NIVA UC1b Agro-environmental indicators

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NIVA
NEW IACS VISION IN ACTION

UC1b Agro-environmental indicators

Stackeholder 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

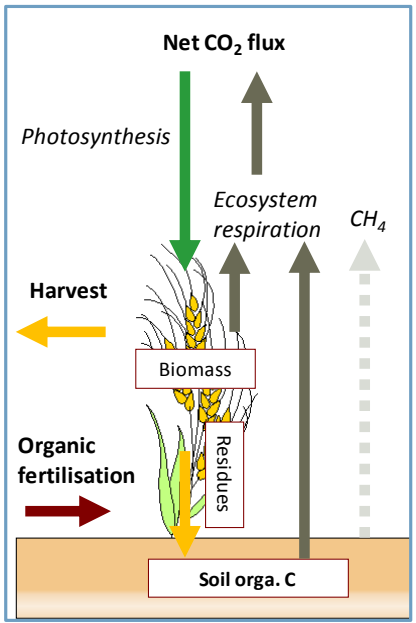
- Are calculated for each cropping year (at 10m/plot level), but can be summed over several years (crop rotation),

- 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, CO_2 fluxes…) but only for 4 crops species (wheat, sunflower, maize and soon rapeseed) + cover crops at this stage.

- A similar conceptual approach:

C budget = Net CO_2 flux – C harvested + Org. manure

ecosystem convention



- Approaches have been discussed with JF Soussana

(vice CEO of INRAe, member of IPCC, coordinator of CIRCASA)

Carbon budget Indicators

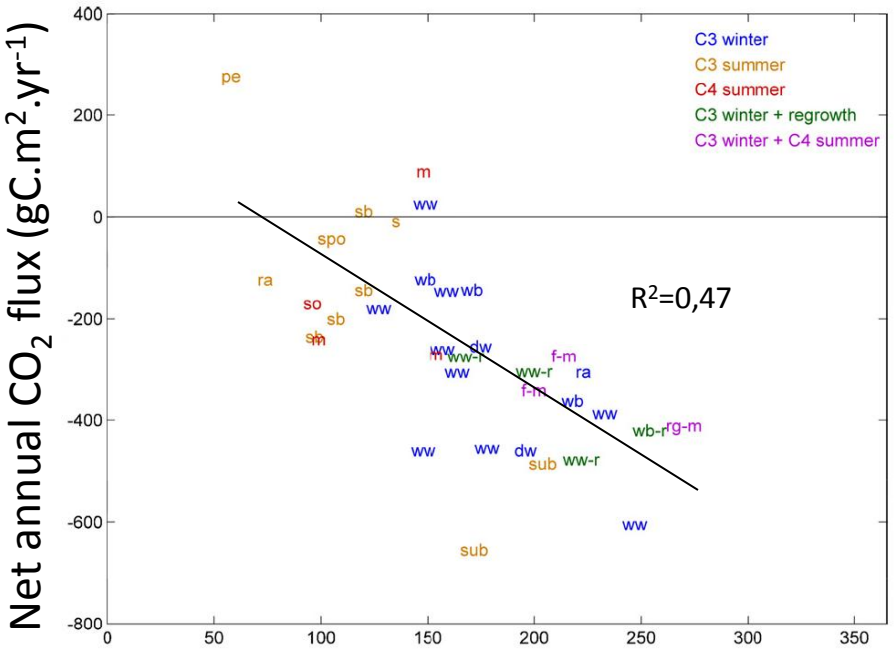
➢ Empirical approaches: plot level/annual ➔ most crop species

TIER 1

C budget = Net CO_2 flux + C harvested – Org. fertil.

