IPCC Reporting Methods for Emissions and Removals in Cropland and Grassland

[background information to facilitate the workshop]

Project MediNet

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1 IPCC Reporting Methodologies for Emissions and Removals in Cropland and Grassland

The main objective of this report[1] is to make an overview and a summary basic IPCC concepts and reporting method used for the purposes of reporting on emissions and removals in cropland and grassland under the UNFCCC. The use of these guidelines is mandatory for the official reporting of emissions and removals to all Parties of the United Nations Framework Convention on Climate Change.

The estimation methodologies for Cropland and Grassland are described in detail in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and in particular in Volume 4 Agriculture, Forestry and Other Land Use (AFOLU)[2].

This report does not aim to replace the full reading of the IPCC Guidelines, but focuses instead on some of the main concepts of emissions and removals reporting, as these are important aspects for the good functioning of the workshop. In it, we highlight the main features of the reporting requirements for AFOLU, with a special emphasis on those aspects that influence the reporting of cropland and grassland.

2 Land Representation

2.1 Land-use Categories

The IPCC requires that all countries report all lands aggregated under 6 basic categories:

1. **Forest Land (FL)**: all land with woody vegetation consistent with a national "forest" definition. It also includes systems with a vegetation structure that temporarily fall below, but *in situ* could potentially reach the threshold values used by a country to define the FL category;
2. **Cropland (CL)**: cropped land, including rice fields and agro-forestry systems where the vegetation structure falls below the thresholds used for the FL category;
3. **Grassland (GL)**: rangelands and pasture land that are not considered CL. It also includes woody vegetation and other non-grass vegetation such as herbs and shrubs that fall below the threshold values used in the FL category. The category also includes all grassland from wildlands to recreational areas as well as agricultural and silvi-pastoral systems, consistent with national definitions;
4. **Wetlands (WT)**: areas of peat extraction and land that is covered or saturated by water for all or part of the year (e.g. peatlands) and that does not fall into the FL, CL, GL or ST categories. It includes water reservoirs and natural rivers and lakes;
5. **Settlements (ST)**: all developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories, and consistently with national definitions;

[1] This report completes the information produced by MediNet and to aims to provide a minimum background on IPCC Methods for discussions at the Workshops of Project MediNet

[2] http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html

6. **Other Land (OL)**: bare soil, rock, ice, and all land areas that do not fall into any of the other five categories.

If data are available, countries are encouraged to classify unmanaged lands by the above land-use categories (e.g., into Unmanaged Forest Land, Unmanaged Grassland, and Unmanaged Wetlands).

While all countries need to respect that basic aggregation, each country is free to further stratify (disaggregate) each of the categories into more homogeneous units. In the case of cropland, that may involve stratification of cropland according to main crop type, management practices, ecological or climate zones, and/or soil types.

2.2 Land-use Conversions

While each land-use/management system has a unique profile of emissions and removals, most emissions and/or removals will actually occur when changes to land-use take place. Classic examples include changes in land-use categories, such as afforestation (e.g. conversion of an area of pasture to a forest) and deforestation (e.g. conversion of a forest to an urban area).

For that reason the IPCC requires that land-use conversions should also be reported with the aggregation described below:

FF	=	Forest Land Remaining Forest Land	LF	=	Land Converted to Forest Land
GG	=	Grassland Remaining Grassland	LG	=	Land Converted to Grassland
CC	=	Cropland Remaining Cropland	LC	=	Land Converted to Cropland
WW	=	Wetlands Remaining Wetlands	LW	=	Land Converted to Wetlands
SS	=	Settlements Remaining Settlements	LS	=	Land Converted to Settlements
OO	=	Other Land Remaining Other Land	LO	=	Land Converted to Other Land

Other relevant conversions for emissions and removals reporting are changes *within* a land-use category, such as plantation of orchards on annual crop area (e.g. conversion from a cereal to a citrus plantation, which are both considered cropland) or changes in management system *within* the same crop, such as introduction of no-tillage in a crop where conventional tillage was the norm.

