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Innovation, productivity and growth: towards sustainable agri-food production

ASSESSING THE GREENING CONTRIBUTION TO CLIMATE CHANGE MITIGATION IN ITALY

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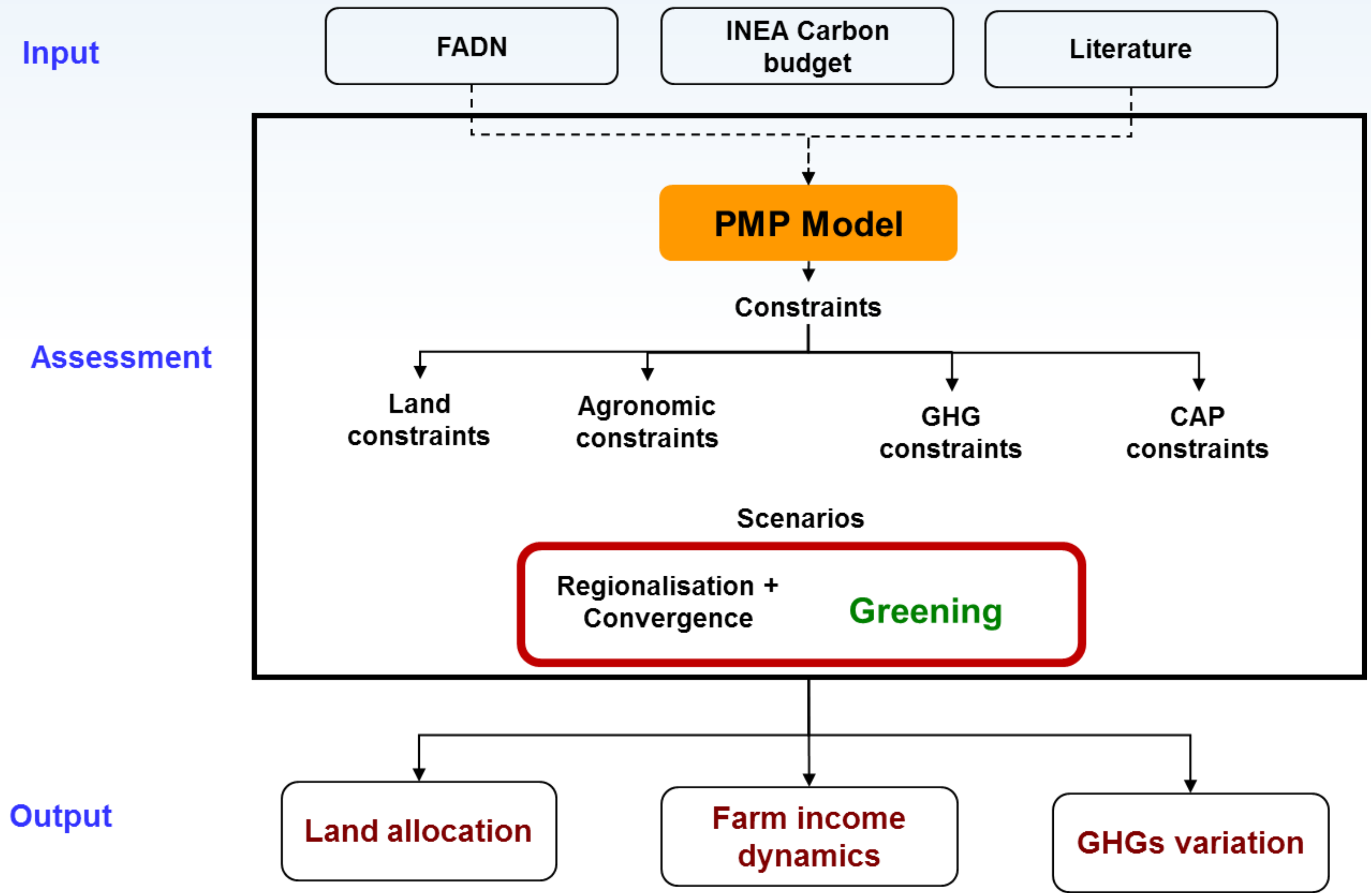
Objectives

