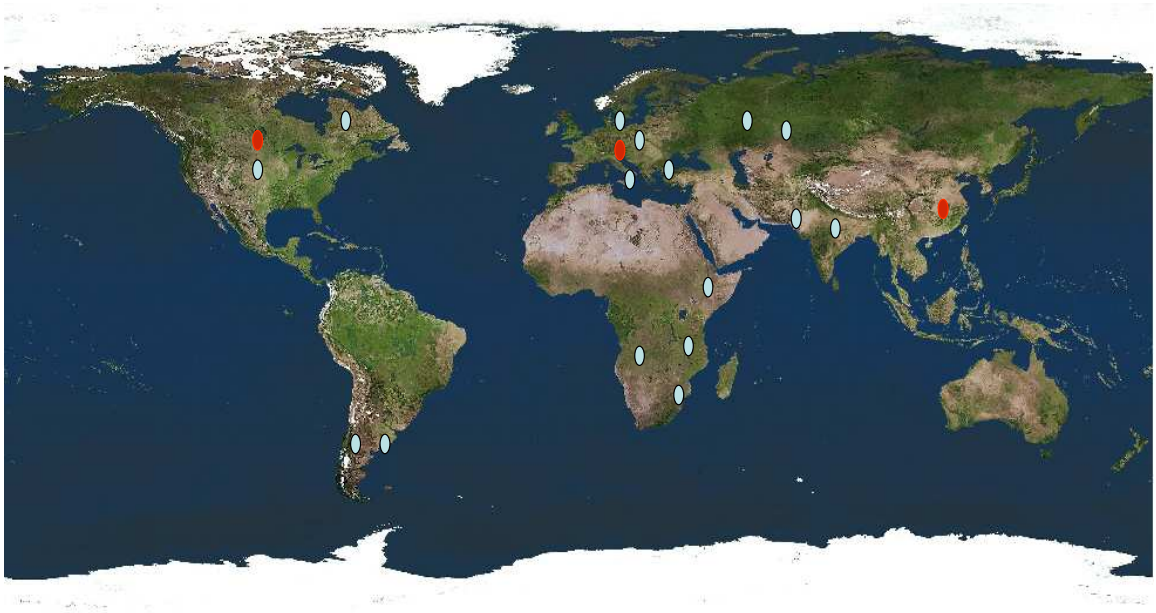
GEO AG TASK 07 03

GROUP ON EARTH OBSERVATIONS

Workshop on Best Practices for Crop Area Estimation with Remote Sensing Data: Summary of Country Inputs



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Content

ARGENTINA

Scale of Coverage	**Regional / province** non - extensive crops (potatoes in the SE province of Buenos Aires province
Input Data	
Spatial resolution	Landsat and Medium resolution (SAC-C, 175 m pixel size) imagery
Sampling Design	Stratified Sampling based on digital cadastral maps and other ancillary data
Image analysis	Digital analysis
Accuracy evaluation	
User acceptance	National Argentine government agency (SAGPyA), responsible for agricultural estimates.
Cost/benefit	
Results of analysis	
Software/package	ERDAS commercial s/w used
Available/not available, Cots/ Open source	
Training/Procedure Manual	Reference needed
Source	National Commission of Space Activities (CONAE)

BELGIUM & POLAND

Scale of Coverage	National to EU regional level Winter crop 71.5% and spring crops 6.9%, root crops (sugar beet, potatoes).
Input Data	MERIS, SPOT, Landsat
Sampling Design	Full area coverage will be input to Area Frame Sampling (AFS)
Image analysis	Arable land cover mask generation based on Corine land cover (CLC) product. Decision rule based classification using Temporal coverage for Fraction of Green Vegetation (GLCV).
Accuracy evaluation	76% for winter spring crops and 68% for root crops compared to Agricultural statistic database from IACS (Belgium case) and from IGIK (MOCA-JRC) (Poland case). Relative deviation from database statistic is 4% for winter crop, 15% for spring crops and 8% for root crops.
User acceptance **User type**	Infoterra France
Cost/benefit	Cost effective 0.5€/km^2
Timeliness	Before harvest
Software/package	**OVERLAND^{TM} s/w** Dedicated module of the agricultural monitoring system using analogy-year approach
Training/Procedure Manual	Reference needed
Source	Cayrol *et al*. (2006). ISPRS Archives XXXVI-8/W48 Workshop proceedings. Remote sensing support to crop yield forecast and area estimates. Commission VIII, WG VIII/10, Stresa, Italy; vol. 36 (8/W48): 3-6