2.3 Approaches to Land-Representation

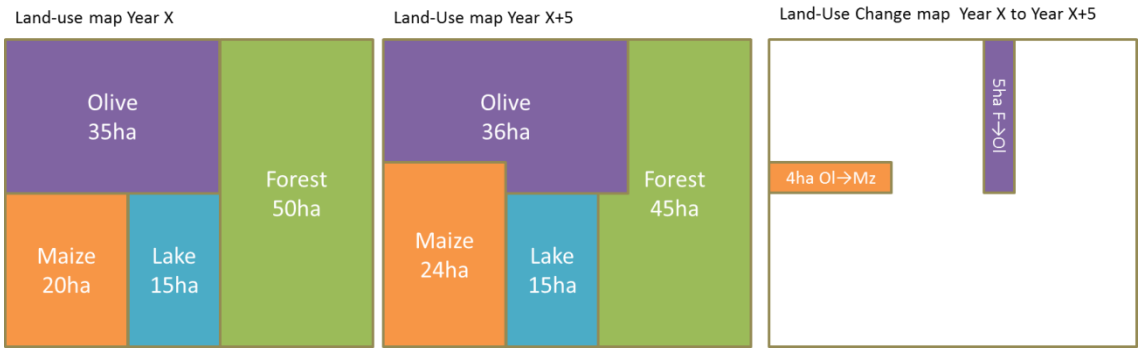
The IPCC defines 3 approaches to adequately address land-representation for the purposes of emissions and removals reporting.

They reflect increasing levels of information content. Approach 1 identifies the total areas for each individual land-use category within a country, but does not provide information on the nature and area of conversions between land-uses (e.g. cropland statistics). Approach 2 introduces tracking of land-use conversions between categories, but is not spatially explicit (amount of land-use changes is known, but the location of those changes is not). Approach 3 is similar to approach 2 but land-use conversions can be tracked in a spatially explicit manner.

The most complete land representation is obtained using approach 3, when land-use maps are available annually (or at regular periods of time), which allow (1) quantify total areas along time; (2)

quantify the areas which went through land-use changes; (3) know the location of current land-uses, past land-uses and land-use changes. An example is presented in Figure 1.

Figure 1: Hypothetical Land-Use and Land-Use Change Maps



According to the IPCC, the different approaches are not mutually exclusive, and can even be combined within the same country to reflect emissions estimation needs and national circumstances. One Approach may be applied uniformly to all areas and land-use categories within a country, or different Approaches may be applied to different regions or categories or in different time intervals.

3 Carbon Pools and Carbon Flows

A Carbon Pool (sometimes also referred to as Carbon Stock or Carbon Reservoir) refers to a component of the cropland or grassland ecosystem that contains carbon as one important element of its constituents. A Carbon Flow refers to transfers (or movements) of Carbon between these components. When these flows involve the atmosphere, they are called a Removal (sometimes also referred to as a Sink or Sequestration), if the flow implies a transfer between the atmosphere and, e.g., the biomass of plants; or as an Emission, if the flow implies a transfer between, e.g., the soil and the atmosphere (through decomposition of organic matter).

3.1 Carbon Pools

The IPCC requires that reporting should be done according to pre-defined Carbon Pools. Those carbon pools are:

- Living Biomass (LB): all biomass of living vegetation, both woody and herbaceous, both above and below the soil.
    - Above-ground biomass (AGB) includes stems, stumps, branches, bark, seeds, foliage.
    - Below-ground biomass (BGB) includes live roots. Fine roots of less than (suggested) 2mm diameter are often excluded because these often cannot be distinguished empirically from soil organic matter or litter.
- Dead Organic Matter (DOM): all dead wood and litter.
    - Dead wood (DW) includes all non-living woody biomass not contained in the litter, either standing, lying on the ground, or in the soil. Dead wood includes wood lying on the surface, dead roots, and stumps, larger than or equal to 10 cm in diameter (or the diameter specified by the country).

- Litter (LT) includes all non-living biomass with a size greater than the limit for soil organic matter and less than the minimum diameter chosen for dead wood, lying dead, in various states of decomposition above or within the mineral or organic soil. This includes the litter layer as usually defined in soil typologies. Live fine roots above the mineral or organic soil (of less than the minimum diameter limit chosen for below-ground biomass) are included in litter where they cannot be distinguished from it empirically.

