# LULUCF reporting for Cropland and Grassland - Italy

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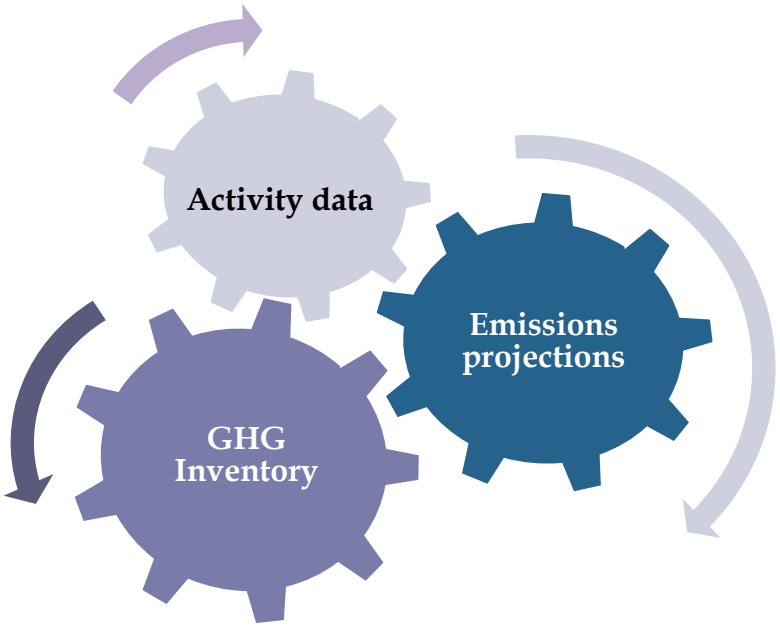
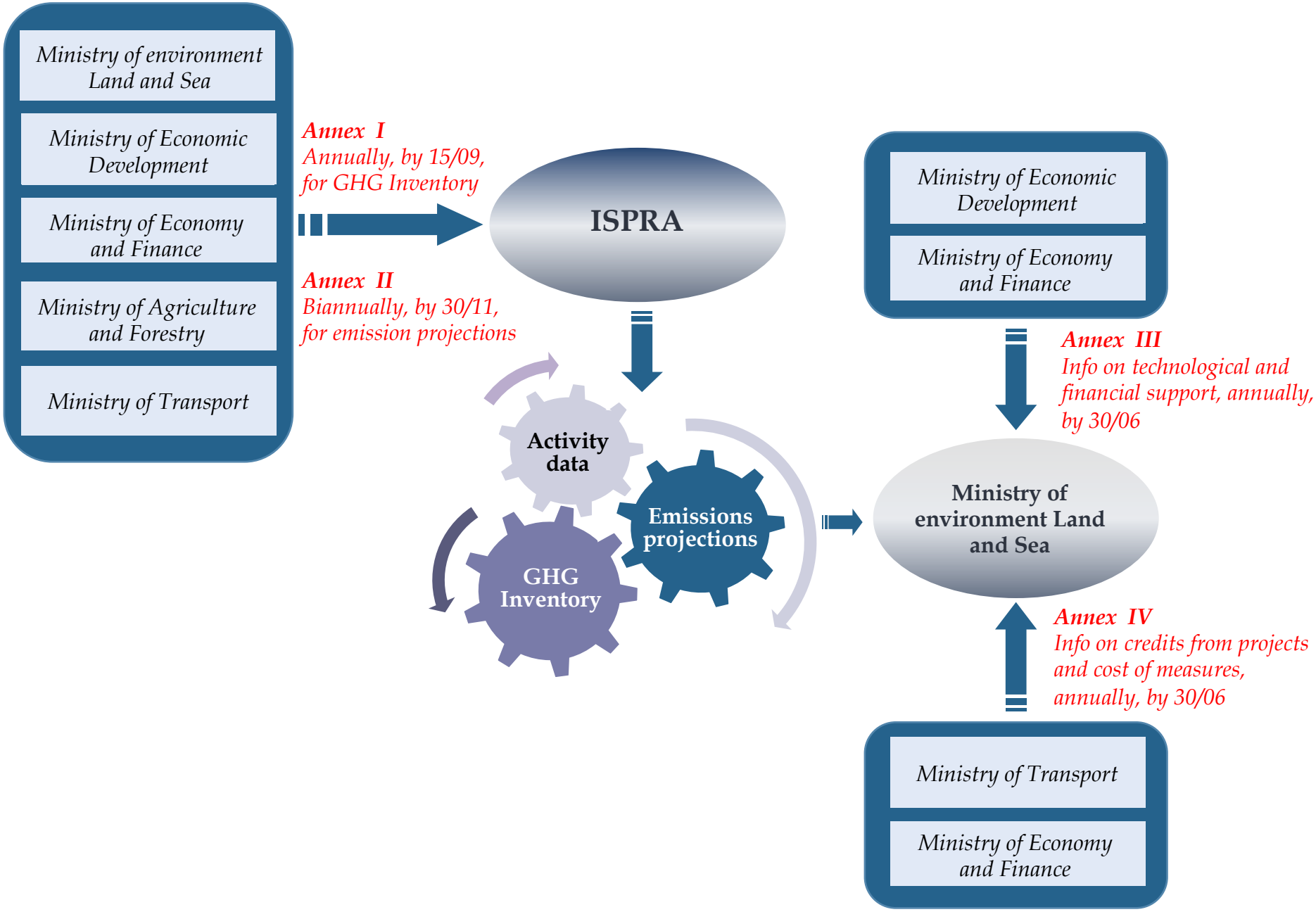
# National system for policies, measures and emissions projections

In 2016, in the context of the Kyoto Protocol commitments and its amendment ('*Doha amendment*') for the second Commitment Period (2013-2020), Italy adopted the Law n. 79/2016, "Ratification of the Doha amendment to the Kyoto Protocol" which establishes the ***National system for policies, measures and emissions projections***, in line with art. 12 of the EU Monitoring Mechanism Regulation (MMR 525/2013/EU)

ISPRA is responsible of this system and, in cooperation with IMELS, collects all the information and data from the competent Ministries. The list of information and data that the competent ministries have to provide to IMELS and ISPRA are reported in the article 1 of the Law, as well as the timing for providing such information.



# National system for policies, measures and emissions projections



# National system for policies, measures and emissions projections

## Annex I - GHG inventory

1. Ministero dello sviluppo economico:

a. per il settore «energia»: Dati di produzione e distribuzione dell'energia elettrica e calore per combustibile e utilizzo;

b. per il settore «Processi industriali e utilizzo di prodotti»: Dati di produzione, composizione delle materie prime e informazioni sui processi tecnologici;

c. per il settore «emissioni fuggitive da combustibili»: Consumi e perdite di gas dalla rete di distribuzione;

d. per il settore «agricoltura»: Tipologia di alimentazione ai digestori, perdite di biogas dei digestori, biogas bruciato in torcia.

2. Ministero delle infrastrutture e dei trasporti:

a. per il settore «trasporti»: Parco veicoli circolanti al 31 dicembre dell'anno precedente;

b. per il settore «trasporti»: Flussi e velocità di traffico al 31 dicembre dell'anno precedente.

