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UC1b Agro-environmental indicators

Stackholder Forum, 10/12/2020

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ASP : Ludovic Arnaud, Emmanuel De Laroche



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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,

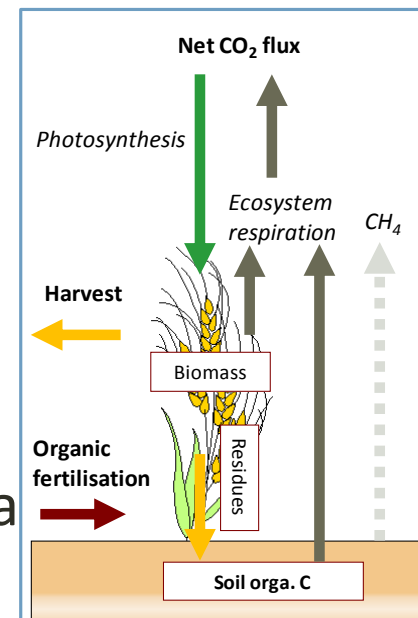
– TIER 3 is based on the SAFY-CO2 crop model assimilating LAI derived from Sentinel 2 data ➔ allows other indicators to be calculated (biomass, yield, CO₂ fluxes...) but only for 4 crops species (wheat, sunflower, maize and soon rapeseed) + cover crops at this stage.

➤ 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

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

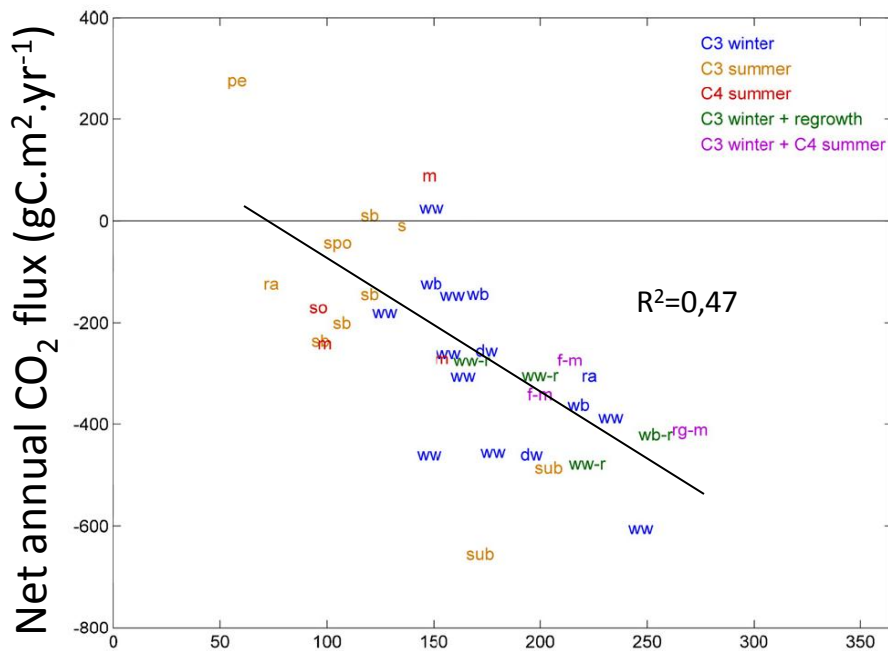
TIER 1



CO₂ release



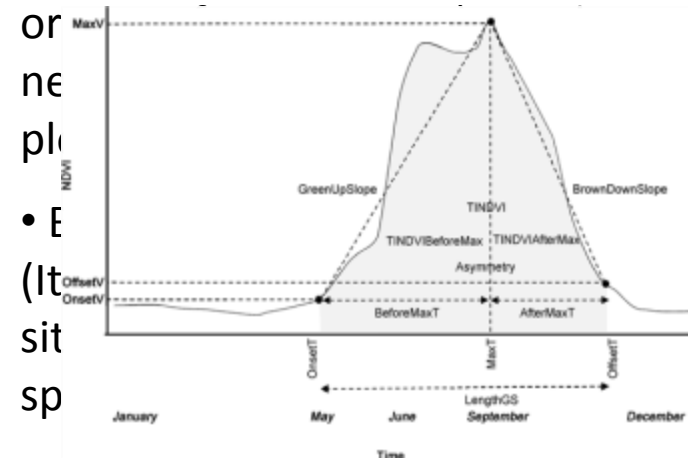
CO₂ fixation



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 cover crops)



- The longer soil coverage, the better (same conclusion as the French 4/1000 expertise; *Pellerin et al., 2019*).



