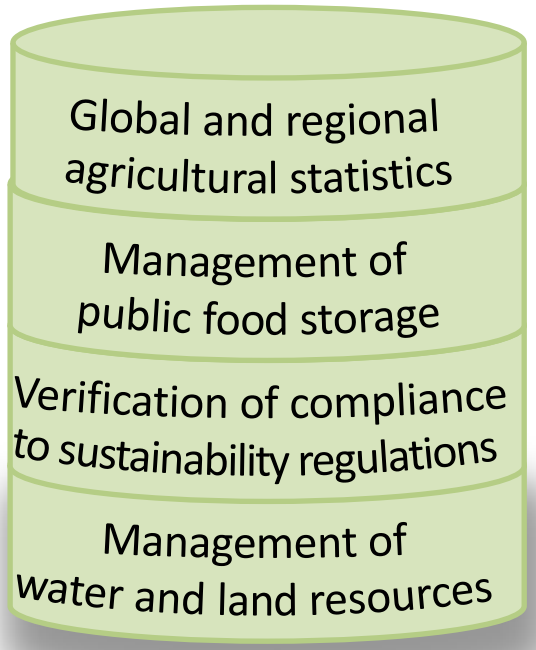
Earth Observation of agricultural sites should go beyond monitoring and provide answers:

- Which crop should be cultivated in which location to achieve optimal sustainable yields?
- What kinds of seeds are required where and when?
- How much fertilizer/growth-regulator/plant-protection is needed and how much should sustainably be applied where?
- Where should agriculture be intensified (to tap unused potentials)?
- Where should agriculture be extensified (to become sustainable)?

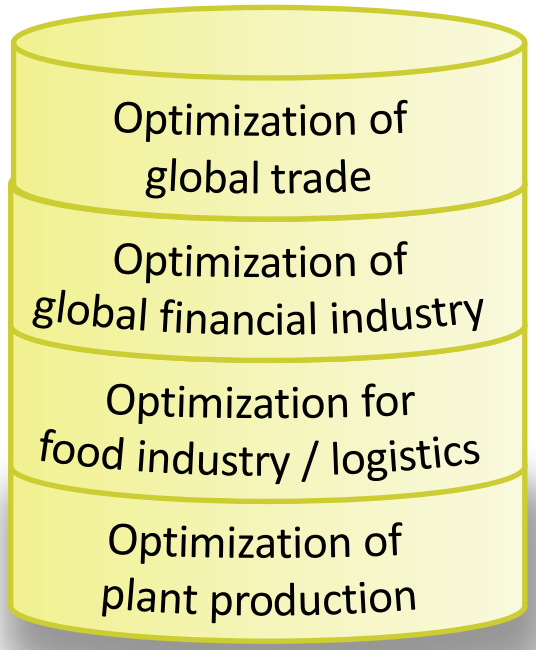
These questions need to be addressed considering climate change.