3. Ministero delle Politiche agricole, alimentari e forestali:

a. per il settore «agricoltura»: Dati sulle consistenze di bestiame, sulle superfici e produzioni agricole, secondo il dettaglio concordato ai sensi dell'art. 2, comma 2 del presente decreto, sulle razioni alimentari del bestiame in allevamento, sulla produzione di latte e relativo contenuto di grasso per categoria di bestiame;

b. per il settore «destinazione dei suoli, cambiamento della destinazione dei suoli e silvicoltura (LULUCF)»: Base di dati relativi alle aree percorse da incendi per tutte le regioni e informazioni connesse ai singoli eventi;

c. per i settori «destinazione dei suoli, cambiamento della destinazione dei suoli e silvicoltura (LULUCF)" e "agricoltura»: Superfici con dettaglio regionale delle tipologie di pratiche agricole da utilizzare ai fini della contabilizzazione delle attività di Gestione di terreni coltivati (CM) e Gestione dei pascoli (GM);

d. per i settori «destinazione dei suoli, cambiamento della destinazione dei suoli e silvicoltura (LULUCF)" e "agricoltura»: Valori di contenuto organico di suolo (SOC) e relativi fattori correttivi (FLU, FMG, *FI)* relative ai terreni soggetti alle coltivazioni, con disaggregazione per tipologia di pratica agricola da utilizzare ai fini della contabilizzazione delle attività di Gestione di terreni coltivati (CM) e Gestione dei pascoli (GM);

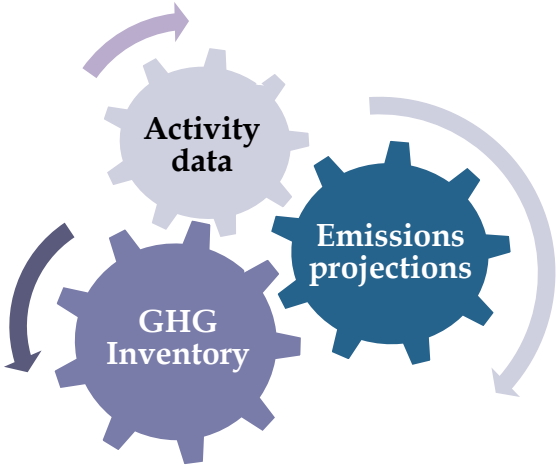
e. per i settori «destinazione dei suoli, cambiamento della destinazione dei suoli e silvicoltura (LULUCF)» e «agricoltura»: ove opportuno, eventuali altri dati inerenti le singole «key categories» dei settori considerati;

f. per il settore «destinazione dei suoli, cambiamento della destinazione dei suoli e selvicoltura (LULUCF)»: dati relativi alla consistenza quantitativa e qualitativa del patrimonio forestale italiano, così come determinato dall'Inventario nazionale delle foreste e dei serbatoi forestali di carbonio (INFC).

4. Ministero dell'ambiente e della tutela del territorio e del mare

a. per i settori «agricoltura» e «rifiuti»: dati relativi alle superfici di spandimento fanghi;

b. per il settore «processi industriali e utilizzo di prodotti»: dati di produzione di pitture, vernici e prodotti per carrozzeria.




## Annex II - Emissions projections

1. Ministero dello sviluppo economico, relativamente ai settori dell'approvvigionamento energetico, del consumo energetico, dei trasporti e dei processi industriali:

a. elenco delle misure implementate (corredate dei dati di base energetici), adottate e previste ai fini di aumentare l'efficienza energetica e ridurre le emissioni da gas serra; in particolare l'elenco include tutte le misure rendicontate all'Unione europea ai sensi dell'art. 22 della Direttiva 2009/28/UE;

b. ove disponibili, i costi delle misure implementate, adottate e previste ai fini di aumentare l'efficienza energetica e ridurre le emissioni da gas serra;

c. ove disponibili, valutazioni ex-post degli effetti di ciascuna politica e misura;

d. dati di scenari energetici.

2. Ministero delle infrastrutture e dei trasporti, relativamente al settore dei trasporti:

a. elenco delle misure implementate, adottate e previste ai fini della riduzione dei consumi energetici e delle emissioni di gas serra;

b. ove disponibili, i costi delle misure implementate, adottate e previste ai fini della riduzione dei consumi energetici delle emissioni da gas serra;

c. ove disponibili, valutazioni ex-post degli effetti di ciascuna politica e misura;

d. dati di scenario in materia emissiva ed energetica.

3. Ministero delle politiche agricole, alimentari e forestali relativamente ai settori dell'agricoltura e delle attività forestali:

a. elenco delle misure implementate, adottate e previste al fine di ridurre le emissioni da gas serra;

b. ove disponibili, i costi delle misure implementate, adottate e previste ai fini di ridurre le emissioni da gas serra;

c. ove disponibili, valutazioni ex-post degli effetti di ciascuna politica e misura;

d. ipotesi di sviluppo delle attività del settore agricolo in materia emissiva ed energetica.

4. Ministero dell'ambiente e della tutela del territorio e del mare

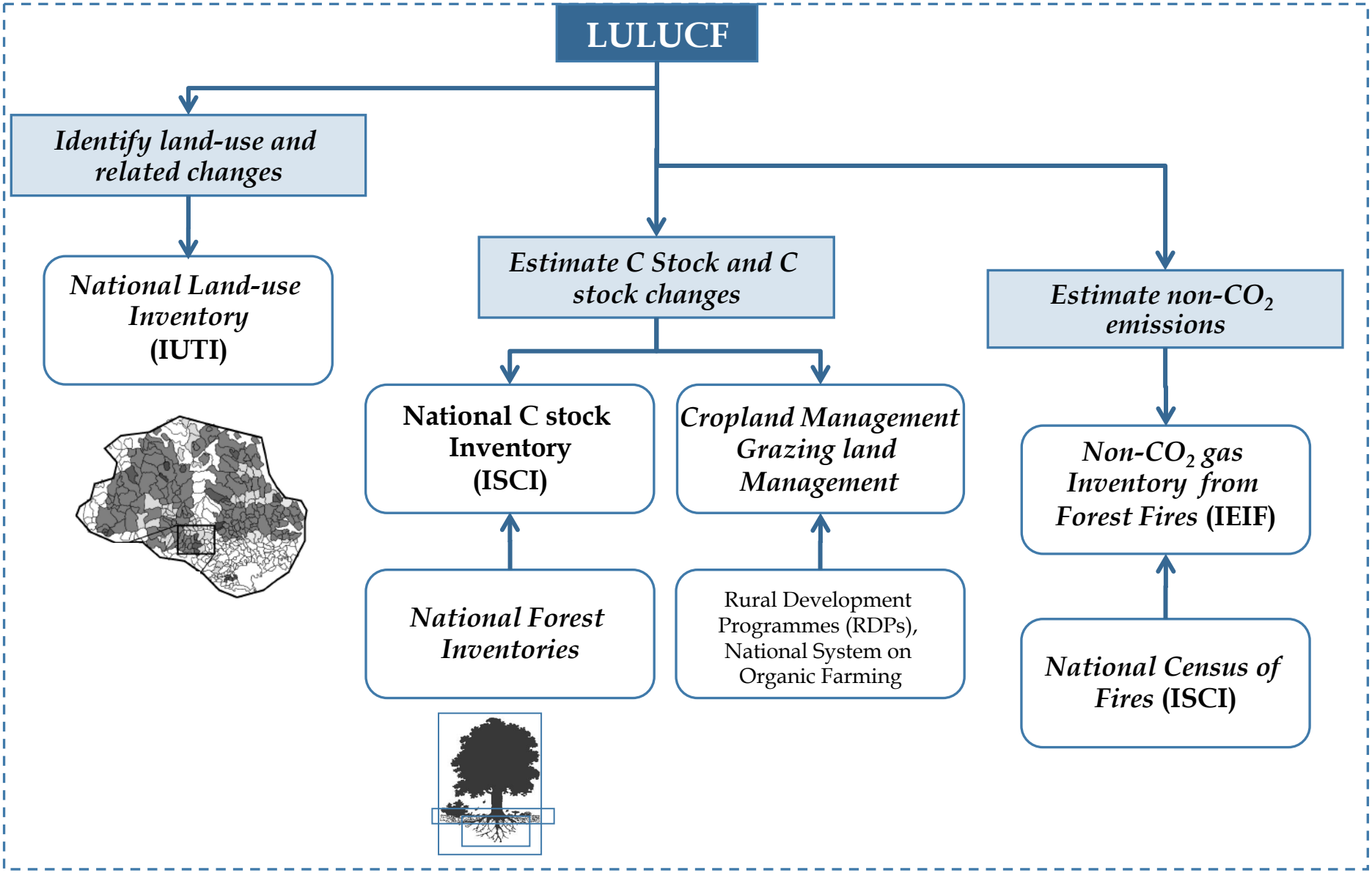
a. elenco delle misure implementate, adottate e previste ai fini della gestione dei rifiuti, dell'economia circolare, del miglioramento della qualità dell'aria, per aumentare l'efficienza energetica e ridurre le emissioni da gas serra, per ridurre l'uso dei composti fluorurati ed ai fini di regolare e monitorare i cambiamenti dell'uso del suolo anche con riferimento agli incendi;

