

CAP monitoring in Romania using Copernicus data – Challenges and Perspectives

Traian Crainic**, Marian Dumitrescu**

Institution:

* Terrasigna, Romania,

** Romanian Agency for Payments and Intervention in Agriculture (APIA), Romania.

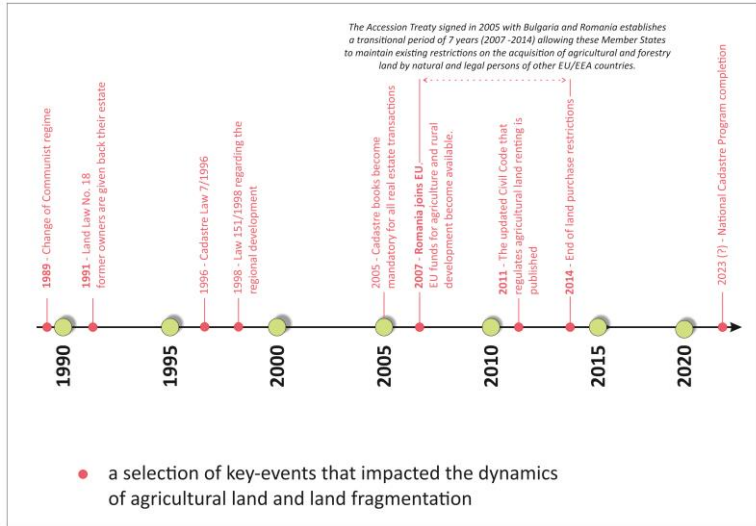


Structure of presentation

- 1. The Romanian agricultural landscape**
- 2. DataBio project**
- 3. Copernicus data for agriculture monitoring in Romania**
- 4. Validation and results**
- 5. Conclusions and perspectives**

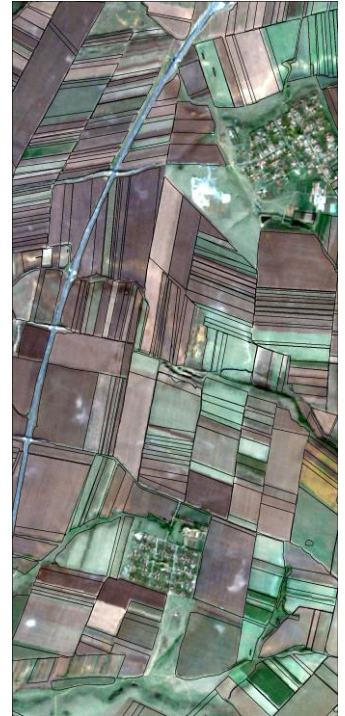
The Romanian Agricultural Landscape

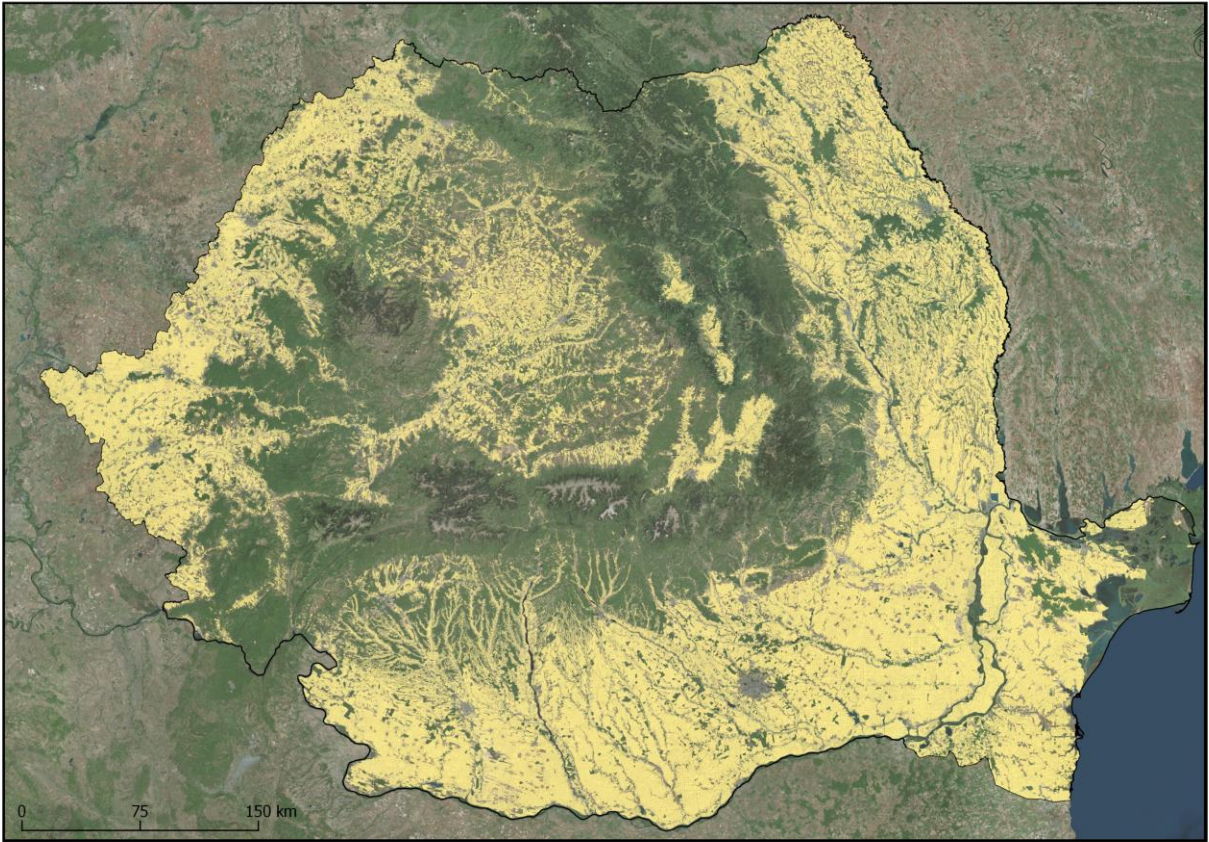
- Several social-economical events in Romania's history have produced consequences that still make great influence on the current agricultural development.
- In **2007**, Romania joined the EU, marking a new era in the agricultural economy and rural development of the country.
- In this context, Romania had to quickly adapt their agricultural economy and rural development in order to integrate into the EU internal market and fully adopt the Common Agricultural Policy (CAP).



