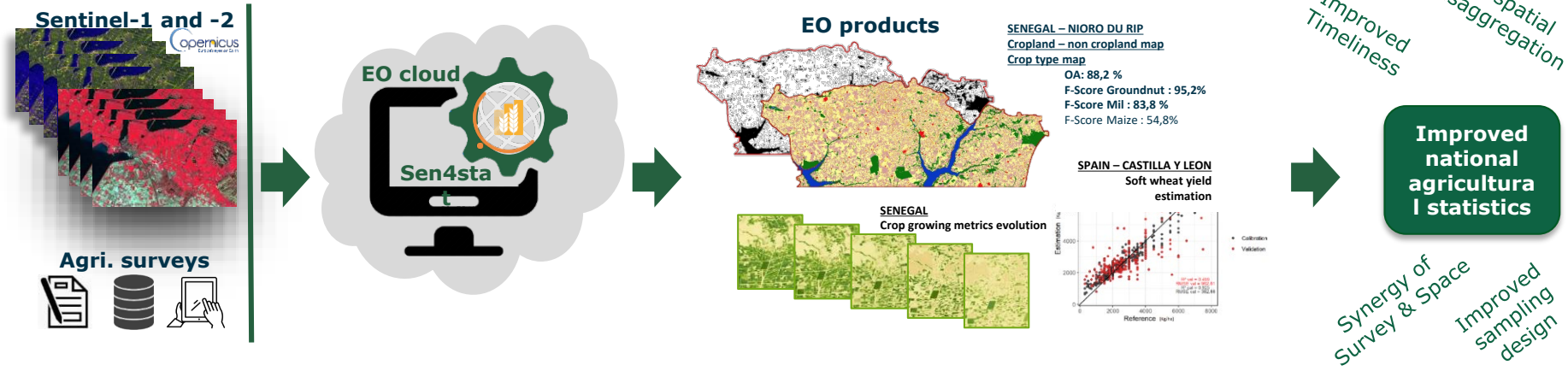
https://esa-sen4stat.org/

ESA project
“Sentinels for Agricultural Statistics”

NoR sponsorship 3314cf
Final report

ESA Sen4Stat – EO to support official agricultural statistics

- Timely and accurate information on food production to address food security challenge
- Potential of EO data recognized for decades but not demonstrated so far
- **Sen4Stat** project aims at
  - providing **validated algorithms** and **best practices** for agricultural statistics with EO **facilitating the uptake of EO information** in the National Statistical Offices (NSO)
  - **engaging NSO** to demonstrate the **benefit of EO information** within their operational workflows

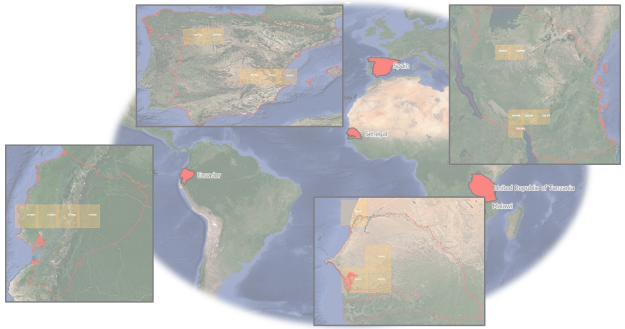


Project Phase 2: scaling-up to national scale for real-life demonstrations

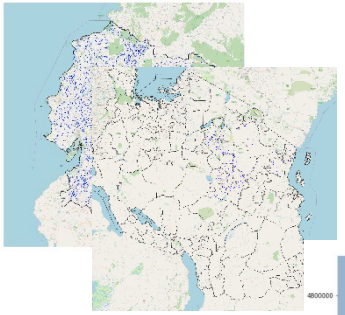
Methods development
Working on test sites

