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GEOSPATIAL media + communications

G-tech for agriculture

Introduction GEOAGRI -session

Mark Noort

Latin America Geospatial Forum, Mexico City, 2014

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Scope

In relation to crop farming and livestock farming, the term "agriculture" may be defined as:
the art and science of growing plants and other crops and the raising of animals for food, other human needs, or economic gain

Focus on:

- **Growing** plants and other crops (including pasture),
- **Transportation** of agricultural produce to the market,
- Derived products and services related to agriculture with a distinctive geospatial component, such as (re-)**insurance**, monitoring of compliance with agricultural **policies** and regulations and other forms of (risk) **management**.

GEOAGRI *Dimensions to characterize farmers' operations*

1. **Type of agriculture**: *crops, livestock, fishery/aquaculture, forestry.*
2. **Purpose / goal of agricultural activity**, *such as subsistence farming, market- oriented farming or a mixture of subsistence and market-oriented farming.*
3. **Property structure and means for engagement in agricultural activities**: *human, financial and social/cultural capital employed, such as ownership of and access land and means, tenancy arrangements, credit facilities, government policy and subsidies (e.g. sharecropping, cooperative farming, communal lands, etc.).*
4. **Technology level**: *low, medium, high (e.g. precision agriculture is part of high level technology).*

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Issues & trends in Agriculture

- **Food security** and **increased production** and **productivity**;
- Adaptation to and mitigation of the effects of **climate change**;
- **Empowering local communities,** bridging the rural digital divide;
- **Food prices** and **markets**;
- **Risk management** (including insurance).

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Drivers

- The increasing world population,
- Environmental factors (including climate change),
- The availability of water resources,
- Increasing urbanization and growing middle class population -> increased consumption and changing consumption patterns
- Land management (land as a scarce resource).

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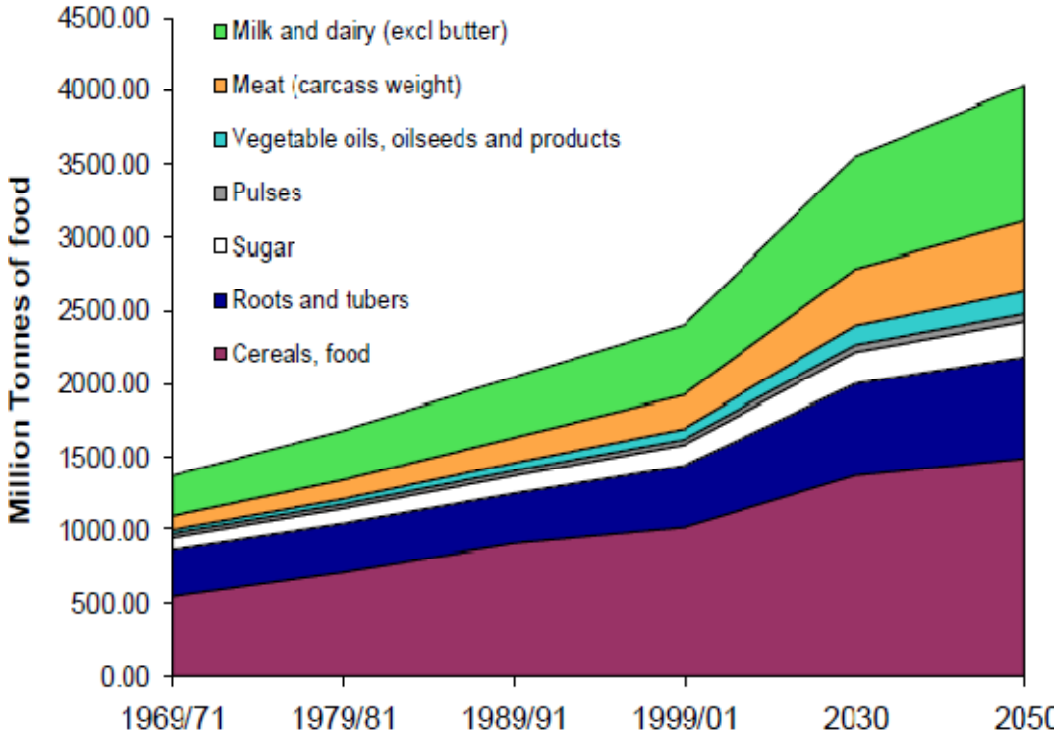
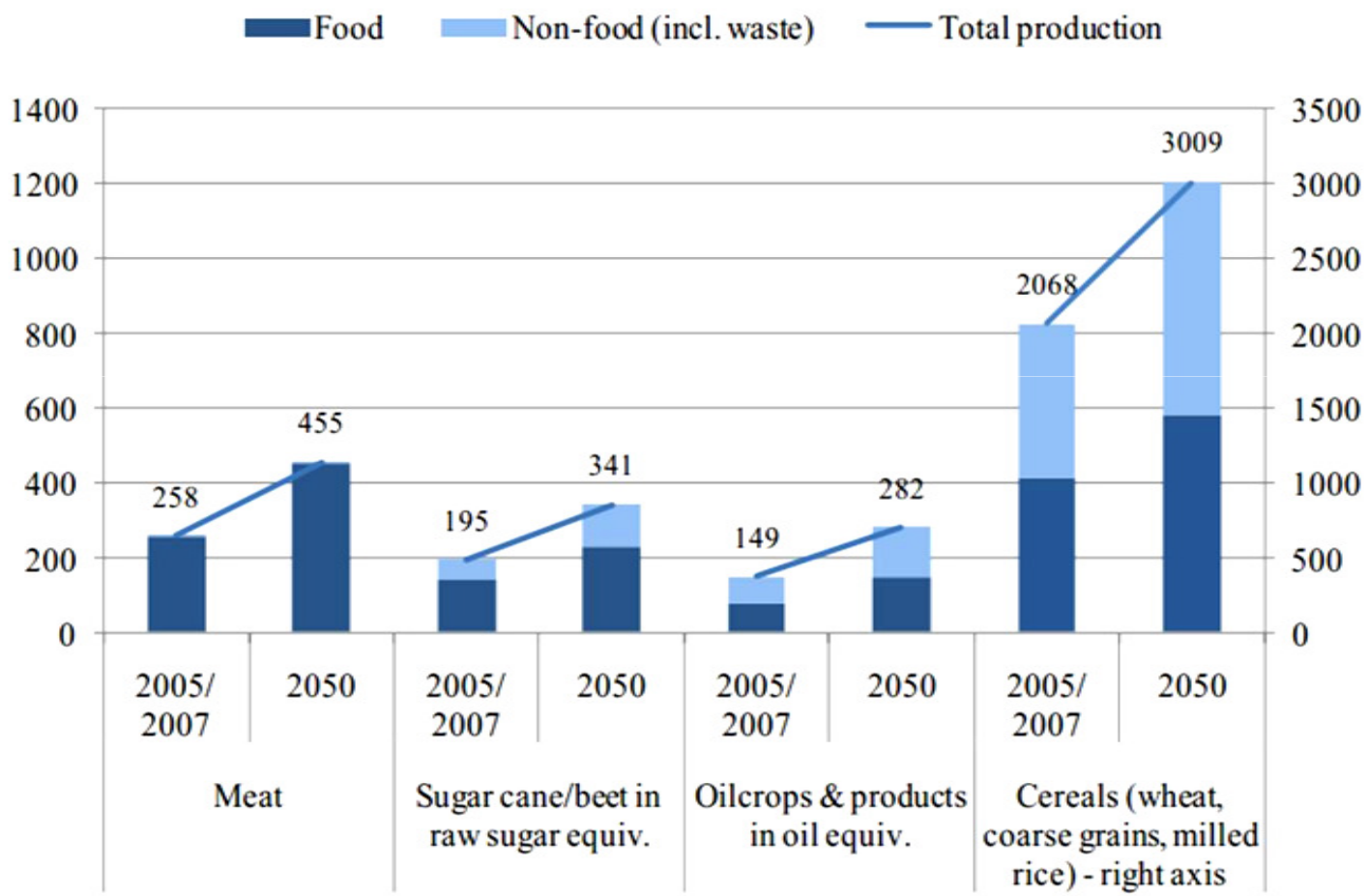
- Population growth ↑
- Protein consumption ↑
- Global warming ↑
- Energy crops ↑
- Food prices ↑
- Land & soil quality ↓
- Available land & water ↓
- % Rural population ↓