The Romanian Agricultural Landscape

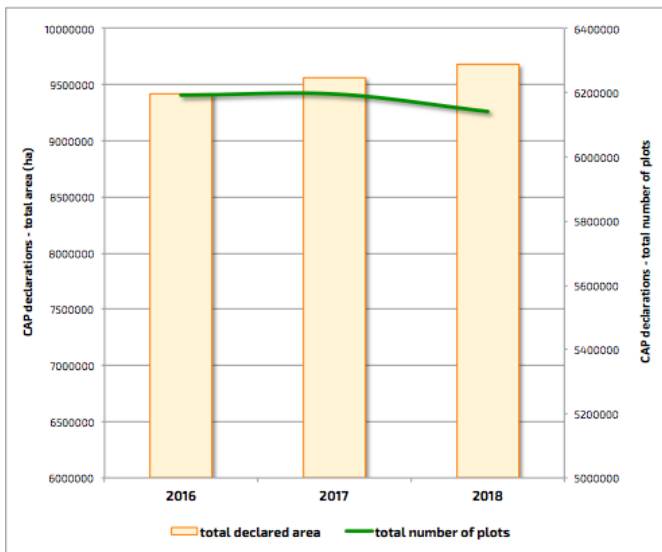
- According to the Food and Agriculture Organisation of the United Nations (FAO) in 2011 Romania holds **139.820 km²**, more than half of its territory
- The total area eligible for CAP support in 2018 sums **96.781 km²** according to the Romanian Agency for Payments and Intervention in Agriculture (APIA)
- The Eurostat Yearbook 2010 places Romania on **rank 6 in EU** with **0.41 ha arable land per inhabitant**, almost double comparing with the EU average
- Agriculture in Romania is not yet established as a strong economic branch. According to the Romanian National Statistics Institute, in 2013 the agriculture contributed mere **5.6% to the national GDP** while employing close to **30% of the country's workforce**





The Romanian Agricultural Landscape

- Between 2016 and 2018 the total declared area **increased** with 2500 km².
- Between 2016 and 2018 the total number of plots eligible for CAP support decreased with 49.291 (0.79%).
- Currently (2018) 9.678.170 hectares corresponding to 6.141.512 plots are registered for CAP support



Romania - total declared area and number of plots registered for CAP support (2016-2018) Data Source: Agency for Payments and Intervention in Agriculture (APIA), Romania

The Romanian Agricultural Landscape

- The current structure of agricultural holdings (2018) reveals that the **small plots (< 5 ha)** represent 95% of the total number of plots registered for CAP support while accounting for only 46% of the total area.
- **Medium-size plots (5 - 30 ha)** represent **4.31%** of the total number of registered plots and **30%** of total area.
- **Big plots (> 30 ha)** represent **< 1%** of the total number of registered plots and **24%** of total area.

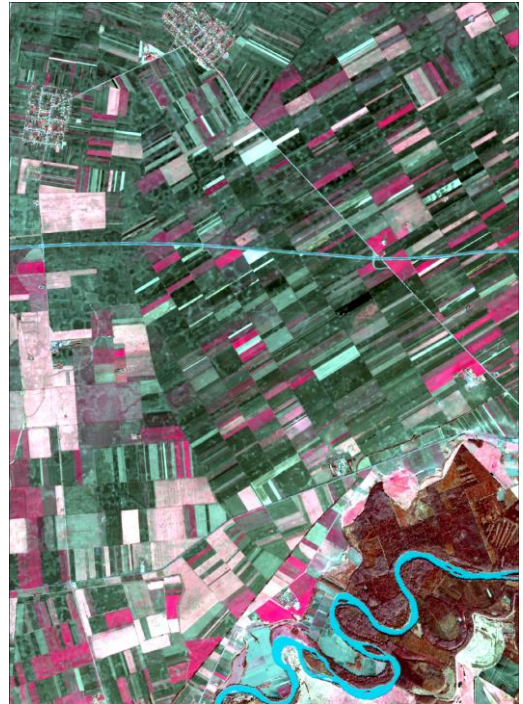
Plots / Holdings	2016				2017				2018			
	Number of plots	%	Area (ha)	%	Number of plots	%	Area (ha)	%	Number of plots	%	Area (ha)	%
0-5 ha	5902049	95.34	4340670	46	5897141	95.18	4379052	46	5835789	95.02	4413072	46
5 - 10 ha	140743	2.27	966924	10	146557	2.37	1007717	11	151055	2.46	1039930	11
10-20 ha	78584	1.27	1081416	11	81709	1.32	1124994	12	83563	1.36	1150491	12
20-30 ha	28662	0.46	692460	7	29451	0.48	711594	7	29970	0.49	724670	7
30-50 ha	23215	0.37	883897	9	23464	0.38	892640	9	23584	0.38	898067	9
50-100 ha	13913	0.22	937294	10	14047	0.23	944835	10	14005	0.23	941913	10
> 100 ha	3637	0.06	518091	5	3529	0.06	503342	5	3546	0.06	510029	5

Romania - Structure of agricultural holdings (2016 - 2018) based on UAA size

Data Source: Agency for Payments and Intervention in Agriculture (APIA), Romania

The Romanian Agricultural Landscape

- The **Agency for Payments and Intervention in Agriculture** (APIA) performs annual verifications of the farmers that applied for subsidies using 3 approaches:
 - ✦ “classical” on-site verifications;
 - ✦ compliance verifications;
 - ✦ verifications using remote sensing techniques.
- In 2015, **56.669** farmers were selected for verifications:
 - ✦ 7.091 - “classical” on-site verifications;
 - ✦ 7.686 - compliance verifications
 - ✦ 41.892 - verifications using remote sensing techniques.
- The overall reported error rate for the 2014 campaign is 2,93%, while for 2013 is 2,01%.



