Biomass Data on Cropland and Grassland in the Mediterranean Region

Deliverable D5/A4

Project MediNet

Project MediNet is a LIFE Preparatory Project
and is funded by Programme LIFE of the EU
under the contract LIFE 15 PRE IT/732295

Acknowledgments and Disclaimer

The authors would like to acknowledge and thank the contributions of all the people listed below. They have provided data, directed us to scientific references and/or provided very useful comments to earlier versions of this report. We would also like to thank all participants in the MediNet Workshop (see Annex III) for their engagement and active participation in the workshop, which provided a wealth of inputs for this report.

We note however that the methodology, the selection of data for compilation, views and opinions expressed in this report are of the responsibility of the authors, and do not necessarily reflect the views of any individual listed below.

Adriano Sofo
Ana Luísa Fernando
Ana Sá
Angelos Mimis
Antonio Brunori
António Monteiro
Armindo Martins
Asma Jebari
Borja Velázquez Martí
Boštjan Mali
Carlos Carvalho
Carlos Lopes
Carlos Miranda
Clara Lopes
Cristina Garcia
Damiano Zanotelli
Emilia Fernández-Ondoño
Giacomo Grassi
Gianni Picchi
Giuseppe Celano
Giuseppe Montanaro
Iordanis Tzamtzis
João Azevedo
José Merino
Kostas Bithas
Lúcio do Rosário
Magdalena Galvez
Mar Ferrero
María Almagro
María José Sanz
María Martínez-Mena
Marina Vitullo
Marjan Jongen
Maurizio Ventura
Melanie Hausler
Melina Menalaou
Mitja Ferlan
Myrsini Christou
Paz Fuentes
Raul Zornoza
Robert Colas
Sandro Federici
Simone Rossi
Stefano Amaducci
Vassilis Lychnaras
Xavier Lecomte

This report should be cited as:

Canaveira, P., Manso, S., Pellis, G., Perugini, L., De Angelis, P., Neves, R., Papale, D., Paulino, J., Pereira, T., Pina, A., Pita, G., Santos, E., Scarascia-Mugnozza, G., Domingos, T., and Chiti, T. (2018). Biomass Data on Cropland and Grassland in the Mediterranean Region. Final Report for Action A4 of Project MediNet. http://www.lifemedinet.com/

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1 Introduction

The main objective of this report[1] is to propose new default coefficients for the reporting of emissions and removals from living biomass in cropland (permanent crops) and grasslands (shrublands), within the Greenhouse Gases inventory and reporting obligations under the UNFCCC and its Kyoto Protocol, and the related EU decisions and regulations (Decision 529/2013/EU, Regulation EU 525/2013) for the sector Land Use, Land Use Change and Forestry (LULUCF).

The main carbon pools in cropland and grassland are living biomass and soil carbon. It is very likely that the contribution of living biomass or deadwood from annual crops or grasses to climate change is only marginal (as gains are offset by losses on an annual basis), the same will not be true for permanent crops and shrubby grasslands and for agri-forests systems or systems involving tree or shrub hedges. As there are no inventories of biomass for permanent crops and grasslands, the main objective of this study is to identify “equivalent” sources of information to improve default factors for biomass pool in the Mediterranean area.

Section 2 describes the methodology used and provides a review of existing information on biomass in cropland and grassland types and respective management practices available from the Mediterranean Country considered in Project MediNet (Figure 1).

Figure 1: Area of Intervention of Project MediNet

The results obtained for biomass stocks in cropland and grasslands are provided in Section 3, particularly for olive trees, vineyards, fruit trees and shrublands.

On the basis of the results from the previous section, new coefficients for reporting emissions and removals from living biomass in cropland (permanent crops) and grasslands (shrublands) are provided in Section 4.

Finally, section 5 makes an overview of the results and identifies information gaps and areas for further work to improve the quality of the estimates in future inventory methodologies.

[1] This report is the fourth report of Project MediNet and is the final deliverable of action A4 “Gains and Losses in Living Biomass and Deadwood”

2 Methodology

Atmospheric carbon accumulates in both aboveground and below-ground living biomass of annual and perennial plants. Biomass of annual and perennial herbaceous (i.e., non-woody) plants is characterized by an annual cycle where emissions from decay are balanced by removals in the following year, thus the C stocks in this biomass is considered to be stable in the long term (IPCC2006). The 2006 IPCC "Guidelines for National Greenhouse Gas Inventories" methods focus on C stock changes in biomass of woody plants and trees that in cropland and grassland categories are associated to orchards and shrubs respectively. IPCC 2006 provides two methods for assessing the net C fluxes in the biomass pool:

- **The Gain-Loss Method**: requires the biomass carbon loss (harvesting, natural disturbances, etc) to be subtracted from the biomass carbon gain (growth in aboveground and below-ground components).
- **The Stock-Difference Method**: requires biomass carbon stock inventories for a given land area, at two points in time. Annual biomass change is the difference between the biomass stock at time t2 and time t1, divided by the number of years between the inventories.

The IPCC 2006 suggests values for default coefficients in Permanent Crops (Table 1) that can be used in the above methods. Equivalent values for shrublands are not available.

With relation to Permanent Crops, the following observations can be made:

- There are no specific values proposed for the Mediterranean Region, which is contained in a broad class "Temperate (all moisture regimes)";
- Permanent Crops are treated as a single category, i.e. there is no differentiation between crop types or management regimes;
- Maturity of biomass accumulation in the class "Temperate (all moisture regimes)" is assumed to occur at 30 years;
- Values for Below Ground Biomass are not provided.

Table 1: Default IPCC values for Biomass in Permanent Cropland[2]

TABLE 5.1
DEFAULT COEFFICIENTS FOR ABOVE-GROUND WOODY BIOMASS AND HARVEST CYCLES IN CROPPING SYSTEMS CONTAINING PERENNIAL SPECIES

Climate region	Above-ground biomass carbon stock at harvest (tonnes C ha^{-1})	Harvest /Maturity cycle (yr)	Biomass accumulation rate (G) (tonnes C ha^{-1} yr^{-1})	Biomass carbon loss (L) (tonnes C ha^{-1} yr^{-1})	Error range[1]
Temperate (all moisture regimes)	63	30	2.1	63	± 75%
Tropical, dry	9	5	1.8	9	± 75%
Tropical, moist	21	8	2.6	21	± 75%
Tropical, wet	50	5	10.0	50	± 75%

Note: Values are derived from the literature survey and synthesis published by Schroeder (1994).
[1] Represents a nominal estimate of error, equivalent to two times standard deviation, as a percentage of the mean.

[2] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4 Agriculture, Forestry and Other Land Use, Chapter 5 Cropland, Table 5.1, page 5.9

As shown in section 3 “Biomass Stocks for Cropland and Grassland” below, these values constitute a gross overestimation of the values recorded in the Mediterranean Region and should therefore be refined to better reflect cropland groups and climate regions.

To propose new data applicable to the Mediterranean conditions, Project MediNet undertook a systematic quantitative review of the available information from scientific literature and other publications on both Carbon (C) Stocks and/or C Flows in cropland and grassland. The review focused not only on the woody biomass (stem and large/small branches, roots) but also data on leaves and fruits (Figure 2 and Figure 3) although not required for living biomass calculation under the IPCC methodology, but useful as input for calculations under other sectors or pools (see section 4 below).

Figure 2: Biomass Components in Perennial Crops

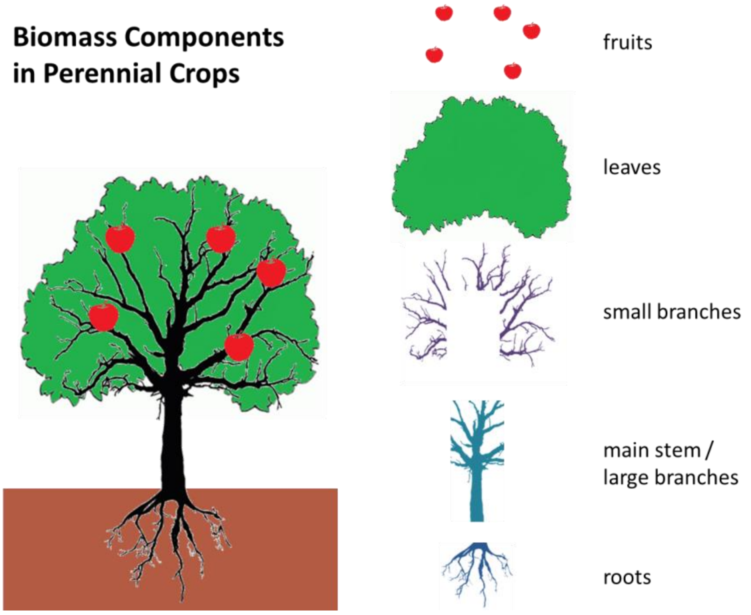
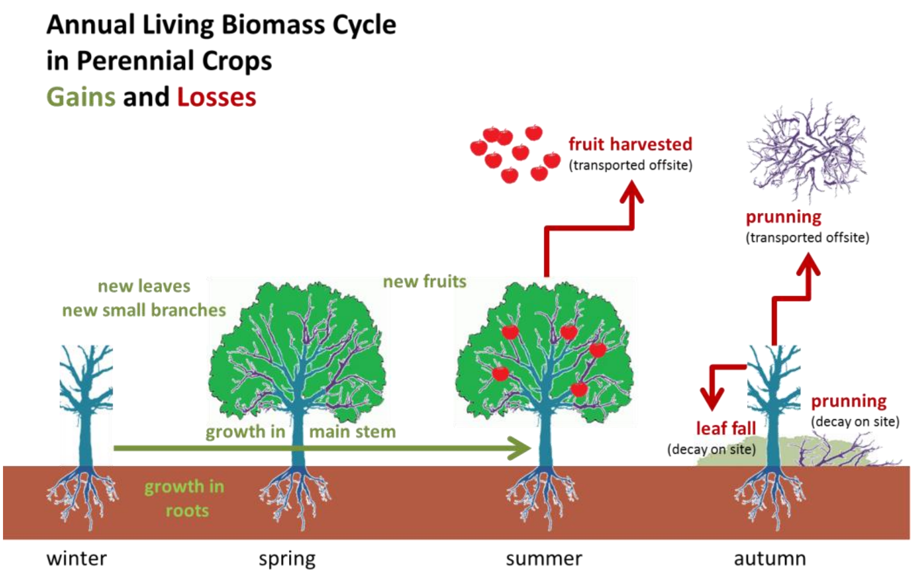


