

# JECAM Guidelines for cropland and crop type definition and field data collection

This document is the first (draft) version of the JECAM Guidelines for field data collection. It has been prepared based on 24 JECAM site reports for 2013, and the discussions from several working sessions in the framework of different international on-going efforts, including the FP7-SIGMA project which supports this work. The JECAM partners are invited to provide feedback and suggestions for the forthcoming JECAM meeting (July 2014, Ottawa).

## I. Objective

The JECAM network facilitates data sharing and collaborative satellite remote sensing research to develop crop assessment and agricultural monitoring methods for a large variety of agriculture systems. This JECAM *Guidelines* document aims to establish a common language for the agriculture monitoring research community regarding the **definition** and data collection **protocols** of both **cropland** and **crop type** information. It set the basis of a common approach for cropland and crop type map production and validation.

## II. Cropland and crop types definition

The challenge is to share common cropland and crop type definitions that (a) are relevant to, and compatible for, in situ and satellite remote sensing observations, and (b) encompass as much of the diversity found within global agricultural systems as possible.

### A. Annual cropland

In a context of crop monitoring systems, the restriction of croplands to “*land that is actually cultivated on an annual basis*” seems relevant, excluding the different stages of fallows and perennial crops. The annual cropland can thus be seen as a distinct land cover type next to other land cover classes (such as permanent cropland, grassland, shrub land, water bodies, etc.).

The general definition of annual cropland (including area affected by crop failure) could be as follows:

The **annual cropland** is a piece of arable land that is sowed or planted at least once within a 12 months period.

FAO has also started to develop an overall framework defining the cropland according to the LCML ISO standards to further document it (cf. preliminary overview in Annex I).

### B. Annual cropland class from remote sensing perspective (legend definition)

In the context of global mapping, the identification and the validation of the cropland class is limited by the resolutions of the remote sensing imagery. A specific definition is then proposed:

The **annual cropland from a remote sensing perspective** is a piece of land of minimum 0.25 ha (min. width of 30 m) that is sowed/planted and harvestable at least once within the 12 months after the sowing/planting date. The annual cropland produces an herbaceous fcover\* of at least 30 % and is sometimes combined with a maximum woody (height > 2 m) fcover of 20 %.\*\*

\*fcover corresponds to the fraction of soil background covered by the living vegetation.

\*\*There are 3 known exceptions to this definition. The first concerns the sugarcane plantation and cassava crop which are included in the cropland class although they have a longer vegetation cycle and are not yearly planted. Second, taken individually, small plots such as legumes do not meet the minimum size criteria of the cropland definition. However, when considered as a continuous heterogeneous field, they should be included in the cropland. The third case is the greenhouse crops that cannot be monitored by remote sensing and are thus excluded from the definition.

An “annual cropland map or mask from remote sensing” can be updated on a yearly basis to take into account the extension/reduction of cultivated areas.

### C. Crop types and land cover classes (legend definition)

The proposed general legend gathers the global diversity of crop types and follows a **hierarchical grouping of crops to share common aggregation levels**. This grouping is based on the Indicative Crop Classification (ICC) developed by FAO in the frame of agricultural censuses<sup>1</sup>. As the considered crop types occur only within the annual cropland area (as defined in section II.B), all the permanent crop type listed in ICC are not considered here. In the same way, all meadows and grasses are considered in separated land cover classes.

Land cover	Crop group	Crop type	Sub-class
Annual cropland	1 Cereals	11 Wheat	
		12 Maize	
		13 Rice	
		14 Sorghum	
		15 Barley	
		16 Rye	
		17 Oats	
		18 Millets	
		19 Other cereals	191 Mixed cereals
			192 Other
	2 Vegetables and melons	21 Leafy or stem vegetables	211 Artichokes
			212 Asparagus
			213 Cabbages
			214 Cauliflowers & broccoli
			215 Lettuce
			216 Spinach
			217 Chicory
			219 Other
		22 Fruit-bearing vegetables	221 Cucumbers
			222 Eggplants (aubergines)
			223 Tomatoes
			224 Watermelons
			225 Cantaloupes and other melons
			226 Pumpkin, squash and gourds
			229 Other
	23 Root, bulb, or tuberous vegetables	231 Carrots	
		232 Turnips	
		233 Garlic	
		234 Onions (incl. shallots)	
		235 Leeks & other alliaceous vegetables	
		239 Other	