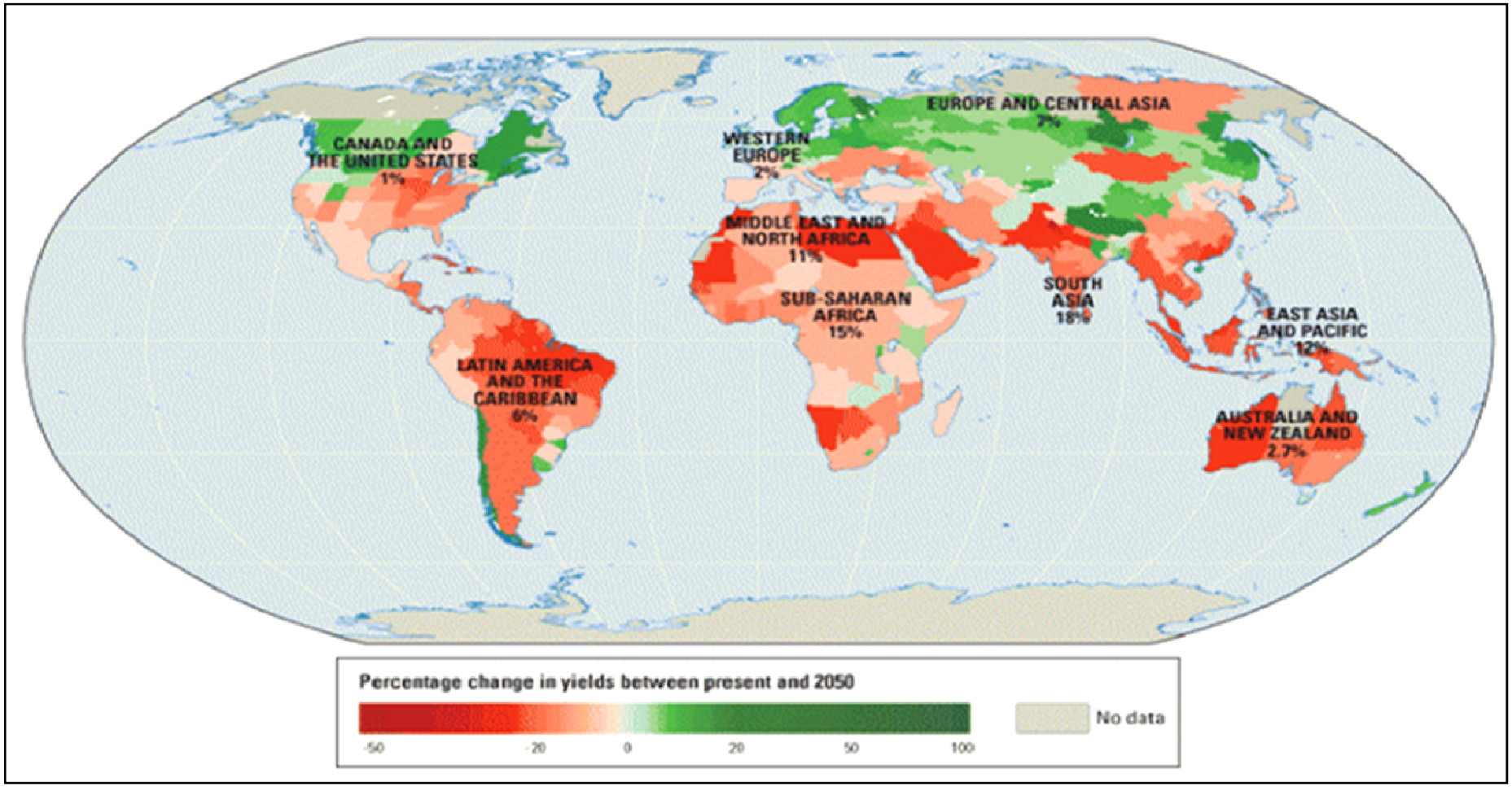
World food production must rise by 50% in 2030 to meet increasing demand Source: FAO/UN, 2008

World agricultural production and use, major products (in tonne)



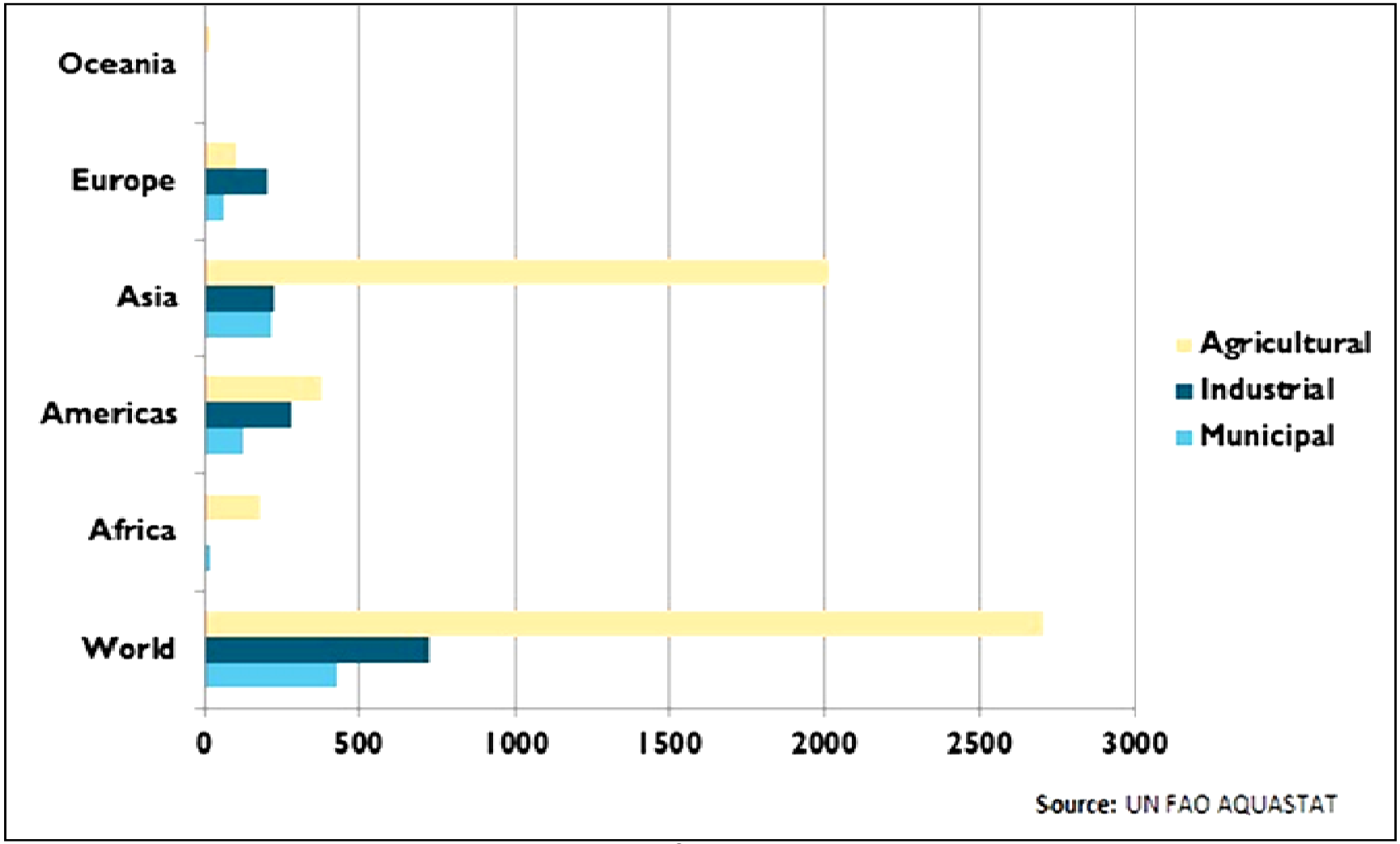
Source: World agriculture towards 2030 / 2050 (FAO)

Climate change: percentage change in yield between now and 2050



Source: Penn State University - for 11 major crops

Natural resources: total water withdrawal by sector



Source: Worldwatch - in km^3 per year (2013)

Core geospatial technologies used in agriculture

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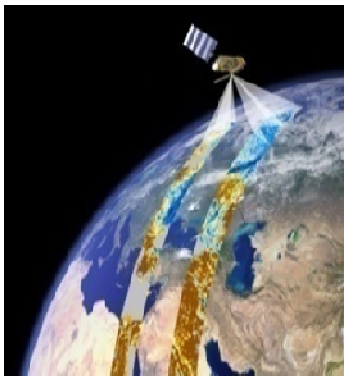
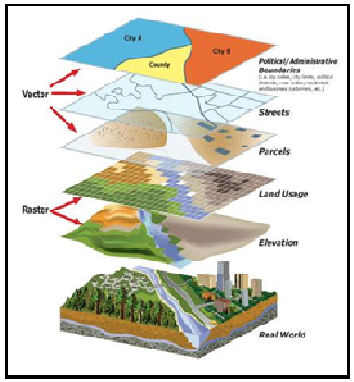
Remote Sensing