Figure 3: Main Carbon Flows in Perennial Crops



2.1 Literature Database

2.1.1 Literature Identification

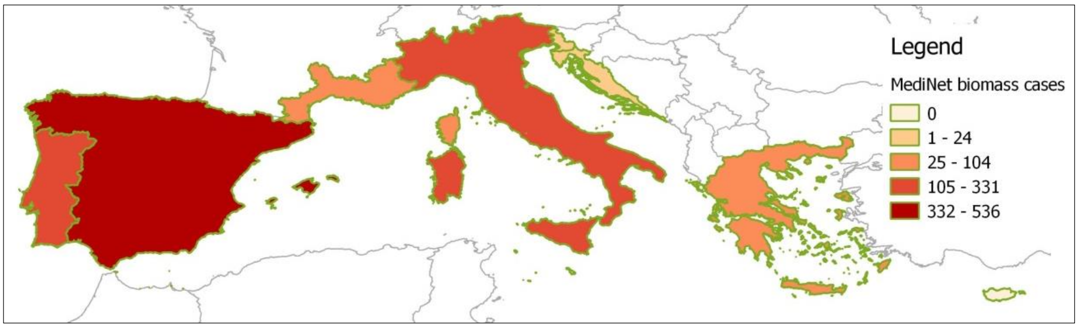
The first step of the study consisted on the identification and collection of data on biomass from cropland and grassland. This was done by searching for relevant scientific papers. The identification of relevant data included the following sources:

- GHG Inventory Reports of MediNet countries;
- Scientific literature (peer reviewed papers on national and international journals)
- Grey literature (project reports, master thesis, congress proceeds, etc.)
- Direct information requests to paper's authors and focal points of Project MediNet;

Papers were considered relevant if they contained data collected in MediNet Countries and related to important crops in the region. Additionally, some data from US, Chile, Egypt and Tunisia were also collected, as they referred to permanent crops that exist in MediNet Countries and are grown in similar climatic conditions (Mediterranean Climate) and similar management systems.

A total of 150 papers, containing 1483 biomass entries to the database were identified and processed in the following phases (see Annex I). The location of the database entries per MediNet country is indicated in Figure 4.

Figure 4: Number of entries in the Biomass Database per MediNet Country



2.1.2 Database Fields

The second step consisted in the extraction of the relevant information contained in the papers that could be useful for the purposes of Project MediNet.

As expected, different papers focused on different aspects and addressed problems and questions that were not always fully aligned with the Project's objectives. As a consequence, their information was not homogeneous and presented a challenge in terms of organisation.

All information was collected in a database, keeping the information as close as possible to the format used in the original paper. For that reason, the database had to contain an extensive number of fields. However, this format also allowed an easier implementation of Quality Assurance / Quality Control procedures (details provided in section 2.3 Quality Assurance / Quality Control below).

Table 2 provides the list of information that was searched in each paper, nevertheless not all papers contained all the information required.

Where information contained in one scientific paper could be separated into different species, ages, tree densities or other aspects, an entry in the database was inserted to reflect a unique combination of these parameters, resulting in a total of 1483 entries in the database, out of the 150 papers that were analysed.

Table 2: Information Collected from the Literature Surveyed

Level 1	Level 2	Level 3	Observations / definition
General Data	Reference code		Internal reference to paper
	Common name		Common name of the permanent crop
	Scientific name		Scientific name of the permanent crop
	Species cultivar		Cultivar of the permanent crop
	Training system		Information on how the permanent crop is pruned and trained
	Crop age		Age of the permanent crop when study was conducted
	Maximum age		Reference provided by the paper on maximum age of the crop (replacement age)
Site Location	Country		Country where the study was conducted
	Location		Region/town where the study was conducted
	Latitude		Exact latitude of sample plots
	Longitude		Exact longitude of sample plots
	Altitude		Exact altitude of sample plots
Climatic Information	Mean annual temperature		Relative to site location
	Mean annual precipitation		Relative to site location
	Annual evapotranspiration		Relative to site location
Management Information	Irrigation	Irrigation amount	Value of irrigated water provided by the study
		Irrigation amount unit	Unit of measurement used by the study
		Type of irrigation	List: I = Irrigated, NI = not irrigated, PI = Precise irrigation, SI = surface irrigation; Spi = sprinkler irrigation; NA = Not applicable; NR = Not Referred
	Tillage		List: CT = Conversional Tillage, NT = No Tillage, RT = Reduced Tillage, RtT = Rotational tillage system; NA = Not applicable; NR = Not Referred
	Fertilization	Fertilization amount	Value of fertilizer provided by the study
		Fertilization amount unit	Unit of measurement used by the study
		Type of fertilization	List: OF = Organic fertilizer, CF = Convention mineral fertilizer, SF = Slow mineral fertilizer, NF = not actively fertilized; NA = Not Applicable; NR = Not Referred
	Crop residue management		List: FB = Field burning, CT = Collected and transported out of the field, Inc = Incorporated into the soil with tillage, Nde = Natural decay of residues on soil surface, Ins = In situ grazing of crop residues; NA = Not Applied; NR = Not Referred
	Use of cover crops	Type of cover crops	List: PCs = Permanent coverage of soil (crop + seeded cover crop), PCn = Permanent coverage of soil (crop + natural vegetation), SW = Soil exposed part of the year (winter), SS = Soil exposed part of the year (summer); NA = Not Applicable; NR = Not Referred
		Cover crops mowing events	Average mowing events number during a year
	Grazing		List: IG = Intensive all year round, EG = Extensive all year round, Igp= Intensive grazing in part of the year, Egp Extensive grazing in part of the year, NG = Grazing is not practiced; NA = Not Applicable; NR = Not Referred

Level 1	Level 2	Level 3	Observations / definition
	Landscape elements		List: IT = Isolated trees among the crop, CG = Crop grown in agro-forestry systems, WH = Fields have woody vegetation on its hedges, FM = Fields margins are left uncultivated and with natural vegetation; NA = Not Applicable; NR = Not Referred
	Organic farming		List: Y = yes; N = No; NA = Not Applicable; NR =Not referred
Tree density	Tree density value		Value of tree density provided by the study
	Tree density value unit		Unit of measurement used by the study
Stocks of Tree biomass pools **or** **Net-Primary Production (NPP) of Tree biomass pools**	Stump	Stump average value	Average of pool as provided by the study
		Stump average unit	Unit of measurement used by the study
		Stump sample size	Size of sample used to calculate the average
		Stump standard error	Standard error as provided by the study
		Stump carbon content	Carbon content of the pool as provided by the study
		Stump moisture level	Moisture level of biomass of the pool as provided by the study
	Main trunk	Main trunk average value	Average of pool as provided by the study
		Main trunk average unit	Unit of measurement used by the study
		Main trunk sample size	Size of sample used to calculate the average
		Main trunk standard error	Standard error as provided by the study
		Main trunk carbon content	Carbon content of the pool as provided by the study
		Main trunk moisture level	Moisture level of biomass of the pool as provided by the study
	Branches	Branches average value	Average of pool as provided by the study
		Branches average unit	Unit of measurement used by the study
		Branches sample size	Size of sample used to calculate the average
		Branches standard error	Standard error as provided by the study
		Branches carbon content	Carbon content of the pool as provided by the study
		Branches moisture level	Moisture level of biomass of the pool as provided by the study
	Woody components (sum of stump, main stem and branches)	Woody components average value	Average of pool as provided by the study
		Woody components average unit	Unit of measurement used by the study
		Woody components sample size	Size of sample used to calculate the average