<sup>1</sup>FAO Statistical Development Series, A system of integrated agricultural censuses and surveys, World Programme for the Census of Agriculture, 2010, ISBN 92-5-105375-8, <http://www.fao.org/docrep/009/a0135e/A0135E00.htm#TOC>

		24	Mushrooms and truffles		
		29	Other		
4	Oilseed crops	41	Soya beans		
		42	Groundnuts		
		43	Other	431	Castor bean
				432	Linseed
				433	Mustard
				434	Niger seed
				435	Rapeseed
				436	Safflower
				437	Sesame
				438	Sunflower
				439	Other
5	Root/tuber crops with high starch or inulin content	51	Potatoes		
		52	Sweet potatoes		
		53	Cassava		
		54	Yams		
		59	Other		
6	Beverage and spice crops	62	Spice crops	6211	Chilies & pepers
				6212	Anise, badian, and fennel
				6219	Other
7	Leguminous crops	71	Beans		
		72	Broad beans		
		73	Chick peas		
		74	Cow peas		
		75	Lentils		
		76	Lupins		
		77	Peas		
		78	Pigeon peas		
		79	Other		
8	Sugar crops	81	Sugar beet		
		82	Sugar cane		
		83	Sweet sorghum		
		89	Other		
9	Other crops	91	Grasses and other fodder crops		
		92	Fibre crops	9211	Cotton
				9212	Jute, kenaf, and other similar crops
				9213	Flax, hemp, and other similar products
				9219	Other
		93	Medicinal, aromatic, pesticidal, or similar crops		
		95	Flower crops		
		99	Other		
Permanent cropland					
Grassland & meadows					
Shrub land					
Build-up surface					
Water bodies					
Forest					
Bare soil					

This comprehensive legend aims to provide a common framework to translate a site-specific legend to a compatible one across sites using the same hierarchical levels.

An annual cropland area or any other crop type parcel is labelled as irrigated when permanent irrigation infrastructure is visible on the ground. This is a restrictive definition of irrigation practices but it will allow a consistent definition to be used across regions and seasons.

### III. Field data collection for cropland and crop type

#### A. Objective

The quality of field observations is very important since they serve as independent reference data to assess remote sensing products (**validation** of cropland and crop type maps). Field observations are also used for **calibration/training** purposes.

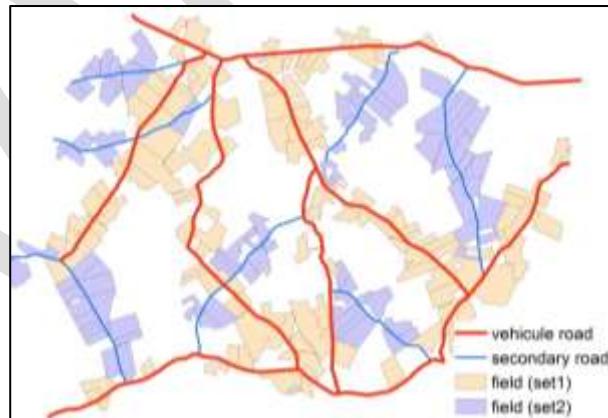
The objective is thus to capture the diversity of crop types and land cover classes (as defined in the section II.C) found within the JECAM site and collect the required number of samples for each class. While random sampling is theoretically most suitable to avoid spatial bias due to the location of field observations, it is not always possible to implement it in operational field survey. A more pragmatic approach is also proposed to serve as minimum common protocol to collect reference in situ data. Due to the diversity of the JECAM sites, the proposed sampling strategy has to be adapted according to the site conditions.