- Soils: all soil organic matter (SOM) in both organic and mineral soils. Includes organic carbon (OC) in mineral soils to a specified depth chosen by the country and applied consistently through the time series. Live and dead fine roots and DOM within the soil that are less than the minimum diameter limit for roots and DOM, are included with soil organic matter where they cannot be distinguished from it empirically. The default for soil depth is 30 cm.
    - Organic Soils (OS): Soils that meet criteria 1 *and* 2 or 1 *and* 3 listed below:
        1. Soils with an organic horizon with a thickness ≥10 cm. A horizon of less than 20cm must have 12% or more OC when mixed to a depth of 20cm.
        2. Soils that are never saturated with water for more than a few days must contain more than 20% OC by weight (i.e., about 35% SOM).
        3. Soils that are subject to water saturation episodes and have either: at least 12% OC by weight (i.e., about 20% SOM) if the soil has no clay; or at least 18% OC by weight (i.e., about 30% SOM) if the soil has 60% or more clay; or an intermediate, proportional amount of OC for intermediate amounts of clay.
    - Mineral Soils (MS): all other soils.

In the case of cropland and grassland, Living Biomass sub-pools are reported together (i.e. differentiation between above and below-ground biomass is not required) and, likewise, the Dead Organic Matter sub-pools are also reported together (i.e. differentiation between dead wood and litter is not required).

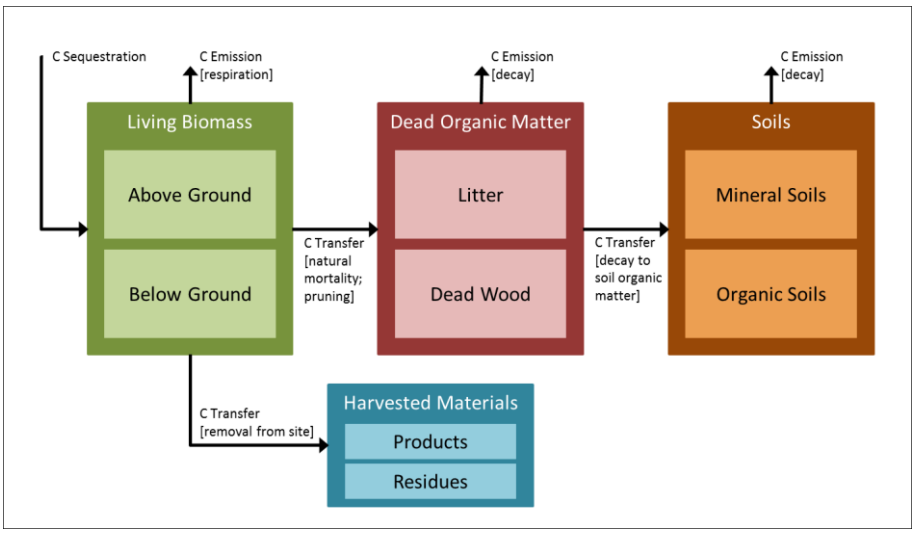
3.2 Carbon Flows

As already mentioned, the IPCC requires that reporting is done by Carbon Pool. From the individual Carbon Pool perspective all entries to the pool should be treated as “gains” while all exits from the pool as “losses” (see Figure 2).

This means, e.g., that when leaves fall in the autumn this is simultaneously a loss in the “living biomass” pool and a gain in the “dead organic matter” pool. The decay of those leaves will later constitute a loss in the “dead organic matter” pool. Part of that loss will go to the atmosphere, while another part (the part that is converted into soil organic matter) will constitute further gains in the “soils” pool. The later decay of this soil organic matter will be a loss in the “soils” pool.

In the case of cropland, an additional flow needs to be considered – the harvested materials, which refers to products and residues which are removed from the site. This is because these materials constitute a loss from the living biomass pool, but not a gain to the dead organic matter pool. According to IPCC Guidance these transfers are treated as an “instant oxidation”, i.e., as if they are completely transformed into CO_2 the moment their harvesting occurs.

Figure 2: Main Carbon Flows and their Relation to Carbon Pools



4 Estimating Emissions and Removals

4.1 Activity Data and Emission Factors

The general approach to estimating emissions and removals is relatively straightforward and results from a simple multiplication of Activity Data (usually the area of a specific crop) and an Emission (or removal) Factor (which represents the total emission or removal of 1 ha of that specific crop) (see Figure 3).

Figure 3: General Approach to Estimation of Emissions and Removals

4.2 Estimating Carbon Stocks

In many cases, the Carbon Stock is usually not measured directly but is rather obtained from measurements of related variables (biomass, % of soil organic matter). In these situations the available information is further processed to deliver the required Carbon stock level. This usually involves a number of additional factors to convert the original measurements into tons of Carbon.

