



UC1b Agro-environmental indicators

Stakeholder Forum, 10/12/2020

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1. NIVA's objectives

NIVA objectives

1. Harnessing innovations to simplify the governance;
2. Reducing socio-economic and administrative burden to farmers;
3. Reducing the gap between IACS data use and potential broader uses

=> including high ambitions to improve environmental conditions and mitigate climate change



1. UC1b OBJECTIVES

UC1b fundamental objectives

- Agricultural practices have a strong impact on environment
 - This impact should be measured to orient farming practices (farmers, advisers, providers, market) and to support environmental policies. (Decision making -> implementation -> monitoring)
- ⇒ **Need for agro-environmental indicators that could be available to farmers, agricultural advisers, policy makers, ONG...**
- ⇒ **Develop indicators, produce them on a large scale, test them with stakeholders in France (APCA, French Biodiversity Agency) and other EU countries (DK, NL, SP so far)**

List of Agro-Environmental Indicators

➤ We proposed 11 A.E. indicators addressing 3 CAP objectives and 5 categories of environmental issues related to:

- **Climate mitigation:** C budget, reduction of N fertilisers
- **Water quality:** nitrate leaching, pesticides, herbicides, fungicides
- **Biodiversity:** biodiv. conservation, biological control, pollination
- **Soils:** quality, erosion
- **Landscapes:** aesthetic value



➤ For each type of indicator we propose between 1 and 3 methods of calculations: TIERS 1 to 3. All of them are evidence-based, published and several were adapted from the H2020 DiverImpacts project (scoring systems from 0 to 1),

➤ Three were considered as a priority by the DG Agri, DG Climate and the Ministries of Agriculture (red boxes).

Carbon budget Indicators

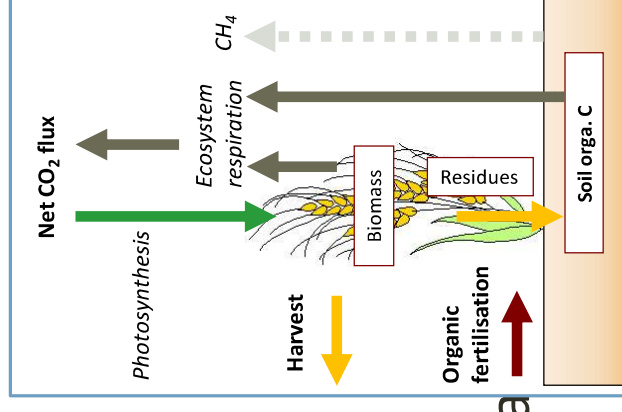
- Are calculated for each cropping year (at 10m/plot level), but can be summed over several years (crop rotation),
- 3 TIERS:
 - TIER 1 (a proxy) and TIER 2 (C budget) are based on empirical approaches and can be applied to most crops species except rice,
 - TIER 3 is based on the SAFY-CO2 crop model assimilating LAI derived from Sentinel 2 data → allows other indicators to be calculated (biomass, yield, CO₂ fluxes...) but only for 4 crops species (wheat, sunflower, maize and soon rapeseed) + cover crops at this stage.

- A similar conceptual approach:

$$\text{C budget} = \text{Net CO}_2 \text{ flux} - \text{C harvested} + \text{Org. manure}$$

ecosystem convention

- Approaches have been discussed with JF Soussana (vice CEO of INRAe, member of IPCC, coordinator of CIRCASA)