#### B. Field observation for validation/calibration data sets

The **crop type** must be identified by field observation during the main growing season for each selected parcel or piece of land larger than 0.25 ha with a minimum width of 30 m. This information can be collected using different tools, such as an application developed for a tablet/smartphone showing the position of the operator on a recent very high resolution image (for instance, from Bing or Google maps) and the direction of operator movement. Based on ground inspection, the operator adds points (or polygons) to the map by clicking on the screen and defining the corresponding crop types. Several applications have been tested and are described in a separated document.

Collecting crop type point only partly supports cropland validation. It is also important to add a significant set of “non-cropland” points (i.e. other **land cover** classes) to complement the validation data set obtained through field observation.

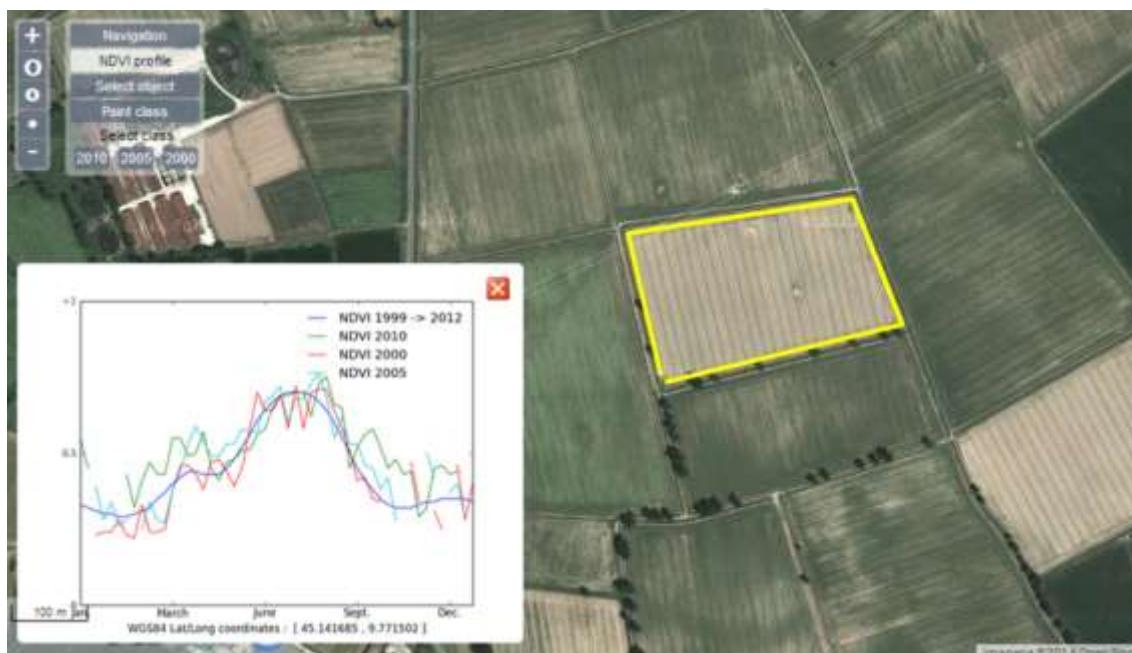
The proposed sampling strategy consists in “Windshield surveys” from vehicles. This technique allows a data collector to easily and rapidly capture the entire crop diversity from all visible fields (set 1 as illustrated in the figure above). The main principle of this approach is to identify long transects across the JECAM site by selecting a set of appropriate roads. It is however recommended that this sampling strategy be complemented by regular additional sampling (set 2) from secondary roads and tracks to reduce the spatial bias brought about by roadside sampling. Several transects running in various directions (NS and EW) will ensure the entire area is covered and while secondary sampling will help the collection of unbiased data set. This secondary sampling has to be regularly spread over the entire site.