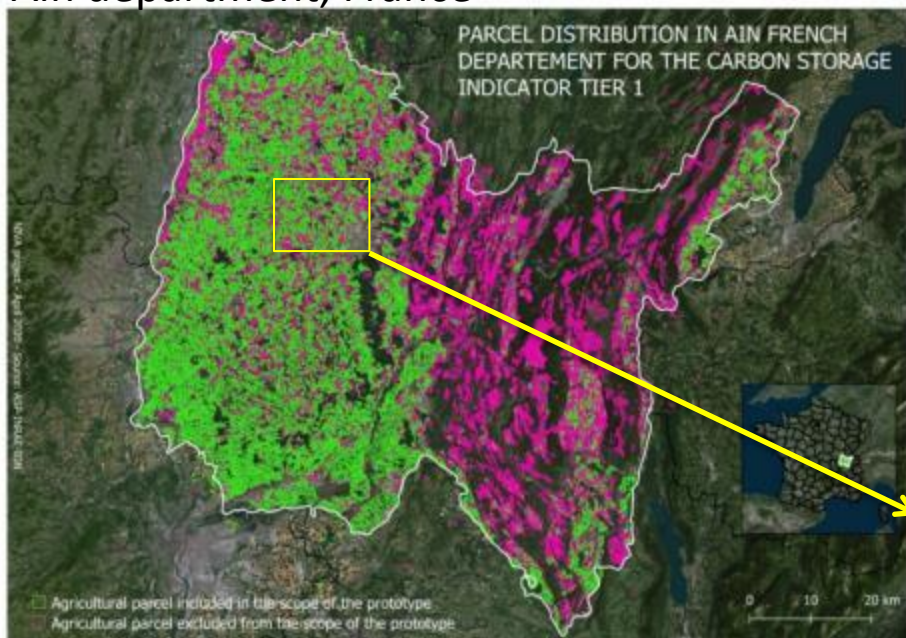
Directly estimated from Sentinel 2 data (NDVI dynamics → Copernicus Phenology service)