CO_2 release

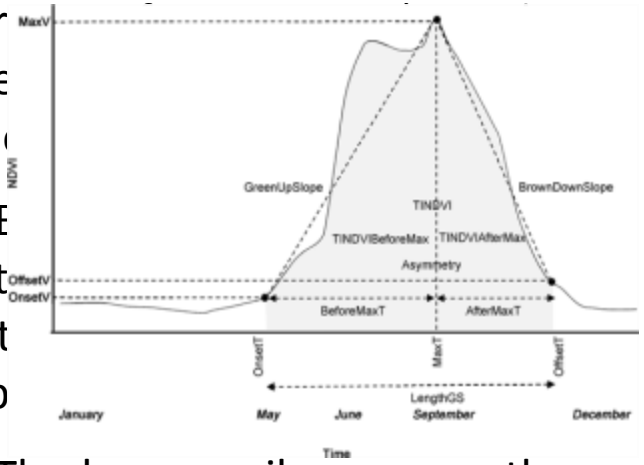
CO_2 fixation



Ceschia et al. (2010)

• Reflects the effect of soil coverage (depending on the crop specie and the presence or

Araya et al. (2017)



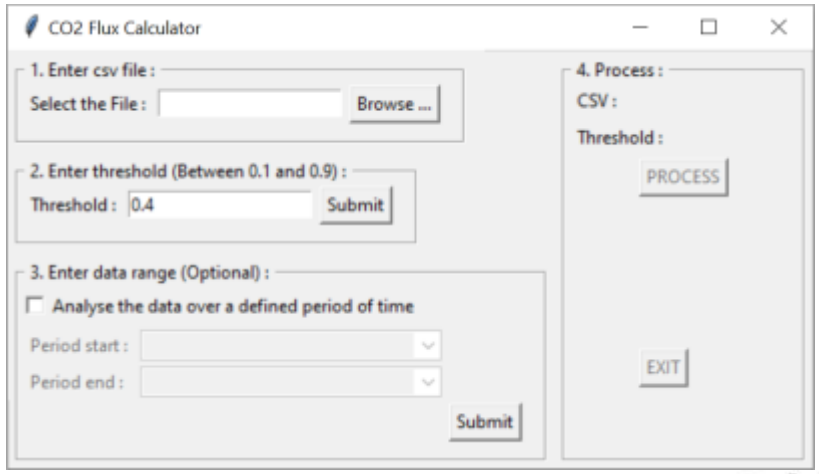
• The longer soil coverage, the better (same conclusion as the French 4/1000 expertise; *Pellerin et al., 2019*).

Directly estimated form Sentinel 2 data (NDVI dynamics ➔ Copernicus Phenology service)