	Brazil
Scale of Coverage	State level for Rice, Wheat and Soyabean
Input Data	
Spatial resolution	NOAA/AVHRR, Landsat TM, Recently switched to MODIS 250 m resloution
Sampling Design	Full area coverage
Image analysis	NDVI image thresholdings based on decision rule, omage differencing of NDVI images
Accuracy evaluation	
Independent/traditional statistics	fairly good accuracy compared to Independent statistics
User acceptance	
User type: Govt/ Industry /….	National Company for Supply (CONAB Companhia Nacional de Abastecimento http://www.conab.gov.br), the institution responsible for generating national agricultural estimates.
Cost/benefit Results of analysis	
Timeliness	Before harvest
Software/package	
Training/Procedure Manual	Reference needed
Source	Montana *et al*. (2006). ISPRS Archives XXXVI-8/W48 Workshop proceedings. Remote sensing support to crop yield forecast and area estimates. Commission VIII, WG VIII/10, Stresa, Italy; vol. 36 (8/W48): 3-6

CANADA

Scale of Coverage	National level using major agricultural states For Potatoes as single crop
Input Data	Optical and SAR (VV-VH) data, future plan for polarimetric SAR data from Radarsat -2
Sampling Design	Sampling of RS data followed by regression estimator
Image analysis	Multi-temporal classification based on decision rule.
Accuracy evaluation	85% overall classification accuracy
User acceptance	
User type:	Agriculture and Agri-Food Canada (AAFC)
Cost/benefit	
Software/package	commercial s/w PCI-Geomatica, ERDAS, ENVI
Training/Procedure Manual	Reference needed
Source	Agri-Food Canada's (AAFC) Earth Observation Research Branch Team (EORBT), (personal communication).

Prince Edward Island (PEI), Canada

Scale of Coverage	Province level for Potato
Input Data	
Spatial resolution	Medium resolution, Earth Observation (EO) satellite data
Sampling Design	Stratified Sampling combined with a regression estimator
Image analysis	
Accuracy evaluation	The coefficient of variation (CV) of the estimate increased to 3.7% in 2007 compared with 1.7% in 2006 Forecast two (2) weeks earlier than in 2006, and also earlier than official Statistics Canada
User acceptance	Department of Agriculture, CANADA
Cost/benefit	
Results of analysis	
Software/package	commercial s/w PCI-Geomatica, ERDAS, ENVI
Available/not available, Costs/ Open source	
Training/Procedure Manual	Reference needed
Source	(Personal communication)

	CHINA
Scale of Coverage	National level to global level (26 countries, representing 80% grain production) Eight crops - winter and spring Wheat, early Rice, semi-late Rice and late Rice, spring and summer Maize and Soyabean.
Input Data	NOAA/AVHRR, SPOT-VGT, Landsat TM and Radarsat，presently switched to MODIS, IRS-P6/AWIFS，BJ-1 and HJ-1a/b
Sampling Design	Full area coverage with remote sensing data Transact sampling for crop types
Image analysis	Multi-temporal satellite data, Spectral profile based on NDVI.
Accuracy evaluation	Around 95 %
User acceptance	State Grain Administration, etc.
User type:	Govt. Body, E-government
Cost/benefit	
software/package	**CropWatch®** Software package
Training/Procedure Manual	Reference needed
Source	Wu Bingfang (2006). ISPRS Archives XXXVI-8/W48 Workshop proceedings. Remote sensing support to crop yield forecast and area estimates. Commission VIII, WG VIII/10, Stresa, Italy; vol. 36 (8/W48)