Carbon budget Indicators

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

TIER 1 Operational tool in test phase

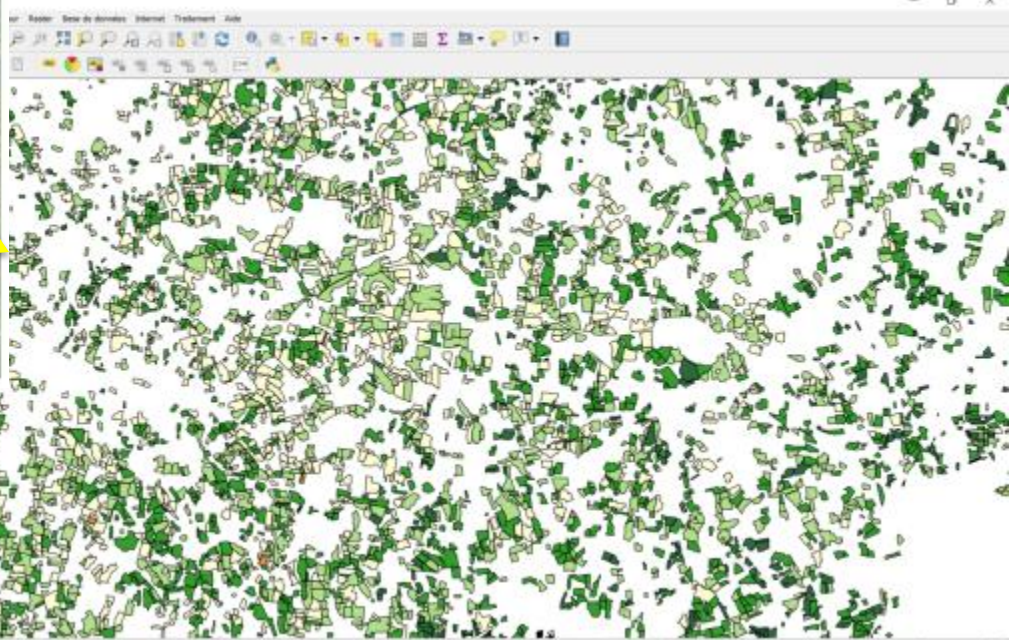
Ain department, France



CO2 Flux Calculator

1. Enter csv file :
Select the File : Browse ...
2. Enter threshold (Between 0.1 and 0.9) :
Threshold : Submit
3. Enter data range (Optional) :
 Analyse the data over a defined period of time
Period start :
Period end : Submit
4. Process :
CSV :
Threshold :
PROCESS

EXIT



Carbon budget Indicators

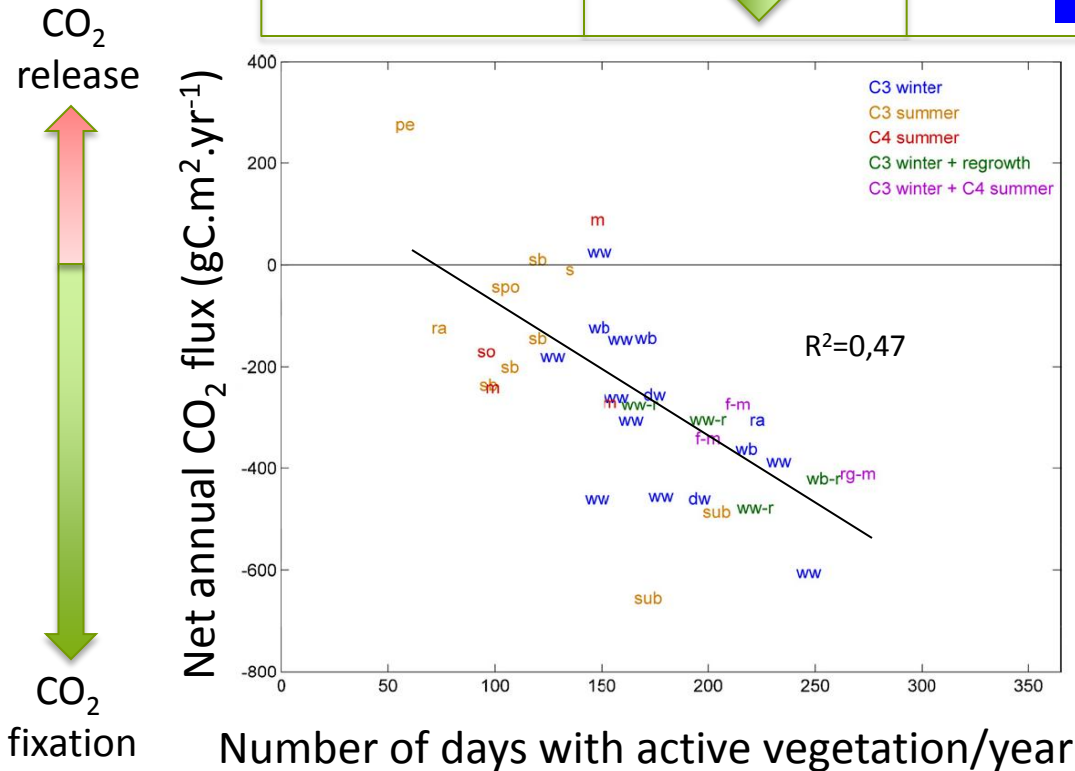
➤ Empirical approaches: plot level/annual → most crop species

TIER 2

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

TIER 1

Farmer's data (FMIS)