Copernicus data for agriculture monitoring in Romania

Challenges

large area to be surveyed
geographical variability
small / narrow plots
crops diversity
clouds





Copernicus Sentinel-2


10 m spatial resolution
5 days revisiting time
superior radiometric resolution
archive since 2015
sustainability (no data costs)
continuity

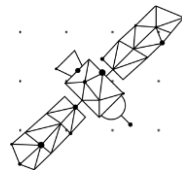


A service for agriculture monitoring in Romania should be able to

 address small / narrow plots distributed over diverse location

 provide results for a broad variety of crops

 make use of the Copernicus Sentinel temporal resolution



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BIG DATA VALUE
PUBLIC-PRIVATE PARTNERSHIP

This project is part of BDV PPP

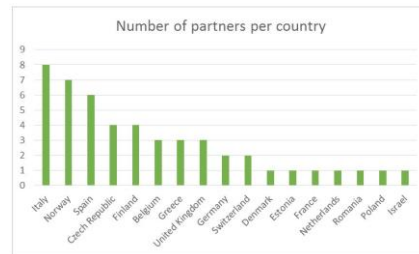
DATABIO – DATA-DRIVEN BIOECONOMY



DataBio Consortium

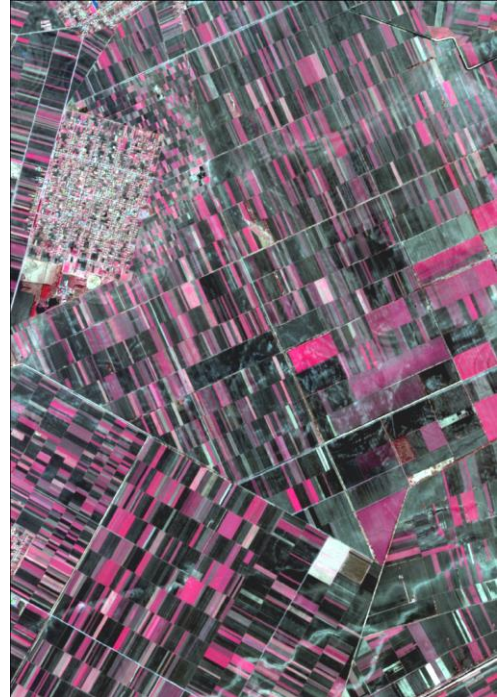


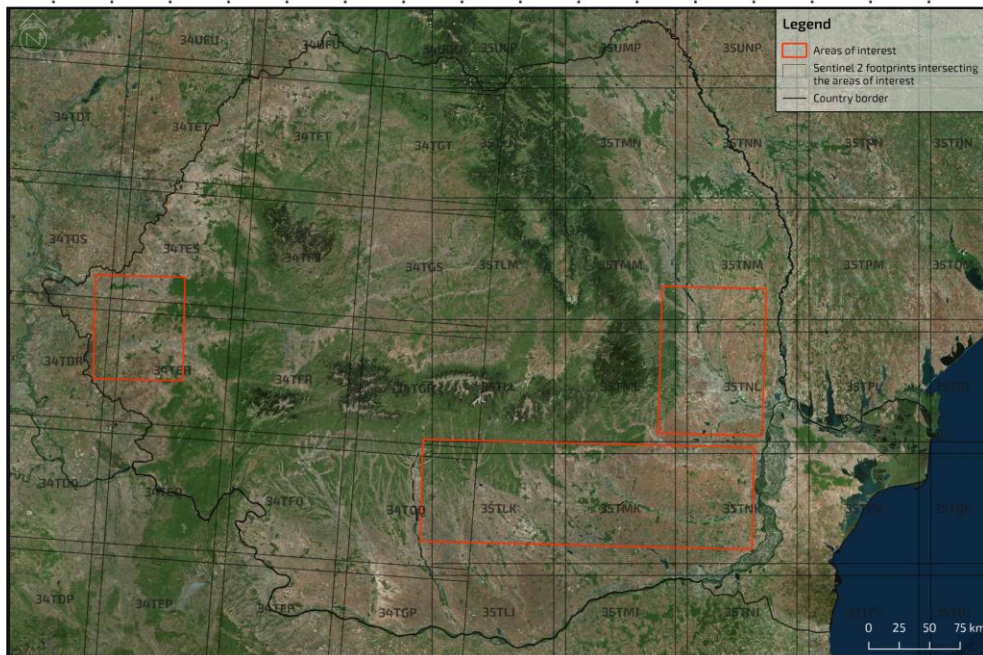
- 48 Partners
- 17 states (14 member states)
- 70+ associated partners
- 3 pilots focused on forestry, agriculture & fishery



Romania, CAP support monitoring

- ✦ Under the framework of DataBio project Terrasigna developed a CAP support monitoring service for 3 **areas of interest**
- ✦ The AOIs are located in the most representative agricultural areas
- ✦ **2 iterations:** 2017 and 2018
- ✦ 885.290 plots, 2.116.138 hectares
- ✦ **Representative sample.** The 3 AOIs sum up to **21%** out of the total **declared area** in Romania and **14%** out of the total number of **plots** registered under the CAP.
- ✦ Input **EO data:** Copernicus Sentinel-2 and LANDSAT
- ✦ Romanian National Projection System - Stereo 70 (EPSG 3844)

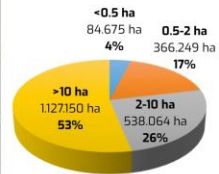




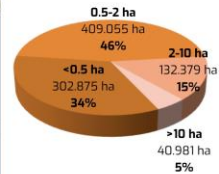
Legend

- Areas of Interest
- Sentinel 2 footprints intersecting the areas of interest
- Country border

Total area (ha)



Plots count

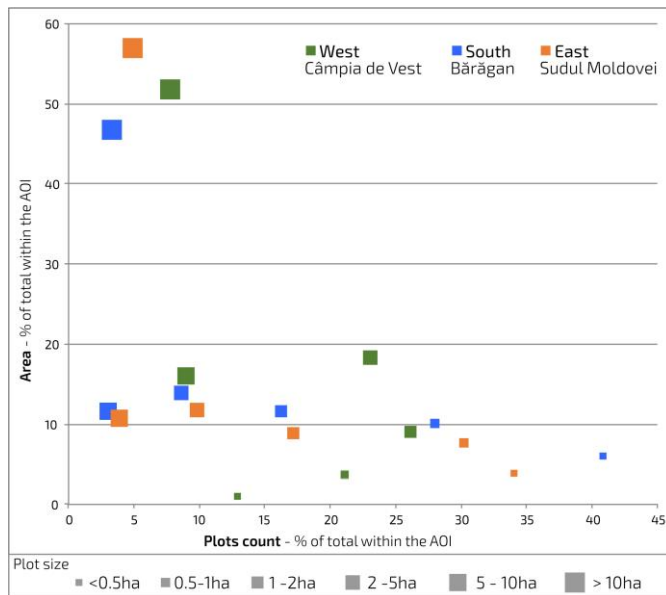


Plot average area
 East: 2.13 ha
 South: 2.90 ha
 West: 3.06 ha

Plot area	West (Câmpia de Vest)				South (Bărăgan)				East (Sudul Moldovei)			
	Count	% of total	Total area (ha)	% of total	Count	% of total	Total area (ha)	% of total	Count	% of total	Total area	% of total
< 0.5 ha	12583	13	3807	1	158316	34	45475	4	131976	41	35393	6
0.5 - 1 ha	20542	21	13613	4	140414	30	89427	8	90477	28	58784	10
1 - 2 ha	25447	26	33506	9	79780	17	103280	9	52395	16	67639	12
2 - 5 ha	22450	23	67649	18	45589	10	137111	12	27780	9	81106	14
5 - 10 ha	8707	9	59184	16	18115	4	125639	11	9738	3	67375	12
> 10 ha	7526	8	191331	52	22788	5	663585	57	10667	3	272234	47
Total	97.255	100	369.090	100	465.002	100	1.164.517	100	323.033	100	582.531	100