Figure 4 illustrates a case where only fresh above ground biomass is known. In this case a conversion between fresh biomass and carbon will involve the knowledge of the % of dry matter and the % of carbon in the biomass. In this example, where only above ground biomass is known, an additional factor is needed to take into account the biomass in the root system.

Figure 4: General Approach to Estimation Carbon Stocks in Biomass

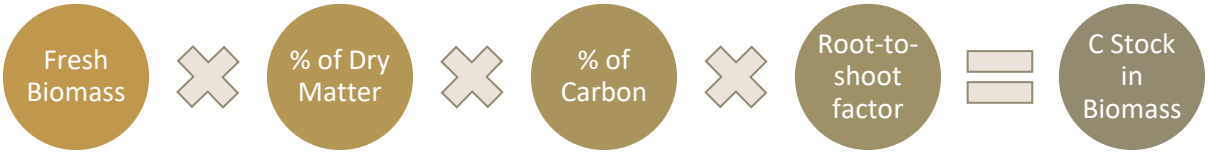


Figure 5 illustrates the more general case in soils, where measurements are commonly made in % of Soil Organic Matter. In this case a conversion involves the knowledge of bulk density (mass per unit of volume), the volume of soil being represented (up to 20 cm or other depth) and the % of Carbon in Soil organic matter.

Figure 5: General Approach to Estimation Carbon Stocks in Soil

4.3 Main Methods for Estimating Emissions and Removals

The IPCC provides two alternatives to estimating emissions and removals from Land-Use: the “Stock-Change Method” and the “Gains-Losses Method”. If correctly applied, both methods should produce the same results. They are, therefore, considered by the IPCC as equivalent and no preference over one or another is expressed. The two methods can also be combined, e.g., by using one method for one pool and a different method for another pool.

4.3.1 The Stock-Change Method

The Stock-Change Method (see Figure 6) is based on the estimation and comparison of C Stocks of a particular Carbon pool at different periods in time. An increase in C Stocks over time means that more Carbon is being added to the pool than removed, meaning that a "Net-Carbon Sequestration" in that pool is taking place over that period. Likewise a loss in a Carbon pool over time means that more Carbon is being removed from that pool than added, meaning that a "Net-Carbon Emission" is taking place.

Figure 6: The "Stock-Change Method" for Estimating Emissions and Removals

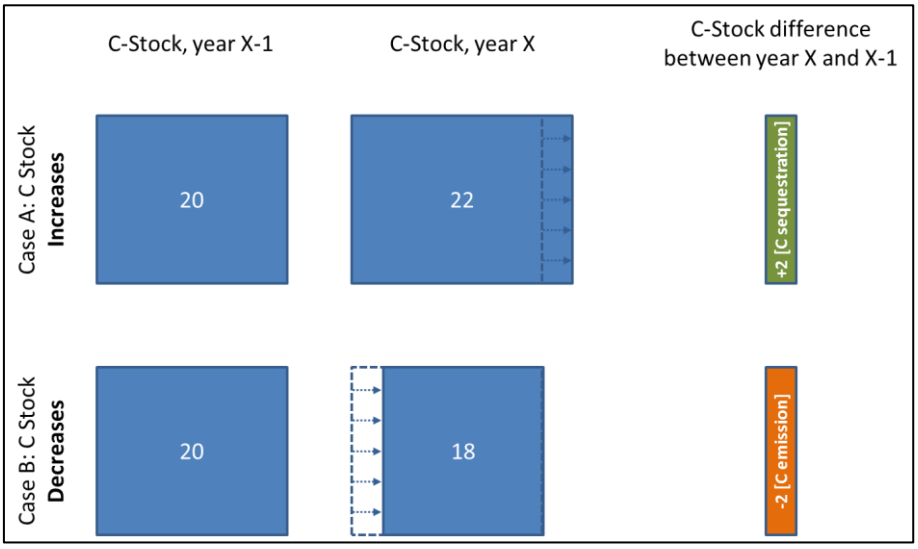


Figure 6 shows in

Case A: a situation where Carbon Pools have increased from 20tC to 22tC between two consecutive years, leading to a net C sequestration of +2tC/year;

Case B: the opposite situation, i.e., a loss of Carbon from 20tC to 18tC, leading to a net C emission -2tC/year.