Level 1	Level 2	Level 3	Observations / definition
		Woody components standard error	Standard error as provided by the study
		Woody components carbon content	Carbon content of the pool as provided by the study
		Woody components moisture level	Moisture level of biomass of the pool as provided by the study
	Current year branches	Current year branches average value	Average of pool as provided by the study
		Current year branches average unit	Unit of measurement used by the study
		Current year branches sample size	Size of sample used to calculate the average
		Current year branches standard error	Standard error as provided by the study
		Current year branches carbon content	Carbon content of the pool as provided by the study
		Current year branches moisture level	Moisture level of biomass of the pool as provided by the study
	Pruned materials	Pruned materials average value	Average of pool as provided by the study
		Pruned materials average unit	Unit of measurement used by the study
		Pruned materials sample size	Size of sample used to calculate the average
		Pruned materials standard error	Standard error as provided by the study
		Pruned materials carbon content	Carbon content of the pool as provided by the study
		Pruned materials moisture level	Moisture level of biomass of the pool as provided by the study
	Leaves	Leaves average value	Average of pool as provided by the study
		Leaves average unit	Unit of measurement used by the study
		Leaves sample size	Size of sample used to calculate the average
		Leaves standard error	Standard error as provided by the study
		Leaves carbon content	Carbon content of the pool as provided by the study
		Leaves moisture level	Moisture level of biomass of the pool as provided by the study
	Fruits	Fruits average value	Average of pool as provided by the study
		Fruits average unit	Unit of measurement used by the study

Level 1	Level 2	Level 3	Observations / definition
		Fruits sample size	Size of sample used to calculate the average
		Fruits standard error	Standard error as provided by the study
		Fruits carbon content	Carbon content of the pool as provided by the study
		Fruits moisture level	Moisture level of biomass of the pool as provided by the study
	Thinned Fruits	Thinned Fruits average value	Average of pool as provided by the study
		Thinned Fruits average unit	Unit of measurement used by the study
		Thinned Fruits sample size	Size of sample used to calculate the average
		Thinned Fruits standard error	Standard error as provided by the study
		Thinned Fruits carbon content	Carbon content of the pool as provided by the study
		Thinned Fruits moisture level	Moisture level of biomass of the pool as provided by the study
	Coarse roots	Coarse roots average value	Average of pool as provided by the study
		Coarse roots average unit	Unit of measurement used by the study
		Coarse roots sample size	Size of sample used to calculate the average
		Coarse roots standard error	Standard error as provided by the study
		Coarse roots carbon content	Carbon content of the pool as provided by the study
		Coarse roots moisture level	Moisture level of biomass of the pool as provided by the study
	Fine roots	Fine roots average value	Average of pool as provided by the study
		Fine roots average unit	Unit of measurement used by the study
		Fine roots sample size	Size of sample used to calculate the average
		Fine roots standard error	Standard error as provided by the study
		Fine roots carbon content	Carbon content of the pool as provided by the study
		Fine roots moisture level	Moisture level of biomass of the pool as provided by the study
	Total above ground biomass	Total above ground biomass average value	Average of pool as provided by the study
		Total above ground biomass average unit	Unit of measurement used by the study
		Total above ground biomass sample size	Size of sample used to calculate the average

Level 1	Level 2	Level 3	Observations / definition
		Total above ground biomass standard error	Standard error as provided by the study
		Total above ground biomass carbon content	Carbon content of the pool as provided by the study
		Total above ground biomass moisture level	Moisture level of biomass of the pool as provided by the study
	Total below ground biomass	Total below ground biomass average value	Average of pool as provided by the study
		Total below ground biomass average unit	Unit of measurement used by the study
		Total below ground biomass sample size	Size of sample used to calculate the average
		Total below ground biomass standard error	Standard error as provided by the study
		Total below ground biomass carbon content	Carbon content of the pool as provided by the study
		Total below ground biomass moisture level	Moisture level of biomass of the pool as provided by the study
	Total permanent biomass	Total permanent biomass average value	Average of pool as provided by the study
		Total permanent biomass average unit	Unit of measurement used by the study
		Total permanent biomass sample size	Size of sample used to calculate the average
		Total permanent biomass standard error	Standard error as provided by the study
		Total permanent biomass carbon content	Carbon content of the pool as provided by the study
		Total permanent biomass moisture level	Moisture level of biomass of the pool as provided by the study
	Total biomass	Total biomass average value	Average of pool as provided by the study
		Total biomass average unit	Unit of measurement used by the study
		Total biomass sample size	Size of sample used to calculate the average
		Total biomass standard error	Standard error as provided by the study
		Total biomass carbon content	Carbon content of the pool as provided by the study

Level 1	Level 2	Level 3	Observations / definition
		Total biomass moisture level	Moisture level of biomass of the pool as provided by the study
Stock of Cover crop biomass pools **or** **Net-Primary Production of Cover crop biomass pools**	Above ground biomass	Above ground biomass average value	Average of pool as provided by the study
		Above ground biomass average unit	Unit of measurement used by the study
		Above ground biomass sample size	Size of sample used to calculate the average
		Above ground biomass standard error	Standard error as provided by the study
		Above ground biomass carbon content	Carbon content of the pool as provided by the study
		Above ground biomass moisture level	Moisture level of biomass of the pool as provided by the study
	Below ground biomass	Below ground biomass average value	Average of pool as provided by the study
		Below ground biomass average unit	Unit of measurement used by the study
		Below ground biomass sample size	Size of sample used to calculate the average
		Below ground biomass standard error	Standard error as provided by the study
		Below ground biomass carbon content	Carbon content of the pool as provided by the study
		Below ground biomass moisture level	Moisture level of biomass of the pool as provided by the study
	Total biomass	Total biomass average value	Average of pool as provided by the study
		Total biomass average unit	Unit of measurement used by the study
		Total biomass sample size	Size of sample used to calculate the average
		Total biomass standard error	Standard error as provided by the study
		Total biomass carbon content	Carbon content of the pool as provided by the study
		Total biomass moisture level	Moisture level of biomass of the pool as provided by the study
Stock of Other pools	Litter	Litter average value	Average of pool as provided by the study
		Litter average unit	Unit of measurement used by the study
		Litter sample size	Size of sample used to calculate the average

Level 1	Level 2	Level 3	Observations / definition
or Net-Primary Production of Other Pools		Litter standard error	Standard error as provided by the study
	Dead wood	Dead wood average value	Average of pool as provided by the study
		Dead wood average unit	Unit of measurement used by the study
		Dead wood sample size	Size of sample used to calculate the average
		Dead wood standard error	Standard error as provided by the study
	Humus	Humus average value	Average of pool as provided by the study
		Humus average unit	Unit of measurement used by the study
		Humus sample size	Size of sample used to calculate the average
		Humus standard error	Standard error as provided by the study
Root-to-shoot ratio	Root-to-shoot average value		Average ratio as provided by the study
	Root-to-shoot sample size		Size of sample used to calculate the average
	Root-to-shoot standard error		Standard error as provided by the study
Pruning-to-fruit yield ratio	Pruning-to-fruit yield average value		Average ratio as provided by the study
	Pruning-to-fruit yield sample size		Size of sample used to calculate the average
	Pruning-to-fruit yield standard error		Standard error as provided by the study

2.2 Database Harmonization

2.2.1 Main problems identified

The Database collected a large amount of information with a high level of heterogeneity on the type and quantity of information provided. The following list focuses on the main identified problematic issues linked to the MediNet scope of work:

- **Stock vs NPP**. While many studies focused on stocks, some studies provided information on annual net-primary productivity;
- **Area vs Plant**. Some studies presented data on a per area basis (e.g. t/ha), while others presented data on a per plant basis (e.g. kg/plant);
- **Fresh matter vs Dry matter vs C vs CO_2**. Biomass or Productivity data was presented in four different formats: fresh matter (kg of biomass after collection in the field); dry matter (kg of biomass after oven drying); carbon (kg of biomass expressed as C); or CO_2 (kg of biomass expressed as carbon dioxide). Also, it was not always clear if the values were expressed in dry or fresh weight;
- **Large spectrum of plantation densities**.
- **Large spectrum of plantation ages**. But most of the data is concentrated in young and very young plantations;
- **Management information largely unknown**. Presence/absence of irrigation is the most common;
- **Uneven country distribution of studies**. A large number of studies are located in Spain, Italy and Portugal. No data were available from Malta and Cyprus.

- **<u>Uneven crop distribution of studies</u>**. A large number of studies were found on permanent crops, although this might result from a bias from the search strategy used, which focused on these crops from the beginning; only a few data were found on annual crop, shrublands and grassland studies.

2.2.2 Variable Selection and Harmonization Process

Given the large heterogeneity of the data available the dataset was further elaborated to harmonize and aggregate the data in order to make it comparable, to the extent possible. In order to do so, and given the data variability and the concentration of data in some categories, the following *ex-ante* decisions were taken:

- To focus on Permanent Crops and Shrublands only, aggregated in the following categories:
  - Olive Trees;
  - Vineyards;
  - Fruit Trees;
    - Includes data on trees of the following species apple, apricot, cherry, fig, orange, other citrus, peach, pear and plum.
  - Shrublands
    - Includes data on: natural woody vegetation that does not meet the forest definition.

  <u>Reason</u>: the amount of other crop type data was considered insufficient; available data did not allow a further disaggregation between different fruit tree types.

- To concentrate on the following biomass variables:
  - **Permanent Above Ground Biomass – Permanent AGB** (defined as all above ground biomass measured after pruning and fruit collection);
  - **Pruned Biomass – PB** (all biomass pruned in that year);
  - **Below Ground Biomass – BGB** (all below ground biomass).