Carbon budget Indicators

➤ Empirical approaches: plot level/annual → most crop species

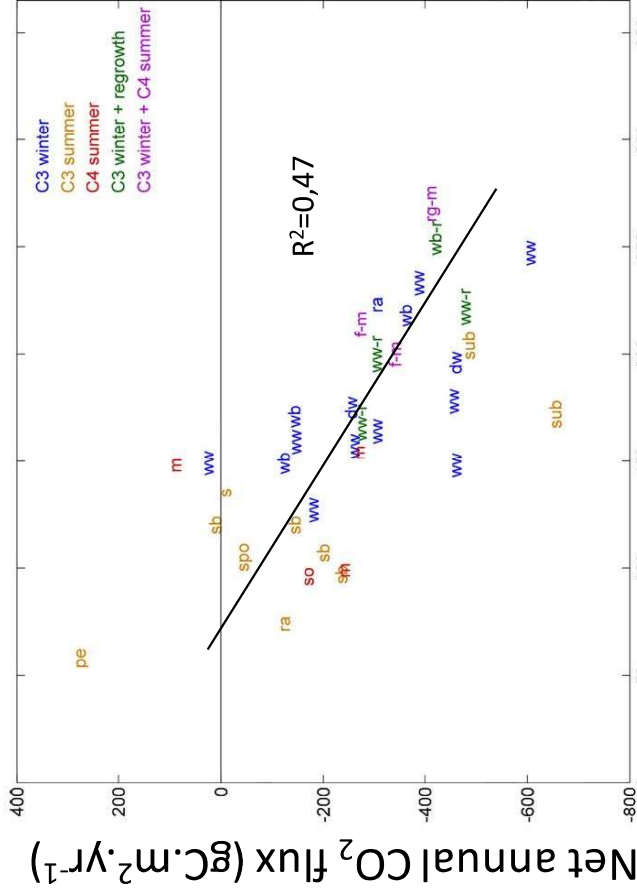
TIER 1

$$C \text{ budget} = \text{Net CO}_2 \text{ flux} + C \text{ harvested} - \text{Org. fertil.}$$

CO₂ release

Net annual CO₂ flux (gC.m⁻².yr⁻¹)

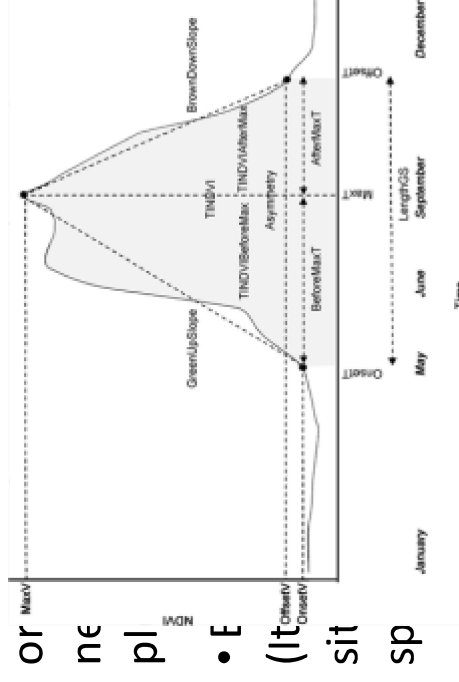
CO₂ fixation



Number of days with active vegetation/year

Ceschia et al. (2010)

- Reflects the effect of soil coverage (depending on the crop species and the presence of the crop)



- The longer soil coverage, the better (same conditions) as the French data (NDVI dynamics) expertise; (It is estimated from Sentinel 2 data (47,000 dynamics) Perren et al., 2019)