- **Evaluate the potential effects of the Greening on the GHG reduction in a Italian macro-region (Emilia-Romagna, Lombardia and Veneto).**
- The assessment is carried out by applying a Positive Mathematical Programming (PMP) model using **individual farm FADN information.**
- The **farm model** implements the scenario included in the last reform for evaluating in particular:
  - The **regionalisation and convergence effect**
  - The **greening actions**
- The results can provide **information on changes in land allocation and the contribution of Greening on CO2 emissions.**

Model structure



PMP model

1.

$$\max_{\mathbf{x}_r \geq 0, \mathbf{x}_l \geq 0} GM = (\mathbf{p}_r - \mathbf{c}_r)' \mathbf{x}_r + (\mathbf{p}_l - \mathbf{c}_l)' \mathbf{x}_l$$

- prices of realized (r) and latent (l) crops
- costs of realized (r) and latent (l) crops
- quantities of realized (r) and latent (l) crops

$$S.t. \quad \mathbf{A}_r \mathbf{x}_r + \mathbf{A}_l \mathbf{x}_l \leq \mathbf{b} \qquad (\mathbf{y})$$
→ Structural constraint

$$\mathbf{x}_r \leq \overline{\mathbf{x}}_r + \varepsilon \qquad (\boldsymbol{\lambda}_r)$$
→ Calibrating constraint for realized crops $\overline{\mathbf{x}}_r$

$$\mathbf{x}_l \leq \varepsilon \qquad (\boldsymbol{\lambda}_l)$$
→ Calibrating constraint for latent crops

2.

$$\begin{bmatrix} \mathbf{c}_r \\ \mathbf{c}_l \end{bmatrix} + \begin{bmatrix} \boldsymbol{\lambda}_r \\ \boldsymbol{\lambda}_l \end{bmatrix} = \begin{bmatrix} \overline{\mathbf{x}}_r \\ \overline{\mathbf{x}}_l \end{bmatrix} \mathbf{Q}_{rl}$$

→ Marginal cost, where Q is the decision matrix estimated by GME (benchmark information + self-selection)

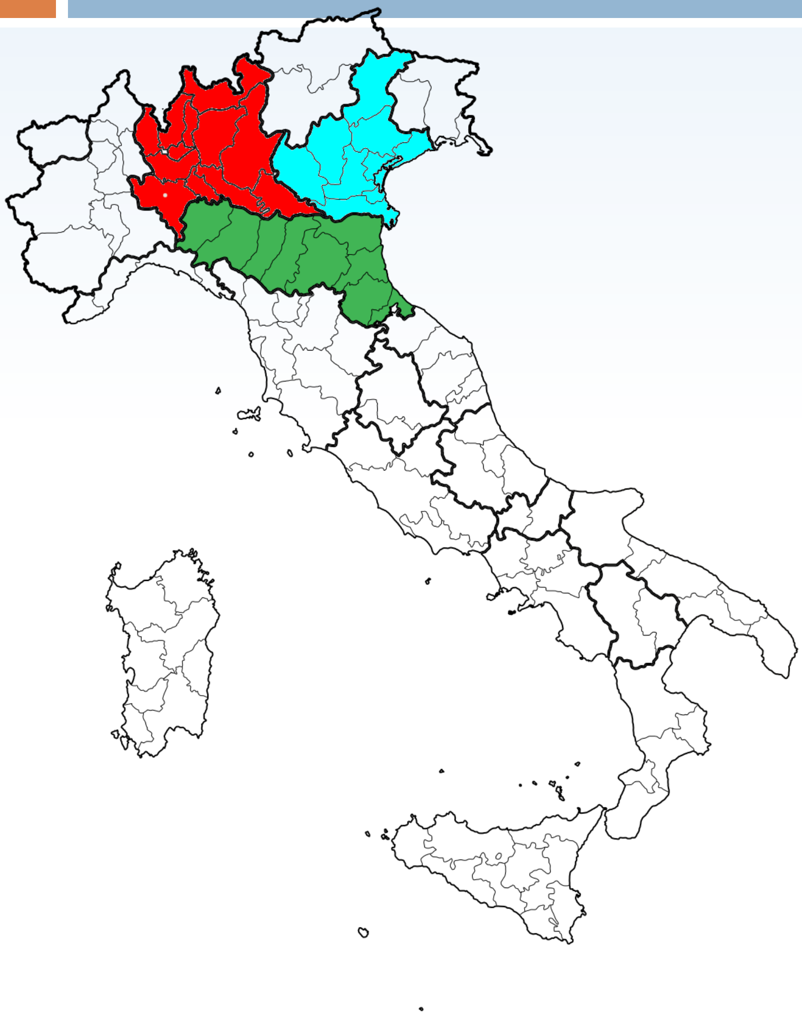
3.