System demonstration
Up to national scale

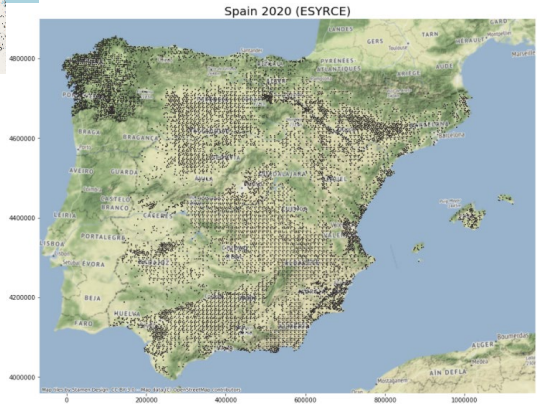
NoR sponsorship 3314cf



- Test sites all over the world
  - Run on local servers



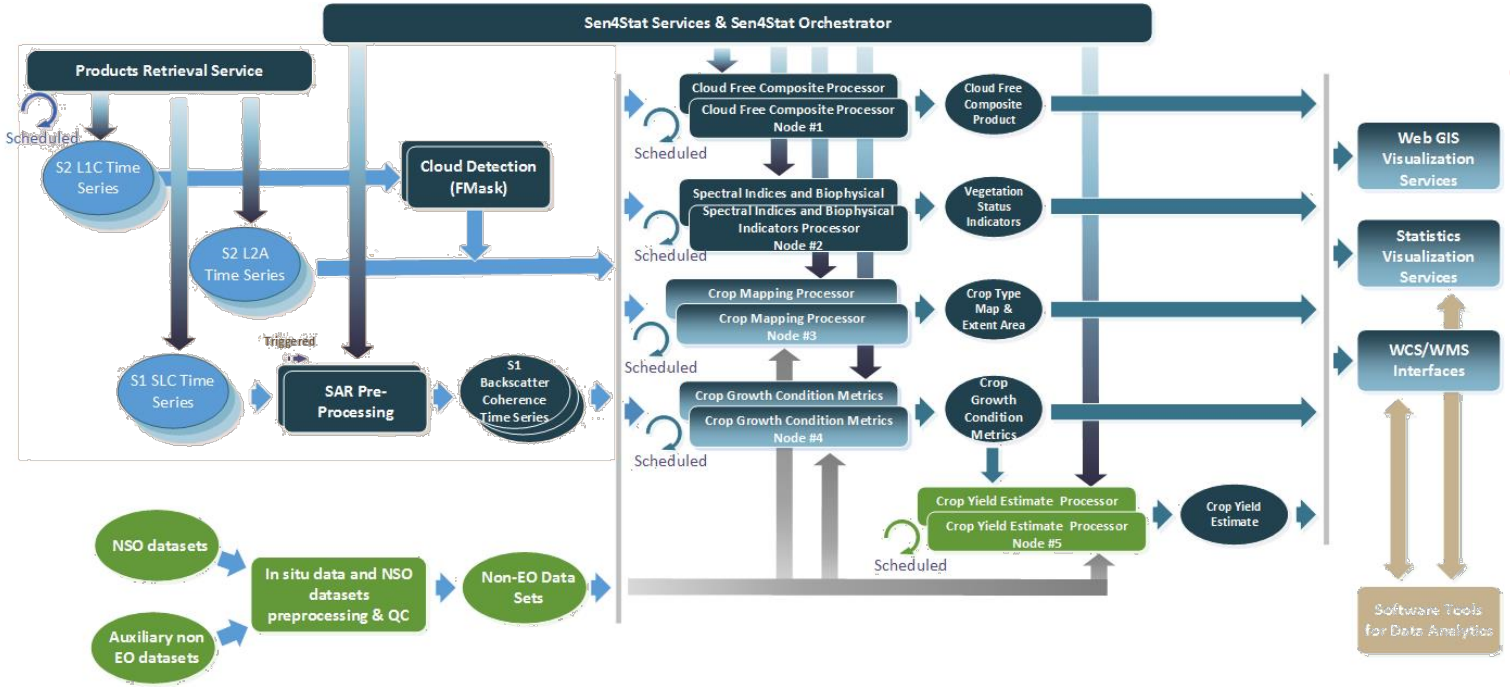
- From 2018 to 2020, depending on the country
- Sentinel-2 L1C & L2A + Sentinel-1 SLC full archive



Development of the Sen4Stat open source system

S-1 & S-2 full processing supporting the improvement of ag. Stats at national scale

