Agricultural Land Cover Change

Break-out group

Charge

- What observing systems are currently being used
- Are they adequate – pick the criteria which are most appropriate e.g coverage, timeliness spatial resolution, data accessibility
  - How good or bad are they?
- What are the prospects for their continuity/enhancement.
- Are there critical gaps/shortfalls in the current system to meet task needs?

What observing systems are currently being used

- Coarse
  - MODIS, AVHRR, SPOT VGT, FY 1 and 3.
- Moderate
  - Landsat, CBERS, AWIFS, SPOT-HRV, LIS, ASTER?, BEIJING 1
- Ultra-fine
  - IKONOS etc
- Radar
  - Palsar, Radarsat (locally?), ASAR, Unclear how much interferometric SAR is currently available (use lack of coherence)

Are they adequate – pick the criteria which are most appropriate e.g coverage, timeliness spatial resolution, data accessibility How good or bad are they?

- Coarse
  - Daily, free and accessible, appropriate spectrally and radiometrically. Would be good to have all the bands at 300m (is coming with VIIRS, Proba-V and Sentinel and FY series + Indian?). MERIS does not have global acquisition.

Are they adequate – pick the criteria which are most appropriate e.g coverage, timeliness spatial resolution, data accessibility How good or bad are they?

- Moderate
  - Many not free, only Landsat has a systematic global acquisition strategy, no coordination in acquisition strategies, Wide field (AWIFS, DMC, HJ) improve temporal frequency but challenges of off-nadir viewing still not completely understood.
  - Many data are not readily accessible for all users.
  - Repeat cycle needs improvement – it is typically a week plus, and ideally we need daily.
  - Lack of responsiveness of providers to agricultural needs, but appears to be improving (e.g. FEWS) but requires intensive interactions.
  - Problems of too many systems only giving DNs rather than geophysical quantities (e.g. TOA or surface reflectance) thereby hindering integration.
  - Need long term continuity of sensors.
  - Data policy issues are sometimes restrictive.
  - Almost complete absence of thermal and SWIR needs to be more widely available.
  - Orthorectification is essential. International standards need to be established.
  - Unvalidated data sets should not be made available.

Are they adequate – pick the criteria which are most appropriate e.g coverage, timeliness spatial resolution, data accessibility How good or bad are they?

- **Ultra-fine**.
  - Spatial resolution sufficient for some validation and also for area frame sampling
  - Radiometry at least for some sensors seems fine
  - Too expensive for many applications.
  - Unresponsive to orders.
  - Policy issues make the data availability restrictive.
  - Low repeat cycle at nadir.
  - Ordering from multiple sources is an overhead for users.

Are they adequate – pick the criteria which are most appropriate e.g coverage, timeliness spatial resolution, data accessibility How good or bad are they?

- **Radar**
  - All weather
  - One day coherence may provide useful z information.
  - Useful for rice – paddy.
  - Lack of discrimination between many crops, but some useful discrimination for crop groups (e.g. in Belgium) but requires dense time series.
  - Programming unhelpful because of need for consistent time series and it is not possible to get enough acquisitions
  - Only Palsar has a systematic global acquisition strategy but even that is inadequate for agricultural monitoring purposes.
  - Costs, but costs not necessarily high.
  - Time series often need to be denser than is currently possible.

What are the prospects for their continuity/enhancement.

- Coarse
  - Looks good overall, but could be some gaps.
  - For some systems reductions in capability (e.g. VIIRS).
  - Better spatial resolution – 300m throughout.
  - All sorts of improvements feasible but the space agencies are slow in implementing plans developed years ago.
  - Unclear whether systematic acquisitions will be applied for all systems.
- Moderate
  - Multiplicity of systems becoming available permitting much higher frequency of coverage in principle.
  - Overall lack of coordination but LSI could help a lot.
  - Responses to LSI prototype request have been disappointingly modest.
  - Increasing number of portals, ordering systems, charging systems making life difficult for the user.
  - Adoption of standards – grids, formats etc. e.g. as in GLS is highly desirable.

What are the prospects for their continuity/enhancement.

- Ultra-fine
  - Quite good likelihood of enhancements, but it's all commercial so uncertain exactly what will be available (note Rapid Eye, daily at 5m in principle).
  - But unclear whether desirable frequency of acquisition will be achieved.
  - Lack of compatibilty
- Radar*
  - Looks OK for Sentinel
  - But unclear whether we will have sufficiently frequent imaging for ag purposes.
  - Unclear whether there will be multi-polarizing multi-frequency systems which should give better results but experience with these data sets is limited.
  - Some new systems are really expensive e.g. TerraSar

*"Perhaps the Golden age is over." (Matt Hansen 2009)

Are there critical gaps/shortfalls in the current system to meet task needs?

- See many points from above.
- Much more use could be made of existing space-borne sensors.
- Acquisition strategies often inadequate or non-existent.
- Integrated use of different assets is made very difficult by the multiplicity of delivery mechanisms so that often data are simply unavailable.
- Too many experimental one-off missions which do not support long term needs.
- Too much concern by space agencies with nominal specs of sensors which do not have the capability to deliver useful products for agriculture.