Ethiopia, Niger and Zimbabwe

Scale of Coverage	National level, pilot area in Ethiopia For crop/non crop area
Input Data Spatial resolution	Lansat ETM+ / AWiFS other inputs are sample of high resolution images as main variable and the moderate resolution images and other ancillary information included: the SDRN-FAO processed SRTM 90 meter digital elevation model; the FEWSNET primary livelihood zones for Niger; the agro-ecological zones defined by the Water Requirement Satisfaction Index (WRSI) for Zimbabwe; and the International Research Institute woody biomass map for Ethiopia as co-variables
Sampling Design	Sampling frame at 2 km grid and Sample area at 0.5 km.
Image analysis	Field survey/ GT by photo-interpretation on Ikonos and Quickbird
Accuracy evaluation	89.6% in case of Niger and 95 % confidence intervals in all three compared to Central Statistics Authority (CSA) and the Bureau of Agriculture and Rural Development (BoARD).
User acceptance User type:	FEWS NET, USAID
Cost/benefit Results of analysis	Regression estimator
Timeliness	Midseason of crop growth
Software/package	Semi-automated algorithms (developed by GDA Corp.) for developing/generating a crop mask
Training/Procedure Manual	Reference needed
Source	FEWS NET Activity of the Climate Hazards Group, Geography Department University of California, Santa Barbara and USGS

EU-1: EU-MARS 1988-93

Scale of Coverage	EU countries at regional levels
Local/regional/national/continental/global	
Input Data	
Spatial resolution Temporal Resolution Optical/Microwave	Landsat TM, SPOT
Sampling Design	Stratified Sampling, sample segment of 25-200 ha.
Image analysis	
	Supervised/unsupervised/decision rule Mask(Nonagriculture)/multi-stage classification
Accuracy evaluation	
Independent/traditional statistics	70-80 %
User acceptance	
User type: Govt/ Industry /….	
Cost/benefit Results of analysis **Timeliness**	Regression estimator monthly interval since April
Software/package Available/not available, Costs/ Open source	commercial s/w PCI-Geomatica, ERDAS,ENVI
Training/Procedure Manual	Reference needed
Source	Gallego F. J. (1999) Crop area estimation in the MARS project. *Conference on ten years of the MARS Project, Brussels, April 1999*

EU-2: Land Use/Cover Area frame Survey (LUCAS) EU 25

Scale of Coverage	11countries at regional levels Land use/cover area frame survey (LUCAS)
Input Data	
Spatial resolution Temporal Resolution Optical/Microwave	Landsat-TM images
Sampling Design	
	Two way Sampling, 2 km grid fro stratification, each stratum is sampled at different rate based on agricultural area sampled 5 times to non-agri. area
Image analysis	
Accuracy evaluation	
	Stratification efficiency, 1.5-2.2 times.
User acceptance	
User type: Govt/ Industry /….	
Cost/benefit	
Results of analysis	
Software/package	commercial s/w PCI-Geomatica, ERDAS,ENVI
Available/not available, Cots/ Open source	
Training/Procedure Manual	Reference needed
Source	personal communication

EU-3: MARS – Rapid Area Estimate

Scale of Coverage	Regional/national (EU) level
Crops covered	Inter-annual acreage changes for main crops Winter cereals, summer crops, Grassland, Sunflower.
Input Data	SPOT-XS (20 m), Landsat-TM and IRS-1C data
Sampling Design	
Sampling	Multi-stage stratification based on computer assisted photo-interpretation and pixel clustering (unsupervised classification).
Image analysis	A fuzzy classification and a priori information was used where each cluster of pixels was linked to one or several land cover classes through a correspondence table used later to compute estimates which gave flexibility to combine image classification with general information obtained from published data.
Accuracy evaluation	For winter cereal 80-90% In 3 cases (common wheat, durum wheat, rapeseed) the accuracy becomes worse; for maize it remains more or less constant. This means that the contribution of remote sensing to the quality of the results is very debatable
User acceptance	
User type: Govt/ Industry /….	MARS project
Cost/benefit	
Results of analysis	
Software/package	commercial s/w PCI-Geomatica, ERDAS,ENVI
Training/Procedure Manual	Reference needed
Source	Personal communication