b. ove disponibili, i costi delle misure implementate, adottate e previste;

c. ove disponibili, valutazioni ex-post degli effetti di ciascuna politica e misura;

d. dati di scenario in materia emissiva (inclusi i gas nocivi) ed energetica

# The national registry for carbon sinks



# The national registry for carbon sinks

The *National Registry for carbon sinks,* instituted by a Ministerial Decree on 1st April 2008, is part of *National Greenhouse Gas Inventory System* in Italy and includes information on lands subject of activities under Article 3.3 and activities elected under Article 3.4 and related carbon stock changes, following par. 20 of annex to decision 16/CMP.1
ISPRA is responsible for the preparation of emission and removals estimates for the LULUCF sector and for KP LULUCF supplementary information under art.7.1 of the Kyoto Protocol.

Following an update of the abovementioned Ministerial Decree, in 2013, the Institute for Services on Agricultural and Agro-food Market (ISMEA) has been designated for the technical coordination of the section related to cropland and grazing land management of the *National Registry of Carbon Sinks*.

The *National Registry for carbon sinks* is aimed to:

- estimate, following the COP/MOP decisions and in accordance with the IPCC guidelines, the GHG emissions by sources and removal by sinks in the land subject to the art. 3.3 and art. 3.4 activities
- to account for the net removals in order to allow the Italian Registry to issue the relevant amount of RMUs.

# Soils C estimation

**ANNUAL CHANGE IN CARBON STOCKS IN SOILS**

$$\Delta C_{Soils} = \Delta C_{Mineral} - L_{Organic} + \Delta C_{Inorganic}$$

For each inventory time period, the soil organic C stocks are estimated for the first ($SOC_{0\text{-}T}$) and last year ($SOC_0$) based on multiplying the reference C stocks by stock change factors. Annual rates of carbon stock change are estimated as the difference in stocks at two points in time divided by the time dependence of the stock change factors.

$$\Delta C_{Mineral} = \frac{SOC_0 - SOC_{0-T}}{T}$$

$$SOC = \sum_{c,s,i} \left( SOC_{REF_{c,s,i}} \cdot F_{LU_{c,s,i}} \cdot F_{MG_{c,s,i}} \cdot F_{I_{c,s,i}} \cdot A_{c,s,i} \right)$$

$\Delta C_{Mineral}$ = *annual change in carbon stocks in mineral soils*

$SOC_{ref}$ = *reference carbon stock [t C]*

$SOC_0$ = *soil organic carbon stock in the last year of an inventory time period [t C]*

$SOC_{0\text{-}T}$ = *soil organic carbon stock at the beginning of the inventory time period [t C]*

T = *default time period for transition between equilibrium SOC values [yr]. (20yrs default)*

A = *area [ha]*

$F_{LU}$ = *stock change factor for land-use systems or sub-system for a particular land-use*

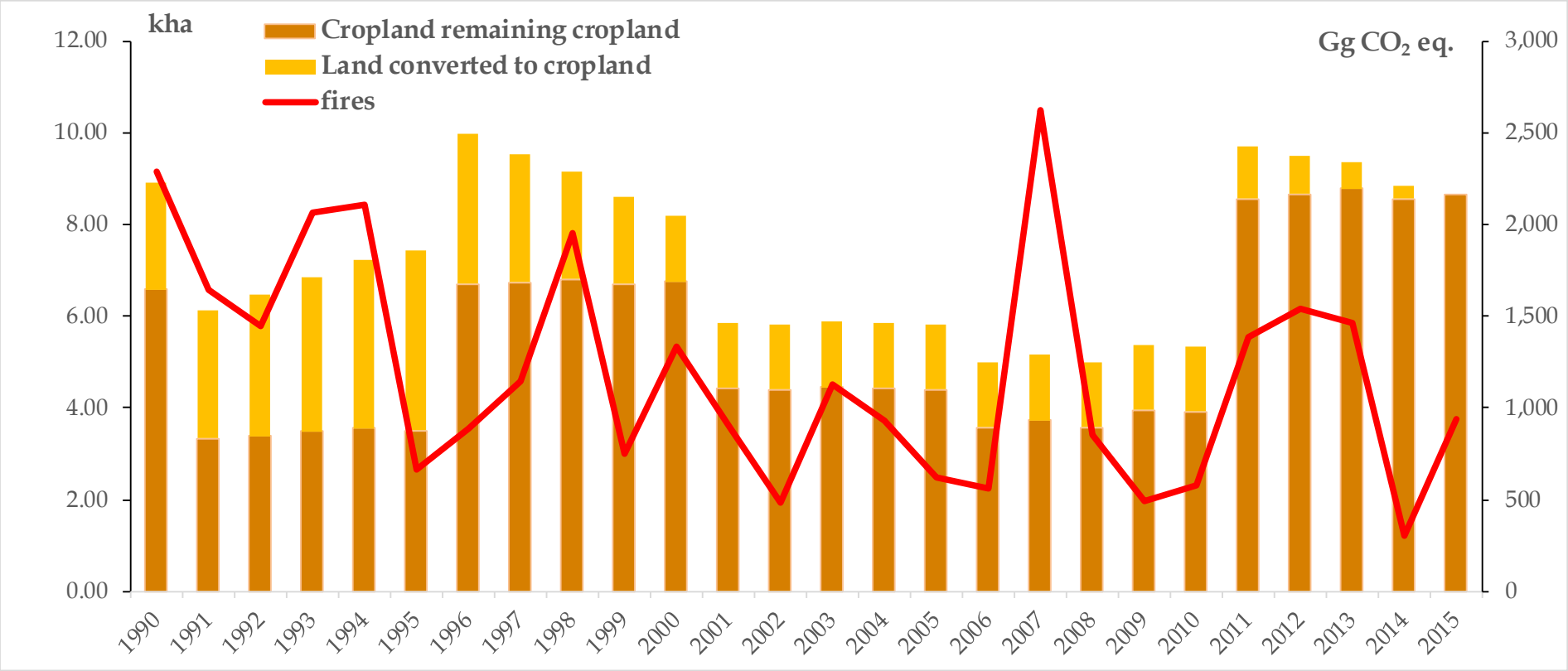
$F_{MG}$ = *stock change factor for management regime*

$F_I$ = *stock change factor for input of organic matter*

*c* represents the climate zones, *s* the soil types, and *i* the set of management systems that are present in a country.