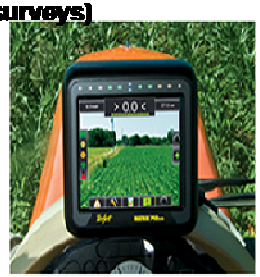


GIS



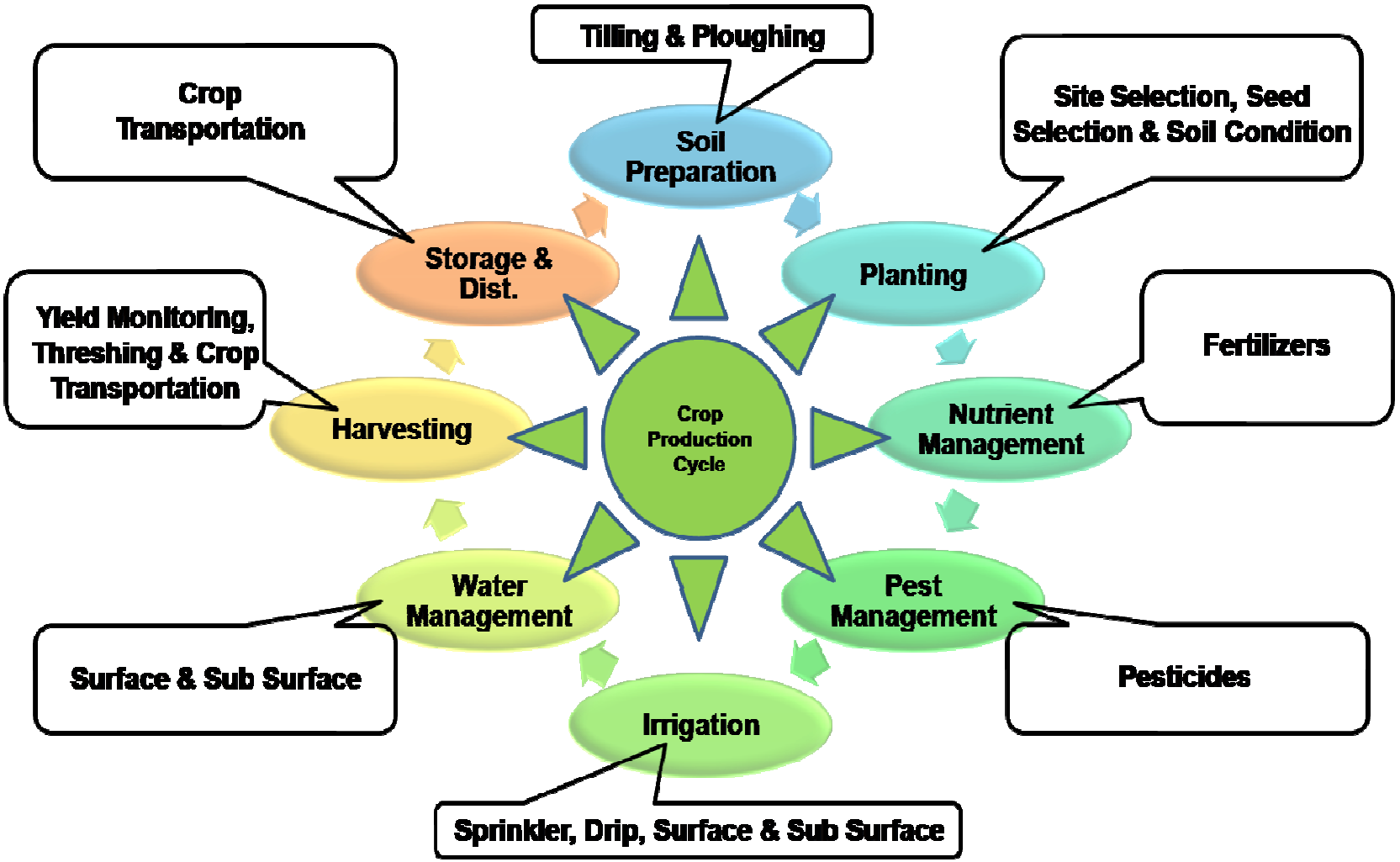
GPS

(used in field surveys)