$$\max_{\mathbf{x}_r \geq 0, \mathbf{x}_l \geq 0} \mathbf{p}_r' \mathbf{x}_r + \mathbf{p}_l' \mathbf{x}_l - \frac{1}{2} [\mathbf{x}_r \quad \mathbf{x}_l] \mathbf{Q}_{rl} \begin{bmatrix} \mathbf{x}_l \\ \mathbf{x}_l \end{bmatrix}$$

$$S.t. \quad \mathbf{A}_r \mathbf{x}_r + \mathbf{A}_l \mathbf{x}_l \leq \mathbf{b}$$

← New problem reproducing the observed production plan by the way of the new total cost function

FADN Data



- The analysis aims to evaluate the effect of Greening in Emilia-Romagna, Lombardia and Veneto.
- The data are collected from **the Italian Farm Accountancy Data Network (FADN)** considering all the farms located in low land area of the region.
- **2,197 farms present in the 2012 dataset**
- **154,455 farms according to the FADN weighting system**.
- **The statistical representativeness is guaranteed at regional and Farm Type (FT) level.**
- **<u>FADN will provide information on observed land use, yields, prices and costs.</u>**

CAP Simulation

- The simulation model integrates information on agronomic rotations and I Pillar CAP constraints:

$$\max_{\mathbf{x}_r \geq 0, \mathbf{x}_l \geq 0} \quad \mathbf{p}_r^{'}\mathbf{x}_r + \mathbf{p}_l^{'}\mathbf{x}_l - \frac{1}{2}[\mathbf{x}_r \quad \mathbf{x}_l]\mathbf{Q}_{rl}\begin{bmatrix}\mathbf{x}_l \\ \mathbf{x}_l\end{bmatrix}$$
$$S.t. \quad \mathbf{A}_r\mathbf{x}_r + \mathbf{A}_l\mathbf{x}_l \leq \mathbf{b}$$

+ *Agronomic constraints* **+** *Greening mechanisms*

- The simulation is developed farm by farm by maximizing a conjoined objective function:

$$\max CGM = \sum_n GM_n$$

CGM = Conjoined gross margin
GM_n = Farm gross margin ($n=1,2,\ldots,N$)