# *Cropland*: methodological issues

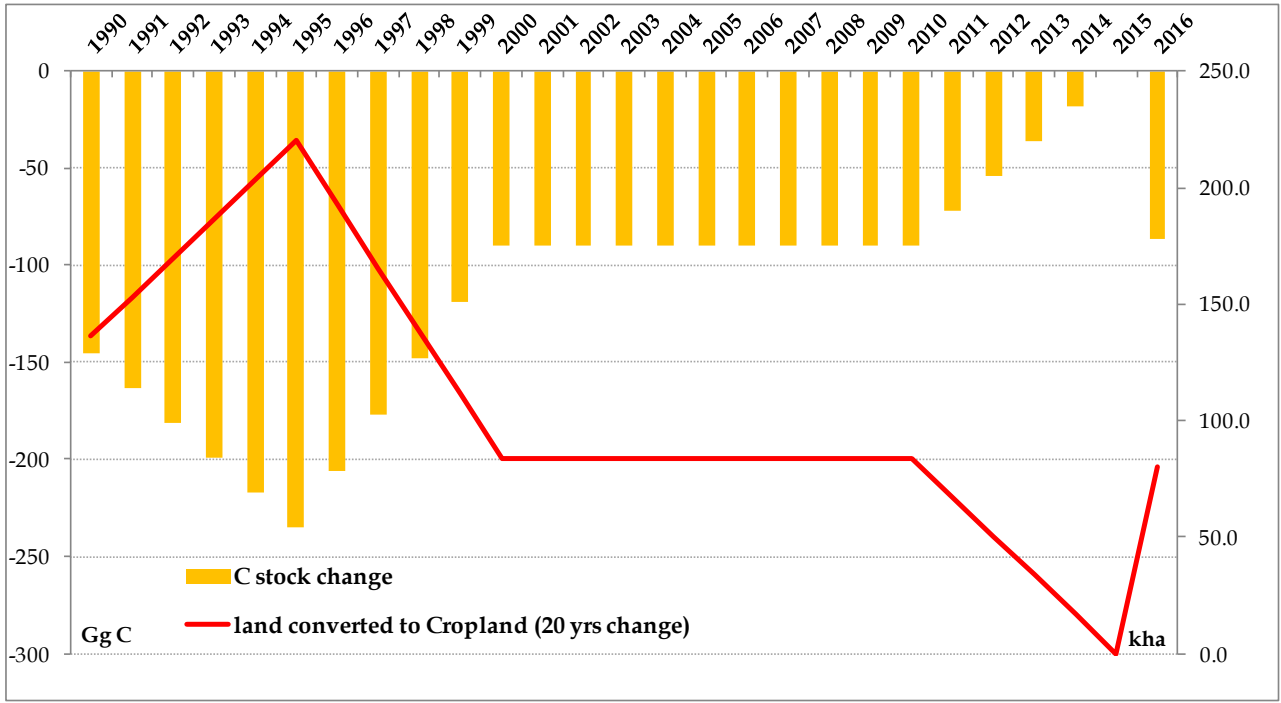
Cropland emissions and removals share 4.6% of total 2016 LULUCF $CO_2$ eq. emissions and removals; in particular, the living biomass emissions and removals represent 50.4%, while the emissions and removals from soils stand for 49.6% of total cropland $CO_2$ emissions and removals.



# *Cropland – Cropland Management*: soils

The change in soil C stocks is the result of a change in practices or management between the two time periods; soil carbon concentration is essentially driven by the change in practice or management. Till now, it wasn't possible to point out different sets of relative stock change factors [FLU (land use), FMG (management), FI (input factor)]; therefore, as no management changes can be documented, resulting change in carbon stocks, in ***cropland remaining cropland***, has been reported as **zero**.

Changes in soil carbon stocks in ***land converted to cropland*** have been estimated following land use changes, resulting in a change of the total soil carbon content, with a land use transition period of 20 years. $\mathbf{SOC_{REF}}$ for cropland has been set to **56.7tC ha$^{-1}$** on the basis of reviewed references, including woody cropland cultivations, such as vineyards and olive orchards, under the most common agricultural practices in Italy.