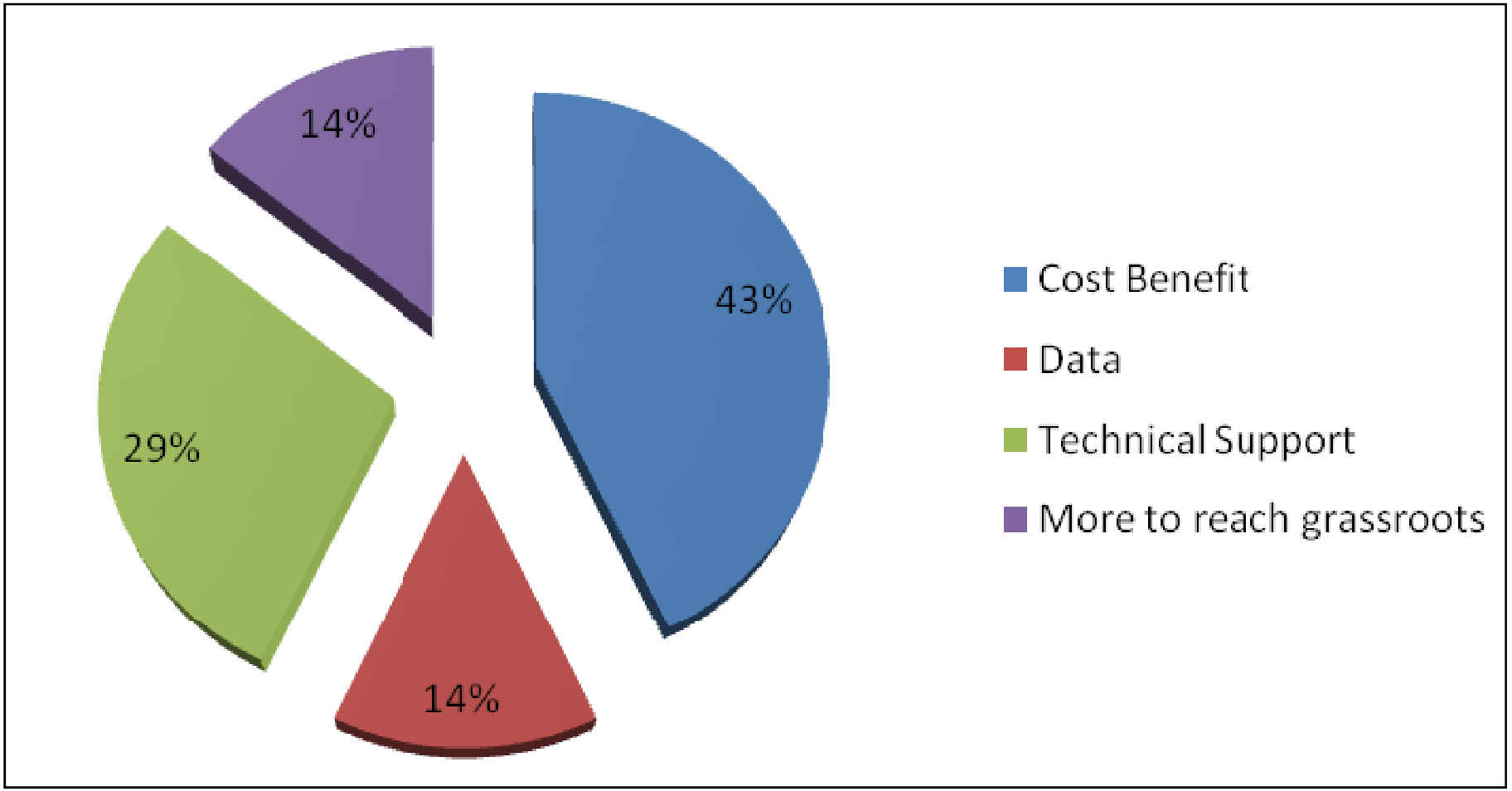
Source: Geospatial Media

Crop production cycle



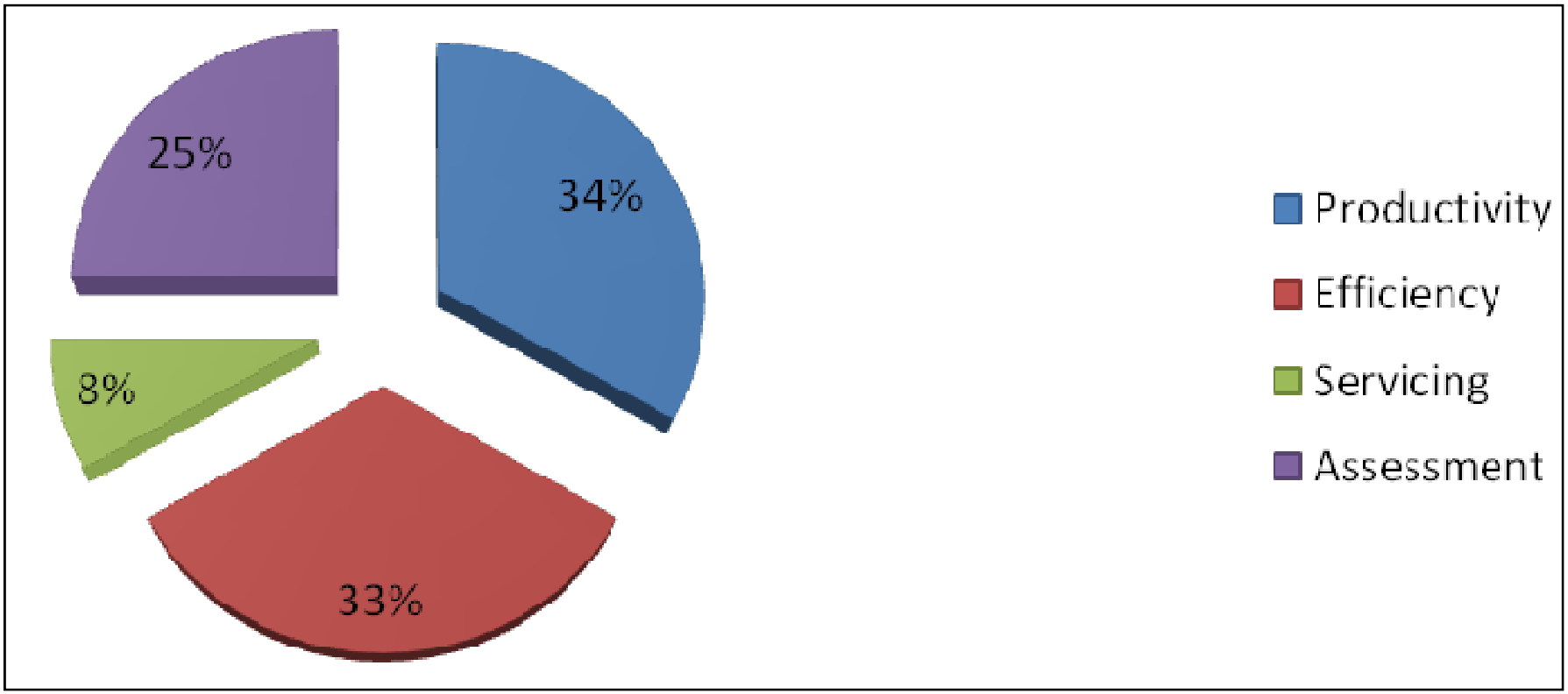
Source: Geospatial Media

Major challenges in using geospatial technologies



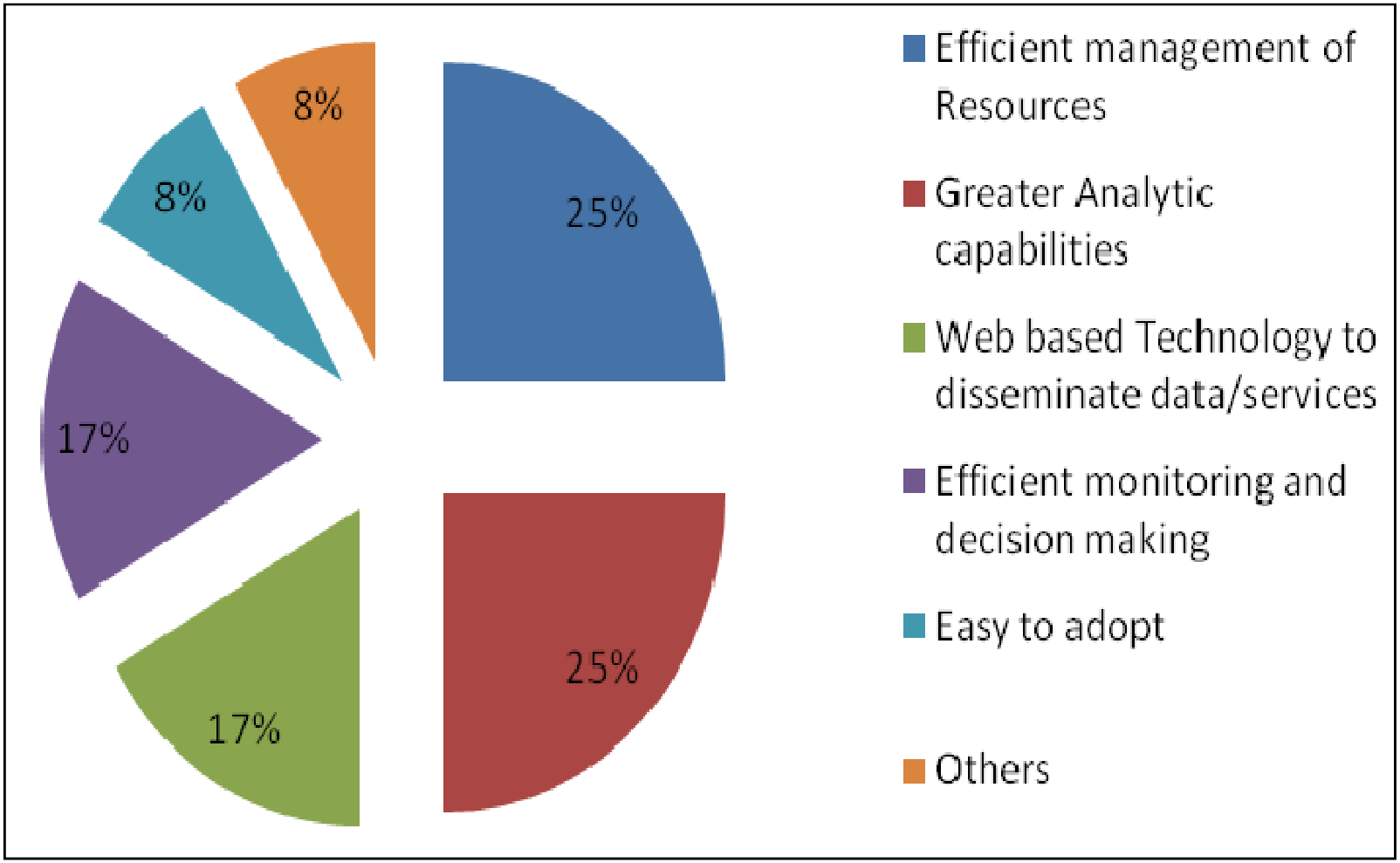
Source: Geospatial media – Asia-Pacific

Contribution of geospatial technologies in agriculture



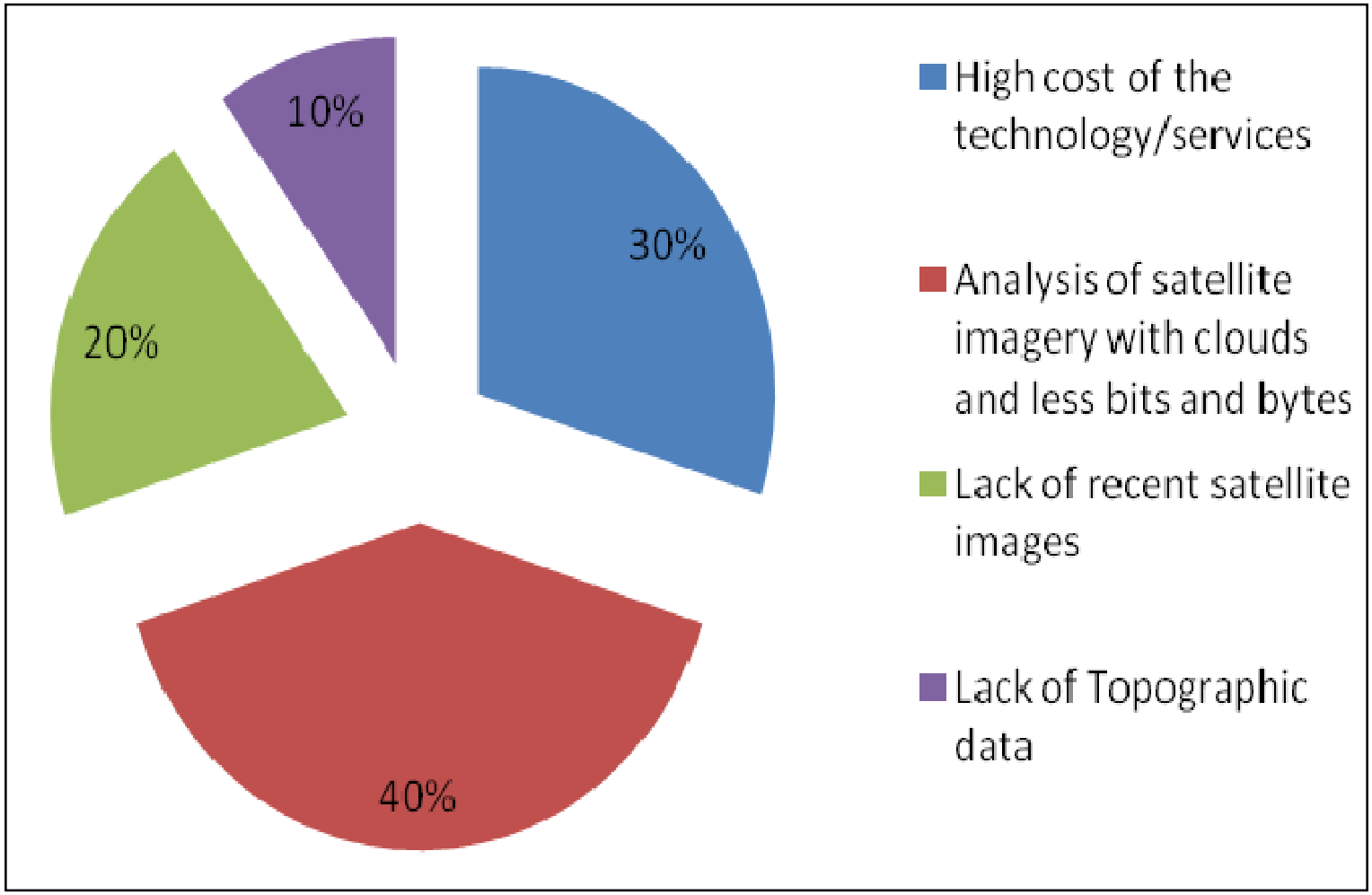
Source: Geospatial Media – South Asia

Factors contributing to increase in use of geospatial technologies



Source: Geospatial Media - Europe

Technological challenges in agriculture sector



Source: Geospatial Media - Europe

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Geospatial technology for agriculture

Three levels of interaction within a country:

- **Country level**
  focusing on policy, research and innovation;
- **Agro-ecological zone or watershed level**
  focusing on extension services and management of regional resources;
- **Farm level**
  focusing on advice and income optimization.