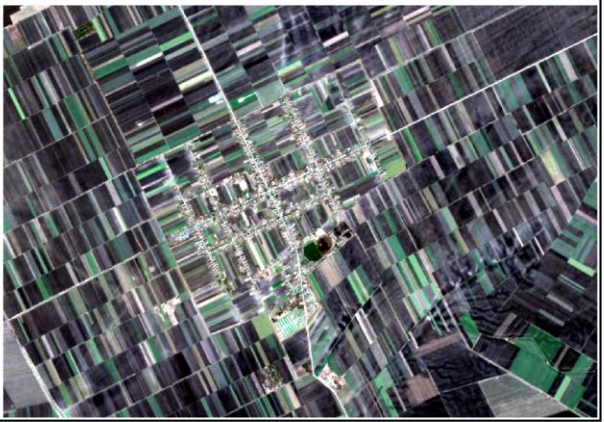
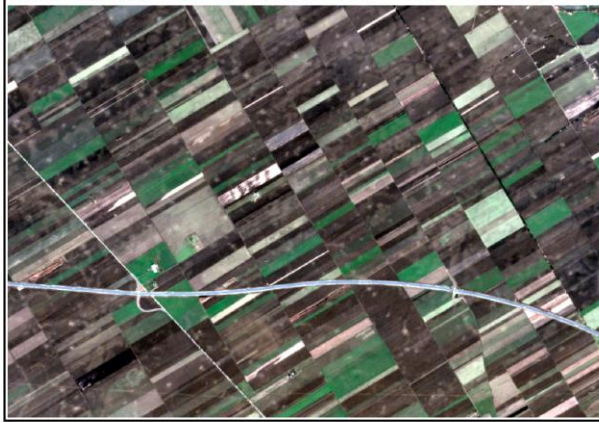
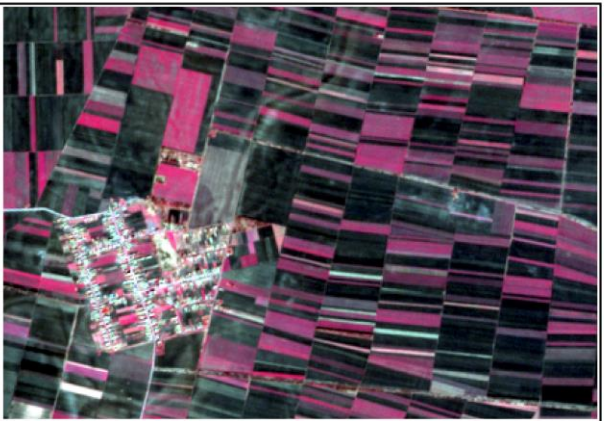
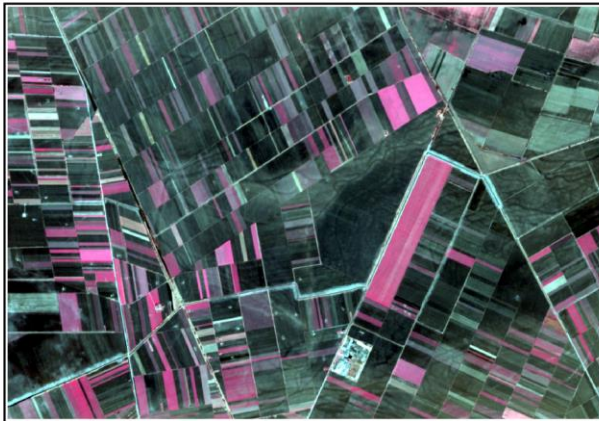
Romania, CAP support monitoring

- **Very small plots (< 0,5 ha)** account for a small total area (4%) despite their count (34.2%).
- **Small plots (0.5-2ha)** account for 17% of the total area and 46% of total count.
- **Medium plots (2-10ha)** account for 26% of the total area and 15% of total count.
- **Large plots (>10ha)** account for 53% of the total area and 5% of total count.



Total declared area and plots count within the 3 AOIs (2018)

Data Source: Agency for Payments and Intervention in Agriculture (APIA), Romania

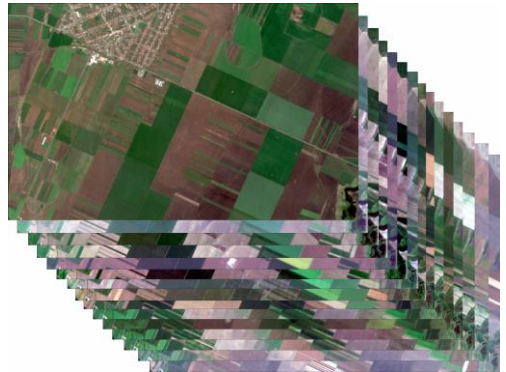


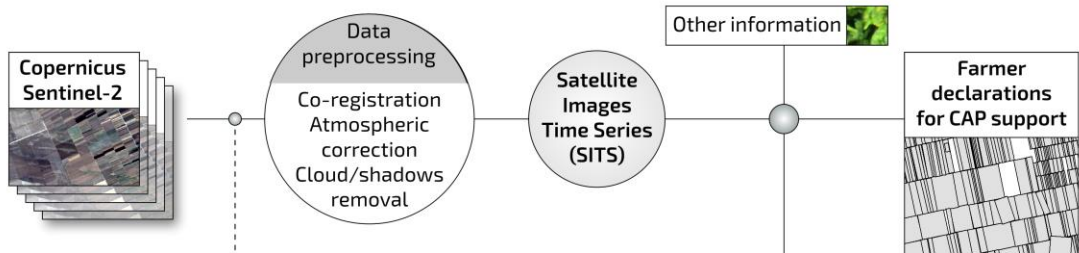
Romania, CAP support monitoring

- **New innovative approach developed by Terrasigna.**
- Input data:
 - ✦ Earth Observation data ingested as satellite images time series (SITS): Copernicus Sentinel-2 & LANDSAT
 - ✦ declared crop types - geometry + crop code (following APIA classification index)
- The classes of pixels with similar evolution are extracted from the SITS through a fuzzy-statistic approach. Each pixel receives a confusion matrix, expressing the probability of belonging to a specific crop type in every individual scene (i.e. at every observed moment).
- **The final results are observed crops maps and compliance maps of discrete levels of trust.** The level of trust can be expressed at pixel or parcel level. Low level of trust means that, from the algorithm's point of view, the current location (pixel or parcel) was cultivated with a different crop then the one declared. A high level of trust means that the observed crop matches the declared one.