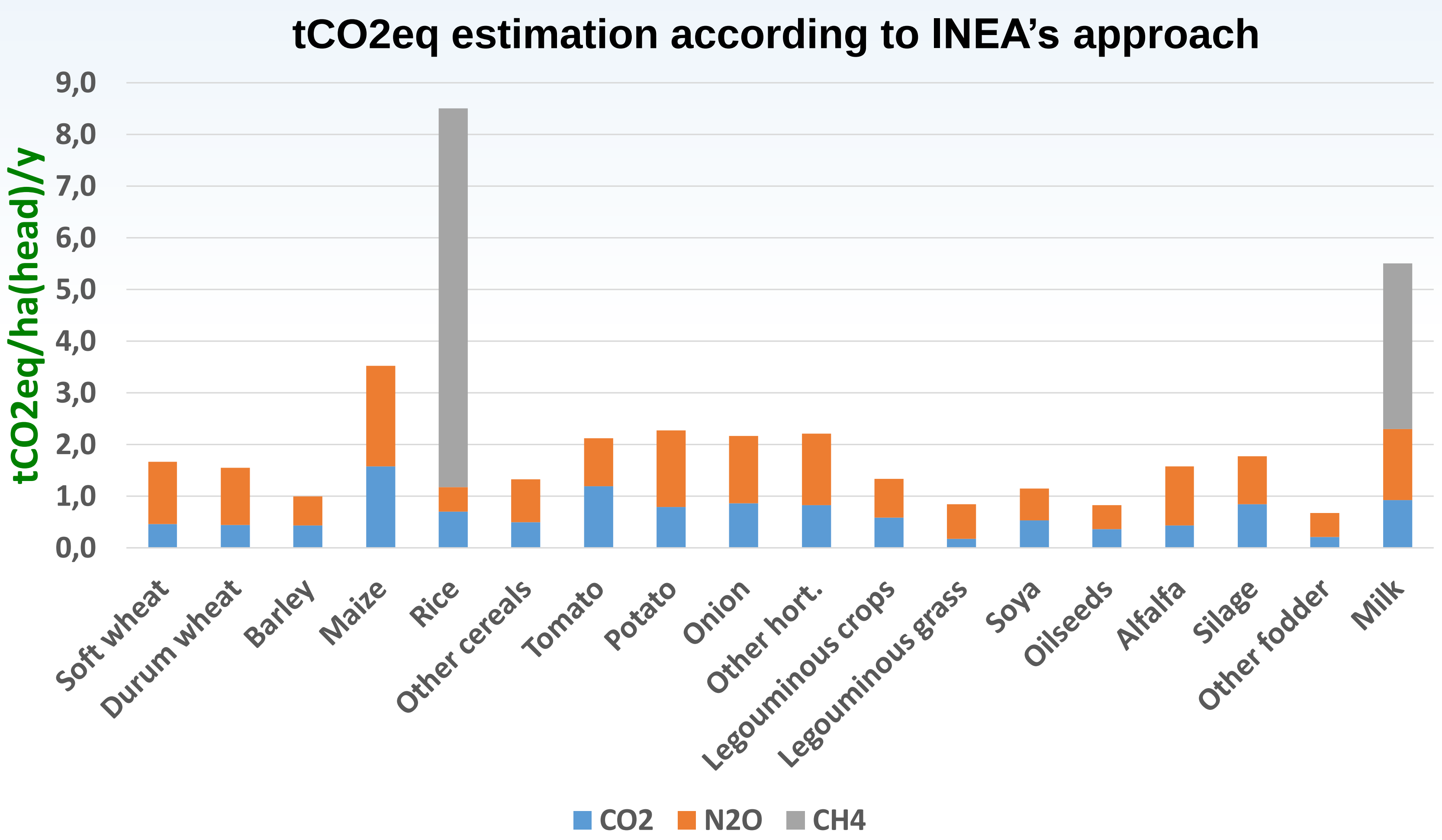
- The Greening scenario investigated is compared to the baseline referred to the baseline scenario:

Baseline 2013 Vs. ***Final CAP (1307/2013)*** → ***3 Greening measures***

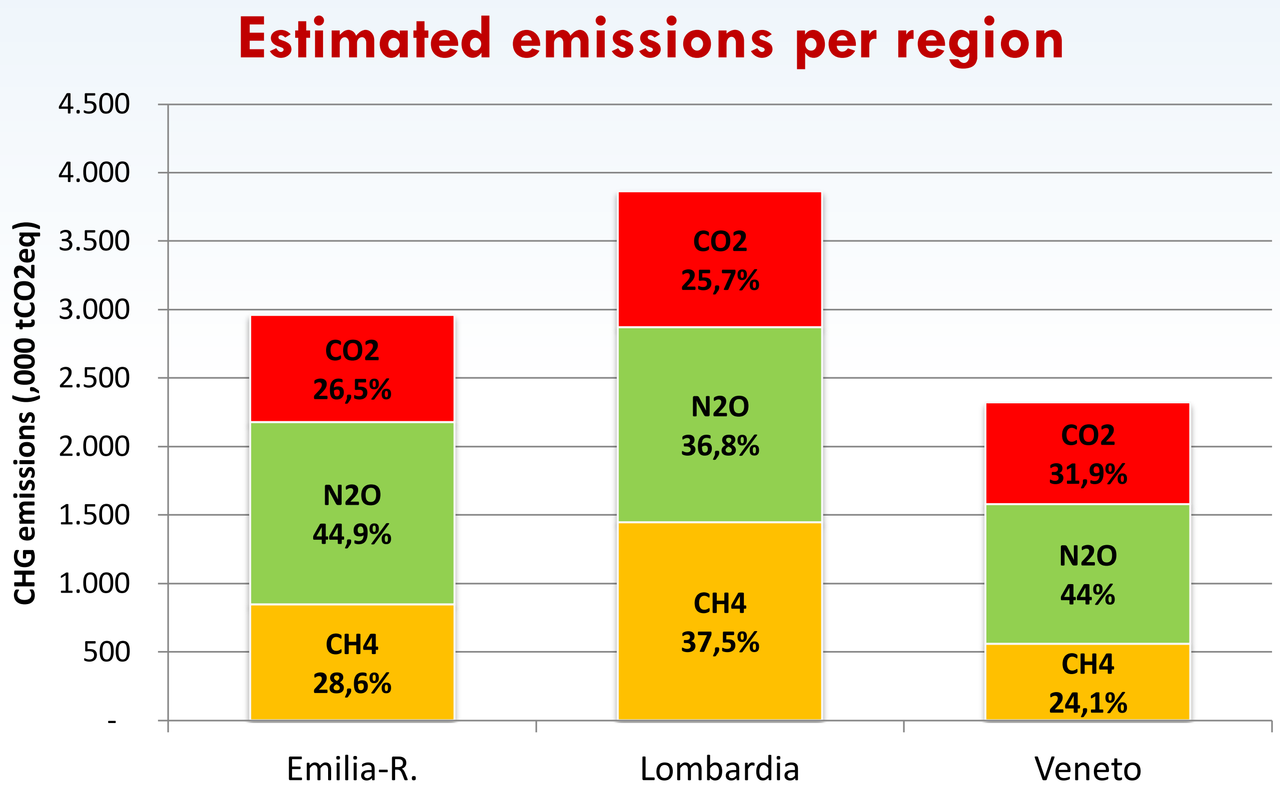
Agriculture GHG Budget

- For evaluating the GHG emissions per crop, we adopted the methodology developed by INEA (Coderoni and Bonati, 2013), in reference to the following sectors:
  - CO_2: fuel need for the different agricultural operations;
  - N_2O:
    - Direct emissions (Animal manure, Fertilizers, N-fixing crops)
    - Indirect emissions (atmospheric deposition, leaching and runoff)
  - CH_4:
    - From enteric fermentation
    - From manure management
    - From rice cultivation
- We do not consider the soil sink action and effects on the LUC.