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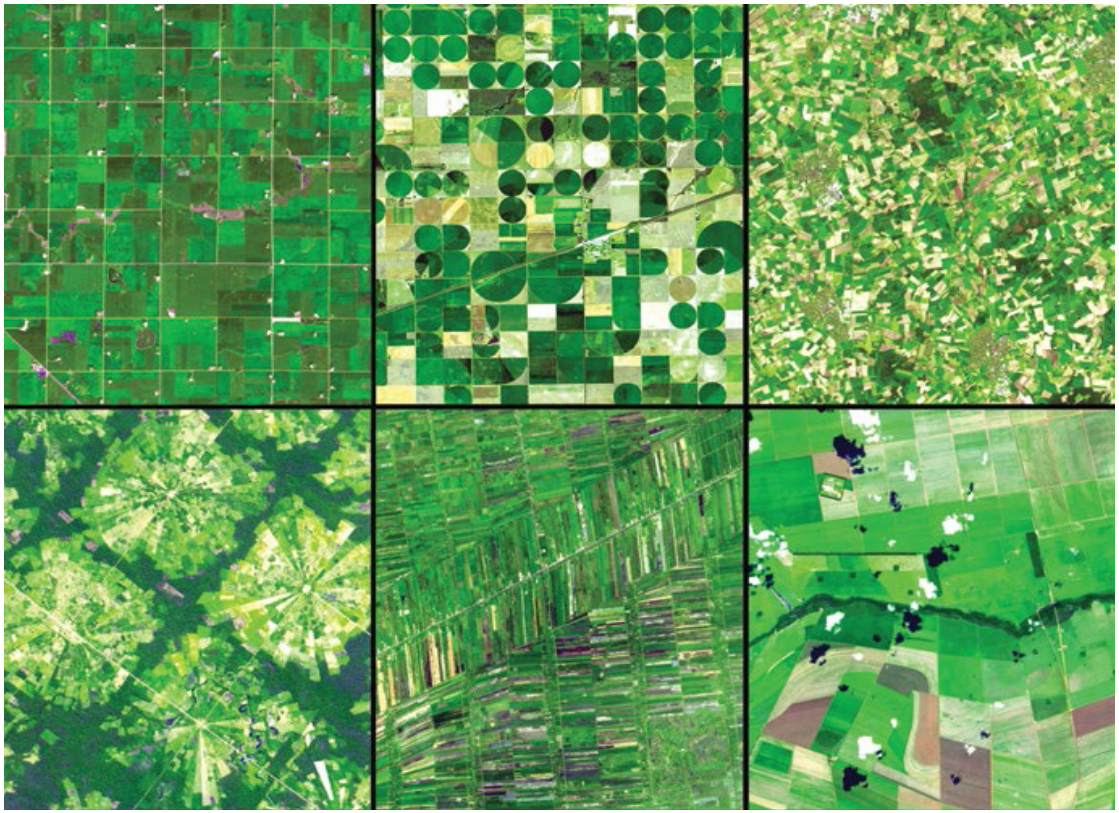
Geospatial technology for agriculture



Remote sensing images showing agriculture patterns (Geospatial World)

Geospatial technology at country level

- **Agricultural knowledge and** *parcel identification and measurement, geo-statistics and crop identification, field survey, subsidy and policy monitoring and control,*
- **National crop and yield monitoring**,
- **Transport infrastructure and transport to market** *(food chain management),*
- **Land rights**,
- **Market information**.

Example agricultural information systems



Agricultural parcel (blue) one single crop group from a single farmer;
farmers' block/plot (red) one single or several crop groups from a single farmer;
and physical block (yellow) one single or several crop groups from one or several farmers.
(GeoCAP, JRC)

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Agricultural information systems

- Parcel identification and measurement, geo-statistics and crop identification, field survey, subsidy and policy monitoring and control. Combines data and information on land use, land administration, crop monitoring and agro-ecological zones for better decision making;
- Geospatial technology improves accuracy, enables more frequent and better monitoring, coverage of large (not easily accessible) areas and facilitates integration of information;
- Cost estimate:
  total cultivated area 100 – 120 k€ / country, mapping of different crops and parcels 1.5 -2.5 € / km^2;
- Main challenges: cost, capacity, data access;

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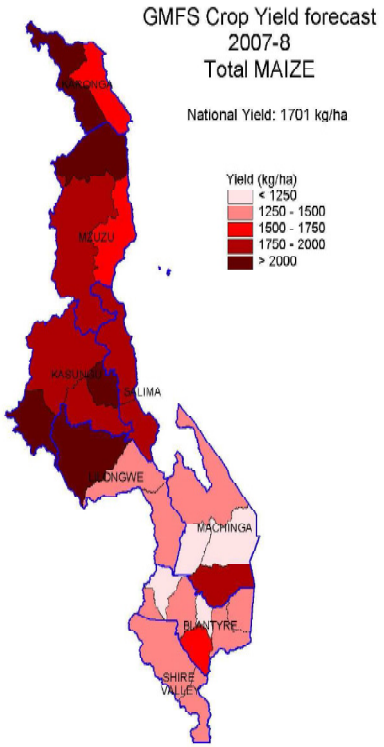
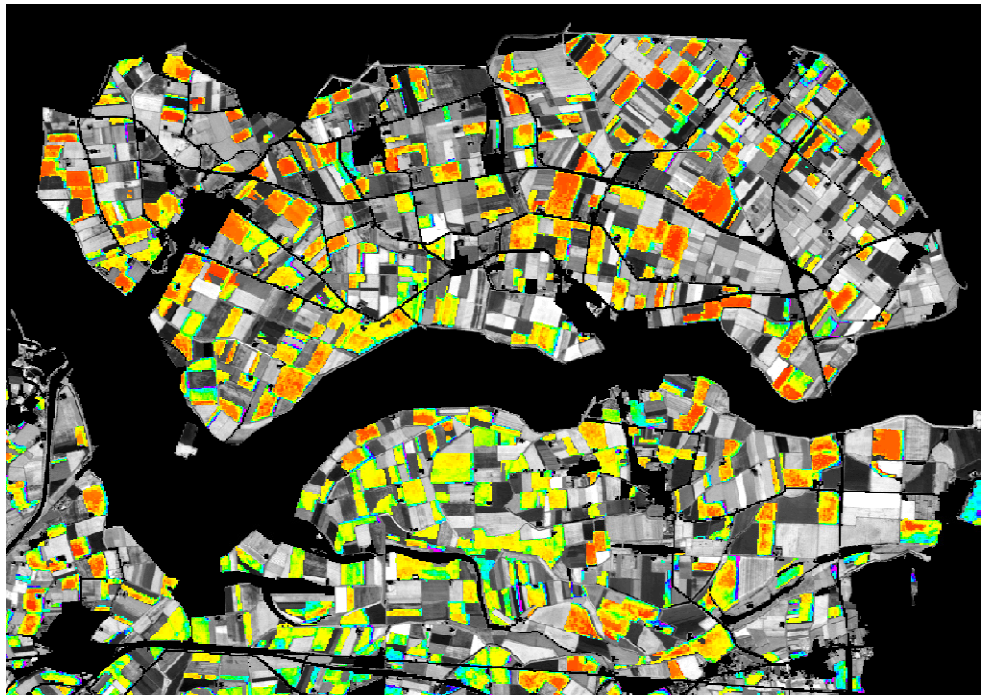
Example crop and yield monitoring



Maize crop yield forecast 2007
Source: Service operations report Malawi 2007 – 2008 (GMFS, 2008)



Field scale wheat yield in the Netherlands (blue: 9 ton/ha, green: 8 ton/ha; yellow: 6 ton/ha, red 4 ton/ha)
Source: eLeaf

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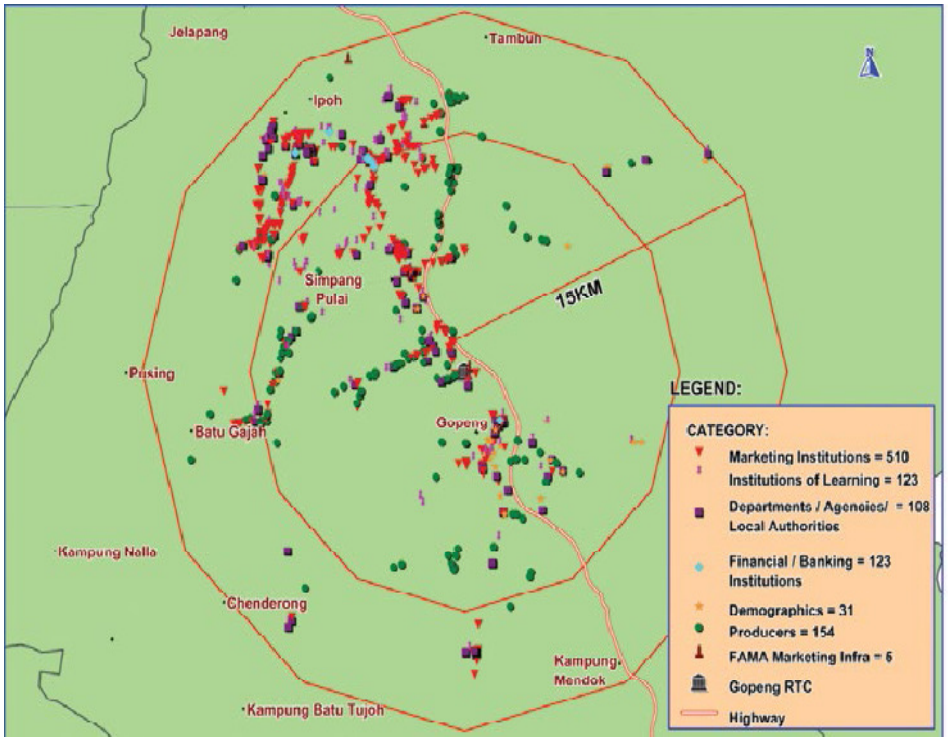
Crop and yield monitoring

- Distinguishes between agricultural land and non-agriculture land, different crop types, assesses crop growth in comparison with historical data, predicts yields (including early warning for possible food shortages);
- Earth observation improves accuracy, enables more frequent and better monitoring, coverage of large (not easily accessible) areas and facilitates integration of information;
- Cost estimate: total cultivated area 100 – 120 k€ / country, mapping of different crops and parcels 1.5 -2.5 € / km^2, early warning crop health 200 – 300 k€ / continent (with 10-day updates), yield prediction 70 – 100 k€ / 2 – 3 crops / 100,000 km^2;
- Main challenges: cost, capacity, data access;