Two Pillars of the Global Food System
EO based Activity Areas

Governance Systems /
Regulations for Sustainability

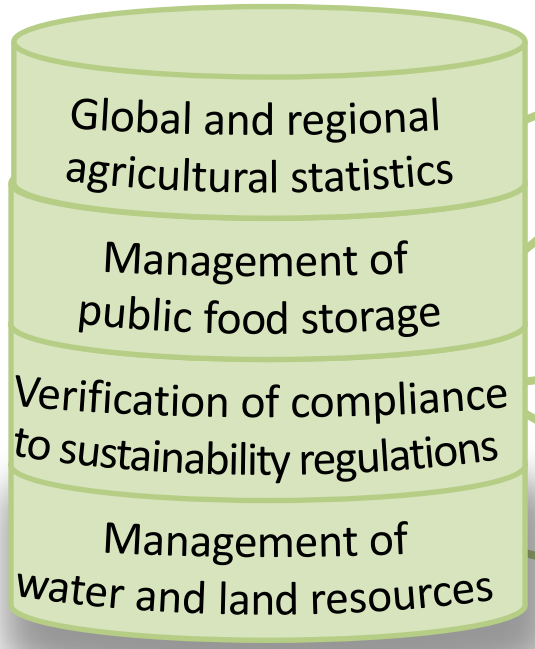


Supply Chain /
Agro- and food industry



Derived Geospatial Information Services

Governance Systems Activity areas



Required Geospatial Information

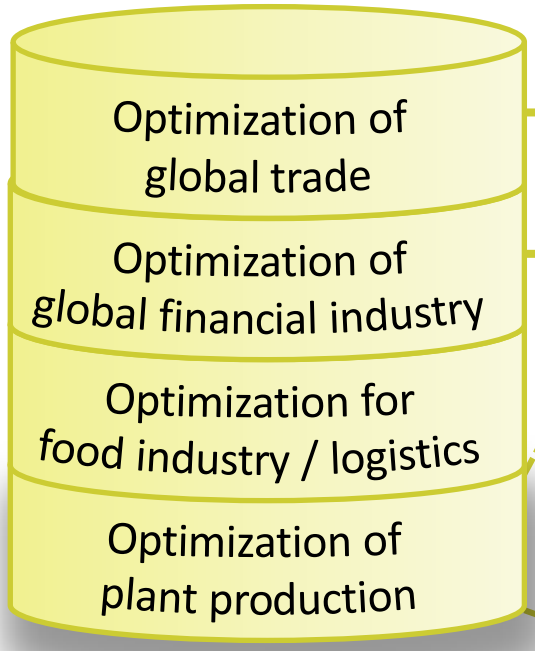
- Yield information including forecast
- Occurrence of diseases and hazards, Monitoring of natural disasters (flooding, drought)
- Nutrients demand and availability (Nitrogen status, P, ..)
- Land use / land cover
- Farm Management (crop rotation,..)
- Water demand and availability
- Crop management (soil conservation, irrigation monitoring)

Derived Geospatial Information Services

Supply Chain / Agro- and food industry

Required Geospatial Information

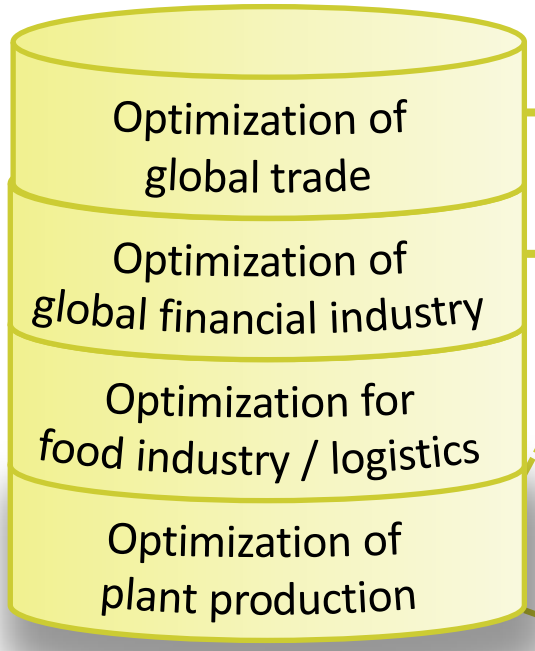
- Yield information including forecast
- Occurrence of diseases and hazards, Monitoring of natural disasters (flooding, drought)



- Yield increase
- More efficient use of water
- More efficient use of fertilizer
- More efficient plant protection
- More efficient use of farming machinery
- Support of on-farm research
- Improved financial services
- Risk reduction services

Derived Geospatial Information Services

Supply Chain / Agro- and food industry



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Required Geospatial Information

- Yield information including forecast
- Occurrence of diseases and hazards, Monitoring of natural disasters (flooding, drought)
- Soil physical and chemical properties
- Plant development maps (biomass, phenology,..)
- Meteorological fields and forecasts
- Dynamic soil conditions (soil moisture,..)
- Nutrients demand and availability (N, ..)
- Water demand and availability
- Farm Infrastructure

Required Geospatial Variables

Information Category	Earth Observation Information Product	number of category x, X or XX	no. of category X	no. of category ?	relative uncertainty of knowledge
Land use / land cover	plant functional type	6	1	6	100%
	crop type	6	2	5	83%
	crop variety	6	1	10	167%
Farm management	crop rotation	4	2	4	100%
	cropping intensity (harvests p.a.)	5	2	5	100%
	irrigated/rainfed area	6	2	5	83%
Farm infrastructure	irrigation ponds, reservoirs, dams	5	1	2	40%
	inland waterways, canal	2	1	2	100%
	melioration and drainage	7	2	10	143%
	access roads	3	1	3	100%
	silos	6	3	7	117%
Crop management	irrigation	4	4	4	100%
	soil conservation (tillage- plowing direction)	4	2	5	125%
	intercropping	2	1	2	100%
	field management: plowing-, tillage-, sowing-, harvest-dates	5	1	5	100%
Soil physical and chemical properties	soil texture	5	2	6	120%
	soil carbon content	3	1	3	100%
	soil fertility	2	1	1	50%
	soil degradation	3	1	4	133%
Dynamic soil conditions, water and nutrient availabilitiy	soil moisture at different depths	3	1	4	133%
	soil suction at different depths	1	1	2	200%
	snowcover	2	2	0	0%
	soil trafficability	2	1	3	150%
	snow water equivalent	1	1	2	200%
	soil nutrient content	1	1	2	200%
	harvest residues	1	1	1	100%
Nutrients demand	chlorophyll content	3	2	1	33%
	plant nitrogen content	3	2	4	133%
	plant protein content	2	2	4	200%
	plant phosphorus content	2	2	4	200%
Water demand	plant water content	3	1	3	100%
	canopy temperature	1	1	0	0%
Plant development	biomass (leaf, stem, fruit)	8	3	10	125%
	fractional ground cover	6	2	5	83%
	crop height	7	1	7	100%
	plant area index (PAI)	6	1	8	133%
	green LAI	7	2	8	114%
	fAPAR	2	2	0	0%
	albedo	4	2	2	50%
	phenology	6	1	10	167%
Yield information including maturity status	yield	5	2	5	100%
	fruit moisture content	3	2	5	167%
	on-field storage	3	0	4	133%
Diseases and local yield damages (hail, insects, etc.)	crop diseases	6	2	9	150%
	crop damage	9	3	11	122%
	downcrop	8	2	10	125%
	weed	6	2	8	133%
	infestation	5	2	7	140%
	flood extent, duration	4	2	0	0%
			2	3	75%
			1	0	0%
			1	5	125%
			3	0	0%
			1	2	67%
			1	0	0%
			1	0	0%
			1	0	0%
			1	0	0%