EU-4: EU_TUSRAD

Scale of Coverage	Regional level (Tuscany.) EU
Crops covered	common wheat, durum wheat, rapeseed and maize
Input Data	SAR data
Sampling Design	Full area coverage
Image analysis	Multi-stage and multi-date using classification using Mask (Non-agriculture areas, etc.) for multi-date SAR data using decision rule based classification.
Accuracy evaluation	Overall 20-40% and kappa coeff. 0.2% The complicated topography of the region, and and a wide variety of agricultural scenarios which are not particularly suited for the use of radar images and image processing procedures (both pre-processing and classification algorithm) that need to be improved before making it operational
User acceptance	
User type: Govt/ Industry /….	JRC-ISPRA
Cost/benefit	
Timeliness	Before harvest
Software/package	commercial s/w PCI-Geomatica, ERDAS,ENVI
Training/Procedure Manual	Reference needed
Source	Personal communication

Hungary

Scale of Coverage	COUNTRY level For 8 main crops Wheat, Soyabean, Colza
Input Data	
Spatial resolution	Landsat TM, SPOT, IRS-1C/1D/ NOAA/AVHRR, EOSAT
Temporal Resolution Optical/Microwave	
Sampling Design	
	Full area coverage
Image analysis	muti-temporal digital data analysis based on decision rule
Accuracy evaluation	85-90% and 0.3-3.7% relative bias from national Level and 1.5-2% at country level.
User acceptance User type: Govt/ Industry /….	Estimate after harvest end of Aug for wheat and barley and December for rest of crops
Cost/benefit Results of analysis	
Software/package	
Available/not available, Costs/ Open source	CROPMON s/w
Training/Procedure Manual	Reference needed
Source	Csornai G.(2006) CROPMON: Hungarian Crop Production Forecast By Remote Sensing. ISPRS Archives XXXVI-8/W48 Workshop proceedings. Remote sensing support to crop yield forecast and area estimates. Commission VIII, WG VIII/10, Stresa, Italy; vol. 36 (8/W48)

INDIA

Scale of Coverage	Local-regional to national
Crops covered	Wheat, Rice, Sugarcane, Mustard, Cotton, Sorghum, Groundnut, and Potato
Input Data	
Spatial resolution	IRS–/III/AWiFS 23/56 m
Temporal Resolution	24/5 days
Microwave	Radarsat SAR
Sampling Design	
Sampling segments at National level	Stratified sampling with 10-15% sample
Image analysis	Supervised maximum likelihood at single date data for local to state level crop acreage estimation. Multi-stage classification using Mask (Non-agriculture areas) for multi-date AWiFS using decision rule based classification
Accuracy evaluation	> 95% compared to DoA estimates and production forecast >90 % compared to independent crop cutting experiments conducted by NSSO
User acceptance	
User type: Govt/ Industry /….	Mainly Government, Centre as well as state
Cost/benefit	
Timeliness	Regular 4 forecasts – pre-season acreage to be sown, early season, mid-season and pre-harvest
Software/package	ERDAS, PCI-GEOMATICA, ENVI & ARC-Map **Developed own module like** CAPEMAN / CAPEWORKS, SAR-CROPS & Auto-Fit programme.
Training/Procedure Manual	Available
Source	Parihar Jai Singh and Oza Markand P (2006). FASAL: An integrated approach for crop assessment and production forecasting. Agriculture and Hydrology Applications of Remote Sensing, edited by Robert J. Kuligowski, Jai S. Parihar, Genya Saito, Proc. of SPIE Vol. 6411: 641101-6411013.