The target sample size for the main crop types<sup>2</sup> found within a JECAM site could be n=100 field observations that are well distributed over the site. A minimum size of n=30 field observations may be suitable for the other crop types.

### C. Complementary data collection for cropland information

Land cover information can be also collected by experts through photo-interpretation using updated very high resolution imagery and associated NDVI profile in a web interface. Experts have the ability to label randomly drawn objects (see yellow boundaries in the figure, below) based on (1) VHR images and (2) medium resolution NDVI temporal profiles (10 years mean, previous year, and current year) computed from medium resolution images. Such an interface is already operational as illustrated below and can be made available on request for any JECAM site.



The legend is language independent and use color code and symbology.

Symbology	Label
●	Annual cropland
■	Permanent cropland
G	Grassland (including meadows)
■	Shrub land
■	Build-up surface (sealed surface)
■	Water bodies
■	Forest
■	Bare soil
?	“Data unclear” if the interpreter cannot decide
○	Fallow land
	Other land cover

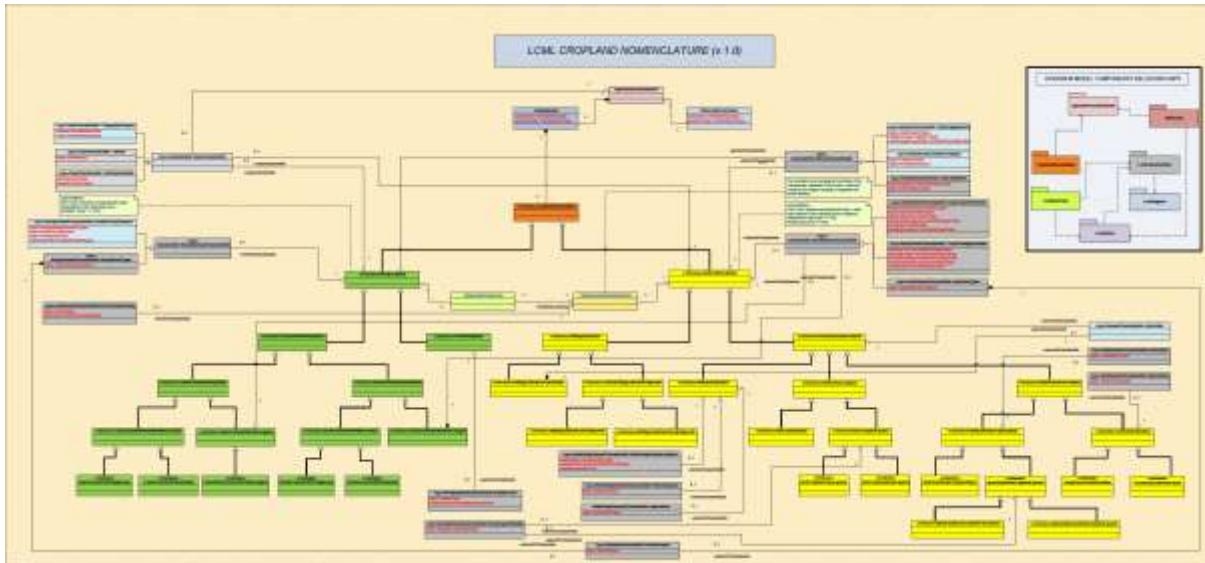
In order to assess the quality of such reference data, three operators could label 600 samples each for a given JECAM site. Two third of their sample should be cross-validated by the two other operators, i.e. one third each. This leads to 1200 reference samples.

<sup>2</sup> The main crop type(s) can be defined either by the JECAM site managers or by the crop type(s) that cover(s) typically about 75% of the annual cropland surface of a region.

	independent sample sets			cross-validated sample sets		
	set 1	set 2	set 3	set 4	set 5	set 6
operator A	■			■		■
operator B		■		■		■
operator C			■		■	

A grey box represents a set of 200 samples (column) labeled by the corresponding operator (line).

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**Annex I: LCML Cropland Nomenclature (v1.0)**

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