Perren et al., 2019

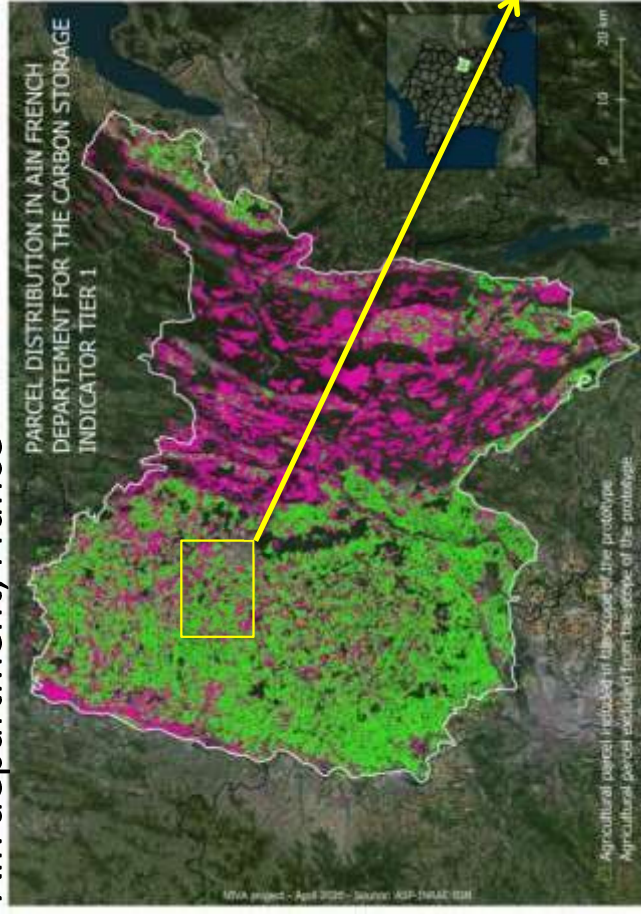


Carbon budget Indicators

➤ Empirical approaches: plot level/annual ➔ most crop species

TIER 1 Operational tool in test phase

Ain department, France



CO2 Flux Calculator

1. Enter csv file:
Select the File:

2. Enter threshold (Between 0.1 and 0.9):
Threshold:

3. Enter data range (Optional):
 Analyse the data over a defined period of time
Period start:
Period end:

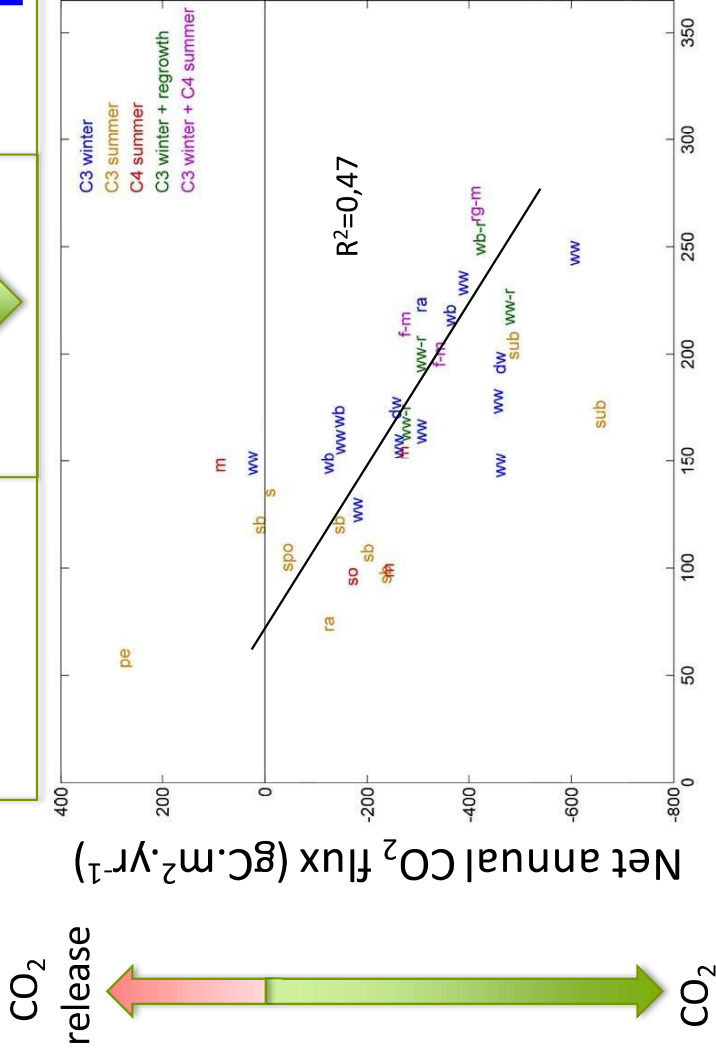
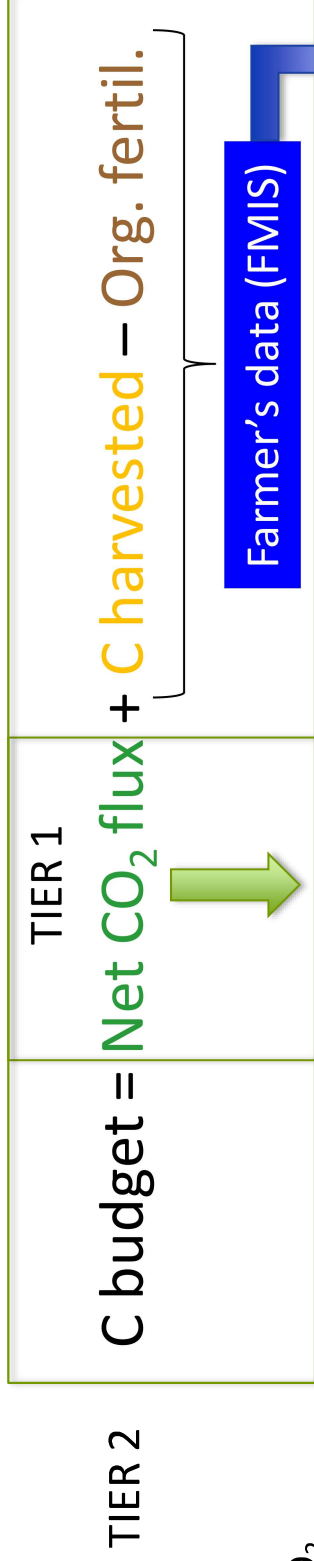
4. Process:
CSV:
Threshold:

The right side of the image shows a map view with a legend for 'INDICATEUR DE PERIBILITE' with a color scale from 0.0 to 10.0. The map displays a dense grid of agricultural parcels, with a yellow box highlighting a specific area that is magnified in the adjacent figure.