ITALY

Scale of Coverage Regional (20 regions)/ province level
For major crop wheat, soyabean, colza

Input Data

Spatial resolution Lansat TM
Temporal Resolution
Optical/Microwave

Sampling Design

Two way Sampling,
1. Stratified area frame sampling, 500 m grid each segment of 50 ha.
2. Regression estimator

Image analysis

Accuracy evaluation

0.9-1.2 relative efficiency.

User acceptance

User type: Govt/ Industry /….

Cost/benefit

Results of analysis

Software/package commercial s/w
Available/not available, Costs/ Open source

Training/Procedure Manual Reference needed

Source personal communication

Kazakhstan

Scale of Coverage	Local level, Pilot project Cereals: winter Wheat, spring Barley combined together
Input Data	
Spatial resolution	MODIS 250 m, IRS LISS-III 23 m
Temporal Resolution	
Optical/Microwave	
Sampling Design	
	Full area coverage
Image analysis	
Accuracy evaluation	
	93 % for crop area with respect to farm land use estimates
User acceptance	
User type: Govt/ Industry /….	
Cost/benefit	
Results of analysis	
Software/package	commercial s/w
Available/not available, Costs/ Open source	
Training/Procedure Manual	Reference needed
Source	personal communication

PAKISTAN

Scale of Coverage	District level (Rahim Yar Khan Dist.)
Crops covered	winter crops, summer crops, double cropping, and dominant pluri-annual and permanent crops
Input Data	SPOT VEGETATION data for stratification and SPOT4&5 HRV for digital analysis
Sampling Design Full area coverage Sampling	Stratified sampling based on NDVI profiles at district level
Image analysis	Multi-stage and multi-date using classification using Mask (Non-agriculture areas, etc.) for multi-date SPOT classification and regression estimator
Accuracy evaluation	Accuracy >80% and c.v less than 10% compared to MOA, Pakistan estimates
User acceptance	
User type: Govt/ Industry /….	Mainly Government (MOA)
Cost/benefit Results of analysis	
Software/package	commercial s/w
Training/Procedure Manual	Reference needed
Source	Mapping Land Use And Forecasting Production – Development Of A Prototype In Pakistan. M. Gay1, J-P. Denux1, F. Baillarin2, G. Gonzales2 1*Laboratoire de Télédétection E.I. Purpan, Toulouse, France* 2*Applications Agriculture Forêt, Spot Image, Toulouse, France*

Russia-1

Scale of Coverage	County level leading to National level For winter crop and sunflower
Input Data	Multidate weekly composited MODIS / SPOT – VGT, Landsat TM /ETM+, NOAA/AVHRR data
Sampling Design	Full area coverage
Image analysis	Decision rule based classification
Accuracy evaluation	
User acceptance	
User type:	ISPRA
Cost/benefit	
Software/package	commercial s/w
Training/Procedure Manual	Reference needed
Source	Sergey A. Bartalev. Earth Observation for Agricultural Monitoring in Russia. Russian Academy of Sciences' Space Research Institute, Moscow, Russia

Russia-2

Scale of Coverage	National level For winter crop and sunflower
Input Data	Terra/Aqua-MODIS (250 m) and SPOT 2&4 - HRV/HRVIR, NOAA-AVHRR, SPOT-Vegetation and Landsat TM/ETM+
Sampling Design	Full area coverage winter crop, Sunflower
Image analysis	Decision rule based classification
Accuracy evaluation	
User acceptance	
User type:	Ministry of Agri. Russian Federation
Cost/benefit	
Software/package	Dedicated module of the agricultural monitoring system using analogy-year approach and commercial s/w PCI-Geomatica, ERDAS,ENVI
Timeliness	Before harvest
Training/Procedure Manual	Reference needed
Source	Friz *et al*. (2006). The Use Of Modis Data In Southern Russia For Crop AcreageEstimations And Inter-Comparison Of Results From Various Crop Acreage Estimation Methods. ISPRS Archives XXXVI-8/W48 Workshop proceedings. Remote sensing support to crop yield forecast and area estimates. Commission VIII, WG VIII/10, Stresa, Italy; vol. 36 (8/W48)