4.3.2 The Gains-Loss Method

In the Gains-Losses Method (see Figure 7), the quantification is focused not on the total Carbon stocks, but on the quantification of the Carbon flows which increase the pool (Gains) and those that decrease the pool (Losses). An example of gains in the living biomass pool is the annual growth in the wood of the stem of an apple tree, while examples of losses include the natural leaf fall in the autumn or the branches removed by pruning during the winter. A Carbon pool is said to be sequestering Carbon if gains are bigger than losses in a particular period, while an emission of Carbon emission takes place in those situations where the losses are bigger than gains.

Figure 7: The "Gains-Losses" Method for Estimating Emissions and Removals

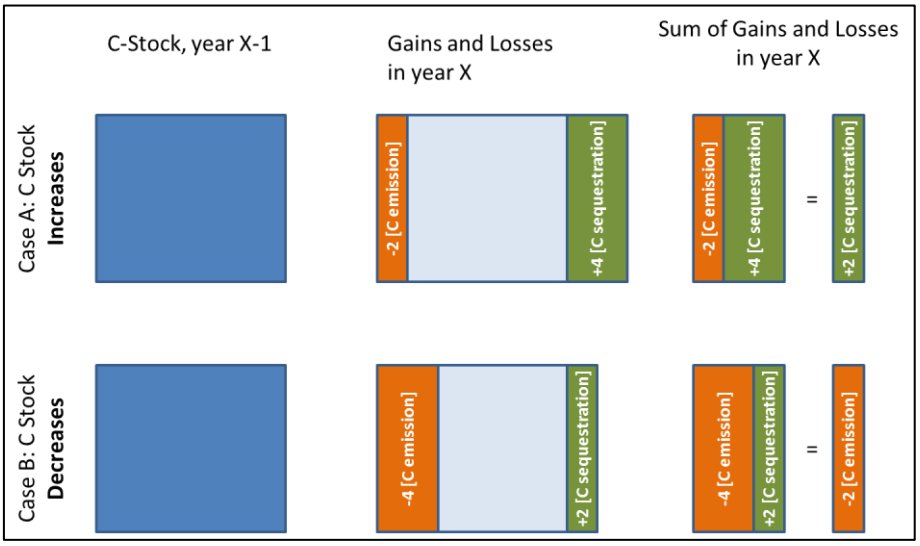


Figure 7 shows in

- Case A: a situation where both gains and losses have occurred between two years, but because gains (+4tC/year) were bigger than losses (-2tC/year) this has resulted in a net C sequestration (+4 -2 = +2tC/year);
- Case B: the opposite situation, i.e., a case where losses were bigger than gains and, hence, a net C emission is reported in the year analysed.

Annex I: Project MediNet

Project focus

Improve the transparency, consistency, comparability, completeness and accuracy of cropland and grassland reporting of emissions and removals in Mediterranean Countries

Project objectives:

1. Compilation and systematization of existing knowledge and data with relevance for reporting croplands and grasslands emissions in Mediterranean conditions, in particular for mineral soil and aboveground biomass of perennial crops
2. Sharing experiences and approaches in reporting croplands and grasslands emissions in Mediterranean conditions
3. Exploring the possible use of common methods and/or reference data and/or data sets for reporting purposes
4. Identifying information and research gaps
5. Enhance the participation and involvement of agriculture stakeholders in climate change mitigation and adaptation

Actions and means involved

To accomplish its objectives, MediNet will involve public Institutions and Universities from different countries in the Mediterranean basin working specifically on themes related to Agriculture and emissions and removals reporting. For this purpose, different Actions of the project will involve both the Institutions with the official responsibilities of reporting on Cropland and Grassland emissions and removals at National level, and the Institutions/Universities working in specific themes related to Grassland and Cropland management.

The establishment of the MediNet network, involving Italy and Portugal as beneficiaries of the project, and Spain, Greece, France, Malta, Cyprus, Croatia, Slovenia as stakeholders, will allow identifying, sharing and maximising the potential of existing knowledge that can be used for reporting purposes. The identification of gaps in data at National level and the adoption of solution to fill these gaps coming from the experience gained by other Mediterranean counties is an aim of the MediNet project. The main objective of the MediNet network is to increase the knowledge on the effect that different management activities applied to Croplands (e.g. conventional agriculture, biological, reduced tillage, other) and Grasslands (e.g. grazed, mowed, sown, other) have on the soil organic carbon (SOC) and biomass C stocks.