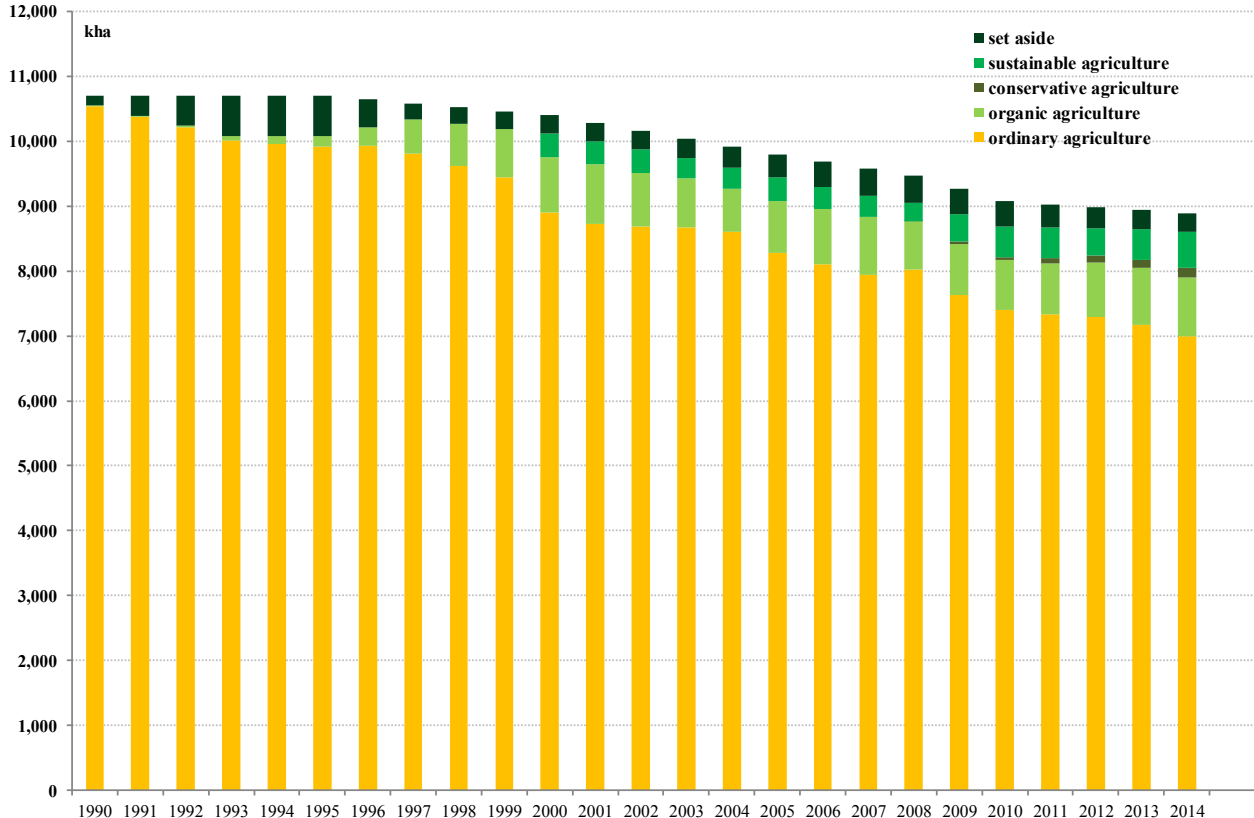


# *Cropland – Cropland Management*: soils

## *Planned improvement*

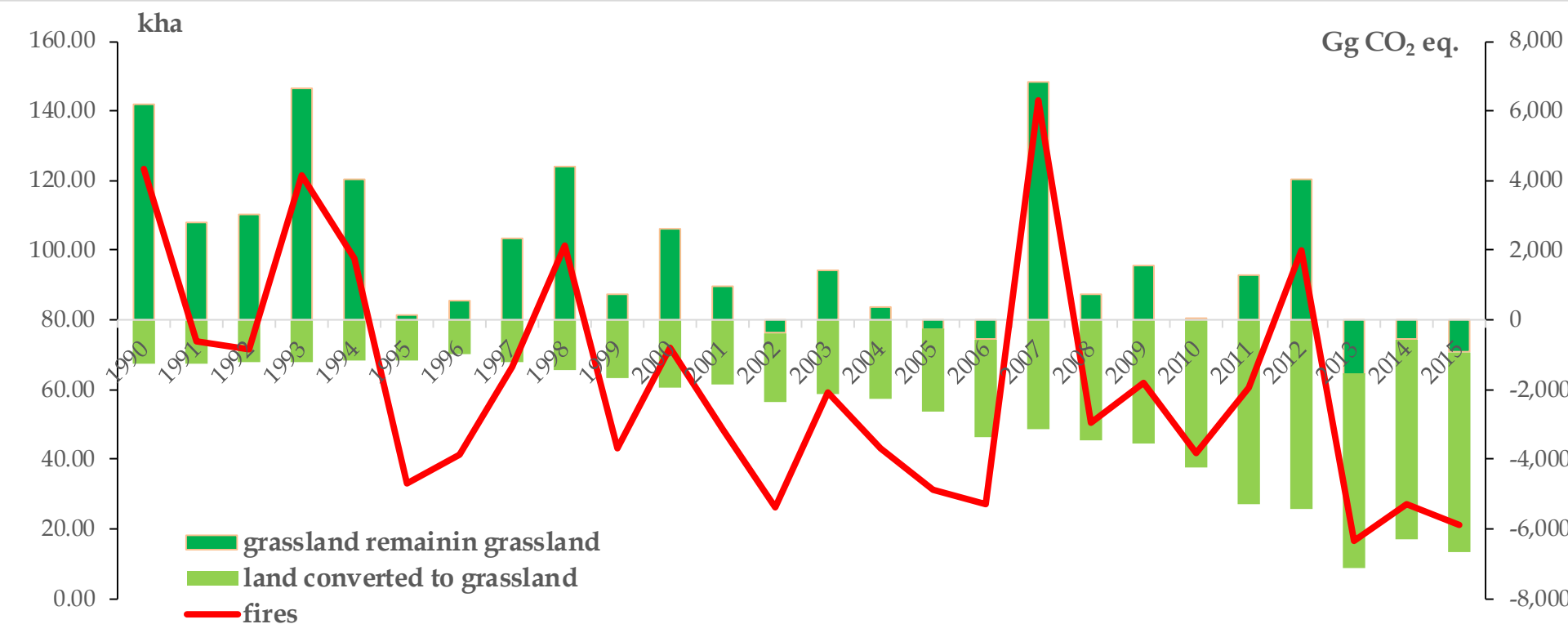
A project with ISMEA is currently ongoing to collect data of cropland and grassland, disaggregated management practices, as resulting by Italian Land Parcel Identification System (**LPIS)**

Based on these data, soil carbon stock change will be estimated and reported, taking into account the country specific $SOC_{REF}$ assessed using the following layers: Climatic Zone layer ( http://esdac.jrc.ec.europa.eu/projects/renewable-energy-directive) Corine Land Cover 2006, italian soil map (Costantini et al., 2013).



# *Grassland:* methodological issues

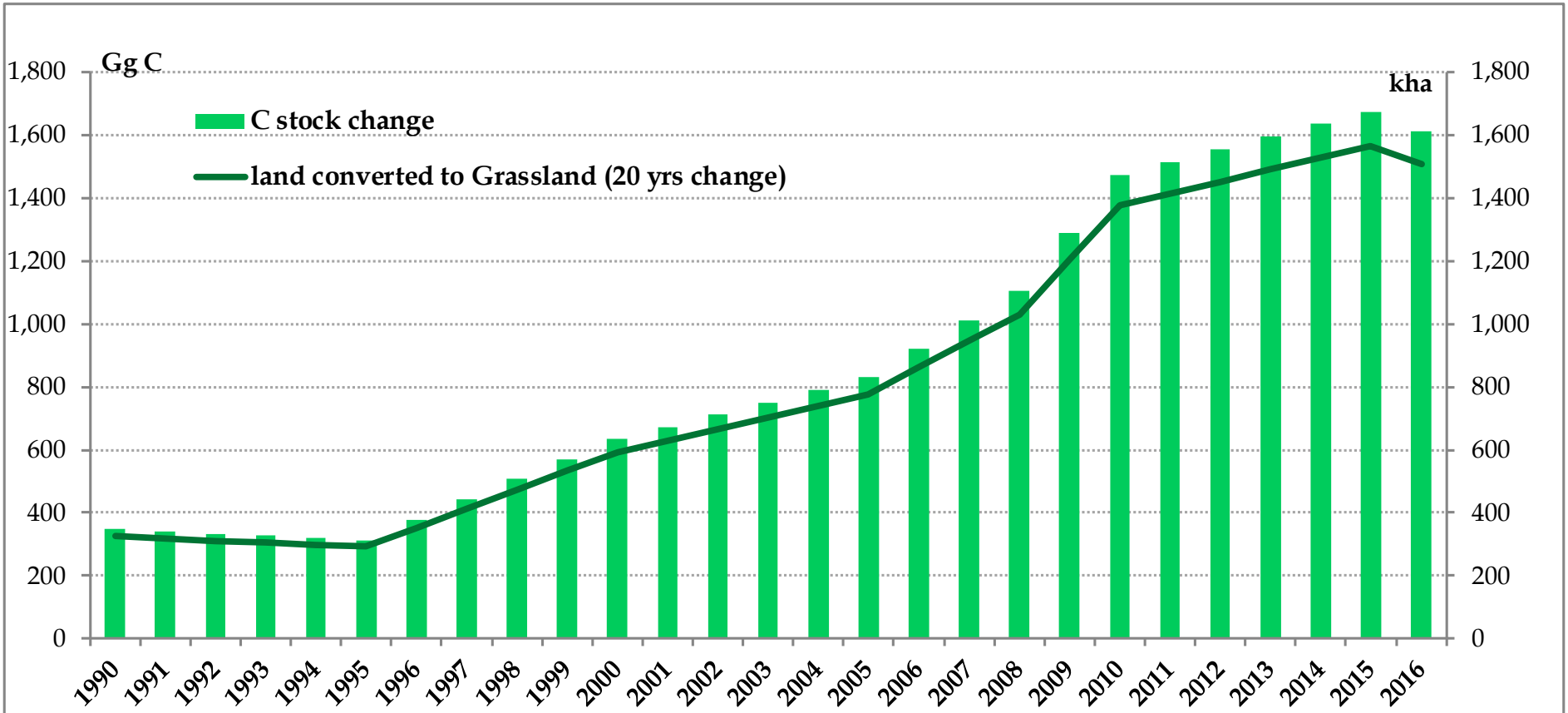
Grassland category is responsible for 6,644 Gg of $CO_2$ removals in 2016, sharing 11.9% of absolute $CO_2$ eq. LULUCF emissions and removals; in particular the living biomass emissions represent 6.8%, while the removals from dead organic matter pool share for 20.5% and removals from soils stand for 72.7% of absolute total grassland $CO_2$ emissions and removals.