Continuous **developments** and **improvements** over the last **4 years**

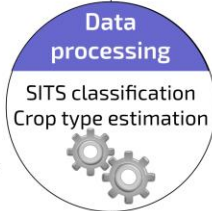
Version v.04 of the algorithm





Classes of pixels with similar evolution are extracted from the SITS through a fuzzy-statistic approach.

Each pixel receives a confusion matrix, expressing the probability of belonging to a specific crop type in every individual scene.



Customizable based on area, crop type etc.

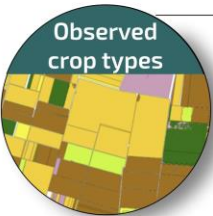
List of hotspots

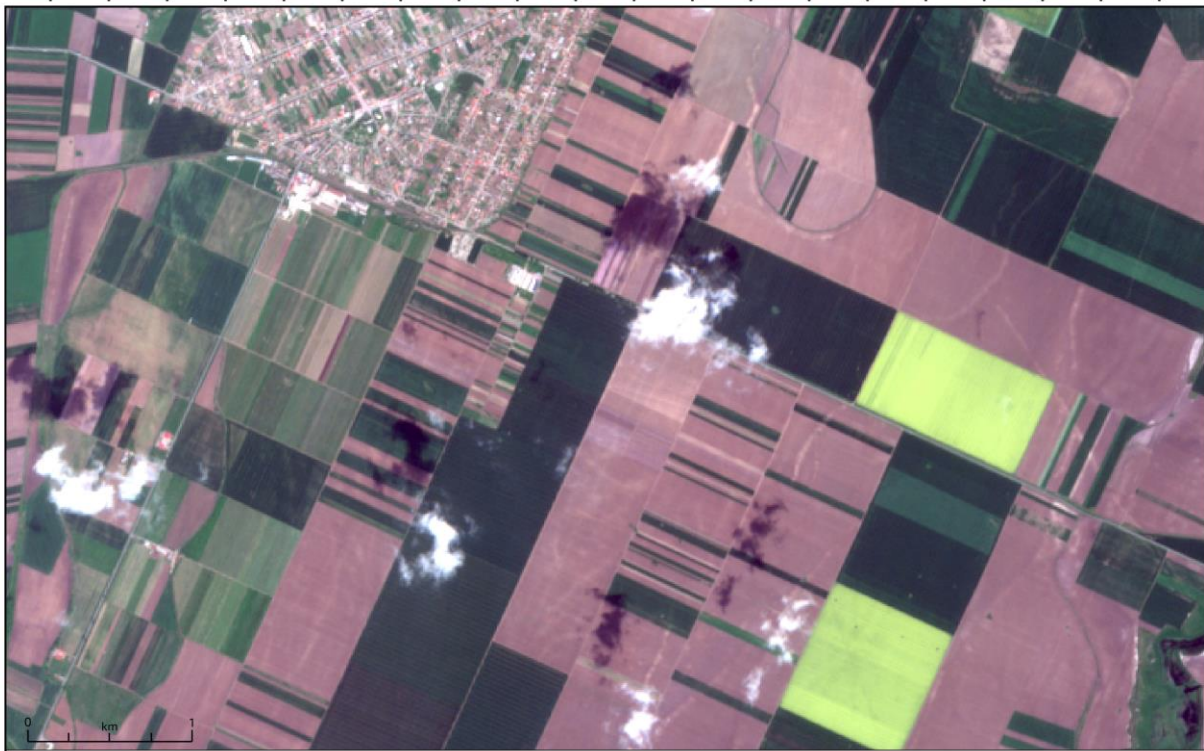


The main results are crops maps and compliance maps with discrete levels of trust. The information can be expressed at both pixel and plot level.



Low level of trust indicates a different crop comparing to the one initially declared.