Agriculture GHG Budget



GHG emissions

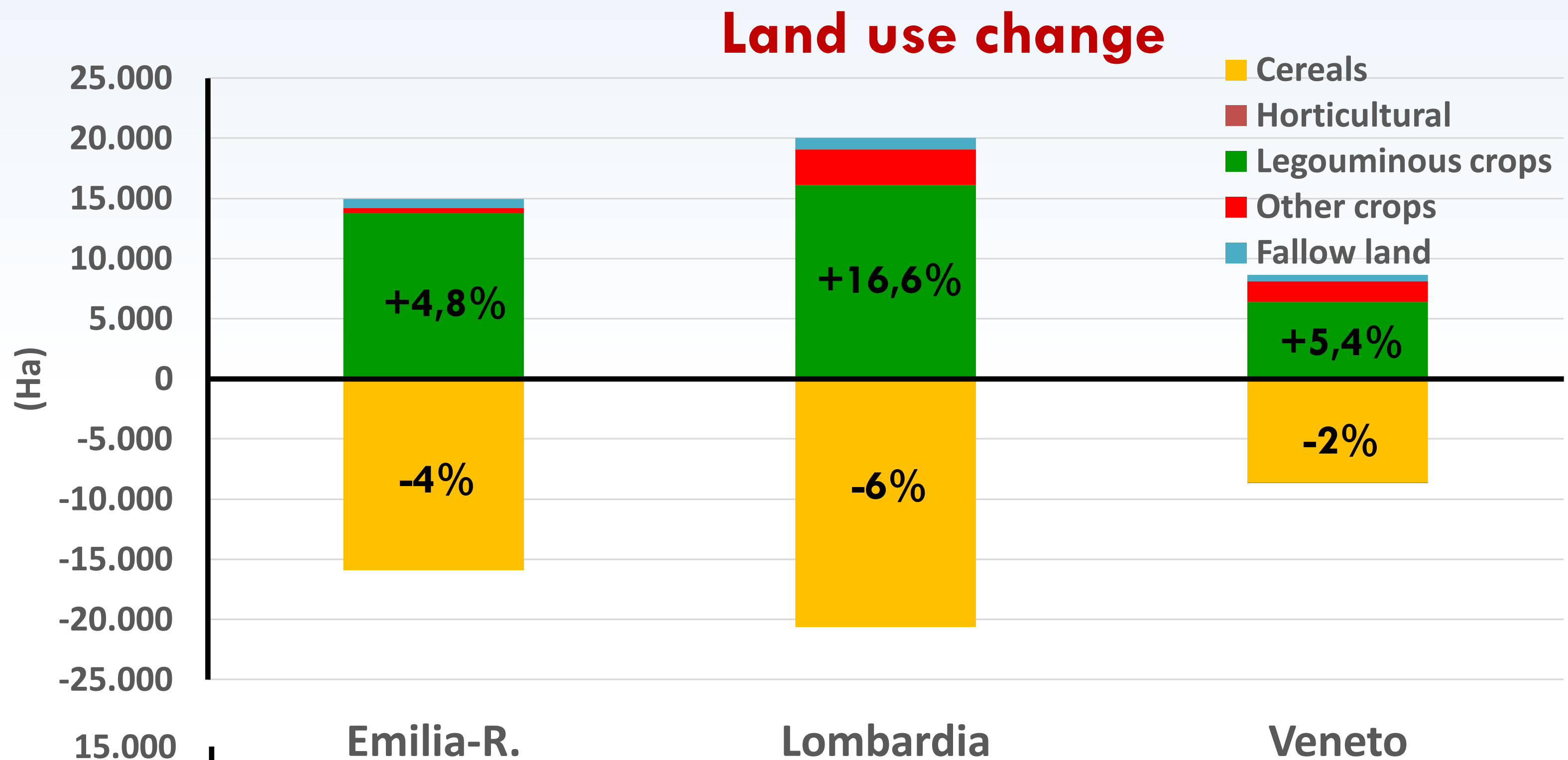


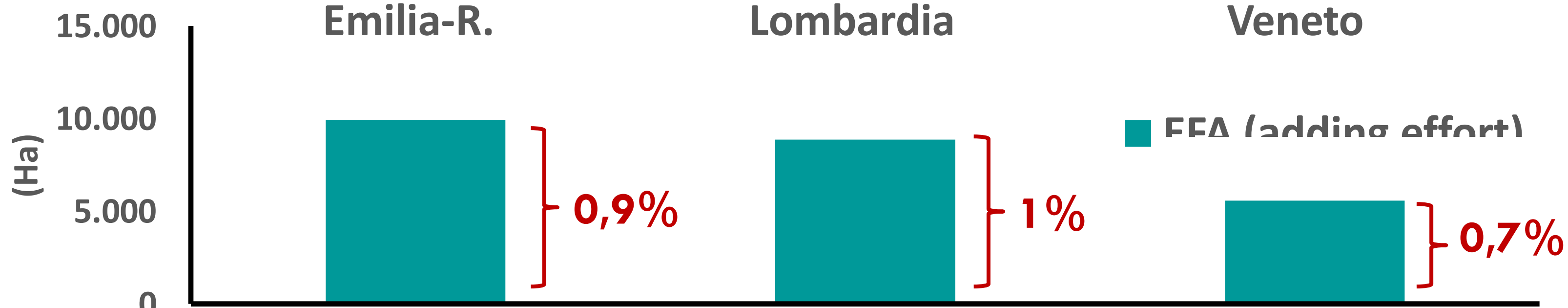
The most important emissions in Lombardia are due to the intensive use of the agricultural soil and the intensive milk cow breeding in the region. The FADN weights have a role as well.