Data access /download | Pre-processing In situ quality control | Processors of products | Analytics and visualization

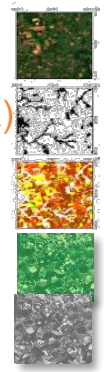


Version 2.0 available for download

Sen4stat toolbox

- Processing Sentinel-1, Sentinel-2 and Landsat-8&9
- Delivering 5 types of products (processors) :

1. **10m optical cloud free temporal synthesis and SAR temporal synthesis**
2. **time series of spectral indices** (NDVI, coherence,…) and **biophysical variables** (LAI, fCover, fAPAR)
3. **10m crop type maps** along the season based on in situ dataset and stratification
4. **a large set of crop growth conditions metrics** (including even meteorological data)
5. **crop yield estimation** at various aggregation levels (national, regional, …)



- EO products combined with statistical survey to improve statistics
- System operational for national scale, running automatically or on-request, in near-real time along the season or off-line, on the cloud or locally

Results in Spain – EO to improve estimates and support new sampling frame

	Data	Acreage (hectares)	Uncertainty		Sampling Error (CV%)	Relative efficiency
			95% Confidence Interval (hectares)			
			Limits	Amplitude		
Wheat (F-Score: 0,845)	Ground (ESYRCE)	1.652.141	Lw: 1.572.269 Up: 1.732.012	159.743	2,47	------
	Ground+RS	1.500.143	Lw: 1.472.431 Up: 1.527.854	55.423	0,94	8,312
Maize (F-Score: 0,965)	Ground (ESYRCE)	401.563	Lw: 338.013 Up: 465.111	127.098	8,07	------
	Ground+RS	365.367	Lw: 349.945 Up: 380.789	30.844	2,15	16,988
Sunflower (F-Score: 0,842)	Ground (ESYRCE)	579.599	Lw: 531.858 Up: 627.341	95.493	4,2	------
	Ground+RS	526.876	Lw: 513.882 Up: 539.870	25.988	1,26	13,51

STAT. GRANULARITY

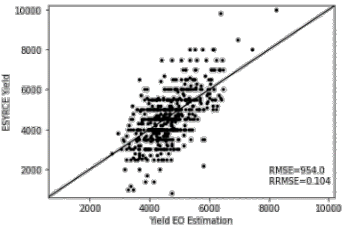
Barley acreage estimates at the municipality level in Zamora

Not available without EO

Municipality		Acreage	
		Has.	Error (CV%)
49020	Belver de los Montes	212.96	29.1
49043	Castroverde	2914.22	8.0
49156	Pinilla de Toro	963.30	10.0
49168	Quintanilla del Monte	466.65	20.3
49219	Toro	615.91	14.0
49235	Vezdemarbán	1358.22	12.6
49250	Villalpando	560.05	39.1
49252	Villamayor de Campos	1056.23	11.1
49260	Villanueva del Campo	784.03	13.2
49263	Villar de Fallaves	844.16	11.0
49267	Villardondiego	516.40	11.5
49270	Villavendimio	656.07	10.4
Total Zamora		10948.2	8.16

Acreage & Yield estimates

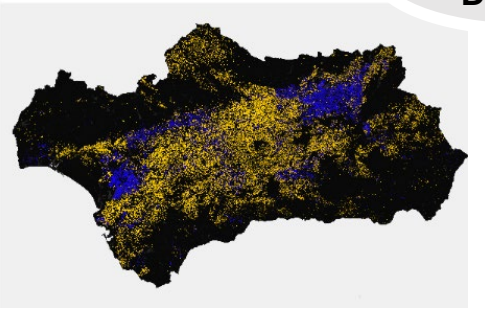
Reduced uncertainty



	ESYRCE			EO Yield Model		
	N	Mean	Sd	N	Mean	Sd
Àvila	107	4241.5	83.0	150	4232.4	34.9
Burgos	315	4826.8	64.9	446	4764.3	38.2
Leòn	37	3822.0	103.8	52	3817.5	57.0
Palencia	211	4602.1	32.3	302	4557.5	17.0
Salamanca	87	4155.8	63.1	122	4155.8	57.9
Segovia	206	4168.0	52.5	294	4134.1	35.4
Soria	192	3640.1	35.2	275	3542.6	26.8
Valladolid	320	4574.6	37.8	459	4531.1	26.5
Zamora	142	4586.8	65.0	204	4569.1	54.7
Castilla Y Leòn	1617	4426.5	16.5	2304	4391.9	14.0