  <u>Reason</u>: data on other small biomass components are very limited; annual gains and losses in other components (e.g. leaves, fruits) are very likely of the same order of magnitude and therefore will cancel each other out.

- To express results in two different units:
  - Tonnes of Dry Mater per hectare (tDM/ha);
  - Tonnes of Carbon per hectare (tC/ha).

  <u>Reason</u>: most activity data will be expressed in hectares and so it is more useful in this format than in mass/plant.

- To present results as a function of age.

  <u>Reason</u>: in woody crops, age is a key driver of biomass stocks; there are insufficient data on other possible drivers for biomass differences (density, country, training system, etc.).

- To ignore management information.

  <u>Reason</u>: insufficient amount of data on other management types.

- To ignore climatic information.

  <u>Reason</u>: insufficient amount of data on other climatic conditions.

The harmonization process was based on the following steps:

1. Unit harmonization: different units of mass/area or mass/plant were used by different papers. All units were converted to tDM/ha and tC/ha (see Figure 5).
2. Best match between entry data (see Table 1, level 2) and definitions of "Permanent Above Ground Biomass", "Pruned Materials" and "Below Ground Biomass" as following:

"*Permanent Aboveground Biomass*" (Permanent AGB): includes main trunk, stumps and brunches. The following checks where performed on the entry data (see Figure 6):

- The sum of *Trunk*, *Stumps* and *Branches* shall be equal or lower than the Total AGB, when provided by the same study
- *Woody components* are considered only when equal or lower than the Total AGB value provided by the same study.
- *Total Above Ground Biomass* data shall be defined and the same study provides data on *fruits*, *leaves*, *current year branches* and *pruning*

Data elaboration and gap filling:

- When *only Total AGB* is provided specifying the portion of *fruits*, *leaves*, *current year branches* and *pruning*, then the biomass of those components (as provided by the same paper) is subtracted to the Total AGB. Otherwise Permanent AGB is estimated as a % of the Total AGB (see section 3.1)
- When only *pruning* is available, the Permanent AGB is estimated as % of pruning (see section 3.1)
- When only Total Belowground Biomass (Total BGB) is available, the Permanent AGB is estimated as % of the Total BGB (see section 3.1)

"Below Ground Biomass" (BGB) refers to the root systems, including coarse and fine roots. The following checks where performed on the entry data (see Figure 7):

- When only *Coarse Roots* are available, then the BGB is assumed to be equal to the Coarse Roots biomass
- When *Coarse* and *Fine Roots* are available, then BGB is equal to the sum of the two

Data elaboration and gap filling:

- When only Permanent AGB is available, the BGB is estimated as % of the Permanent AGB (Root-to-shoot ratio)

"Pruning Biomass" (PM) is the amount of biomass that is selectively removed from the plant during the horticultural practices. Data elaboration and gap filling (see Figure 8):

- When only *Current Year Branches* is available, the Pruned Materials is estimated as % of *Current year Branches*
- When only Permanent AGB is available, the Pruned Materials is estimated as % of the Permanent AGB (see section 3.1)

When the values presented in a particular study could not be "processed" as explained above, the information was discarded.

Figure 5: Decision Tree for Unit Conversions to tDM/ha

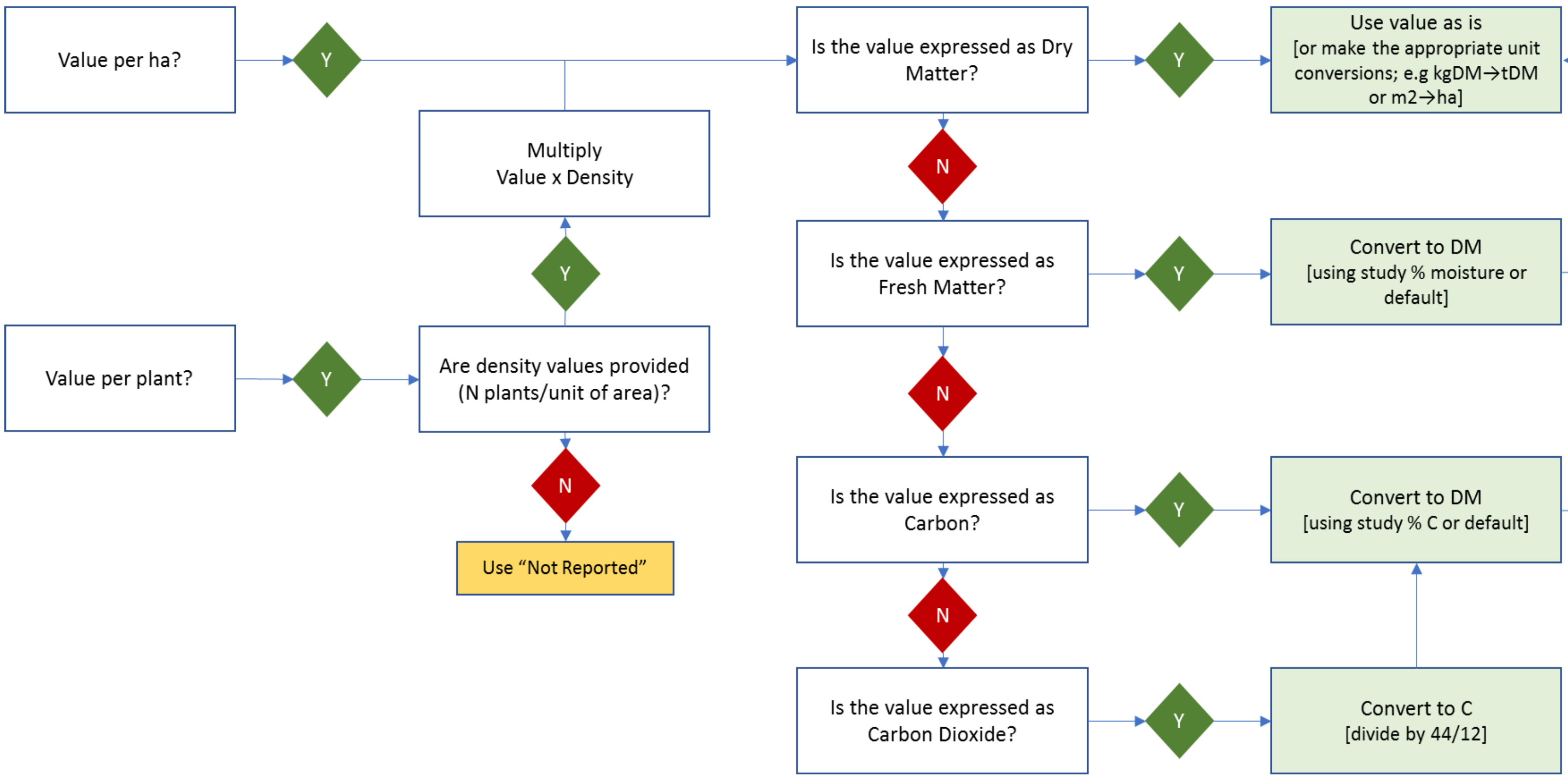


Figure 6: Decision Tree for determining the best match between "Permanent Above Ground Biomass" and the variables contained in the Literature Database