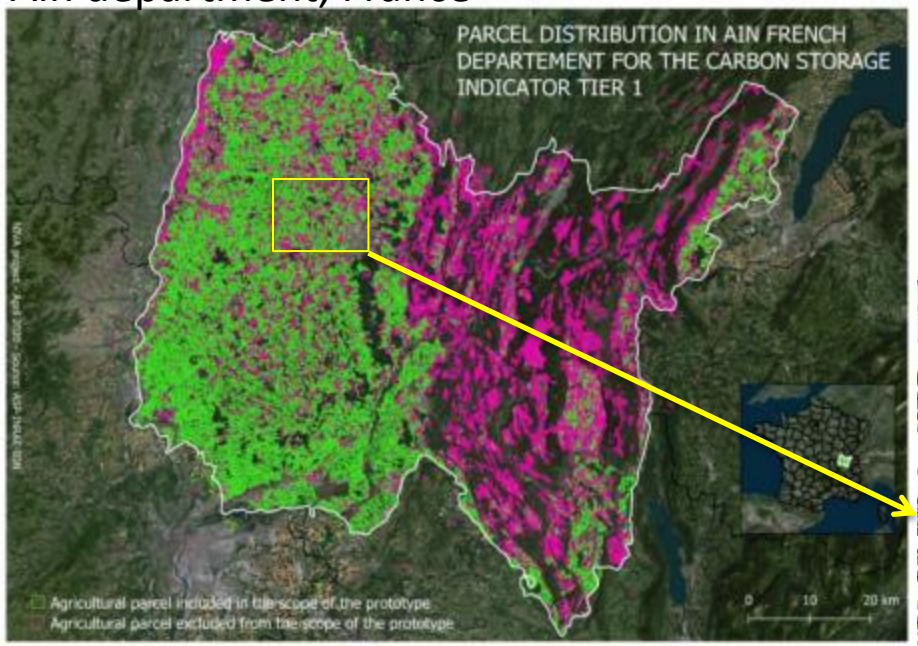
Carbon budget Indicators

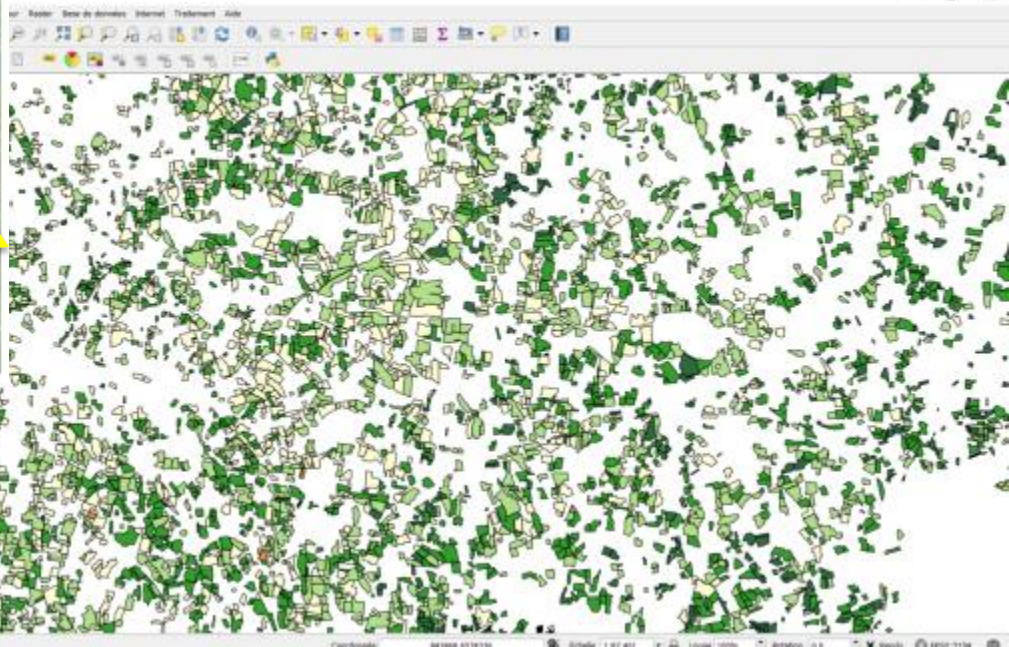
- Empirical approaches: plot level/annual ➔ most crop species