CAP Scenario

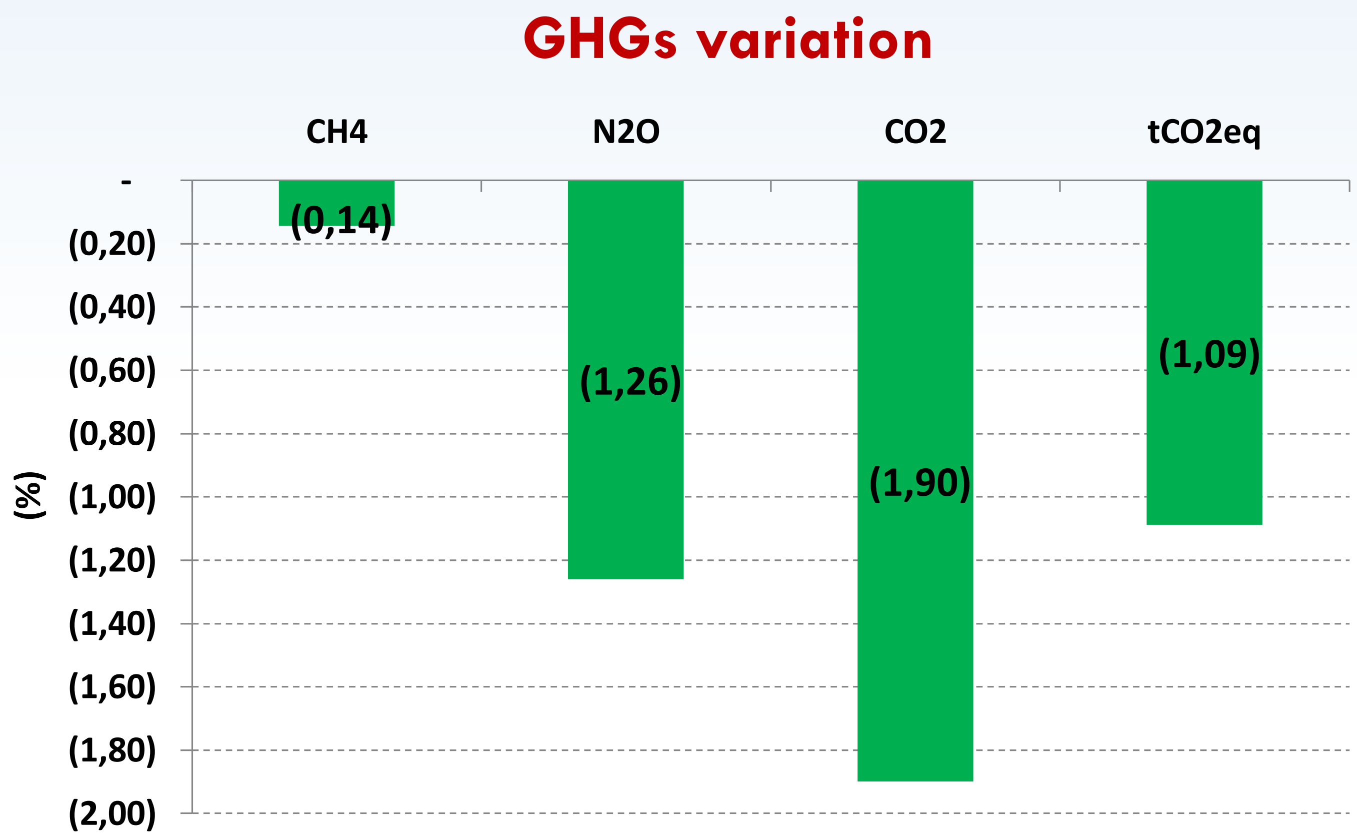
- CAP scenario considers the corresponding intervention system in relation to **Greening:**
  - Crop diversification
  - Maintenance of permanent grassland
  - Ecological focus area (**land left fallow and N-fixing crops with weighting factor 0,7**)
  - Specific involvement and exclusion criteria
- Results capture the impact on land use at territorial level and farm structure (farm size, farm type).