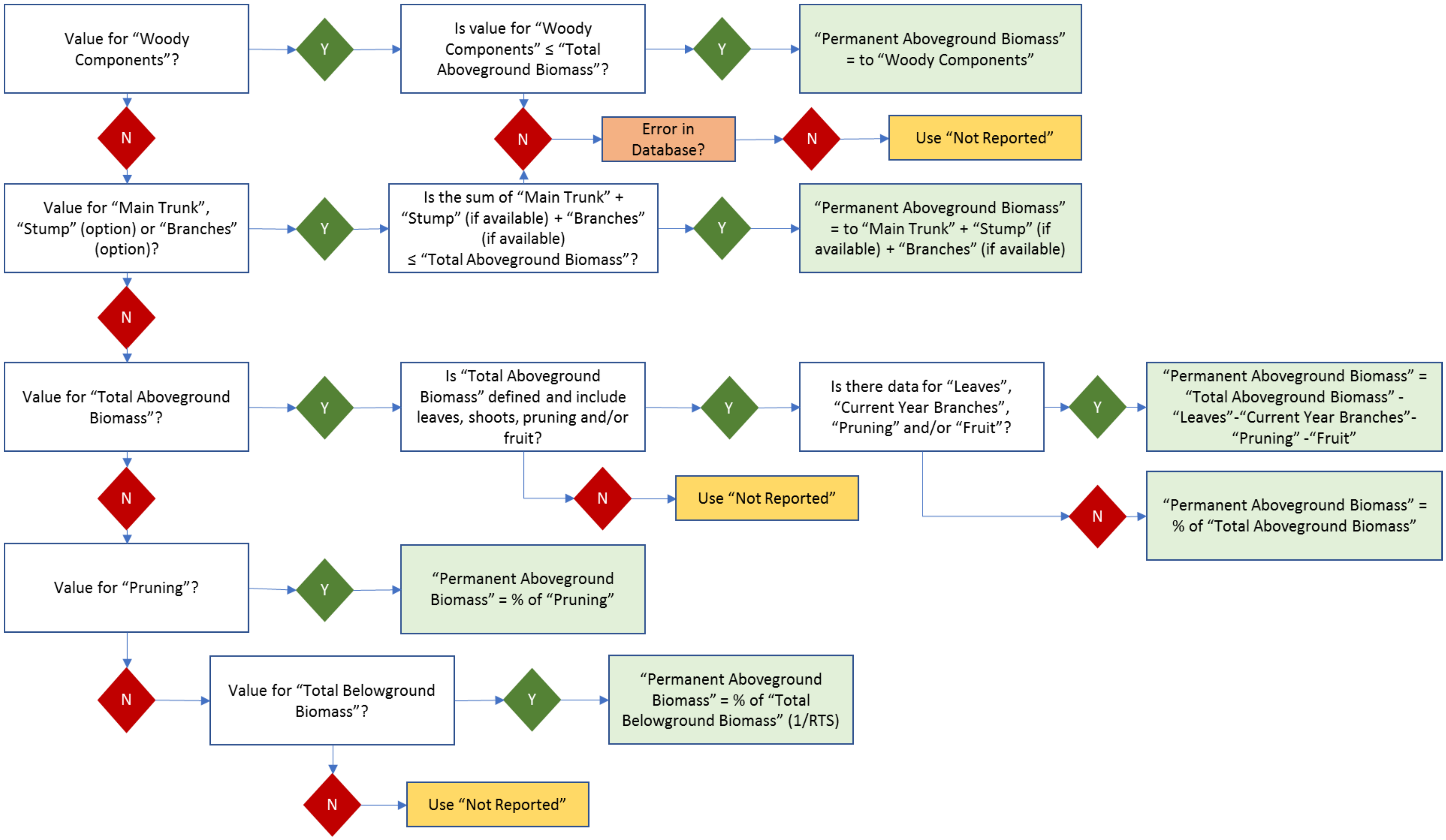


Figure 7: Decision Tree for determining the best match between "Below Ground Biomass" and the variables contained in the Literature Database

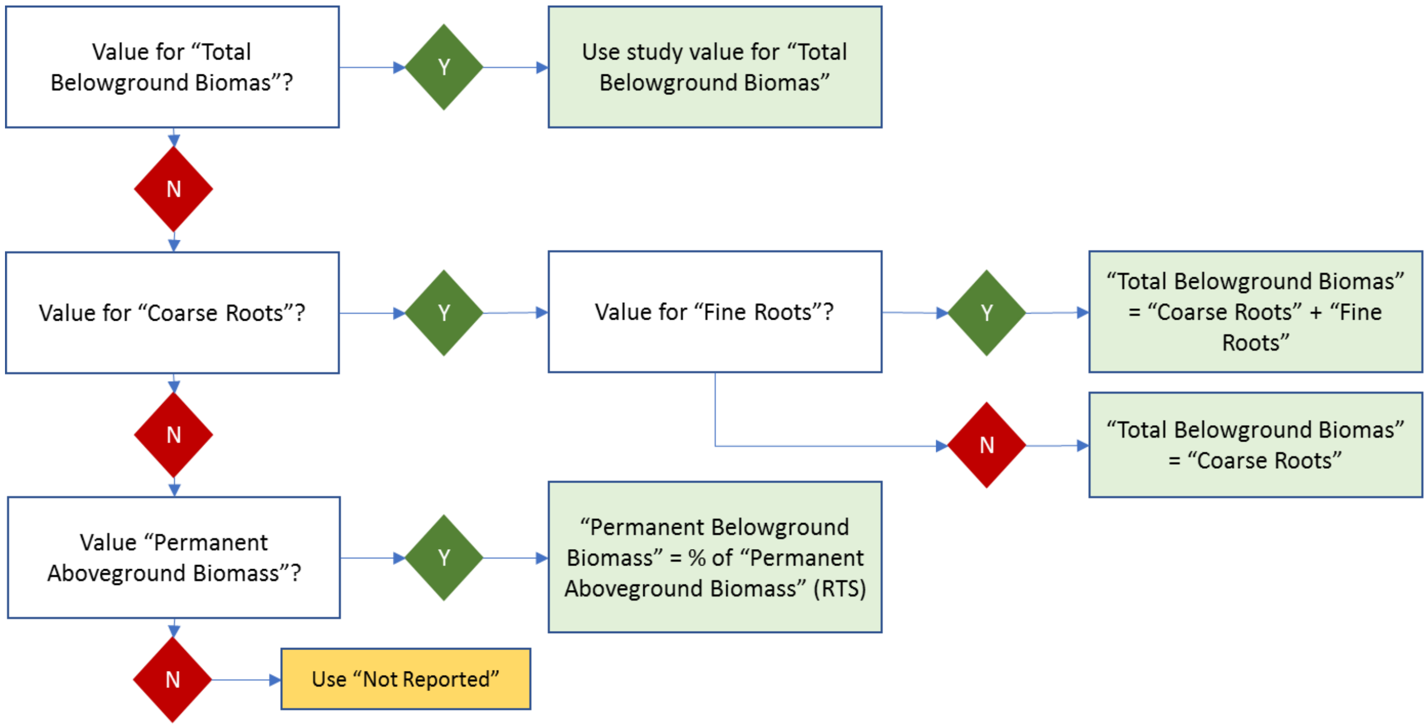
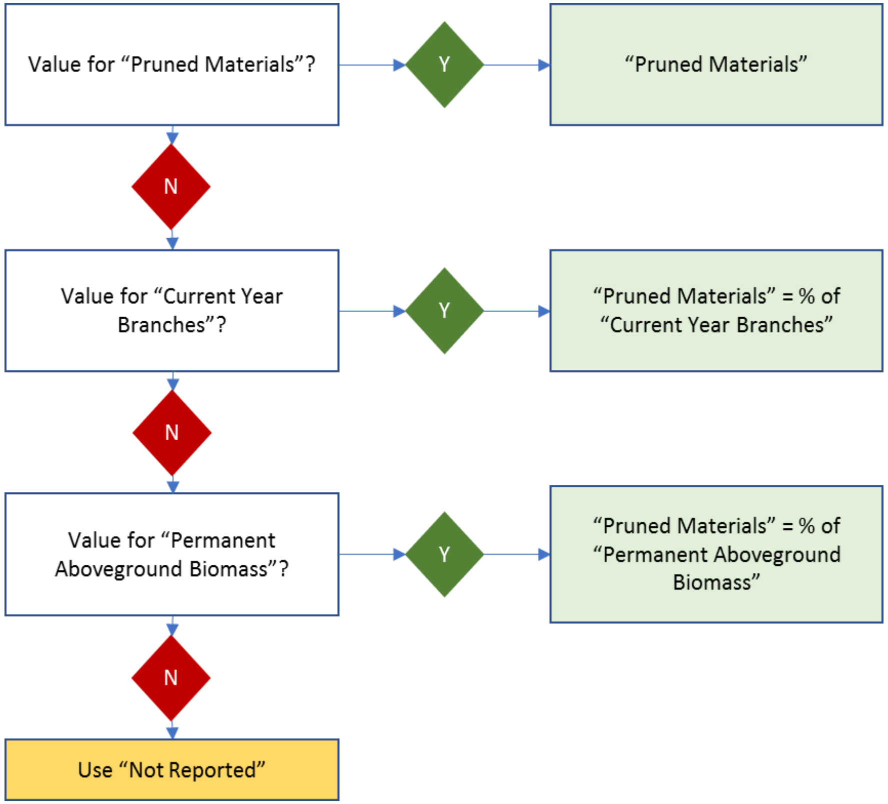


Figure 8: Decision Tree for determining the best match between "Pruned Materials" and the variables contained in the Literature Database



2.3 Quality Assurance / Quality Control

The data collection and harmonisation procedures described above contain multiple opportunities that can lead the user to make mistakes, which, in turn, could limit the quality of the information contained in the database. These may include:

- Lack of understanding of what the scientific paper describes;
- Mistakes in transposing data from the papers to the databases;
- Mistakes in recording the correct unit of measurement;
- Mistakes in the use of correction factors (unit conversions, default values, etc.).

In order to limit these possibilities, the following procedures were implemented:

- Random check of about 10% of the studies. It consisted on a second read of the selected papers by another person who checked possible mistakes made in the database compilation and harmonisation procedures;
- Checks "abnormal values". It consisted on the identification and check of possible outliers;
- "Logical control checks". It consisted on a mathematical test to confirm if the values of parameters that represent the sum of subcomponents are equal to the sum of all the values of each corresponding component.

2.4 Participatory Workshop

The methodology and the preliminary results of the literature survey, were presented in a Participatory WS, held in Lisbon on the 4th and 5th of December 2017.

The participants were asked to review and comment the content of this report and to assist the project team in developing an informed "expert judgement" on new default values for Carbon Stocks in Biomass of Permanent Crops.

Participants were selected on the basis of either their personal experience as emissions and reporting experts in LULUCF reporting and/or their knowledge in biomass and management of permanent crops.

The participation of experts was guided by the IPCC Elicitation Procedure (see Annex II). The summary of the Workshop and the list of participants are presented in Annex III.
Their inputs were considered in this report.