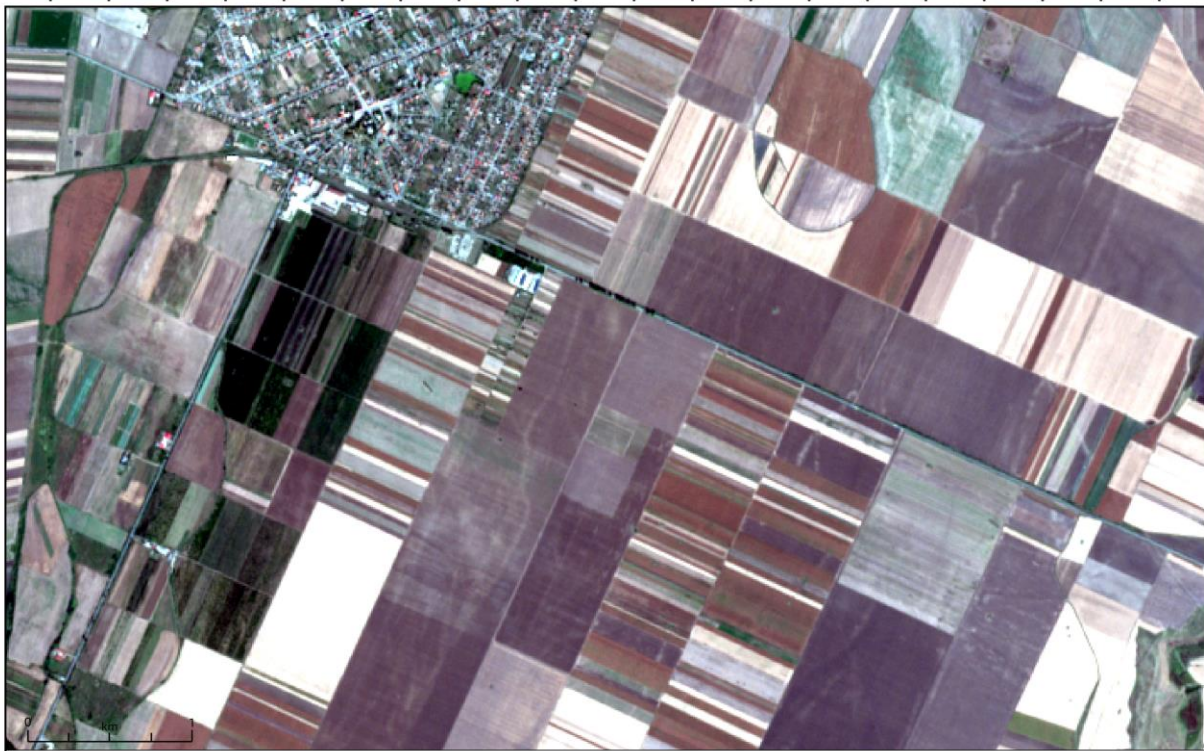




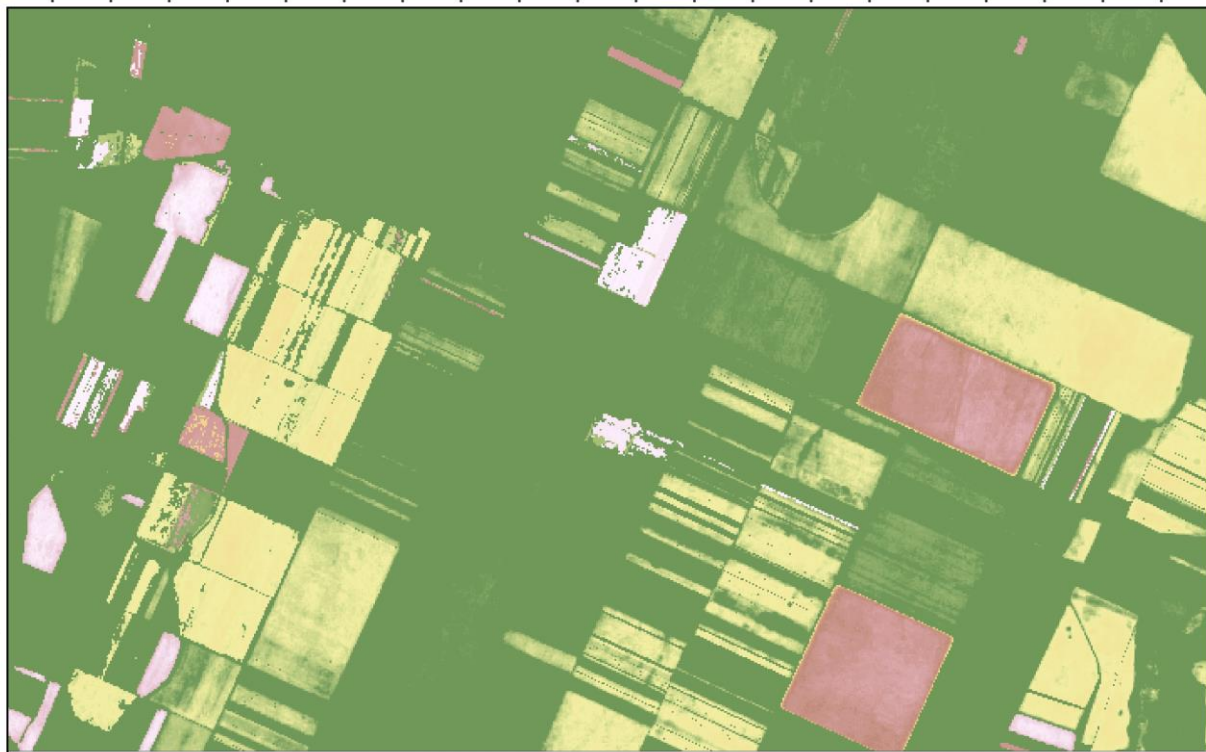
Background image: Copernicus Sentinel data, 2018



Background image: Copernicus Sentinel data, 2018



Background image: Copernicus Sentinel data, 2018

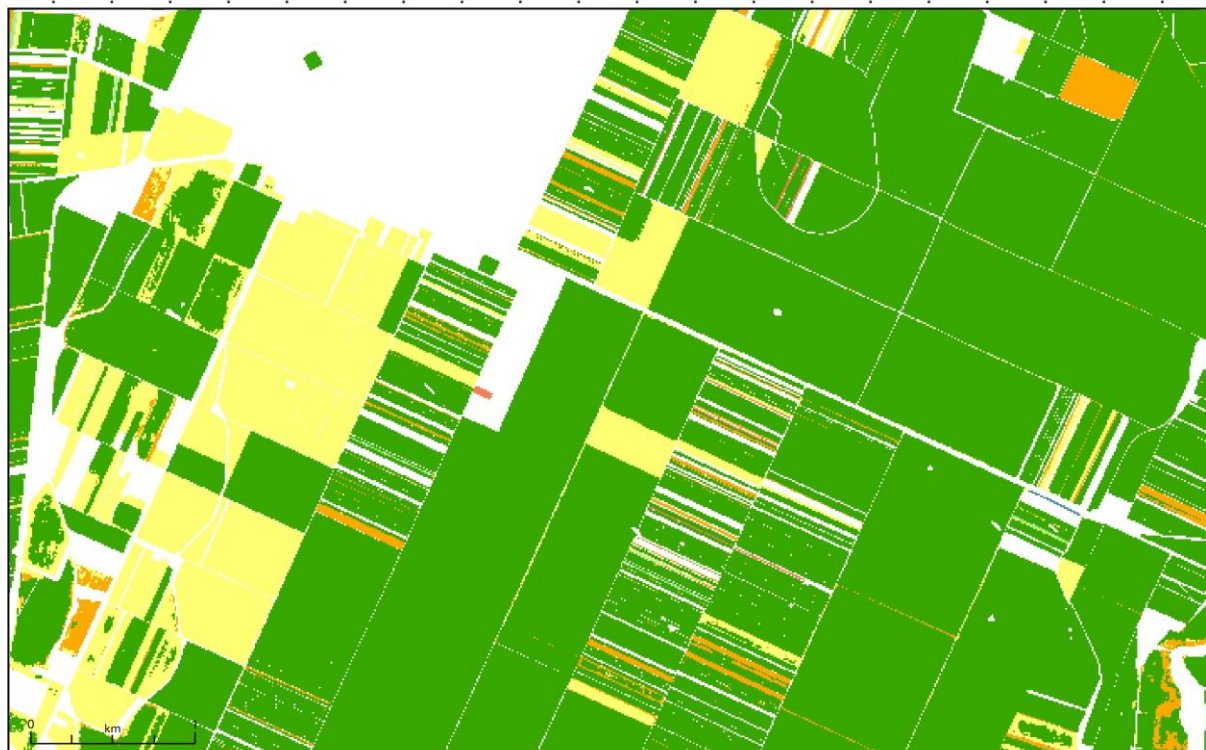


Classification confidence index



Observed crop types map





compliant (the result matches the farmer declaration)



insufficient evidence (not enough information for crop identification)



non-compliant (the result does not match the farmer declaration)