USER ISSUES

- Need for more robust methods of information extraction.
- Need for better validation data sets especially of change- ag agencies and researchers who collect such data should be encouraged to make them available.
- Maps may be produced when not always necessary especially where field areas change little from year to year.
- Do we really know where are the areas of changes in agricultural extent? (e.g. China where there is a lot of change.)
- Do we know reliably the distribution of field sizes so we need which type of sensor should be used – should impact the acquisition strategy.
- Often requirements for improvements are vague and not quantitative.
- Should link work on land cover change to others working on productivity and related properties.
  - What are the implications of changes in ag, area on these properties
- Research should also be focusing on the causes of changes in ag extent.

Agricultural land cover change

Agricultural domain (in or out of cropland land cover)

- Change in land cover extent
  - Typically a categorical approach to identifying extent of agricultural lands
    - Coarse-scale quantification of changes in cropland extent at regional/global scales
    - Finer-scale quantification of cropland extent change germane to national scales
  - Methods and products on changes to cropland extent are not common
  - State of the practice is expert photo-interpretation
  - Change, in general, should be targeted directly using digital methods
- Methods
  - Current practices should be improved upon through the use of digital image processing methods that characterize change directly
  - While challenging to implement, formal validation and convergence of evidence approaches to documenting product quality are critical
  - methods must be peer-reviewed and shared
  - repeatability is important, as is transferability

Crop dynamics

- Change monitoring themes
  - Cropping systems
    - Rotations, double cropping
    - Management (till/no till, irrigation, inputs)
  - Crop condition (within season monitoring)
  - Crop quality (for example, protein content in wheat)
  - Trends in yield
  - Long term trends in all of the above
- Data requirements
  - Feasibility of using a given data source is region-specific, largely related to field size and cropping system
  - This has implications for transferability of methods
  - Many change themes require ancillary inputs
- Methods
  - methods must be peer-reviewed and shared
  - repeatability is important, as is transferability
  - no best approach, but validation and convergence of evidence are critical

Field size and sensor class

Task	Key parameter	Satellite data: Optical Adequate (A)- Particularly (P)- Not adequate (N); Coverage (Gl,C,Reg);				
Field size definition	Field size	Low 1 km	Coarser 250 m	Middle 30 m	High 10 m	Very high 1 m
	> 400 ha	N / G	N / G	A / G	A / C	A / R
	>100 ha	N / G	N / G	P / G	A / C	A / R
	> 30 ha	N / G	N / G	N / G	A / C	A / R
	>10 ha	N / G	N / G	N / G	P / C	A / R
	>3 ha	N / G	N / G	N /G	N / C	A / R
	>1 ha	N / G	N / G	N / G	N / C	A / R

Agricultural land use and sensor class

Task	Key parameter	Satellite data: Optical Adequate (A)- Particularly (P)- Not adequate (N); Coverage (Gl,C,Reg);				
	Number of crop type/ frequency of satellite revisit	Low 1 km	Coarser 250 m	Middle 30 m	High 10 m	Very high 1 m
Field land use type recognition	monoculture	A / G	A / G	P / G	P / C	P / R
	Crop groups	P / G	P / G	P / G	P / C	P / R
	Different crops	N / G	N / G	N / G	N/ C	N / R

Yield forecast and sensor class

Task	Key parameters	Satellite data: Optical Adequate (A)- Particularly (P)- Not adequate (N); Coverage (Gl,C,Reg);				
	Field size/ Ground data	Low 1 km	Coarser 250 m	Middle 30 m	High 10 m	Very high 1 m
Yield Forecast	> 400 ha	P / G	A / G	A / C	A / C	A / R
	>100 ha	N / G	A / G	A / C	A / C	A / R
	> 30 ha	N / G	P / G	A / C	A / C	A / R
	>10 ha	N / G	N / G	P / C	A / C	A / R
	>3 ha	N / G	N / G	N /C	A / C	A / R
	>1 ha	N / G	N / G	N / C	A / C	A / R

Criteria for developing an agricultural land cover monitoring system (focused on primary annually produced commodities)

- Field size
- Crop types
- Crop calendars/phenology
- Management
- Landscape pattern
- Interannual variability of yield and area
- Cloud cover during cropping season

Argentina – temperate feedstock area change estimation and crop condition example

- Field size
  - Large – MODIS/MERIS/SPOT VEGETATION/AVHRR
- Crop types
  - Corn, soybean – optical
- Crop calendar/phenology
  - January/February key time for corn/soy discrimination – near daily
- Management
  - Commercial agriculture
- Landscape pattern
  - Homogeneous, production centers well established, but there is also a growing frontier
- Interannual variability of yield and area
  - Area is expanding
- Cloud cover during cropping season
  - Summer crops, rainfall frequent, clouds a limiting factor for any weekly or bi-weekly system such as Landsat

Niger – semi-arid subsistence area change estimation and crop condition example

- Field size
  - Small – Landsat and finer with more emphasis on in situ reporting
- Crop types
  - Sorghum, millet – cannot discriminate, use crop group monitoring, not types
- Crop calendar/phenology
  - Short rainy season
- Management
  - Mixed cropping, integrated agriculture (pastoral uses)
- Landscape pattern
  - Heterogeneous, fields mixed with natural vegetation
- Interannual variability of yield and area
  - Yield and harvested area vary
- Cloud cover during cropping season
  - Short cropping season coincides with rainy season, requiring almost daily data (2 to 3 day coverage)
- Long term trend
  - information from MODIS/AVHRR/SPOT VEGETATION type data could be helpful in targeting field data collection

Validation