3 Biomass Stocks for Cropland and Grassland

This section presents the summary of results of the critical literature review and data elaboration.

3.1 Conversion Factors

As highlighted above some conversion factors were used to gap-fill missing information in some of the papers that were used. This section explains how each of those conversion factors was calculated and used.

3.1.1 Water Contents in Fresh Woody Biomass

Water Contents was defined as the percentage of water in all fresh woody biomass components, and was used to estimate "Permanent AGB", BGB or PM expressed in tDM/ha, where a particular study provided only values in tFM/ha;

Water Contents was calculated from all studies that provided such value directly or where it could be calculated from studies containing data for both Fresh and Dry Matter for the same variable (see

Table 5 and Table 6 for, respectively AGB and BGB). Only woody components were considered (i.e., fruits, leaves, fine roots were excluded). A total of 225 entry points in the database provided values for Water Contents of Fresh Woody Above Ground Biomass and 24 entry points for Fresh Below Ground Biomass. A summary of the available information is provided in Table 3 and Table 4.

Table 3: Summary of Data relative to Water Contents in Fresh Woody Biomass (Above Ground)

Crop type	Number of entries	Minimum	25% percentile	Median	75% percentile	Maximum	Average	Proposed default
Olive	20	25%	30%	38%	41%	69%	39%	**40% ± 10%**
Vineyard	49	15%	40%	40%	46%	60%	42%	
Fruit Trees	86	23%	35%	40%	40%	62%	40%	
All Perm. Crops	**155**	**15%**	**37%**	**40%**	**44%**	**69%**	**40%**	
Shrubland	70	10%	41%	49%	56%	67%	48%	**49% ± 10%**

Table 4: Summary of Data relative to Water Contents in Fresh Woody Biomass (Below Ground)

Crop type	Number of entries	Minimum	25% percentile	Median	75% percentile	Maximum	Average	Proposed default
Olive	1	-	-	50%	-	-	50%	**52% ± 10%**
Vineyard	7	52%	52%	52%	52%	55%	52%	
Fruit Trees	13	36%	39%	51%	61%	84%	52%	
All Perm. Crops	**21**	**36%**	**49%**	**52%**	**55%**	**84%**	**52%**	
Shrubland	3	45%	45%	49%	57%	57%	50%	**50% ± 10%**

Table 5: References used to Estimate Water Contents in Above Ground Woody Biomass

Crop Type	References
Olive	Spanish NIR (2016); Christou et al. (2007); Di Blast et al. (1997); Regni et al. (2017); Spinelli & Picchi (2010); Spinelli et al. (2011); Voivontas et al. (2001)
Vineyard	Celano (2012); Christou et al. (2007); Colin et al. (2009); Di Blast et al. (1997); Dias (2002); Juhos & Tokei (2012); Magagnotti et al. (2013); Mota et al. (2010); Spinelli et al. (2010); Velázquez-Martí et al. (2011c); Voivontas et al. (2001)
Fruit Trees	Celano (2012); Christou et al. (2007); Di Blast et al. (1997); Dias (2002); Magagnotti et al. (2013); Mota et al. (2010); Picchi et al. (2016b); Spanish NIR (2016); Velázquez-Martí & Fernández-González (2010); Velázquez-Martí et al. (2011b); Velázquez-Martí et al. (2012); Voivontas et al. (2001)
Shrublands	Monteiro (2017); Viana et al. (n.d.)

Table 6: References used to Estimate Water Contents in Below Ground Biomass

Crop Type	References
Olive	Spanish NIR (2016)
Vineyard	Juhos & Tokei (2012); Mota et al. (2010)
Fruit Trees	Mota et al. (2010); Picchi et al. (2016a); Spanish NIR (2016); Zanotelli et al. (2013)
Shrublands	Fernandes (1998); Viana et al. (n.d.); Mota et al. (2010)

3.1.2 Carbon Fraction in [dry] Woody Biomass

Carbon Fraction was defined as the percentage of C in all woody biomass components, expressed in dry matter, and was used to estimate Permanent AGB, BGB or PM expressed as:

- tDM/ha, where a particular study provided only values in tC/ha; and
- tC/ha, where a particular study provided only values in tDM/ha.

Carbon Fraction was calculated from all studies that provided such value directly or where it could be calculated from studies contained data for both Carbon and Dry Matter for the same variable (see

Table 9 and Table 10 for, respectively AGB and BGB). Only woody components were considered (i.e., fruits, leaves, fine roots were excluded). A total of 192 entry points in the database provided values for Carbon Fraction for AGB and 23 entry points for BGB. A summary of the available information is provided in Table 7 and Table 8.

Table 7: Summary of Data relative to Carbon Fraction in Woody Biomass (Above Ground)

Crop type	Number of entries	Minimum	25% percentile	Median	75% percentile	Maximum	Average	Proposed default
Olive	4	43%	44%	48%	49%	50%	47%	**47% ± 3%**[3]
Vineyard	15	45%	46%	48%	50%	67%	49%	**48% ± 2%**
Fruit Trees	43	42%	44%	46%	48%	52%	46%	**46% ± 2%**
All Perm. Crops	**62**	**42%**	**45%**	**46%**	**49%**	**67%**	**47%**	**47% ± 3%**
Shrubland	130	45%	49%	50%	51%	56%	50%	**50% ± 2%**

[3] For the Olive Trees category there were not enough data to calculate a specific default value, therefore the proposed default for “All Permanent Crops” was applied.

Table 8: Summary of Data relative to Carbon Fraction in Woody Biomass (Below Ground)

Crop type	Number of entries	Minimum	25% percentile	Median	75% percentile	Maximum	Average	Proposed default
Olive	1	-	-	50%	-	-	50%	**45% ± 2%[4]**
Vineyard	8	44%	44%	44%	45%	45%	44%	
Fruit Trees	8	43%	44%	45%	48%	48%	46%	
All Perm. Crops	**17**	**43%**	**44%**	**44%**	**47%**	**50%**	**45%**	
Shrubland	6	45%	45%	51%	56%	56%	51%	**50% ± 5%**

Table 9: References used to Estimate Carbon Fraction in Above Ground Woody Biomass

Crop Type	References
Olive	Almagro et al. (2010); Kricka et al. (2010); Spanish NIR (2016); Velázquez-Martí et al. (2014)
Vineyard	Celano (2012); Juhos & Tokei (2012); Kricka et al. (2010); Morandé et al. (2017); Mota et al. (2010); Spanish NIR (2016)
Fruit Trees	Celano (2012); Grossman & Dejong (1993b); Juhos & Tokei (2012); Kricka et al. (2010); Liguori et al. (2009); Mota et al. (2010); Panzacchi (2008); Spanish NIR (2016); Velázquez-Martí et al. (2012); Velázquez-Martí et al. (2012); Spanish NIR (2016); Zanotelli et al. (2013)
Shrublands	Almagro et al. (2010); Fonseca et al. (2007); Viana et al. (n.d.); Montero et al. (2013)

Table 10: References used to Estimate Carbon Fraction in Below Ground Biomass

Crop Type	References
Olive	Spanish NIR (2016)
Vineyard	Juhos & Tokei (2012); Morandé et al. (2017); Mota et al. (2010); Spanish NIR (2016)
Fruit Trees	Grossman & Dejong (1993b); Juhos & Tokei (2012); Mota et al. (2010); Panzacchi (2008); Spanish NIR (2016); Zanotelli et al. (2013)
Shrublands	Fernandes (1998); Fonseca et al. (2007); Viana et al. (n.d.)

3.1.3 Root to Shoot Ratio

Root to Shoot Ratio (RTS) was defined as the ratio between BGB and Permanent AGB and was used to estimate:

- Permanent AGB, where a particular study provided only values for BGB; and
- BGB, where a particular study provided only values for Permanent AGB.

A correlation between the two variables was calculated from all studies that provided data for both variables, independently on the age of the considered species (or system). This is illustrated in Figure 9 for the case of Olive Trees. A summary of all the equations is presented in Table 11.

[4] For Olive Trees, Vineyards and Fruit trees there were not enough data to calculate specific default values, therefore it was applied the proposed default of "All Permanent Crops".