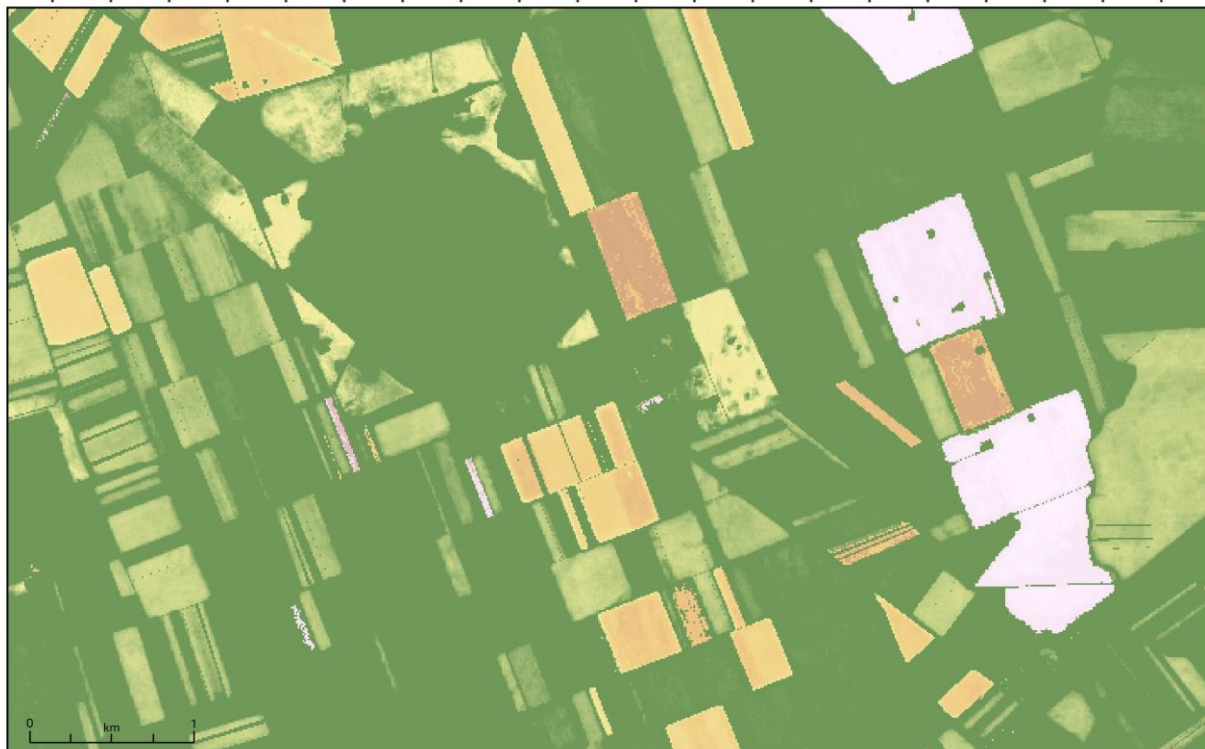
Background image: Copernicus Sentinel data, 2018



Background image: Copernicus Sentinel data, 2018



Background image: Copernicus Sentinel data, 2018

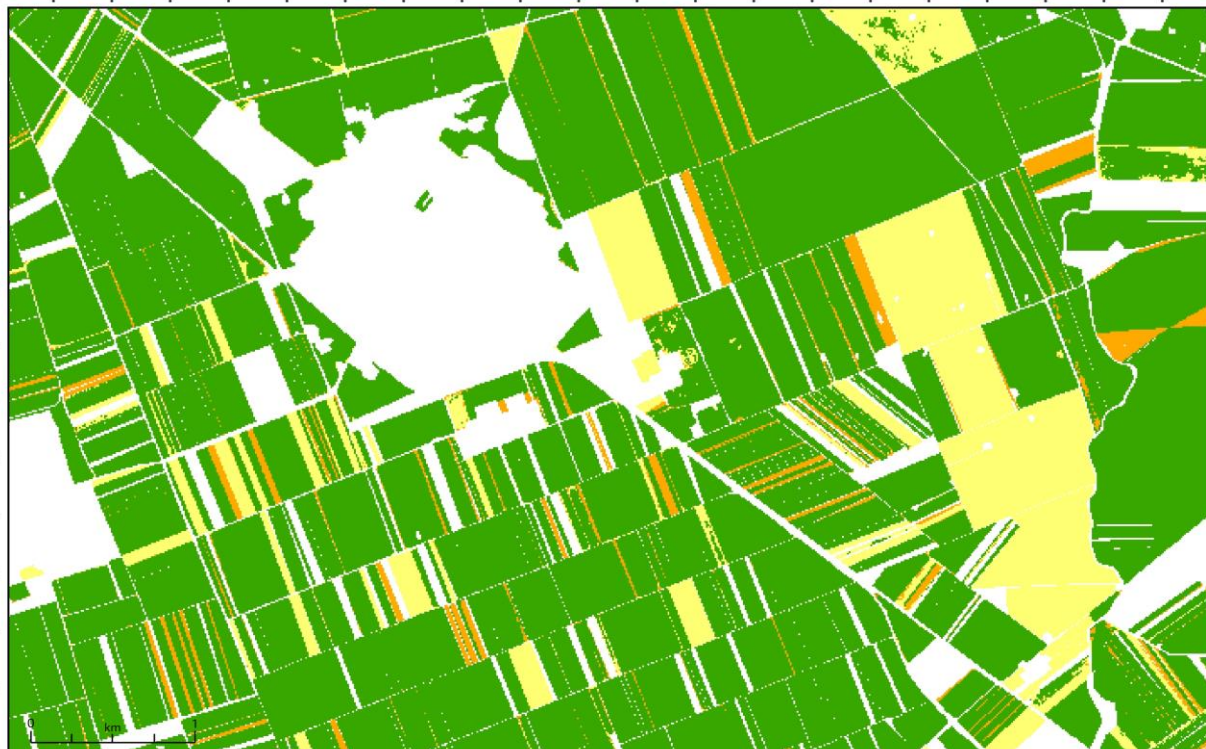


Classification confidence index





Observed crop types map





 **compliant** (the result matches the farmer declaration)

 **insufficient evidence** (not enough information for crop identification)

 **non-compliant** (the result does not match the farmer declaration)

Validation campaigns

	1. South, 2018	2. South, 2018	3. South, 2017	4. West, 2018
Validation data source	Ground truth data	Ground truth data	Ground truth data	Reference data
Sample size	46 plots, 1702 ha	66 plots, 278 ha	54 plots, 2640 ha	6406 plots, 77.221 ha
Number of crops	6	7	6	8
Overall accuracy	91.3%	97%	96.5%	98.3%