# *Grassland:* soils

For grassland remaining grassland, change in carbon stocks has been reported as **zero,** since no management changes can be documented.

Changes in soil carbon stocks in ***land converted to grassland*** have been estimated following land use changes, resulting in a change of the total soil carbon content, with a land use transition period of 20 years. **$SOC_{REF}$** for grassland has been set to **78.9 tC $ha^{-1}$** on the basis of reviewed references, reporting data on soil carbon in mountain meadows, pastures, set-aside lands as well as soil not disturbed since the agricultural abandonment in Italy

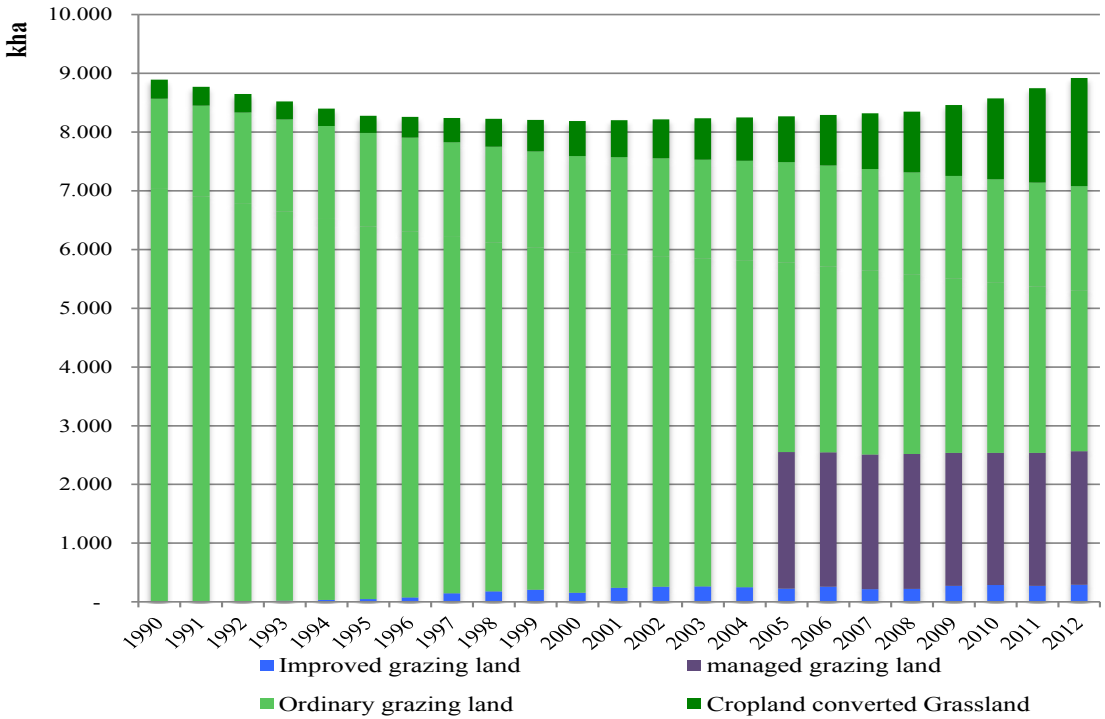


# *Grazing land Management*: soils

Changes in carbon stocks in mineral soils have been estimated on the basis of country specific SOCref deduced by the default reference soil organic carbon stocks for mineral soils (table 2.3, vol. 4, chapter 2, IPCC, 2006).

The assessment of the country specific SOCref has been carried out using the following layers: Climatic Zone layer , Corine Land Cover 2006 , italian soil map (Costantini et al., 2013). The country specific SOCref have been stratified into three macroareas in Italy: north (**78.5 t C ha-1**) , center (**71.3 t C ha-1**) and south (**46.2 t C ha-1**).

| | **Improved grassland** | **nominally managed (not degraded)** |
|---|---|---|
| $F_{LU}$ | 1.00 | 1.00 |
| $F_{MG}$ | 1.14 | 1.00 |
| $F_{I}$ | 1.11 | 1.11 |




Thank you

# Land representation: National Land-use Inventory (IUTI)

A consistent land representation is crucial to estimate emissions and removals of greenhouse gases related to LULUCF sector. Land classification and IPCC categories identification is based on the data from ***National Land-Use Inventory (IUTI).***

IUTI is based on a survey of sample points throughout Italian national territory considered as a population of points, and on the classification of the land use coupled with the sampling points.

The following set of multi-temporal orthophotos was used as basis of photo-interpretation process:

→ *1990, the black and white high resolution full national coverage aerial photography database was used to produce orthophotos in scale 1:75.000, spatial resolution of 1 m (the aerial photos, taken on 1988/89, have the same image acquisition standard adopted by USGS-National High Altitude Program at that time: panchromatic film, 400 lines per millimeter);*

→ *2000, TerraItaly 2000 dataset, digital color aerial orthophotos with spatial resolution of 1 m;*

→ *2008, TerraItaly 2008 dataset, digital color aerial orthophotos with spatial resolution of 0.5 m.*

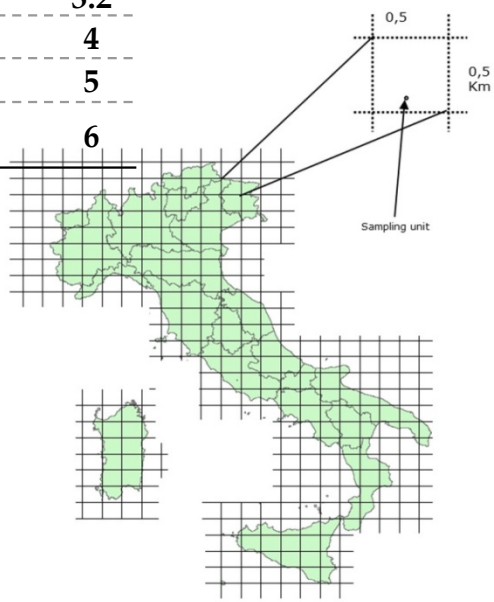
→ *2012, AGEA color and infrared digital orthophotos with spatial resolution 0.5 m; years 2010-12.*

Furthermore, visual interpretation was supported by ancillary information from available thematic forest and land use maps at regional and sub-regional scales.