Carbon budget Indicators

➤ Empirical approaches: plot level/annual → most crop species

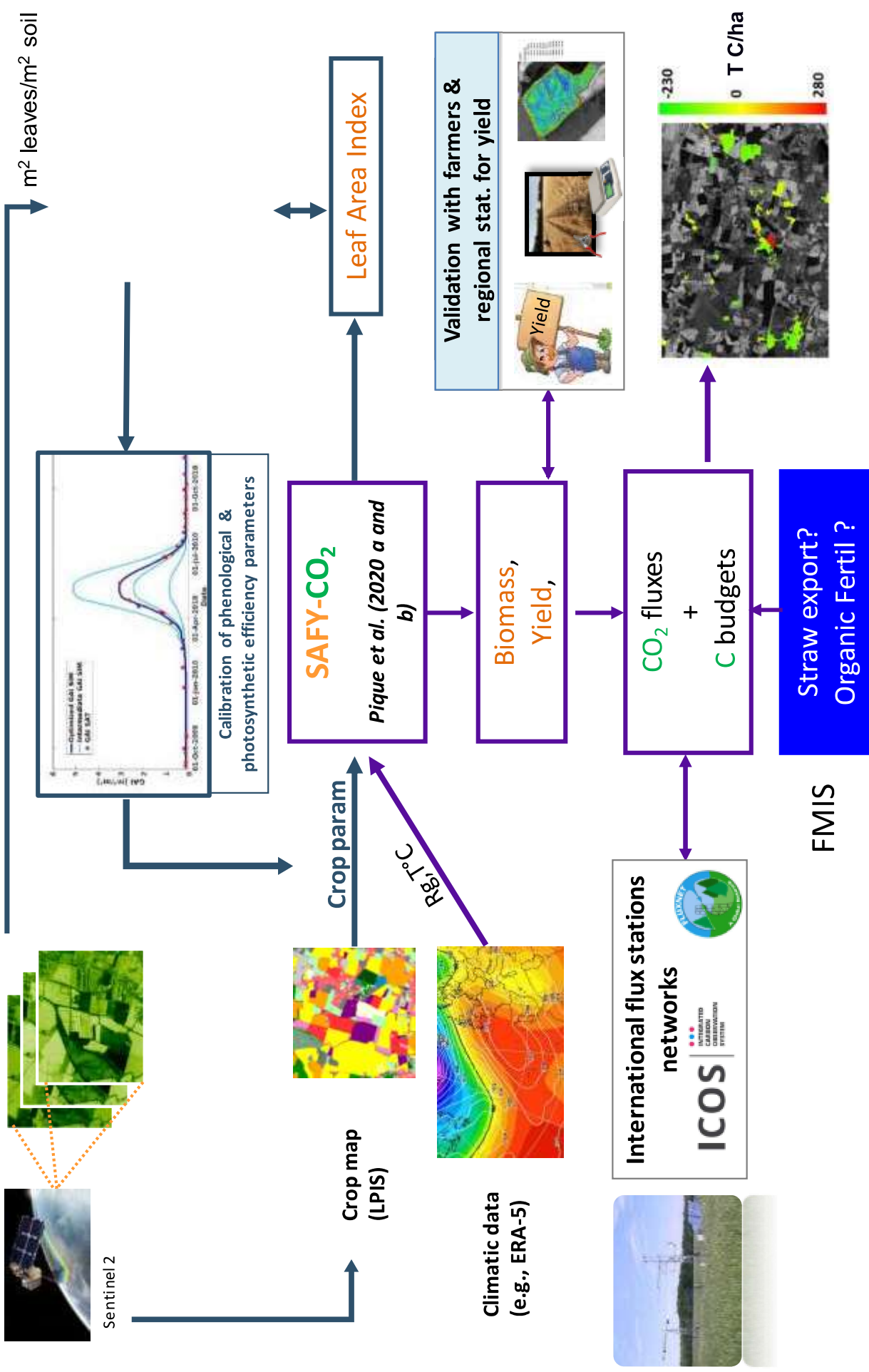


• What do we need to know from the farmers?