Example market access

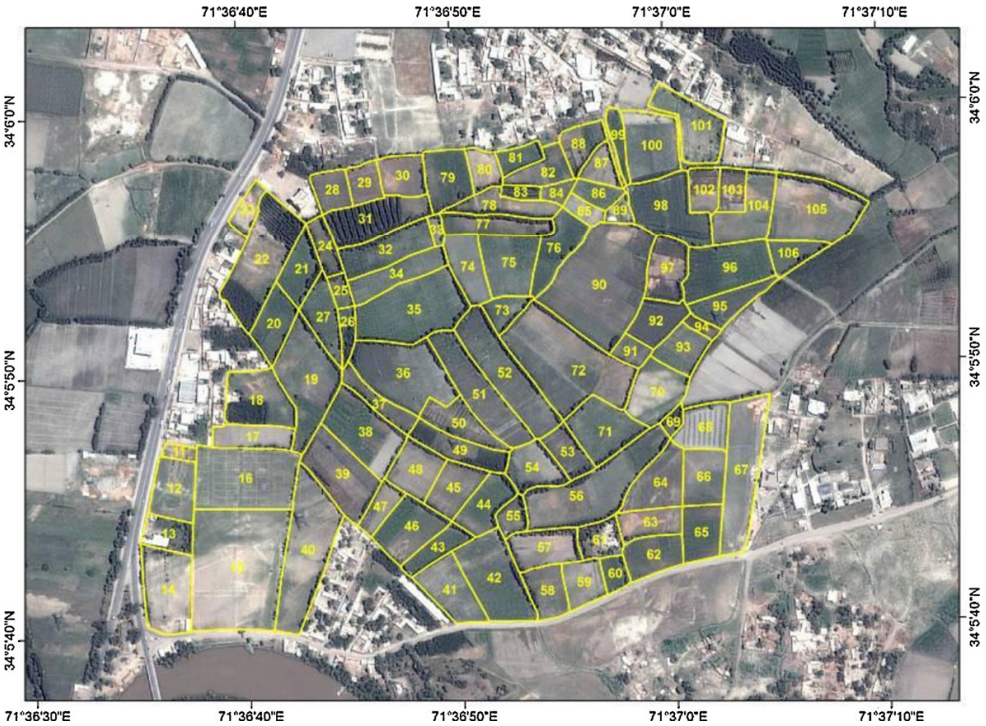


Map of plot locations in relation to markets and extension services (profiling study, Malaysia)

Market access

- Analyses the opportunities and constraints for optimum market access of agricultural produce, supports decision making for planning and improvement of infrastructure, storage and market facilities;
- Geospatial technology provides the base layer for spatial information analysis (including crowd-sourcing) and monitoring of agricultural activities (crop growth and land use change);
- Cost estimate: see agricultural information systems and crop monitoring
- Main challenges: infrastructure, institutions.

Example land rights



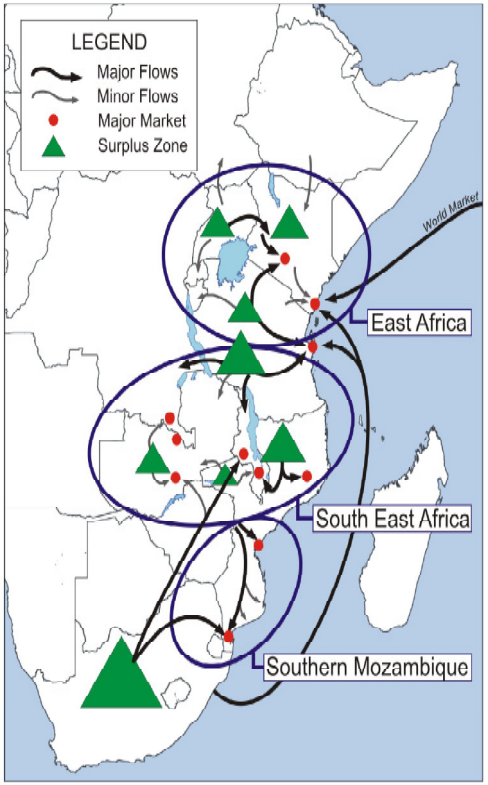
Digitised parcel boundaries on QuickBird HRSI in Zormandi area

(Source: First experiences using high-resolution imagery-based adjudication approach in Ethiopia (WB))

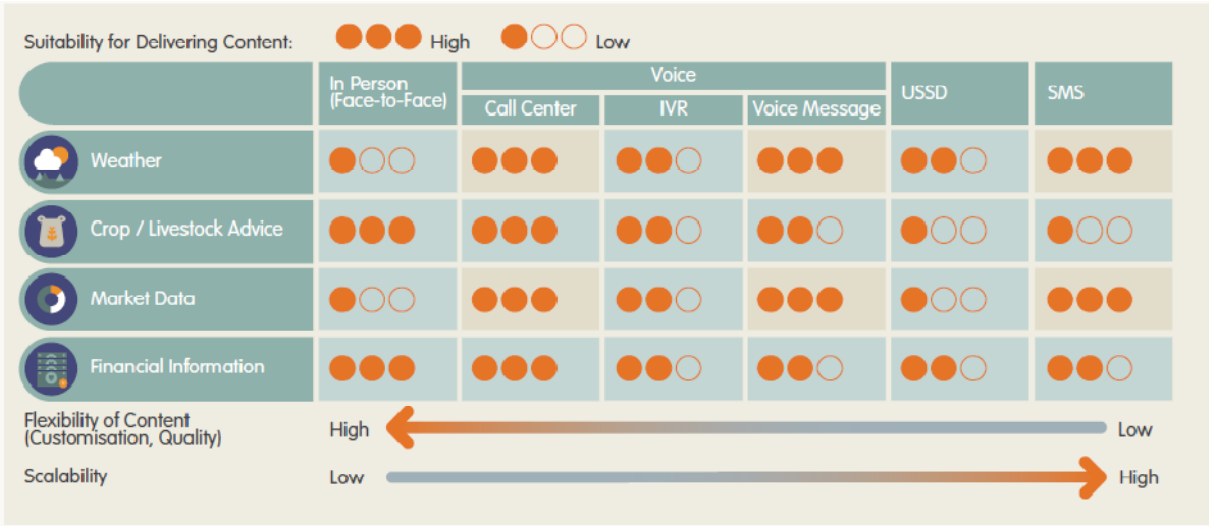
Land rights

- Determines land ownership and land rights to provide a secure basis for farming operations and access to credit;
- Geospatial technoogy provides the base layer for community participation in determining land ownership and (communal) rights and mapping the results. The information is easier to interpret and more up-to-date than conventional maps.
- Cost estimate: see toolkit on urban management, land administration and spatial data infrastructures.
- Main challenges: transparency, institutions.

Example market information



Maize Market Sheds in Eastern and Southern Africa
Source: Unscrambling Africa: Regional Requirements for Achieving Food Security (MSU, 2010)



Suitability for delivering content
Source: AgriVAS market entry toolkit

Market information

- Timely and accurate information on commodity prices and markets helps the farmer to improve decision-making with respect to selling and crop selection;
- Geospatial technology provides the base layer for spatial analysis of market information.
- Cost estimate: on case-by-case basis.
- Main challenges: communication, business model.

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Geospatial technology at agro-ecological zone / watershed level

- Site evaluation
  (sustainable land use, suitability analysis),
- Regional crop and yield monitoring,
- Water management,
- Weather prediction.

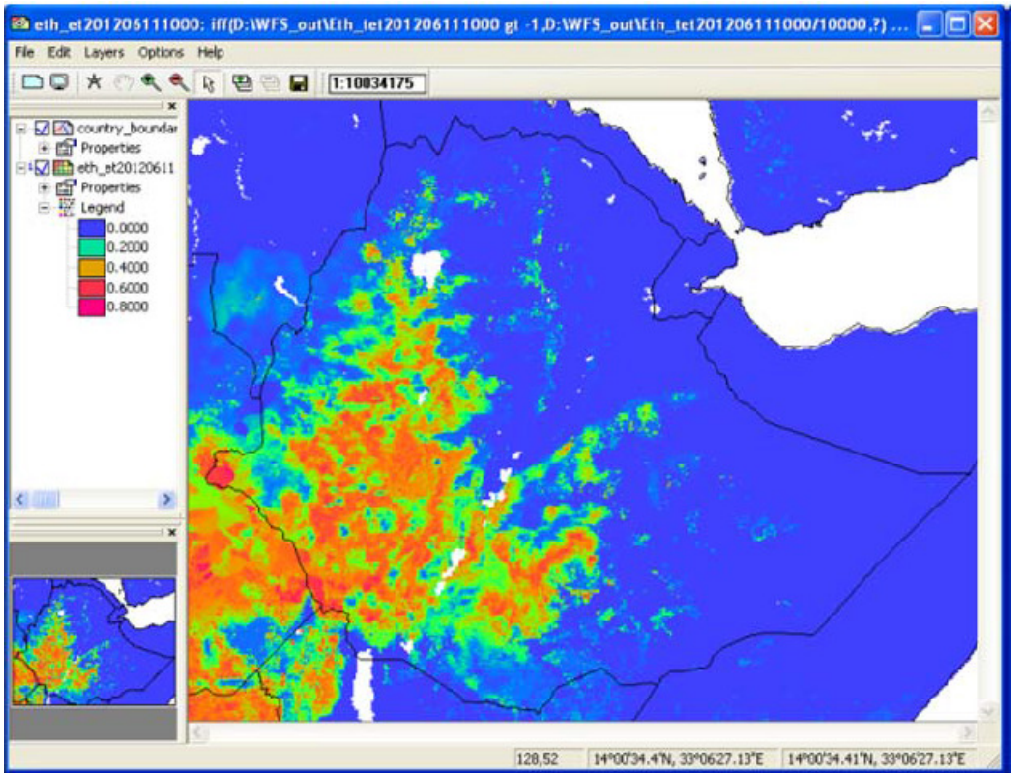
Example site evaluation

Examples of reference parcels super-imposed on aerial orthoimagery (colours correspond to different land cover types) (GeoCAP, JRC)