Meteorological fields and forecasts	precipitation (rain, snow, hail)
	temperature
	humidity
	wind

Overlap with ECVs only marginal

monthly - seasonally

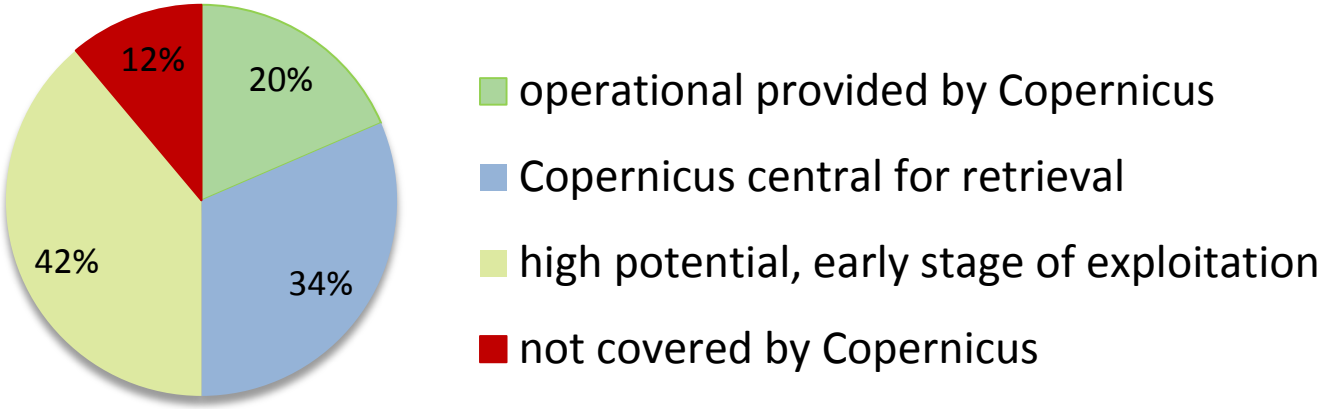
every 3 - 7 days

hourly - daily

Summary of Earth Observation Needs

Information needs of agricultural management and governance are challenging both in terms of quantity and content:

- Very high spatial (10 - 30 m) resolution, but globally available
- high temporal (3 - 7 days) resolution and near-real-time access
- a set of more than 50 geospatial parameters were identified, which are of crucial importance.
- The **Copernicus System** and its international colleagues are **a good start**



Conclusions

- The global food system will have to **double** its output during the next 40 years.
- Agricultural expansion no major option to achieve this.
- Instead major **improvements in efficiency** in natural resource use (water, energy, fertilizer, soil) will have to secure food supply sustainably.
- Information and knowledge, the central commodities of the 21st century, will play the key role
- In the future, as today, a majority of agricultural activities will take place on fields and under the **open sky =>** observable from space.
- EO is **globally** available, not affected by national or regional regulations yet adaptable to regional and even local specificities.
- EO data streams, transformed into information, turn **knowledge** condensed in local, regional and global farm management models **into value**.

Key Question and Challenge

- How to bridge the gap between GCOS observations in coarse scale to field scale that is relevant for agricultural management?

- The challenge is to develop and improve scientific understanding, technological capabilities and integration capacities to exploit the full EO and modelling potentials to support food security and sustainable agriculture

“Don't worry about the harvest, but about the right cultivation of your fields.” (Confucius 551 - 479 v. Chr.)

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