- C harvested:
 - yield (grain t/ha)
 - eventually the amount of straw/cover crop exported (t/ha),
- Are organic amendments applied? If yes:
 - type of amendment,
 - amount (t/ha).

Carbon budget Indicators

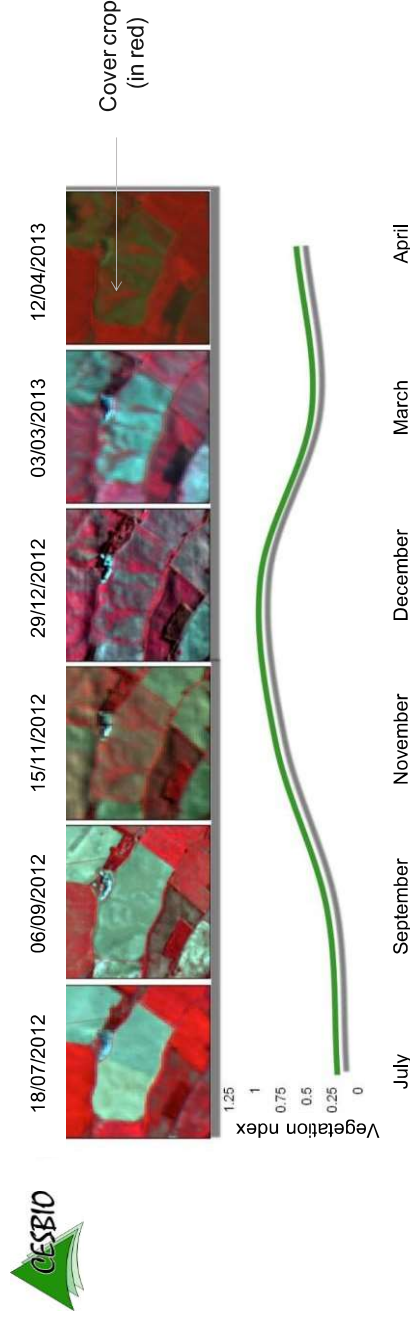
➤ TIER 3, modelling approach: SAFY-CO2



Carbon budget Indicators

TIER 3, modelling approach: SAFY-CO2

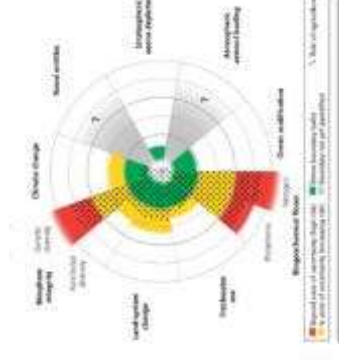
- This modelling approach was developed in the perspective of the Sentinel data,
- Need very few field data → suited for large scale applications at plot level, but only for a few crop species (wheat, maize, sunflower, rapeseed) + cover crops → to be applied in combination with TIER 2,
- Accounts for the « true effect » of crops/cover crop/regrowth/weeds development on the C budget (only approach that allows it),



- Analysis of large scale transposability during NIVA (research tool → operational MRV tool) → potential use for agricultural C market/Low C label...

Nitrate leaching indicators

- **N biogeochemical** flows exceed planetary boundaries with a major role of agriculture (Campbell et al. 2017) -> N leaching



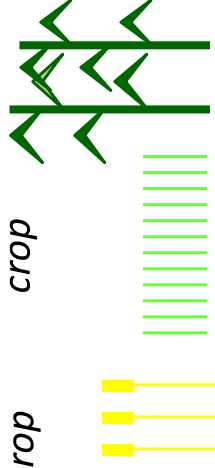
- **Main drivers** to consider (Beaudoin et al., 2005)

Climate, soil



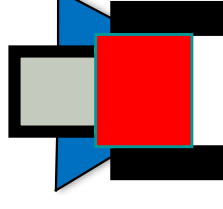
Crop rotation

Previous crop Catch crop Crop



N management

N surplus *N timing*



- **Which indicator?**

- Limits of “classical” nitrogen surplus indicator (Bockstaller et al. 2015)
- **New approach from DiverImpacts** based on literature (e.g. Beaudoin et al. 2005)