Results – Land allocation





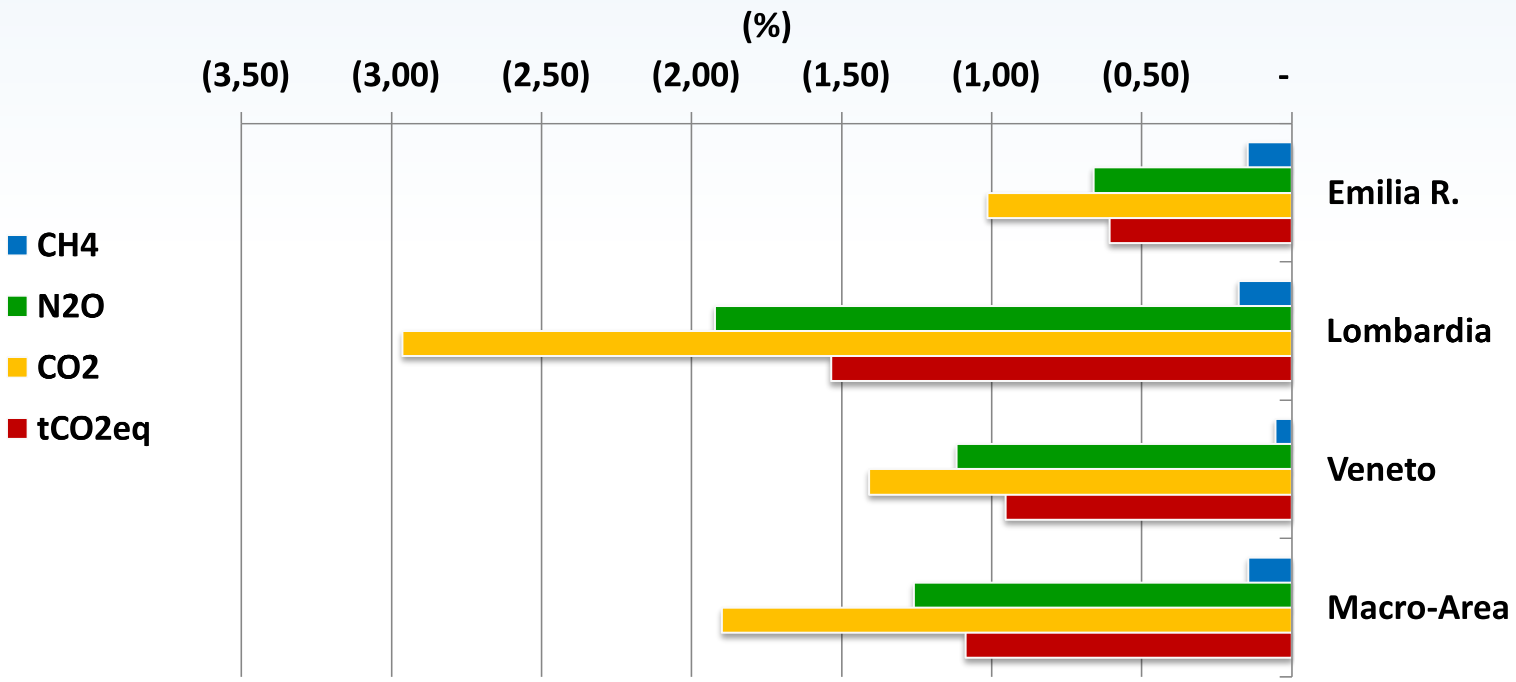
Results – GHG emissions



The total reduction in CO2eq emissions corresponds to 100,000 tons for the entire macro-region

Results – GHG emissions

GHGs variation at regional level



Lombardia shows the highest contribution in terms of CO2eq reduction, being characterised by a relevant specialization in maize and milk production. The greening measures affects more the CO2 emissions rather than the other GHGs.

Conclusions

- The farm PMP model assesses the response of farmers towards new CAP scenario and evaluates the effect at environmental level.
- The greening impact on farm decisions for the most important regions of Northern Italy is absolutely modest, i.e. low effectiveness of the greening measures
- The highest impact of the greening is in the Lombardia, where the high specialization in some arable crops (maize) has consequences on diversification commitments.
- **Effect very modest on the GHG emission level (-1%).**
- In a frame of integrated climate change mitigation strategy, these reductions could participate to the achievement of the 2020 objective (-13%).
- **The model does not consider entirely the animal production.**
- **The model does not consider the effect of the farm decision on the LUC.**