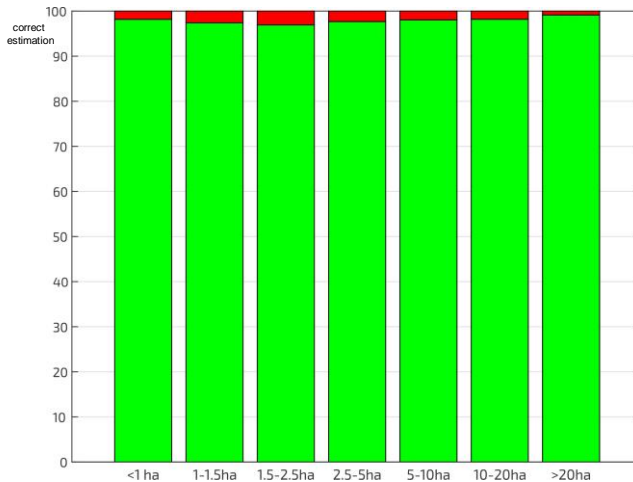
Validation using reference data

- **Reference plots** derived independently against VHRO, Sentinel-2 & other data sources
- **Independent validation** for all 3 AOI (only West completed so far!) against the declaration
- **Representative reference sample:** (West AOI) **6406 plots** (6.58% of total) summarising **77.221 ha** (21% of total)
- The validation focused on the **8 most predominant crops**. The 8 crops sum up to more than 90% of the total declared area
- The results are detailed for *7 plots classes*:
 - ✦ very small plots <1ha,
 - ✦ small plots: 1-1.5ha, 1.5-2.5ha,
 - ✦ medium plots: 2.5-5ha, 5-10ha, 10-20ha,
 - ✦ large plots: >20ha



Validation - overall conclusions all crops

- **Overall performance:** 98.3% correct estimations
- Increased performance for the large plots



Validation - winter wheat

- **Overall performance: 98.3% correct estimations, 0.73% omissions**

Plot class	Total declared area (ha)	Reference area (ha)	Correct estimation (%)	Omission (%)
< 1 ha	4773 ha	130 ha	99.1%	1.25%
1 - 1.5 ha	5232 ha	226 ha	98.6%	1.54%
1.5 - 2.5 ha	9963 ha	619 ha	97.5%	0.97%
2.5 - 5 ha	17913 ha	1919 ha	98.2%	1.27%
5 - 10 ha	18847 ha	3073 ha	98.5%	1.14%
10 - 20 ha	18808 ha	4494 ha	98.3%	0.60%
> 20 ha	48720	22208	99.4%	0.25%

Validation - overall results

	< 1 ha	1 - 1.5 ha	1.5 - 2.5 ha	2.5 - 5 ha	5 - 10 ha	10 - 20 ha	> 20 ha	overall performance
<i>Winter wheat</i>	99.1% N=130 ha	98.6% N=226 ha	97.5% N=619 ha	98.2% N=1919 ha	98.5% N=3073 ha	98.3% N=4494 ha	99.4% N=22.208 ha	98.7% omissions: 0.73%
<i>Maize</i>	99% N=22 ha	94.4% N=30 ha	90.7% N=81 ha	88.1% N=216 ha	90.1% N=396 ha	93.1% N=679 ha	99.1% N=4877 ha	93.7% omissions: 4.93%
<i>Sunflower</i>	97.8% N=25 ha	97.8% N=41 ha	99.6% N=109 ha	96.7% N=320 ha	99.3% N=664 ha	99.1% N=1008 ha	99.5% N=3663 ha	98.8% omissions: 3.99%
<i>Soybean</i>	100% N=4 ha	92.1% N=18 ha	90.1% N=41 ha	99.6% N=186 ha	99.9% N=558 ha	100% N=800 ha	100% N=2370 ha	99.3% omissions: 2.12%
<i>Rapeseed</i>	99.7% N=77 ha	99.6% N=93 ha	98.9% N=268 ha	99.6% N=811 ha	98.6% N=1107 ha	99.4% N=1633 ha	99.8% N=8346 ha	99.5% omissions: 1.16%
<i>Hayfields</i>	98.1% N=111 ha	97.3% N=165 ha	99.2% N=393 ha	99.2% N=1199 ha	99.1% N=2161 ha	99.5% N=3306 ha	99.5% N=7302 ha	99.3% omissions: 2.64%
<i>Peas</i>	n.a.	96.5% N=2.4 ha	100% N=4 ha	100% N=23 ha	100% N=75 ha	86.9% N=93 ha	100% N=348 ha	97.4% omissions: 1.44%
<i>Winter barley</i>	100% N=10 ha	100% N=3.5 ha	91.5% N=24 ha	95.3% N=58 ha	100% N=1477 ha	100% N=442 ha	100% N=1682 ha	98.7% omissions: 2.79%
<i>All crops</i>	97.8% N=336 ha,434 plots	97.4% N=543 ha,436 plots	96.6% N=1446 ha,722 plots	97.5% N=4454 ha, 1216 plots	98% N=8075 ha, 1109 plots	98.2% N=12.261 ha, 865 plots	98.2% N=50.106 ha, 1060 plots	98.3%

Conclusions and perspectives

- ✦ **Solid results** supported by the results of the validation campaigns
- ✦ **Full validation** for all 3 AOIs (2018)
- ✦ More **field campaigns** (2019)
- ✦ Implementation at **national level** (2019)
- ✦ **Trials in other countries / geographical areas** (?!)

An aerial photograph of a rural landscape featuring a complex, patchwork of agricultural fields in various shades of green and brown. A winding river or stream flows through the center of the image, creating a meandering path. The fields are separated by thin lines, likely roads or fences. The overall scene is a dense, textured mosaic of land use.

Thank you!

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