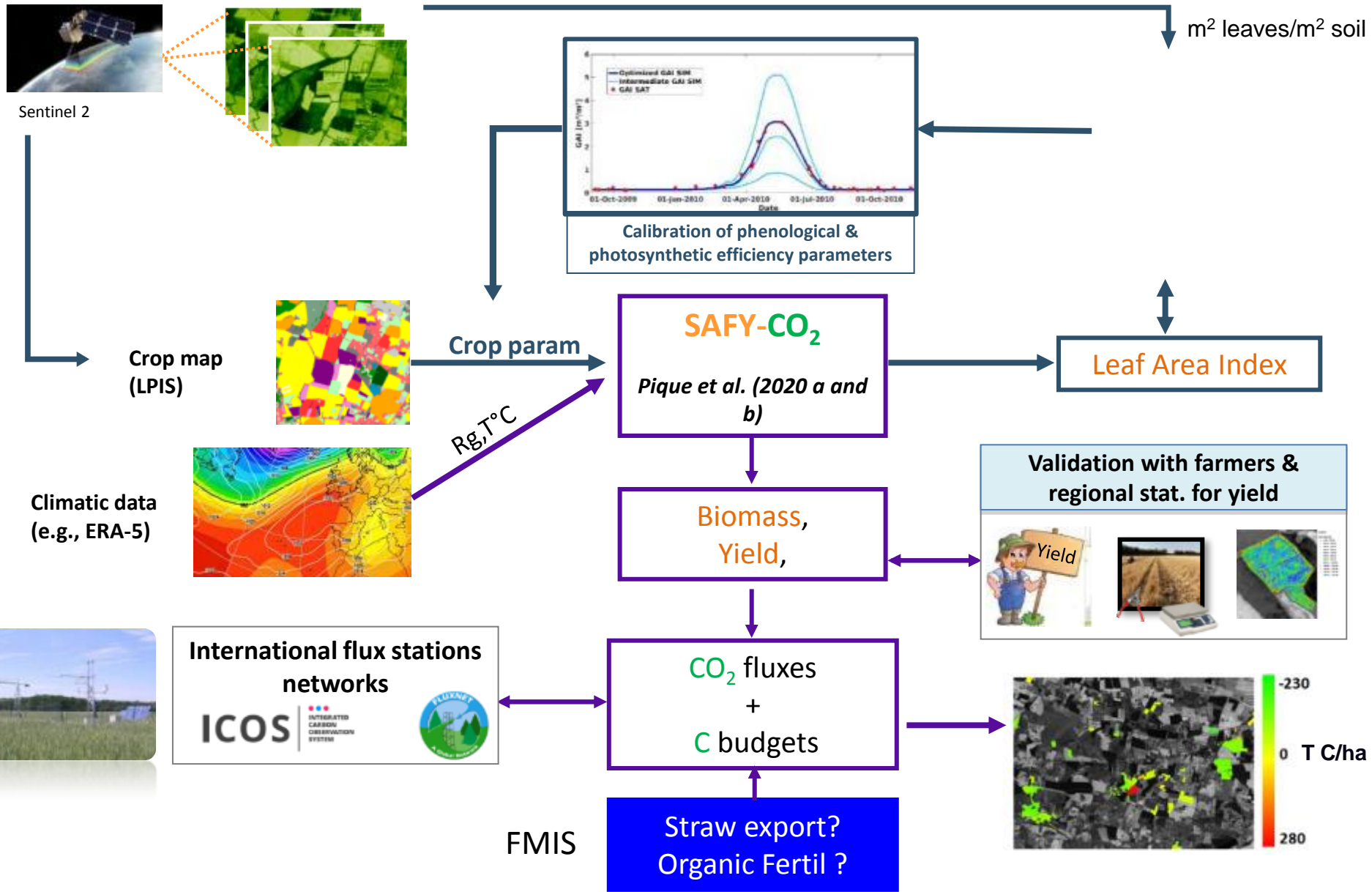
Ceschia et al. (2010)