Site evaluation

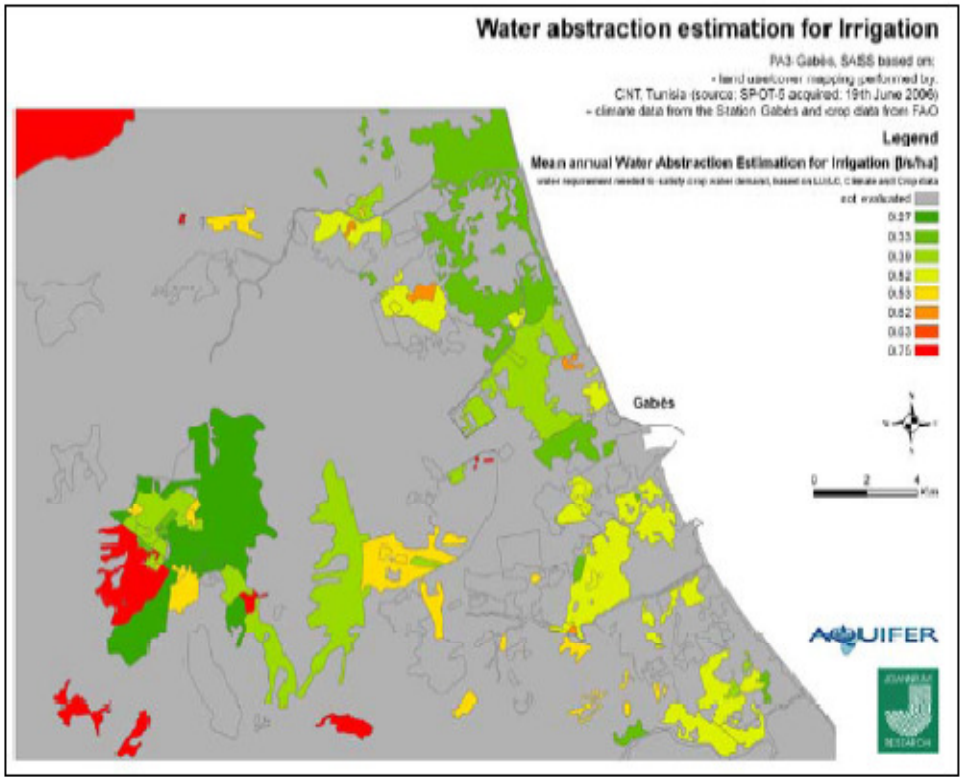
- Analysis and modelling of agro-climatic data, biomass and yield data, soil suitability to achieve optimum and sustainable use of agro-ecological zones;
- Geospatial technology provides the input for modelling and analysis: land cover, land use change, crop identification and monitoring, water resources, soil mapping and climate modelling with more accuracy, wider coverage and higher frequency than conventional methods.
- Cost estimate: on case-by-case basis (costs of crop monitoring + modelling).
- Main challenges: cost, capacity, data access.

Example water management (1)



Example evapotranspiration Ethiopia
Source: GEONETCast presentation (ITC, 2012)

Example water management (2)



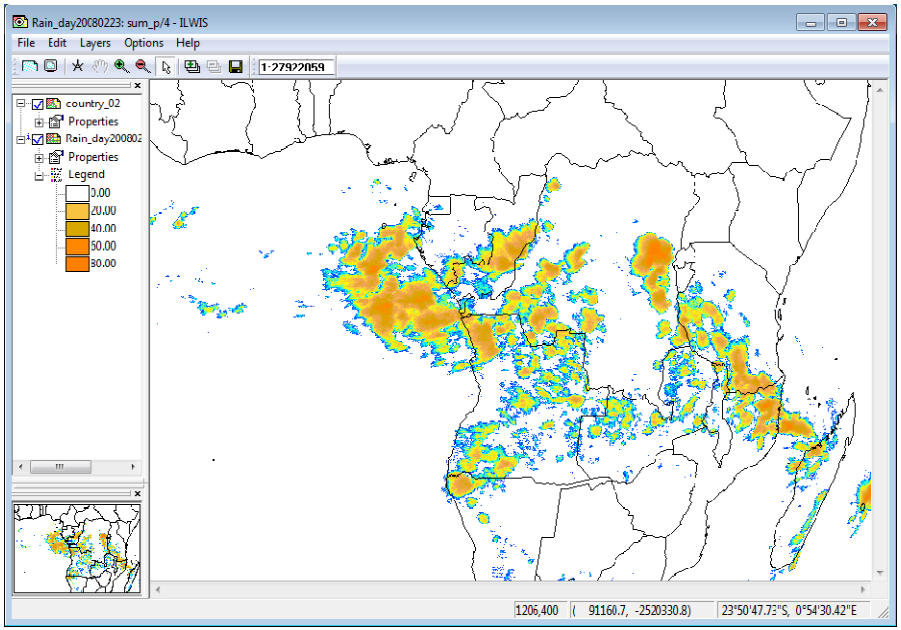
Mean annual water abstraction estimation for irrigation as amount of water needed to satisfy crop demand, Gabes area, Tunisia, 2006.

Source: Application of satellite remote sensing to support water resources management in Africa (TIGER, 2010)

Water management

- Mapping of water resources, analysis and modelling of water quality, water resources and water use to achieve sustainable water management
- Geospatial technology provides higher accuracy, wider coverage and more frequent monitoring of water use for agriculture (evapotranspiration), water quality and availability of water resource. Geospatial technology serves as base layer for hydrological modelling (digital elevation models and determination of surface roughness).
- Cost estimate: on case-by-case basis, mapping of water resources 0.75 € / km^2.
- Main challenges: capacity, account for real cost of water.

Example weather prediction



Precipitation calculated over Central Africa for 23-02-2008
Source: GEONETCast - DevCoCast application manual (ITC, 2012)

Satellite dish installed at National University of Rwanda
Source: GEONETCast presentation (ITC, 2012)

Weather prediction

- Weather prediction assists planning of farming operations, such as sowing, irrigation and harvesting. Weather prediction is also crucial in early warning for extreme events and climate modelling for adaptation to and mitigation of the effects of climate change.
- Thanks to earth observation and progress in modelling (numerical weather prediction) weather forecasts have improved considerably and can provide quick, accurate and up-to-date information to the farmer.
- Cost estimate: most information derived from satellite images is available free-of-charge, processing and delivery is not.
- Main challenges: timely and accurate information provision to farmers.

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Geospatial technology at farm level:

- **Farm site evaluation**,
- **Precision agriculture**: machine guidance, precise planting and harvesting, fertilization advice, yield monitoring, water management advice,
- **Pest management**,
- **Weather prediction**: temperature, rainfall (amount, geographical distribution, intensity, timing), extremes (rainfall, drought, wind, hail, etc.).

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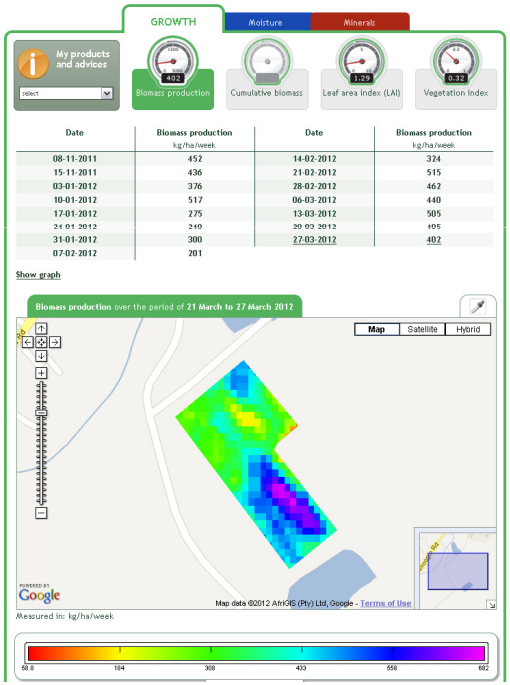
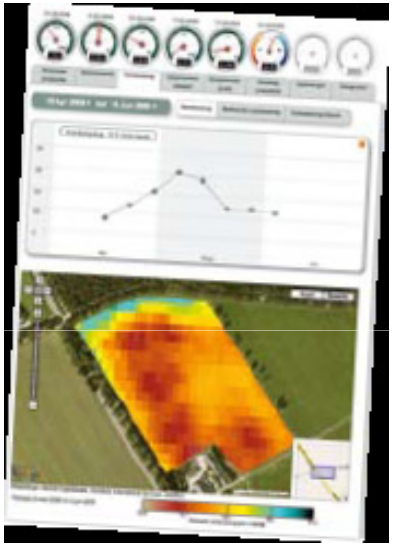
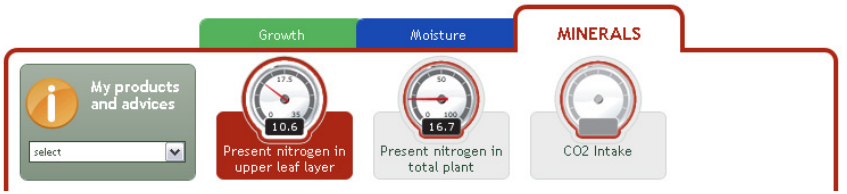
Example precision agriculture (1)





Source:
MijnAkker, Netherlands
&
FieldLook, Ethiopia
(eLeaf 2012 & 2013)