This represents a crucial and necessary point, needed to allow for an identification of new and more specific factors to be related to different management activities for Cropland and Grassland management in the Mediterranean area. As a result, more accurate, complete and consistent estimates of C gain and losses due to emission and removal from Cropland and Grassland will be provided at National level. The sharing of reporting experiences and of specific solutions for reporting (i.e., methodologies, activity data and emission factors) will also allow for increased comparability across Mediterranean Countries.

A preliminary action characterizes the Institutional arrangements (Institution and data provision) for each country involved in MediNet (Actions A.1). Subsequently, the preliminary Action A.2 will select the types of Management Systems for Cropland and Grassland to be used in subsequent Actions. The core of MediNet will be expressed through Actions A.3, A.4 and A.5, that will specifically identify the

type of data and methodologies present in the different Institutions/Universities necessary to report emissions and covering three main topic areas:

- Activity data for Cropland and Grassland under different management types and the area that is annually subject to a land use/management change: methodologies and data sharing;
- Assessment of the contribution of the above and below ground biomass of perennial crops to annual Carbon gains and losses: data available and gaps;
- Soil organic carbon stock and variations in mineral soils under different management options for Cropland and Grassland: data available and gaps.

To accomplish the purposes of MediNet, specific workshops will be held during the course of the project involving both the Institutions doing the emission & removal estimations and the Institutions/Universities working on Cropland and Grassland related themes. People from other LIFE and non-LIFE projects will be also invited so to possibly increase the exchange of data and of experiences. Specifically, the workshops will follow the specific themes treated in Actions A.3, A.4 and A.5, and will be focused on: a) Cropland and Grassland areas that are subject to a change in management; b) SOC data for the different types of management used in Cropland and Grassland; c) contribution of above ground biomass and deadwood from perennial crops. The workshops are included in the implementation Actions rather than in the communication Actions since they aim specifically at allowing for a wider exchange of data, rather than on communicating project results.

An important part of the project is devoted to increase project visibility and in sharing of information among partners and stakeholders. A project website (Action B1) will be created soon after the beginning of the project to specifically widespread information useful for stakeholders (e.g. Institutions) and the general public. To allow information to be spread widely a Facebook page with the LIFE logo will be also created allowing for a wider visibility of the proposed Actions and of the project results (Action B1). Twice per year, the status of the progress made on the different themes treated by the project will be published on the webpage.

Brochures reporting the results/decisions of the specific workshops will be made available soon after their conclusion on the project website. Networking with other projects will also represent an important part of the project (Action B2) allowing collecting information useful for the project.

A Farmer's day (Action B3 and B4) will be organized in each of the two countries (Italy and Portugal) to involve farmers and provide capacity building on agriculture and climate change, the opportunities for improved climate management practices in each of the Rural Development Programmes and share information on specific themes such has the effectiveness of the application of good managements practices (e.g. reduce tillage; organic fertilizers) aimed at soil conservation and to increase soil fertility. Questionnaires will be spread among farmers so to evaluate the uptake and quality of implementation of these practices. The involvement of stakeholders in those workshops, particularly farmers and/or their representative organisations, represents a crucial and fundamental part of the project. All the outputs of the farmer's day will be available on the website of the project (Action B1). A Layman's report (Action B5) and Board Notices (Action B6) will be also performed so to allow for a wider visibility of the project structure and its results, particularly among the general public.

Expected results

The main results expected at the end of the project are the following:

1. Increased knowledge on the soil organic carbon data for at least the top 30 cm (if possible 50 or 100 cm depth) of mineral soil for different crops/grassland management types from each Mediterranean country involved in MediNet. A database will be created to collect all the information correlating the average SOC content and stock to the different management activities applied for Cropland and Grassland.
2. Improved default emission factors in SOC as a result of land management change in Cropland and Grassland for use in Mediterranean conditions, to replace the IPCC tier 1 default factors and to increase the number of management practices that are currently used for reporting purposes at National level.
3. Increased knowledge on the contribution from the above ground biomass of perennial crops and from deadwood to annual emissions and removals. A database will be created to collect all the information and to relate the carbon in the aboveground biomass of perennial crops to the different management activities applied for Cropland and Grassland.
4. Creation of a network of stakeholders to be used for monitoring the agriculture contribution to climate change in the Mediterranean area.