# National Land-use Inventory (IUTI)

The sampling grid and the relative sample plots (1,206,000 sampling points) is uniformly distributed throughout the entire Italian national territory, using a non-aligned systematic sampling. The set of sample points was extracted using a 0.5 km square grid, for a total of about 1,206,000 geo-referenced points randomly located in each square cell and fully covering the Italian territory. A subset of the IUTI sample is represented by the 301,300 first phase sample points of the national forest inventory (INFC).

| IPCC Category Level I | IUTI Category Level II | IUTI Subcategory Level III | Code |
|---|---|---|---|
| **1. Forest land** | *Woodland* | | **1.1** |
| | *Wooded land temporarily unstocked* | | **1.2** |
| **2. Cropland** | *Arable land and other herbaceous cultivations* | | **2.1** |
| | *Arboreal cultivations* | *Fruit orchards and plant nurseries* | **2.2.1** |
| | | *Wood product plantations* | **2.2.2** |
| **3. Grassland** | *Grassland, pastures and uncultivated herbaceous areas* | | **3.1** |
| | *Other wooded land* | | **3.2** |
| **4. Wetlands** | *Marshlands and open waters* | | **4** |
| **5. Settlements** | *Urban development* | | **5** |
| **6. Other land** | *Non-productive areas or areas with scarce or absent vegetation* | | **6** |



# National Land-use Inventory (IUTI)

A **classification hierarchy** has been established to facilitate land use classification.

The first step is related to a land classification, following artificial land level.

Distinctions are therefore made between urbanized and agricultural territories, and natural and semi-natural territories (forest, pre-forest and herbaceous formations, open water, rocky areas).

At the subsequent levels, the classification process follows the prevalent use of land in the category of artificial territories, while the discriminating element for natural and semi-natural territories is essentially given by the vegetative cover degree, considering canopy, shrub and herbaceous cover.

A. LAND WITH ITS ORIGINAL CHARACTERISTICS OF PHYSIOGNOMY AND VEGETATION SIGNIFICANTLY MODIFIED BY HUMAN ACTION, CULTIVATED, CLEARED OR SUBJECT TO URBANIZATION WORK, AND DOMINATED BY ANTHROPIC ARTEFACTS DUE TO RESIDENTIAL, INDUSTRIAL, SOCIO-CULTURAL AND AGRICULTURAL ACTIVITIES.

AI. **Land occupied by other agricultural cultivations**

AI1. Herbaceous cultivations in open fields, subject to regular rotation, for the production of cereals, pulses, other food products or forage.

**ARABLE**

AI2. Arboreal cultivations not subject to regular rotation, destined permanently to the production of fruit or wood products.

AI2a. *Arboreal cultivations destined prevalently to the production of fruit for nutritional purposes (apple orchards, vineyards, olive groves, etc) or for the production of arboreal or shrub species for ornamental purposes*

**ORCHARDS and NURSERIES**

AI2b. *Arboreal cultivations destined prevalently to the production of wood products or of woody biomass for energy generation purposes*

**ARBOREAL CULTIVATIONS FOR WOOD PRODUCTS**

AII. **Areas with residential and industrial buildings and services, transport routes, infrastructures and urban green areas (parks and gardens)**

**SETTLEMENTS**

B. NATURAL OR SEMI-NATURAL LAND NOT SIGNIFICANTLY MODIFIED BY HUMAN ACTION OR IN PHASE OF RENATURALIZATION.

BI. **Formations constituted by trees able to reach the height on maturity *in situ* of 5 m, but temporarily lacking in canopy cover following accidental events or anthropic action.**

**WOODED LAND TEMPORARILY WITHOUT ABOVE-GROUND COVER**

BII. **Formations constituted by trees able to reach the height on maturity *in situ* of 5 m and procuring a degree of canopy cover on the terrain of ≥ 5%.**

BII1. Formation with a degree of cover < 10%

**OTHER WOODED AREAS**

BII2. Formation with a degree of cover ≥ 10%

**WOODLAND**

BIII. **Formations never as above**

BIII1. Formations constituted by shrubs or trees not able to reach a height on maturity *in situ* of 5 m, and procuring a degree of canopy cover on the terrain of ≥ 10%

**OTHER WOODED LAND**

BIII2. Formations constituted by shrubs or trees not able to reach a height on maturity *in situ* of 5 m and procuring a degree of canopy cover on the terrain of < 10%, and silvi-pastural formations with canopy cover from trees able to reach a height on maturity *in situ* of 5 m but with cover < 5%

BIII2a. *Natural herbaceous formations of ground species with a degree of herbaceous cover of ≥ 40%.*

**PASTURES, MEADOWS and UNCULTIVATED HERBACEOUS AREAS**

BIII2b. *Natural herbaceous formations with a degree of herbaceous cover of < 40% or land completely lacking herbaceous cover*

BIII2b1. *Land without vegetation or with sporadic herbaceous vegetation. Rocky outcrops and beaches.*

**OTHER LANDS**

C. AREAS WITHOUT VEGETATION AND COVERED BY STILL OR FLOWING WATER OR AREAS OCCUPIED BY PARTICULAR ECOSYSTEMS OTHER THAN TERRESTRIAL ECOSYSTEMS (FLOATING VEGETATION, WET VEGETATION, SALTWATER VEGETATION, ETC).

**MARSHLANDS AND OPEN WATERS**

# National Land-use Inventory (IUTI)

To achieve land use classification, a 0.5 ha neighborhood of the sample plot is investigated; for each point, the land use category, defined according to the classification system, has to be established.

A grid, composed of 9 squares (3 x 3) of 2500 m² each, for an overall surface area of 22,500 m² is used. This graphic object, at the centre of which the sampling point must be situated, allows to assess whether area intercepted by the sampling point has an extension equal to or greater than the established threshold (equivalent to the surface area of 2 of the 9 cells displayed).

If the surface area value is very close to the threshold and the use of the cells still leaves doubts, a graphic tool for surface area measurement is used for the classification process. The contour of the polygon containing the sampling point is mapped, computing the extent of the area.