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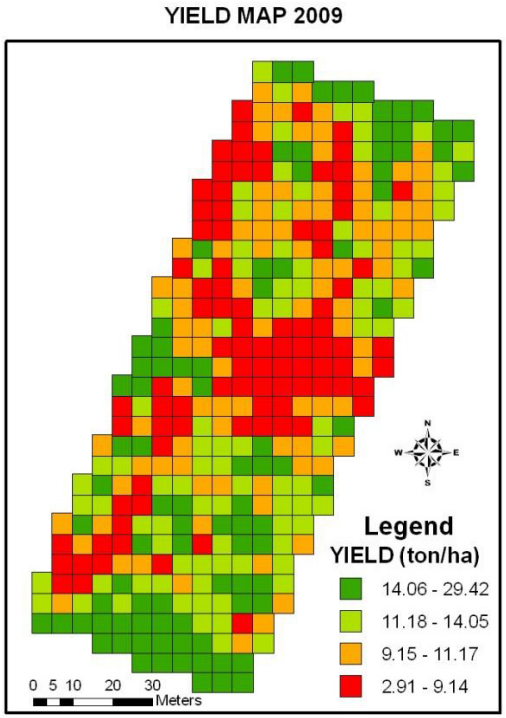
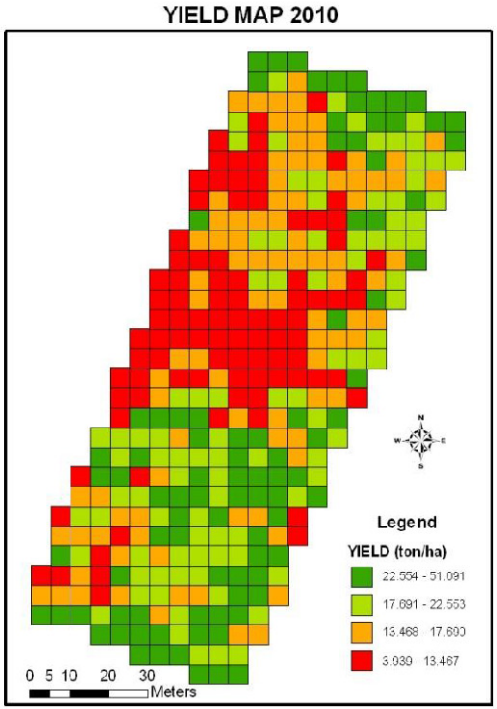
Example precision agriculture (2)





Vineyard yield map and comparison 2010 and 2009

Source: Fountas

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Precision agriculture

- Machine guidance, precise planting and harvesting, fertilization advice, yield monitoring, water management advice.
- High-resolution remote sensing provides accurate information with high frequency that serves, after processing, to reduce fertilizer input, increase efficiency of water use, etc.
- Cost estimate: 10 -15 € / ha.
- Main challenges: affordability, cloud cover.

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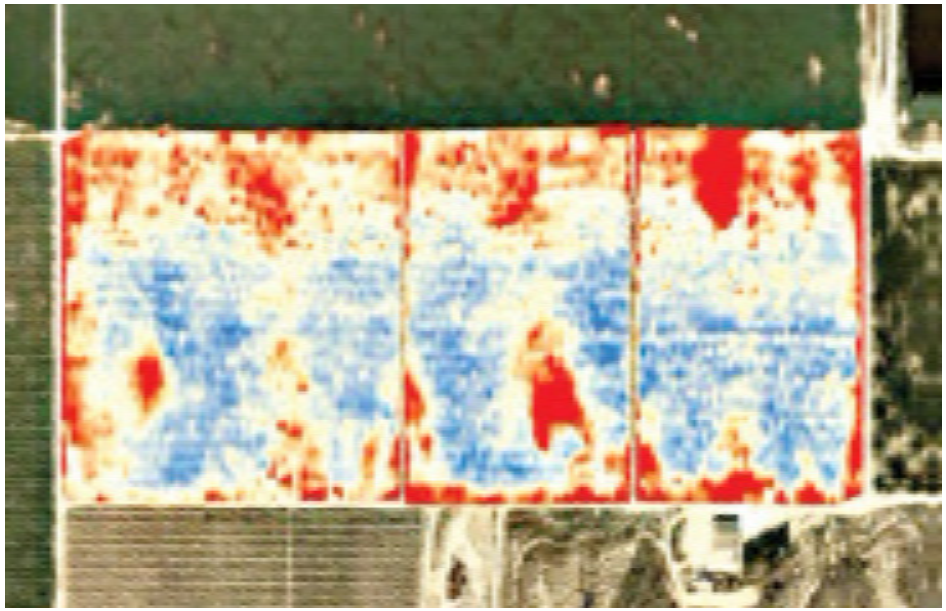
Example pest management

"FieldCopter" used to monitor crop health
(AeroVision, sponsor: EC/ Galileo)



Water stress in a vineyard in Spain (AeroVision)

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Pest management

- Early recognition and treatment of pests, plagues and other diseases / deficiencies.
- Remote sensing provides clues about crops possibly affected by diseases. Due to the high repetition time and resolution required, UAVs may be especially effective (in terms of remote sensing solutions). In special cases, such as locust plagues, earth observation is instrumental for early warning.
- Cost estimate: on case-by-case basis.
- Main challenges: affordability, timing, accuracy.

Example pest management

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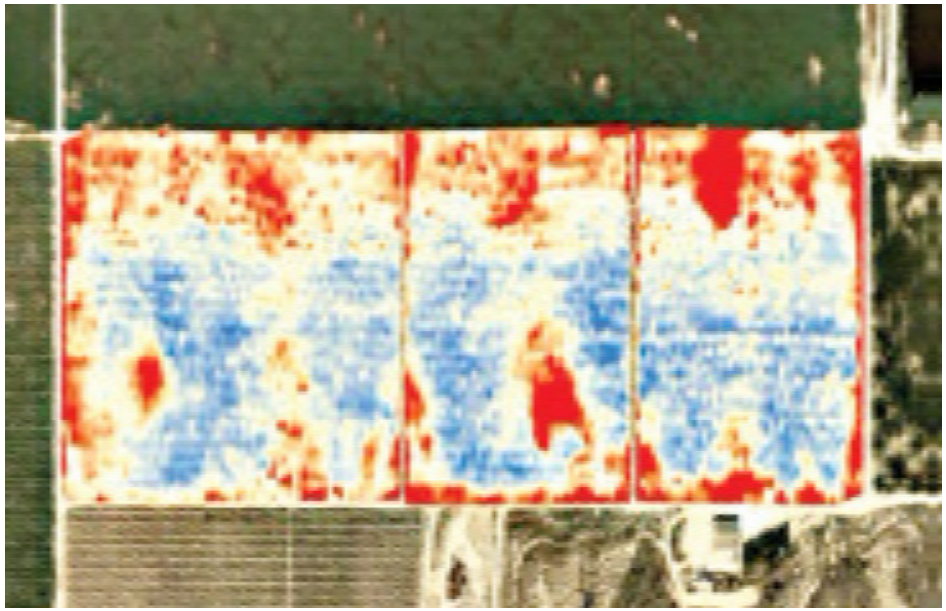

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- Cost estimate: on case-by-case basis.
- Main challenges: affordability, timing, accuracy.

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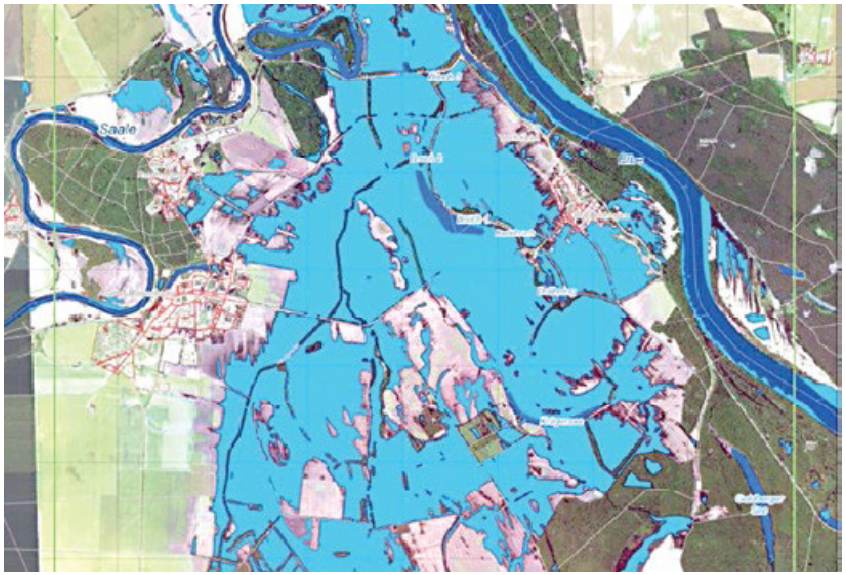
Geospatial technology for agricultural insurance:

- **Plot identification,**
- **Crop identification,**
- **Crop monitoring,**
- **Yield estimation,**
- **Loss event monitoring and verification,**
- **Risk assessment,**
- **Insurance product indicators**
  (precipitation, evapotranspiration, NDVI, etc.).

Example agricultural insurance

Pre-flood situation in the agricultural area around Breitenhagen, Germany (source: Munich Re)



Flood on the River Elbe in the agricultural area around Breitenhagen in Germany in June 2013. The flooded area is shown in light blue, and the reference water level in dark blue (source: Munich Re)

Insurance

- Insurance against extreme events and/or reduced yields is an important safety net for farming.
- Earth observation helps reduce costs in assessing risk and monitoring and verification. Index-based insurance, where pay-out is a based on performance of a single or a small number of parameters, earth observation can play a key role.
- Cost estimate: 10 – 20 € / ha for smallholder farmers in Africa is an acceptable range for premiums.
- Main challenges: acceptance, business model.

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Thank You !!