South Africa

Scale of Coverage	Provincial leading to National
	Maize, Sunflower, Soya Beans, and Sorghum, are cultivated during summer. The second group of crops are grown during the winter and include Wheat, Barley, Oats and Canola.
Input Data	Landsat –5, SPOT 2 & 4
Sampling Design	Stratified Systemic random Sampling stratification based on cultivation intensities GT by aerial survey of sample area
Image analysis	Supervised based on maximum likelihood classifier combined with the parallel-piped functions.
Accuracy evaluation	
User acceptance	Govt.: National Department of Agriculture (DoA)
Cost/benefit	
Results of analysis	
Software/package	ERDAS s/w
Training/Procedure Manual	Reference needed
Source	Ferreira *et al*. (2006),Use Of Remote Sensing In Support Of Crop Area Estimates In South Africa. ISPRS Archives XXXVI-8/W48 Workshop proceedings. Remote sensing support to crop yield forecast and area estimates. Commission VIII, WG VIII/10, Stresa, Italy; vol. 36 (8/W48)

USA-1: USDA

Scale of Coverage	National level using major agricultural states of USA For winter and spring Wheat, Corn, Soyabean and Durum Wheat, Rice and Cotton
Input Data	Landsat TM/ETM+ 30 m resolution from 2004 onwards IRS-P6 AWiFS data 56 m resolution, multidate RS data plus ancillary data of 30 m national elevation data (NED) , LULC
Sampling Design Full area coverage	NASS area sampling frame Sampling
Image analysis	multi-stage classification based on decision rule. Mask (Nonagriculture) generation based on 2006 cropland data layer (CDL), forest canopy, impervious surfaces, NED resampled to 56 m using NN transformation
Accuracy evaluation Independent/ traditional statistics	± 2% - 4% c.v. compared to state level estimate, Agricultural statistics Board (ASB)
User acceptance User type:	Govt. National Agricultural Statistics Service (NASS), USDA, FSA (farm service Agency)
Cost/benefit	Results of analysis released mid March to early July for wheat, for corn reduced forecast time from mid December to mid October
Software/package	'SEE5' integrated with ERDAS s/w, enhanced Predictor algorithms (Ozga 2000,Mueller and Ozga 2002).
Timeliness	Before harvest
Training/Procedure Manual Source	Available Rick Mueller (2006) New Methods And Satellites: A Program Update On The NASS Cropland Data Layer Acreage Program. ISPRS Archives XXXVI-8/W48 Workshop proceedings. Remote sensing support to crop yield forecast and area estimates. Commission VIII, WG VIII/10, Stresa, Italy; vol. 36 (8/W48)

USA-2: USDA - Foreign Agricultural Services (FAS)

Scale of Coverage	Global for major crops of economically important to the United States such as wheat, coarse grains, rice, oilseeds, and cotton
Input Data	
Spatial resolution	MODIS 250 m and recently converted from Landsat to AWiFS
Sampling Design Full area coverage Sampling	
Image analysis	Supervised/unsupervised/decision rule semi-automated algorithms for multi-stage classification
Accuracy evaluation	
Independent/traditional statistics	
User acceptance	
User type: Govt/ Industry	**USDA**
Cost/benefit	
Results of analysis **Timeliness**	midseason
Software/package	Semi-automated algorithms (developed by GDA Corp.) for developing/generating a crop mask
Available/not available, Cost/ Open source	commercial s/w I
Training/Procedure Manual	Reference needed
Source	Curt Reynolds USDA's Foreign Agricultural Service (FAS) Approach for Estimating Crop Area (personal communication)