TIER 1 Operational tool in test phase



Ain department, France





Carbon budget Indicators

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

TIER 2

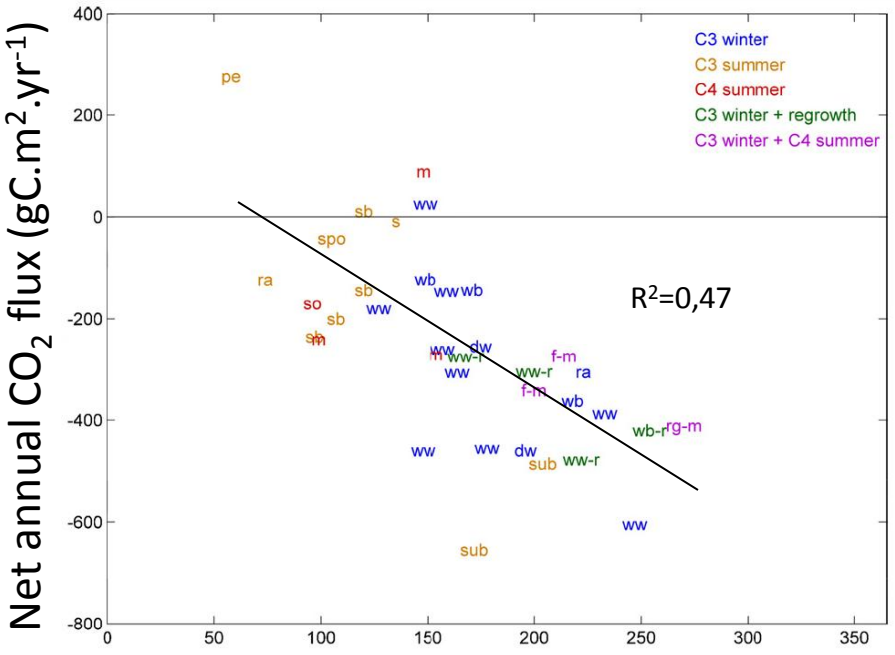
TIER 1

C budget = Net CO_2 flux + C harvested – Org. fertil.

Farmer's data (FMIS)

CO_2 release

CO_2 fixation



Ceschia et al. (2010)

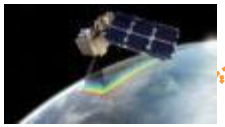
• What do we need to know from the farmers ?

• C harvested:
- yield (grain t/ha)
- eventually the amount of straw/cover crop exported (t/ha),

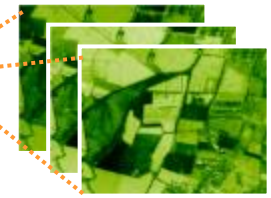
• Are organic amendments applied ? If yes:
- type of amendment,
- amount (t/ha).

Carbon budget Indicators

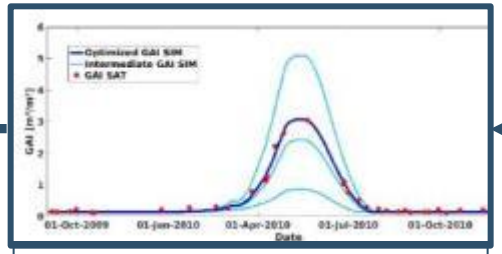
➢ TIER 3, modelling approach: SAFY-CO2



Sentinel 2



m^2 leaves/m^2 soil



Calibration of phenological & photosynthetic efficiency parameters

Crop map (LPIS)

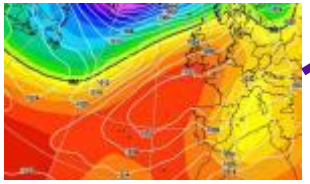
Crop param

SAFY-CO_2

Pique et al. (2020 a and b)

Leaf Area Index

Climatic data (e.g., ERA-5)