• 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

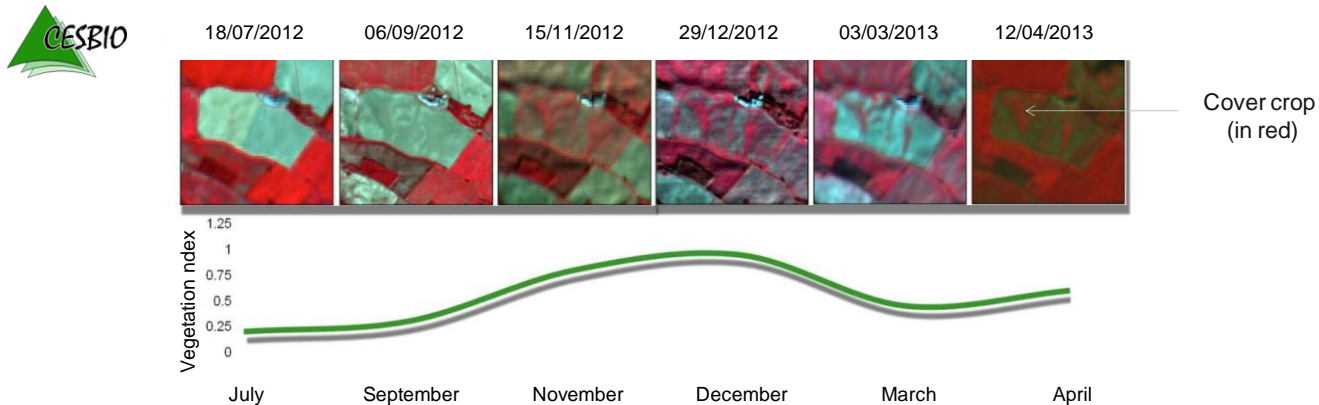
➤ TIER 3, modelling approach: SAFY-CO2



Carbon budget Indicators

TIER 3, modelling approach: SAFY-CO2

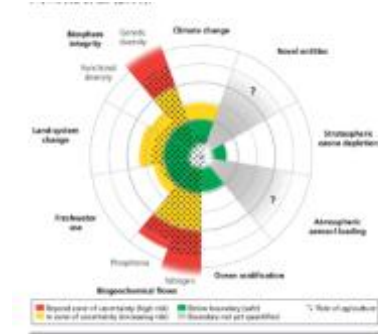
- This modelling approach was developed in the perspective of the Sentinel data,
- Need very few field data → suited for large scale applications at plot level, but only for a few crop species (wheat, maize, sunflower, rapeseed) + cover crops → to be applied in combination with TIER 2,
- Accounts for 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

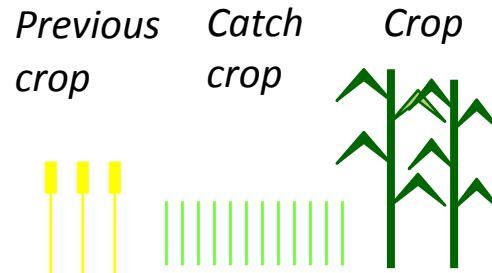


➤ **Main drivers** to consider (Beaudoin et al., 2005)

Climate, soil

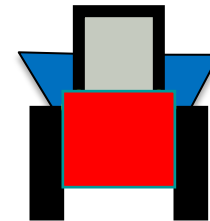


Crop rotation



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)

➤ TIER 2:

➤ Weighting factor (between 0 and 1)

Crop rotation

Previous crop

Catch crop

Crop

Presence of CC
Development intensity
F factor

Type of catch
Crop (FMIS)

Data
needed



IACS data



Sentinel data 1 & 2



IACS data

Mineralisation

crop residue
soil after
previous crop (X2)