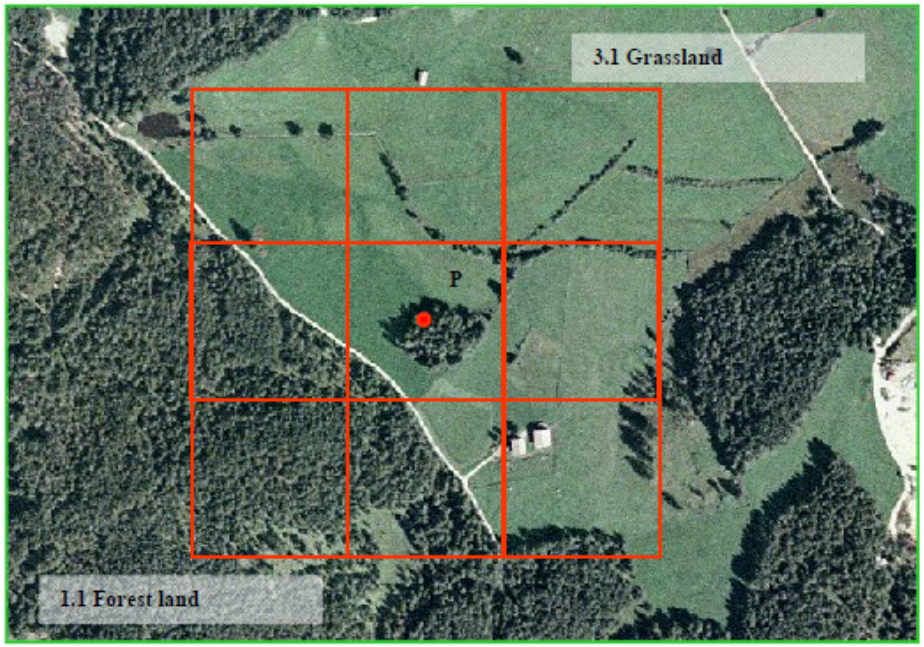



Figure A10.1: Land use classification system - grassland

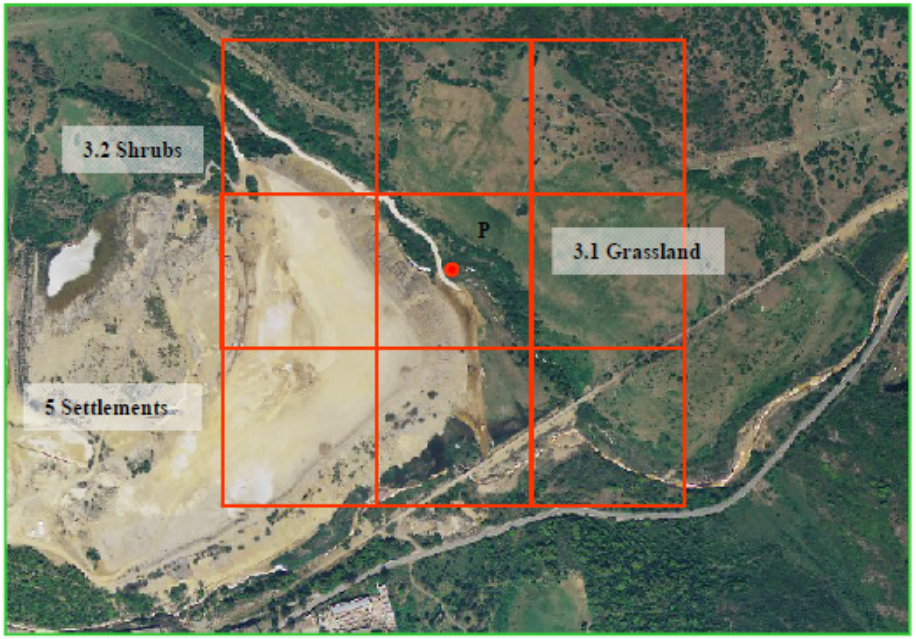



Figure A10.3: Land use classification system – grassland

# Land use classification

IUTI has been carried out in **1990**, **2000** and **2008**, on a sampling grid of 1,206,000 points; in **2012** land use has been assessed on a subgrid (i.e. 301.300 points), in the framework of the III NFI.

Due to the technical characteristics of the IUTI assessment (i.e. classification of orthophotos for 1990, 2000, 2008 and 2012), it was technically impossible to have a clear distinction among some subcategories in cropland and grassland categories (i.e. *annual pastures* versus *grazing land*). Therefore it has been decided to aggregate the cropland and grassland categories, as detected by IUTI, and then disaggregate them into the different subcategories, using as proxies the national statistics related to annual crops and perennial woody crops.

An additional assessment of IUTI is currently ongoing, with reference to year 2016. The ongoing assessment is using the Collect Earth tool for the data collection. Collect Earth is a free and open source software for land monitoring developed by the FAO which facilitates access to multiple freely available archives of satellite imagery, including archives with very high spatial resolution imagery (Google Earth, Bing Maps ) and those with very high temporal resolution imagery (e.g., Google Earth Engine, Google Earth Engine (GEE ) Code Editor).

Furthermore the 2016 IUTI assessment is being carried out on a sampling grid of 120,000 points; in fact a statistical analysis performed on the whole sampling grid, and strata, allowed a sampling points clustering, taking into account the sampling representativeness, the significance and correlated uncertainty.

# Land use change matrices

On the basis of the time series of national land uses, land use change matrices are used to assess land use conversion; the matrices allow to point out the average areas of transition land, separately for each initial and final land use.

In the Italian GHG inventory, the annual figures for areas in transition between different land uses have been derived by a hierarchy of basic assumptions (informed by expert judgement) of known patterns of land-use changes in Italy.

Time series related to the areas to be included into the different IPCC categories have been assembled using the Italian Inventory of Land Use (carried out for the 1990, 2000, 2008 and 2012), the data assessed by the national forest inventories (1985, 2005, 2012).

| | | 1990 | | | | | | *total 1989* |
|---|---|---|---|---|---|---|---|---|
| | | Forest | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| 1989 | Forest | **7.511** | | | | 0,72 | | *7.512* |
| | Grassland | 78,68 | **8.891** | 0,00 | 0,00 | 1,73 | | *8.971* |
| | Cropland | | 0 | **10.841** | 0,00 | 25 | | *10.866* |
| | Wetland | | | | **510** | | | *510* |
| | Settlements | | | | | **1.616** | | *1.616* |
| | Other Land | | | | | 0,00 | **658** | *658* |
| *total 1990* | | *7.590* | *8.891* | *10.841* | *510* | *1.644* | *658* | 30.134 |

| | | 2013 | | | | | | *total 2011* |
|---|---|---|---|---|---|---|---|---|
| | | Forest | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| 2012 | Forest | **9.138** | | | | 3,69 | | *9.142* |
| | Grassland | 58,31 | **8.471** | 0,00 | 0,00 | 0,00 | | *8.529* |
| | Cropland | | 36 | **8.977** | 0,00 | 24 | | *9.038* |
| | Wetland | | | | **519** | | | *519* |
| | Settlements | | | | | **2.251** | | *2.251* |
| | Other Land | | | | | 0,00 | **655** | *655* |
| *total 2013* | | *9.196* | *8.507* | *8.977* | *519* | *2.279* | *655* | 30.134 |

| 20 years matrix | | 1990 | | | | | | *total 1971* |
|---|---|---|---|---|---|---|---|---|
| | | Forest | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| 1971 | Forest | **6.901** | | | | 14,4 | | *6.916* |
| | Grassland | 689 | **8.566** | 136 | 0,00 | 33 | | *9.423* |
| | Cropland | | 325 | **10.704** | 0,00 | 174 | | *11.203* |
| | Wetland | | | | **510** | | | *510* |
| | Settlements | | | | | **1.423** | | *1.423* |
| | Other Land | | | | | 0,00 | **658** | *658* |
| *Total 1990* | | *7.590* | *8.891* | *10.841* | *510* | *1.644* | *658* | 30.134 |
| | **Land converted to:** | 689 | 325 | 136 | 0 | 221 | 0 | |

| 20 years matrix | | 2013 | | | | | | *total 1993* |
|---|---|---|---|---|---|---|---|---|
| | | Forest | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| 1994 | Forest | **7.782** | | | | 41,2 | | *7.824* |
| | Grassland | 1.414 | **7.021** | 34 | 0,95 | 53 | | *8.523* |
| | Cropland | | 1.486 | **8.944** | 6,16 | 455 | | *10.891* |
| | Wetland | | | | **511** | | | *511* |
| | Settlements | | | | | **1.727** | | *1.727* |
| | Other Land | | | | | 2,71 | **655** | *658* |
| *Total 2013* | | *9.196* | *8.507* | *8.977* | *519* | *2.279* | *655* | 30.134 |
| | **Land converted to:** | 1.414 | 1.486 | 34 | 7 | 552 | 0 | |