Rg,T°C

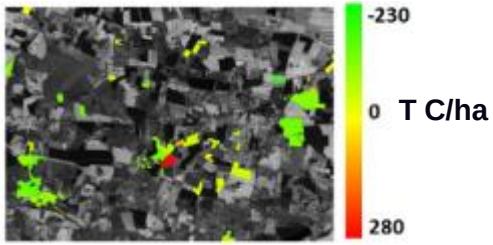
Biomass, Yield,

Validation with farmers & regional stat. for yield

International flux stations networks

ICOS

CO_2 fluxes + C budgets



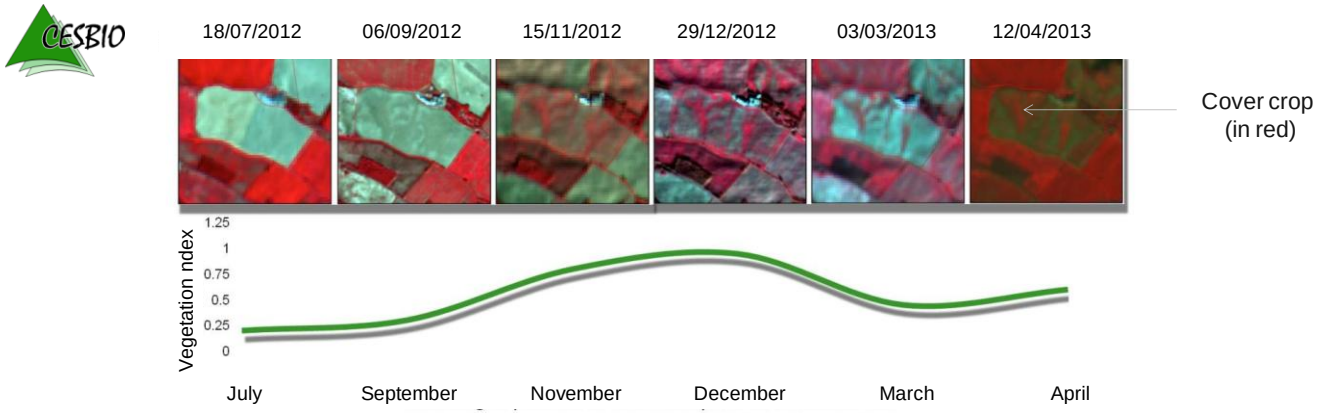
FMIS

Straw export? Organic Fertil ?

Carbon budget Indicators

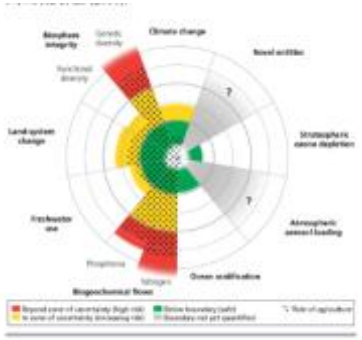
TIER 3, modelling approach: SAFY-CO2

- This modelling approach was developped 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



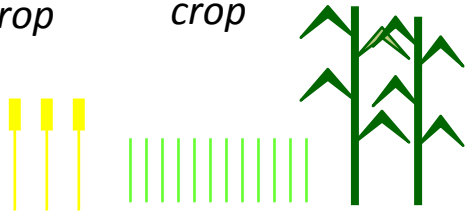
➢ **N biogeochemical** flows exceed planetary boundaries with a major role of agriculture (Campbell et al. 2017) -> N leaching

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

Climate, soil

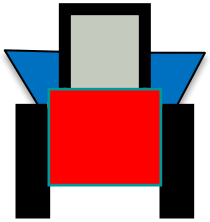
Crop rotation

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 (beween 0 and 1)

Crop rotation

Presence of CC
Development intensity
F factor

Previous crop

Catch crop

Crop

Data needed

IACS data

Sentinel data 1 & 2

IACS data

Mineralisation
crop residue
soil after
previous crop (X2)

–

N uptake
Crop
Catch crop

➢ TIER 2:

➢Weighting factor (beween 0 and 1)

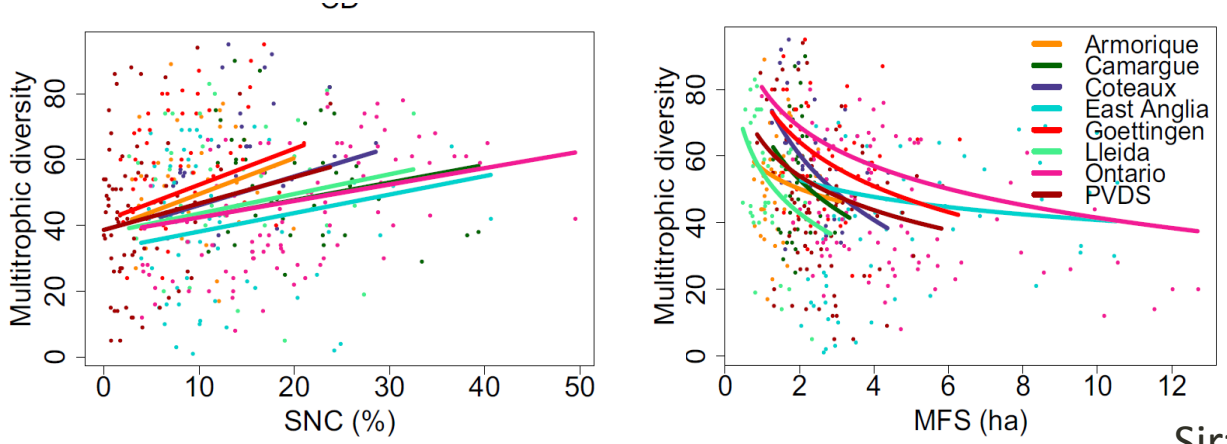
Type of catch Crop (FMIS)