Irrigation maps

SAMPLING DESIGN

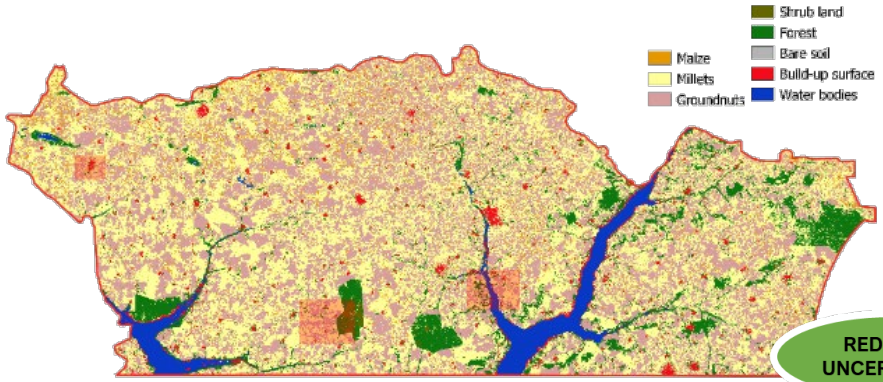


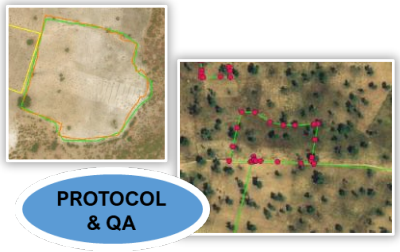
Results in Senegal – adjustment of agricultural survey protocol to facilitate the EO integration

More information needed for a powerful use of EO data supporting agricultural statistics

Pilot field campaign ongoing in Nioro du Rip Department:

1) Record fields area **and field boundaries**
2) Collect **non-cropland geographical information** (mandatory to discriminate between crop and non crop classes)
3) Collect additional information about **mixed crops**, **field heterogeneity** and presence of adventices
4) Take GPS coordinates of the crop-cutting plot for yield estimation



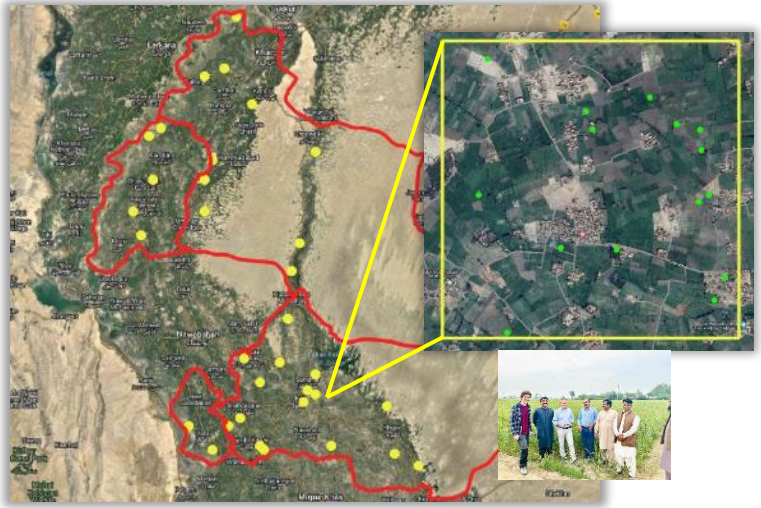


Crop type	Acreage (hectare)	Uncertainty	
		Standard error	Coefficient of variation (%)
Millet	89215	3661.103	4.11
Groundnut	78815	2923.94	3.71

Extension to 6 departments in 2023 (also targeting crop yield)