Figure 9: Linear relation between "Permanent Above Ground Biomass" and "Below Ground Biomass" in Olive Trees

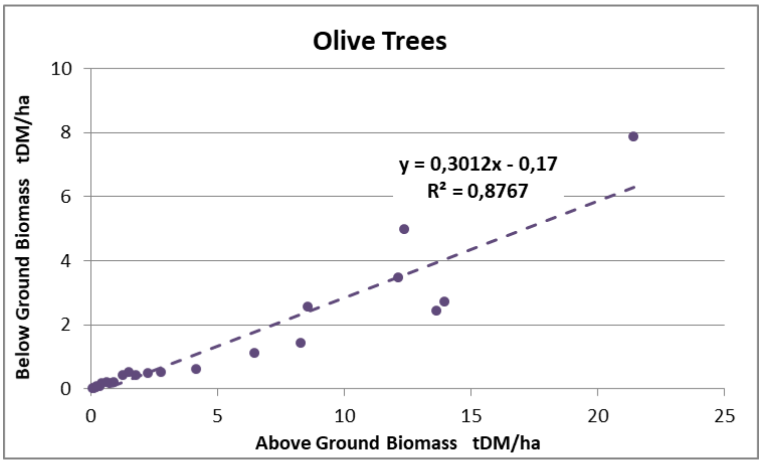


Table 11: Equations used to "gap-fill" missing data on "Below Ground Biomass" and "Permanent Above Ground Biomass"

	Equation	$N_{equation}$	R^2	N_{used}
Olive Trees	BGB = AGB x 0.3012 - 0.17	24	87.7%	73
	AGB = BGB x 2.9107 + 1.0845			4
Fruit Trees	BGB = 0.8326 x AGB – 2.2086	33	62.2%	120
	AGB = 0.7466 x BGB + 5.7889			8
Vineyards	BGB = 0.7631 x AGB + 1.3494	21	62.7%	40
	AGB = 0.821 x BGB + 0.9019			5
Shrublands	BGB = 1.4154 x AGB	5	24.2%	221
	AGB = 0.4839 x BGB			14

$N_{equation}$= Number of data entries used to derive the equation; N_{used} = Number of times the equation was used to gap fill missing data

The references used to estimate root-to-shoot ratio are presented in Table 12.

Table 12: References used to Estimate Root-to-Shoot Ratio

Crop Type	References
Olive	Almagro et al. (2010); Celano et al. (1999); Proietti et al. (2017); Spanish NIR (2016); Sofo et al. (2004); Sofo et al. (2005)
Vineyard	Juhos & Tokei (2012); Miranda et al. (2017); Morandé et al. (2017); Spanish NIR (2016); Zanotelli et al. (2016)
Fruit Trees	Bonomelli & Artacho (2014); Grossman & Dejong (1993a); Grossman & Dejong (1993b); Juhos & Tokei (2012); Liguori et al. (2009); Montanaro et al. (2016); Panzacchi et al. (2012); Rufat & DeJong (2001); Sofo et al. (2004); Sofo et al. (2005); Spanish NIR (2016); Zanotelli et al. (2013)
Shrublands	Almagro et al. (2010); Canadell (1995); Correia et al. (2014); Fonseca et al. (2007); Kummerow et al. (1981); Kummerow et al. (1999); Margaris (1976); Merino et al. (1990); Rapp & Lossaint (1981); Silva & Rego (2004); Vallejo (1997)

3.1.4 Pruning Ratio

Pruning Ratio was defined as the ratio between PB and Permanent AGB and was used to estimate:

- Permanent AGB, where a particular study provided only values for "Pruned Materials"; and
- "Pruning Biomass", where a particular study provided only values for Permanent AGB.

A correlation between the two variables was calculated from all studies that provided data for both variables. This is illustrated in Figure 10 for the case of Olive Trees. A summary of all the equations is presented in Table 13.

Figure 10: Linear relation between PB and Permanent AGB in Olive Trees

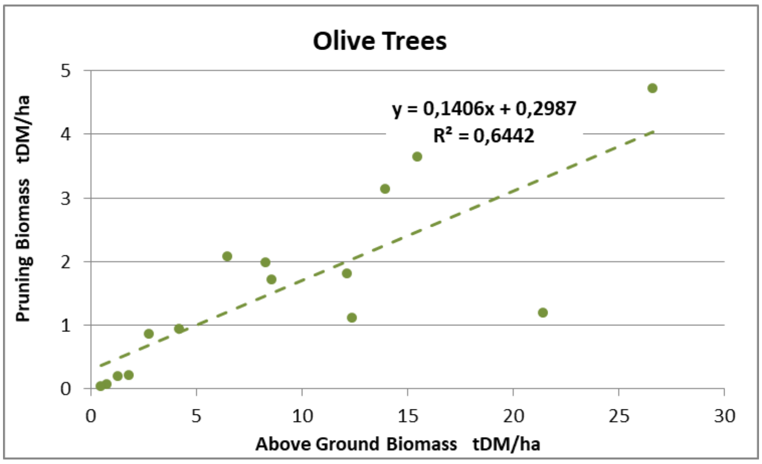


Table 13: Equations used to “gap fill” missing data on “Pruning Biomass” (PB) and Permanent AGB (AGB)

	Equation	$N_{equation}$	R^2	N_{used}
Olive Trees	PB = 0.1406 x AGB + 0.2987	15	64.4%	14
	AGB = 4.5824 x PB + 1.8719			44
Fruit Trees	PB = 0.0684 x AGB + 1.6802	17	7.7%	32
	AGB = 1.1179 x PB + 12.869			61
Vineyards	*No equation: only one data entry*			0
Shrublands	*Not applicable*			

$N_{equation}$= Number of data entries used to derive the equation; N_{used} = Number of times the equation was used to gap fill missing data

The references used to estimate root-to-shoot ratio are presented in Table 14.

Table 14: References used to Estimate Pruning Ratio

Crop Type	References
Olive	Proietti et al. (2016); Proietti et al. (2017); Giucci et al. (2012); Sofo et al. (2005)
Vineyard	Zanotelli et al. (2016)
Fruit Trees	Celano (2012); Panzacchi et al. (2012); Sofo et al. (2005); Zanotelli et al. (2016)
Shrublands	*Not applicable*

3.2 Estimated Biomass in Woody Crops

3.2.1 Methodology

The data contained in the database, after the harmonization and gap-filling described in sections 2.2 and 3.1, was used to adjust growth curves for the three variables: Permanent AGB, BGB and PB, using a logistic function to describe biomass as a function of age.

The logistic function is a widely used analytically model to determine the weight or volume growth of organisms (Karkach, 2006). In this function, growth is described by typical sigmoid function, where growth is initially exponential (increases by a constant percentage with time), and after a certain time slows down (growth rate decreases) and finally, in maturity, an asymptotic level of biomass is reached, i.e., growth stops.

Equation 1: Logistic Growth Model used derive biomass estimates

$$B_y = \frac{a}{1 + e^{-(y-c)/b}}$$

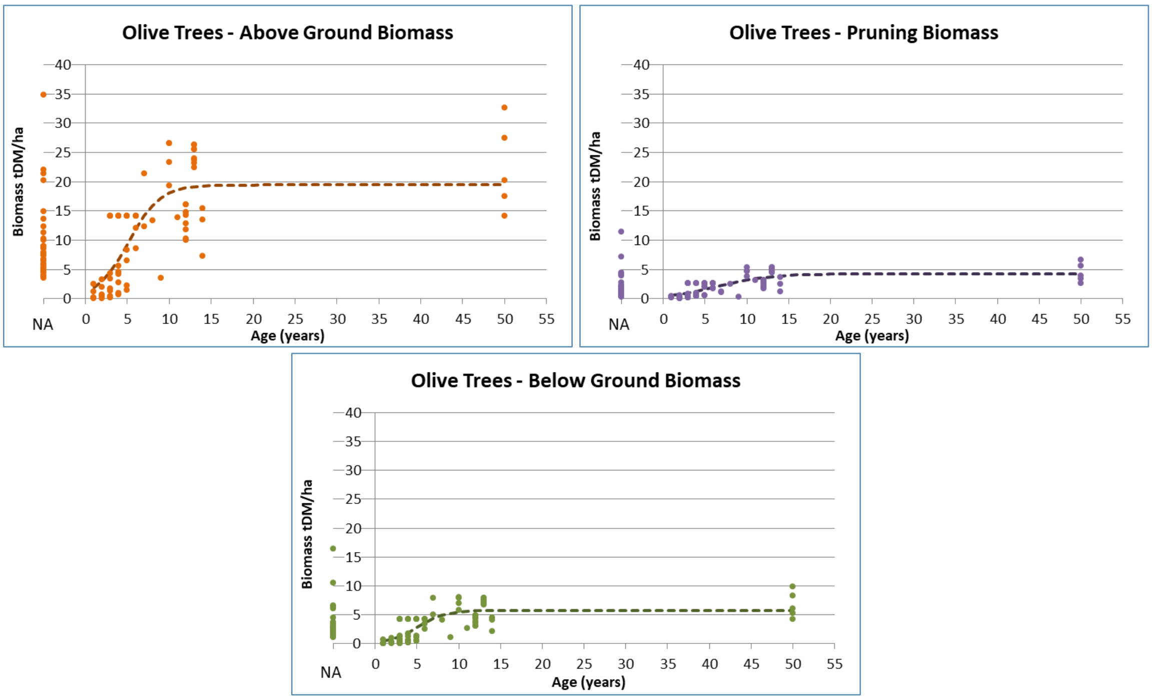
Where:
B_y = Biomass at crop age y;
a = biomass at equilibrium;
b = growth rate during the exponential phase;
c = age at 50% of equilibrium biomass;
y = crop age.

The model was numerically adjusted to the existing data using the module "non-linear regression" of the software IBM SPSS Statistics, in its version 25 for MS Windows, which estimated all three parameters for each case.

3.2.2 Olive Trees

The Logistic Growth Model for Permanent AGB, PB and BGB was adjusted using 73 data entries (see Figure 11). An additional 36 data entries contained data on biomass stocks, but age was unknown, and were not used to adjust the function (shown for information only in Figure 11 as "NA"). Finally, 173 data entries were eliminated from the database, because it was not possible to calculate biomass stocks from the data provided by the respective study.