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



Sirami et al. (2019)

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

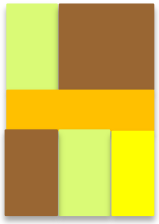
Grassland

Including fallows

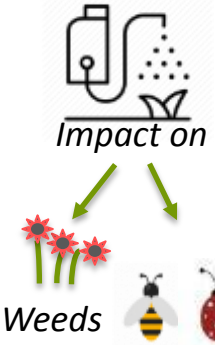
Crop diversity

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

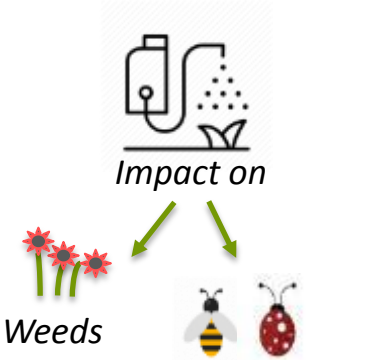
Agro-ecological infrastructures
Crops + cover crops
Artificial surfaces (buildings…)

➢ **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



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

Impact on

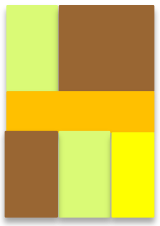
Weeds

Natural enemies
Pollinators etc…

Type of crop and rotation

Including fallows

Field size



Crop diversity

Semi-natural habitats (SNH)

Including Agro-ecological infrastructures

Biodiversity indicators

➢ 2 **TIERS**:

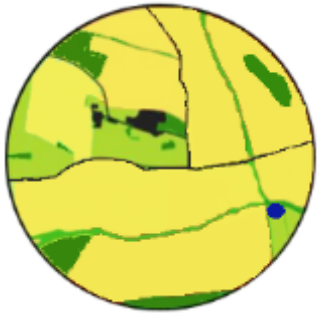
➢ **TIER 1**: proportion of semi natural habitat (SNH)

Prop of SNH

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

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

Prop/type of SNH

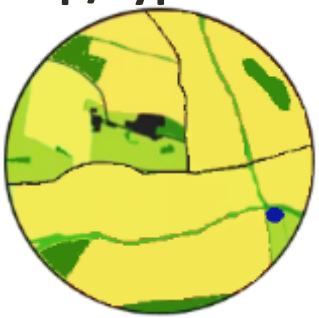


Woods, hedges, grasslands, ponds…
Crops + cover crops
Artificial surfaces (buildings…)

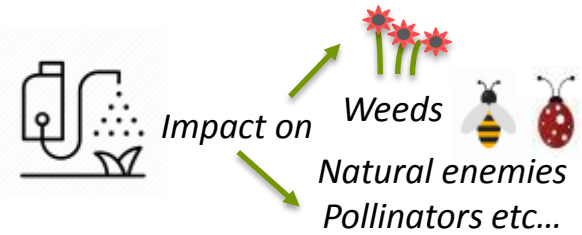
Optional

➢ **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.

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NEW IACS VISION IN ACTION

THANKS for Your attention !

This project has received funding from the european union's horizon 2020 research and innovation programme under grant agreement no. 842009