EOStat

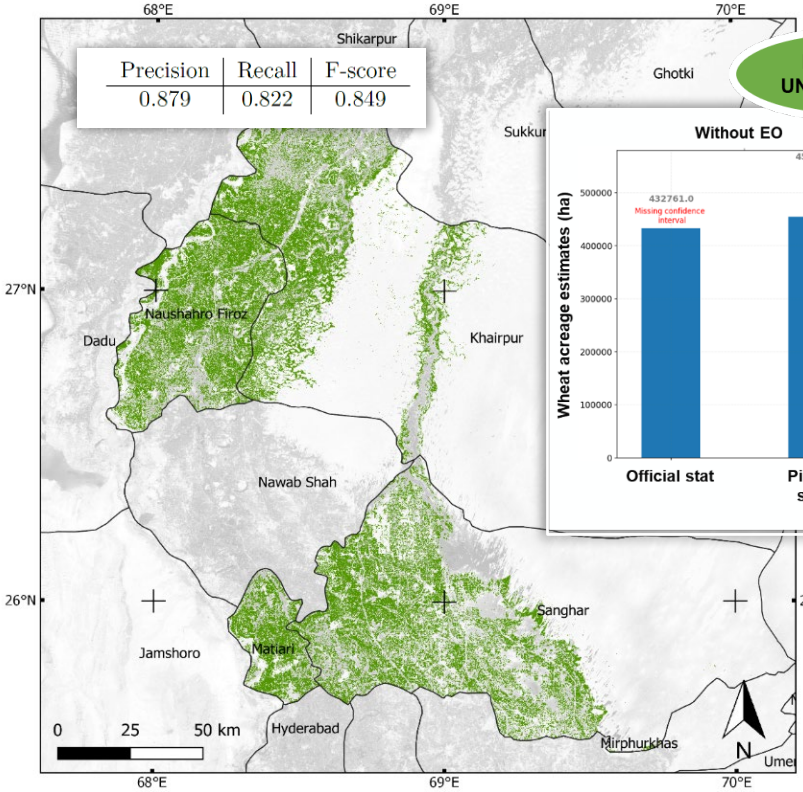
Results in Pakistan – EO for irrigated wheat acreage estimates in Sindh province (Rhabi season)



33 segments over 4 districts + windshield survey (March 24)

	Statistical Survey	Windshield Survey
Irrigated Wheat	208	726
Other Crop	87	448
Non Crop	238	495
Total	533	1707

PROTOCOL & QA



THE WORLD BANK

Sen4Stat on the cloud

- Sen4Stat open-source system developed to be run locally or on the cloud
- Cloud facilities:
  - Direct access to Sentinel data
    - No need to download (band width might be an issue in many countries)
    - No need to store
  - Direct access to the full archive of Sentinel data (>< SciHub)
  - Optimization of the resources during the production (dynamic allocation of resources, machines created and paid during production peaks only - more optimization targeted in the next phase)
- Precautionary measures:
  - Data privacy and security issues: agricultural surveys NSOs are very sensitive data => some reluctance to work on the cloud (specific protocol / cryptation would be an asset)
  - Clouds proposed in the NoR not always well-known in non European countries

Sen4Stat benefits for society

- Need of timely data on agricultural practices and natural resources
  - To support an increase of sustainable agricultural productivity
  - To monitor the Sustainable Development Goals (SDG) at the national level
  - To contribute to the agricultural markets transparency and support food security
- Agricultural monitoring at national scale is a pre-requisite for analyzing the agricultural resources and activities by mandated authorities (NSOs)
  - Most NSOs collect data through agricultural survey – costly !!
  - Potential of EO recognized for long but not yet adopted
- Most benefits will come from the mutual adjustment between in situ sampling (quantity, representativeness and quality) and innovative EO products
  - Sen4Stat demonstration phase to convince about EO benefit
  - Sen4Stat open source system & capacity building to facilitate the EO adoption

Next steps: wider uptake of the system

- System available for download
- Continuing and expanding system demonstration:
  - Spain, Senegal, Pakistan, Angola, Ethiopia, Mali, Rwanda, El Salvador, Philippines, Uganda, Tajikistan, Timor Leste (+Kenya TBC)
  - Support of FAO, World Bank, Asian Development Bank
  - Use case selection with each country - building on what is existing
- User community federation and capacity building: forum, trainings, improved documentation
- System improvement and maintenance

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