N uptake

Crop
Catch crop

Soil climate



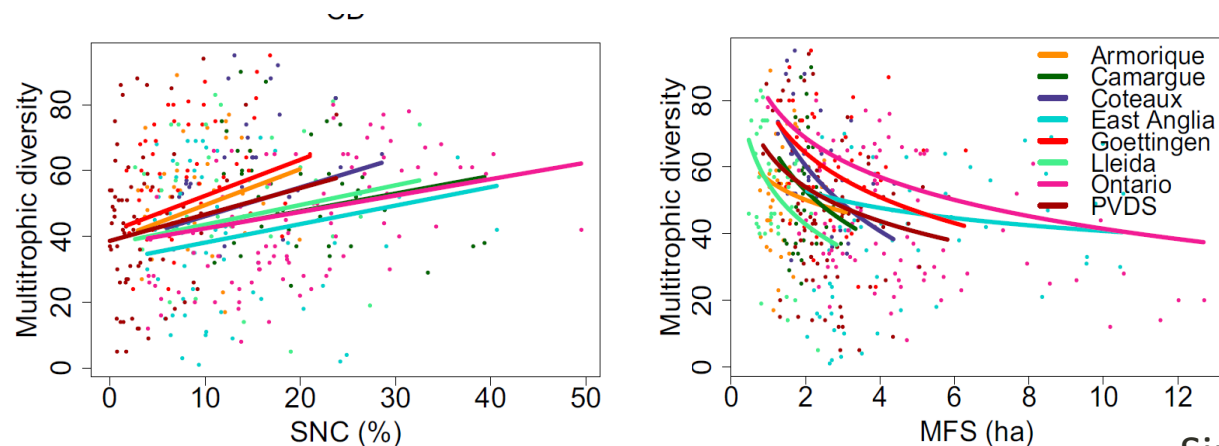
External data
Weather-soil
map

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

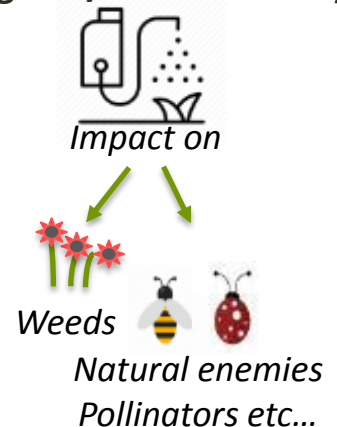


Including catch crops

Field size



Practices (organic/conventional)



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



Impact on



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)



Impact on



Including fallows



Including Agro-ecological infrastructures



Weeds



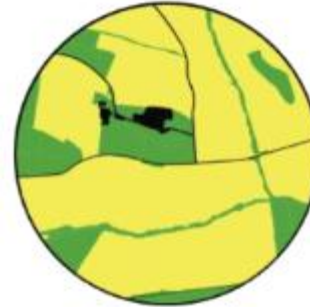
*Natural enemies
Pollinators etc...*

Biodiversity indicators

➤ 2 TIERS:

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

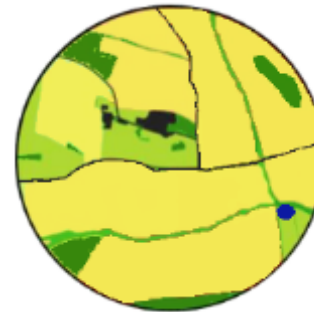
Prop of SNH



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

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

Prop/type of SNH

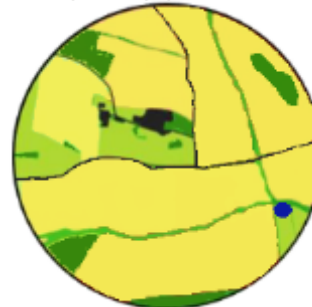


Woods, hedges, grasslands, ponds...
Crops + cover crops
Artificial surfaces (buildings...)

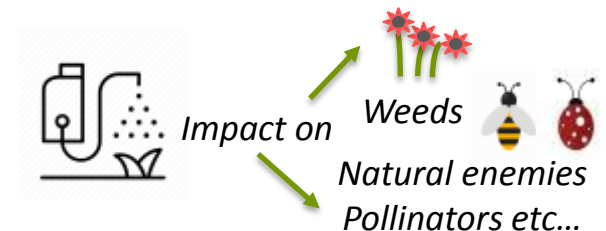
Optional

➤ **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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