Nitrate leaching indicators

➤ Are calculated for each couple previous/current cropping year at plot level, but can be summed at rotation scale

➤ **2 TIERS:**

➤ **TIER 1:**

➤ Scoring method (between 0 and 1)

Crop rotation

Previous crop



IACS data

Mineralisation

crop residue soil after

previous crop (X2)

Catch crop



Sentinel data 1 & 2

N uptake

Crop

Catch crop

Presence of CC
Development intensity
F factor

Crop



IACS data

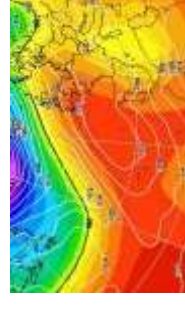
➤ **TIER 2:**

➤ Weighting factor (between 0 and 1)

Type of catch
Crop (FMIS)



Soil climate



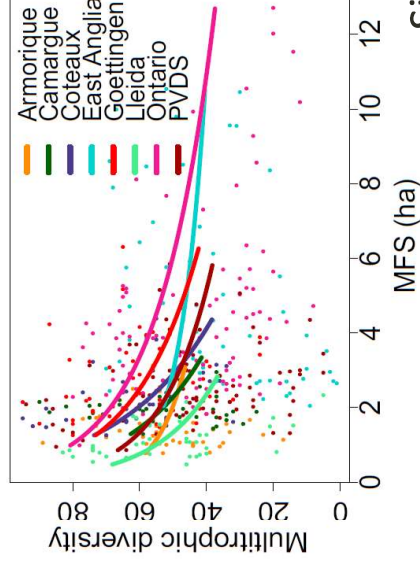
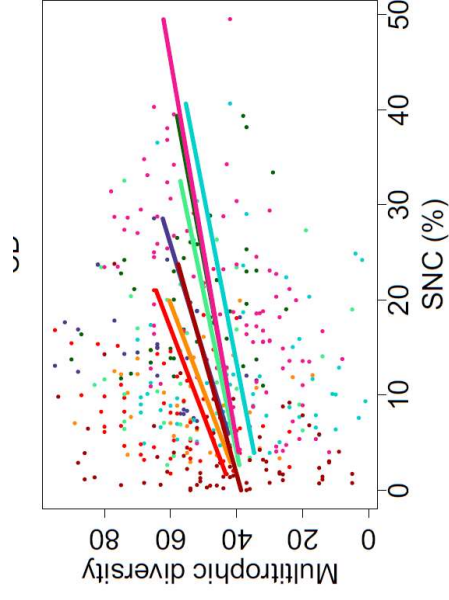
External data
Weather-soil map

Data needed

Biodiversity indicator



- **Method principle:**
 - ✓ There is a good correlation between landscape structure + practices and biodiversity
 - ✓ Biodiversity is correlated with pollination, biological control, cultural services
 - ✓ FarmLand project on multidiversity (synthetic index plants, arthropods, birds) in 8 regions and 5 countries



Biodiversity indicator

- **Calculation levels:**

Indicator will be assessed at the **landscape level**

+ **farm level** = potential contribution of the farm to landscape heterogeneity and biodiversity levels



- **Calculation period:**

- A cultural year
- Mid-October (year n-1) to mid-October (year n)

- **Variables:**

Semi-natural habitats



Including Agro-ecological infrastructures

Grassland



Including fallows

Crop diversity

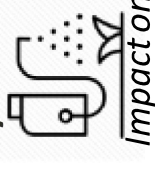


Including catch crops

Field size



Practices
(organic/conventional)



Weeds

Natural enemies

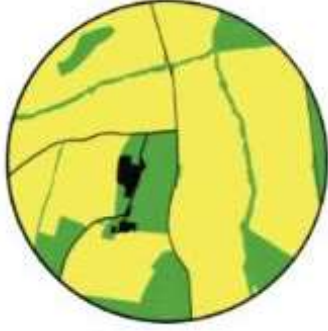
Pollinators etc...

Biodiversity indicator

- **Input data**
 - LPIS: field size + crops + grassland and fallow land + organic
 - Topographical data: semi-natural features

➤ **TIER 1:** proportion of SNH

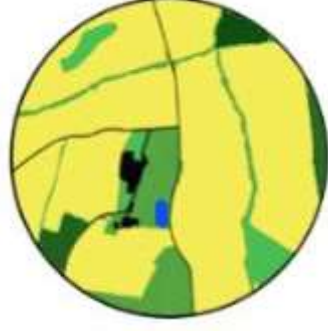
Prop of Semi-Natural Habitats



Agro-ecological infrastructures
Crops + cover crops
Artificial surfaces (buildings...)

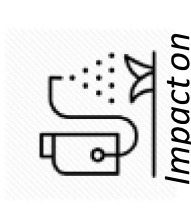
➤ **TIER 2:** proportion + type of SNH
(Advanced TIER 2: + farming intensity)

Prop+Type of SNH



Woods, hedges, grasslands, ponds...
Crops + cover crops
Artificial surfaces (buildings...)

Farming intensity



Weeds



Natural enemies
Pollinators etc...

Biodiversity indicators

- Preserve landscape and biodiversity (Obj. 3 of new CAP) to promote pollinators services (Hass et al. 2018), biological control (Rush et al. 2010), crop production (Dainese et al. 2019), cultural services (Assandri et al. 2018)

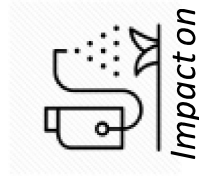


- **Indicator will be assessed at the landscape level**

+ farm level = contribution of the farm to landscape and biodiversity levels in a given context

- **Main drivers to consider** (Holland et al. 2017, Sirami et al. 2019):

Farming intensity	Type of crop and rotation	Field size	Crop diversity	Semi-natural habitats (SNH)
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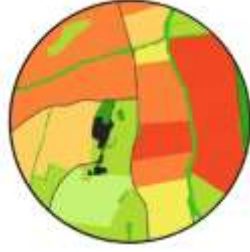
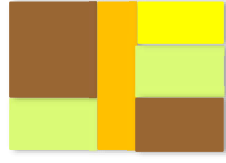
Weeds



Including fallows



*Natural enemies
Pollinators etc...*



Including Agro-ecological infrastructures

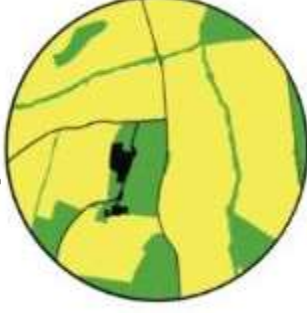


Biodiversity indicators

➤ 2 TIERS:

➤ **TIER 1:** proportion of semi natural habitat (SNH)

Prop of SNH



Agro-ecological infrastructures
Crops + cover crops
Artificial surfaces (buildings...)

➤ **TIER 2:** proportion of SNH + diversity of SNH

Prop/type of SNH

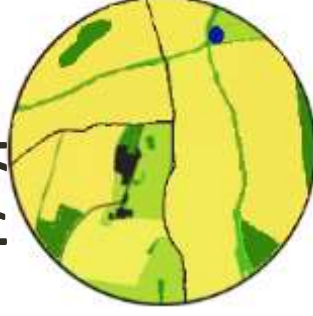


Woods, hedges, grasslands,
ponds...
Crops + cover crops
Artificial surfaces (buildings...)

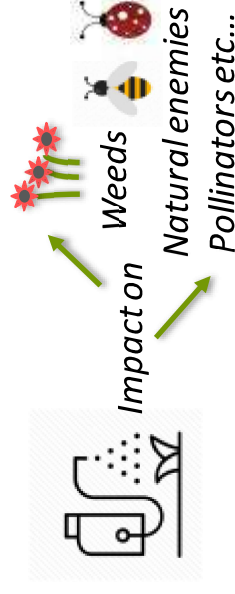
Optional

➤ **TIER 3:** proportion of SNH + diversity of SNH + farming intensity

Prop/type of SNH



Farming intensity





Conclusions

- We are working on 3 indicators that could be implemented operationally at plot/landscape levels all over Europe and then aggregated at relevant level,
- They address 3 objectives of the CAP and 3 categories of environmental issues/ecosystem services,
- TIER 1 approaches could easily be implemented everywhere thanks to the IACS data + the Sentinel data → use of the new Copernicus services (i.e. Phenology, Cropland),
- TIERS 2 and 3 are more complex to implement (require FMIS and/or external data) but they offer higher levels of accuracy/reliability,
- The 3 indicators will be implemented on test areas (France, Spain, Denmark...) within the frame of the UC1b of the NIVA project.



THANKS for Your attention !



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