Figure 11: Biomass data and Adjusted Logistic Growth Curves for Olive Trees



The estimated parameters for Equation 1 for Olive Trees are shown in Table 15 (± denotes the 95% confidence interval of the parameters).

Table 15: Parameters for the Logistic Growth Curves for Olive Trees

Biomass component	a	b	c	R^2	N
AGB	19.454 ± 2.615	1.886 ± 1.150	5.143 ± 1.177	58.6%	73
BGB	5.761 ± 0.760	1.645 ± 1.049	5.082 ± 1.080	56.8%	73
Pruning	4.271 ± 0.879	3.125 ± 1.623	6.565 ± 2.191	57.0%	73

The estimated biomass stocks for Permanent AGB, BGB and PB at reference ages are shown in Table 16.

Uncertainties for AGB, BGB and PB were estimated as the 95% confidence interval for parameter a, which represents "biomass at equilibrium", expressed as percentage of the parameter value.

Implied RTS were calculated from the estimated BGB and Permanent AGB. Implied Pruning Ratios (PR) were calculated from the estimated PB and Permanent AGB. Uncertainties for RTS and PR were estimated using the IPCC 2006 Guidelines Approach 1 for error propagation[5].

Table 16: Estimated Biomass Stocks, Root-to-shoot Ratio (RTS) and Pruning Ratio (PR) from Olive Trees

Age *years*	AGB *tDM/ha*	RTS *%AGB*	BGB *tDM/ha*	PR *%AGB*	PB *tDM/ha*
5	9.4	30%	2.8	17%	1.6
10	18.1	30%	5.5	18%	3.2
20	19.4	30%	5.8	22%	4.2
30	19.5	30%	5.8	22%	4.3
Uncertainty	***13%***	***19%***	***13%***	***24%***	***21%***

The References used are presented in Table 17.

Table 17: References used in Olive Crops biomass

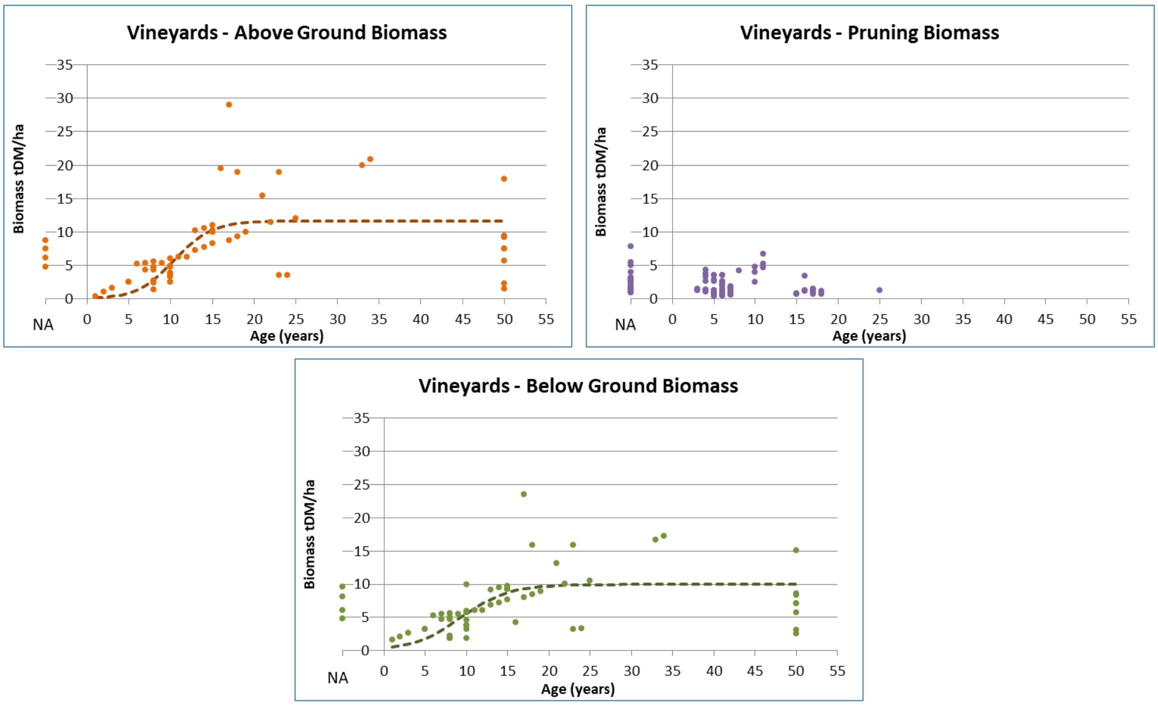
Crop Type	References
Permanent AGB	Aguilera et al. (2015b); Almagro et al. (2010); Celano et al. (1999); Colin et al. (2009); Di Blast et al. (1997); Dias (2002); Gucci et al. (2012); Lopez et al. (2006); Palese et al. (2013); Proietti et al. (2016); Proietti et al. (2017);Regni et al. (2017); Sebastián Nogués et al. (2010); Sofo (n.d.b); Sofo et al. (2004); Sofo et al. (2005); Spanish NIR (2016); Spinelli & Picchi (2010); Tognetti et al. (2006); Velázquez-Martí et al. (2011a); Velázquez-Martí et al. (2012); Villalobos et al. (2006); Voivontas et al. (2001)
Pruning biomass	Aguilera et al. (2015b); Almagro et al. (2010); Bilandzija et al. (2012); Caruso et al. (2011); Celano et al. (1999); Colin et al. (2009); Di Blast et al. (1997); Dias (2002); Gucci et al. (2012); Lopez et al. (2006); Palese et al. (2013); Pastor et al. (2007); Proietti et al. (2016); Proietti et al. (2017); Regni et al. (2017); Sebastián Nogués et al. (2010); Sofo (n.d.b); Sofo et al. (2004); Sofo et al. (2005); Spanish NIR (2016); Spinelli & Picchi (2010); Spinelli et al. (2011); Villalobos et al. (2006);Tognetti et al. (2006); Velázquez-Martí et al. (2011a); Velázquez-Martí et al. (2012); Voivontas et al. (2001)
BGB	Aguilera et al. (2015b); Almagro et al. (2010); Celano et al. (1999); Colin et al. (2009); Di Blast et al. (1997); Dias (2002); Gucci et al. (2012); Lopez et al. (2006); Palese et al. (2013); Proietti et al. (2016); Proietti et al. (2017); Regni et al. (2017); Sebastián Nogués et al. (2010); Sofo (n.d.b); Sofo et al. (2004); Sofo et al. (2005); Spanish NIR (2016); Spinelli & Picchi (2010); Tognetti et al. (2006); Velázquez-Martí et al. (2011a); Velázquez-Martí et al. (2012); Villalobos et al. (2006); Voivontas et al. (2001)

3.2.3 Vineyards

The Logistic Growth Model for Permanent AGB and BGB was adjusted using 63 data entries (see Figure 12). An additional 41 data entries contained data on biomass stocks, but age was unknown, and were not used to adjust the function (shown for information only in Figure 12 as "NA"). Finally, 88 data entries were eliminated from the database, because it was not possible to calculate biomass stocks from the data provided by the respective study. The software was unable to adjust the model to the data on PB, and therefore no curve is presented.

[5] 2006 IPCC Guidelines, Volume 1, Chapter 3, Equation 3.1

Figure 12: Biomass data and Adjusted Logistic Growth Curves for Vineyards



The estimated parameters for Equation 1 for Vineyards are shown in Table 18 (± denotes the 95% confidence interval of the parameters).

Table 18: Parameters for the Logistic Growth Curves for Vineyards

Biomass component	a	b	c	R^2	N
AGB	11.683 ± 2.102	2.232 ± 1.790	10.439 ± 1.917	41.0%	63
BGB	9.965 ± 1.739	2.903 ± 2.291	9.304 ± 2.085	36.5%	63
Pruning	*no model*	*no model*	*no model*	*no model*	76

The estimated biomass stocks for Permanent AGB, BGB and PB at reference ages are shown in Table 19.

Uncertainties for AGB, BGB and PB were estimated as the 95% confidence interval for parameter a, which represents “biomass at equilibrium”, expressed as percentage of the parameter value.

Implied RTS were calculated from the estimated BGB and AGB. Implied PR were calculated from the estimated PB and AGB. Uncertainties for RTS and PR were estimated using the IPCC 2006 Guidelines Approach 1 for error propagation[6].

[6] 2006 IPCC Guidelines, Volume 1, Chapter 3, Equation 3.1

Table 19: Estimated Biomass Stocks, Root-to-shoot Ratio (RTS) and Pruning Ratio (PR) from Vineyards

Age	AGB	RTS	BGB	PR	Pruning
years	*tDM/ha*	*%AGB*	*tDM/ha*	*%AGB*	*tDM/ha*
5	0.9	200%	1.8	*n.a*	1.9 ± 0.25
10	5.3	106%	5.6	*n.a*	
20	11.5	84%	9.7	*n.a*	
30	11.7	85%	10.0	*n.a*	
Uncertainty	***18%***	***25%***	***17%***		***13%***

The references used are presented in Table 20.

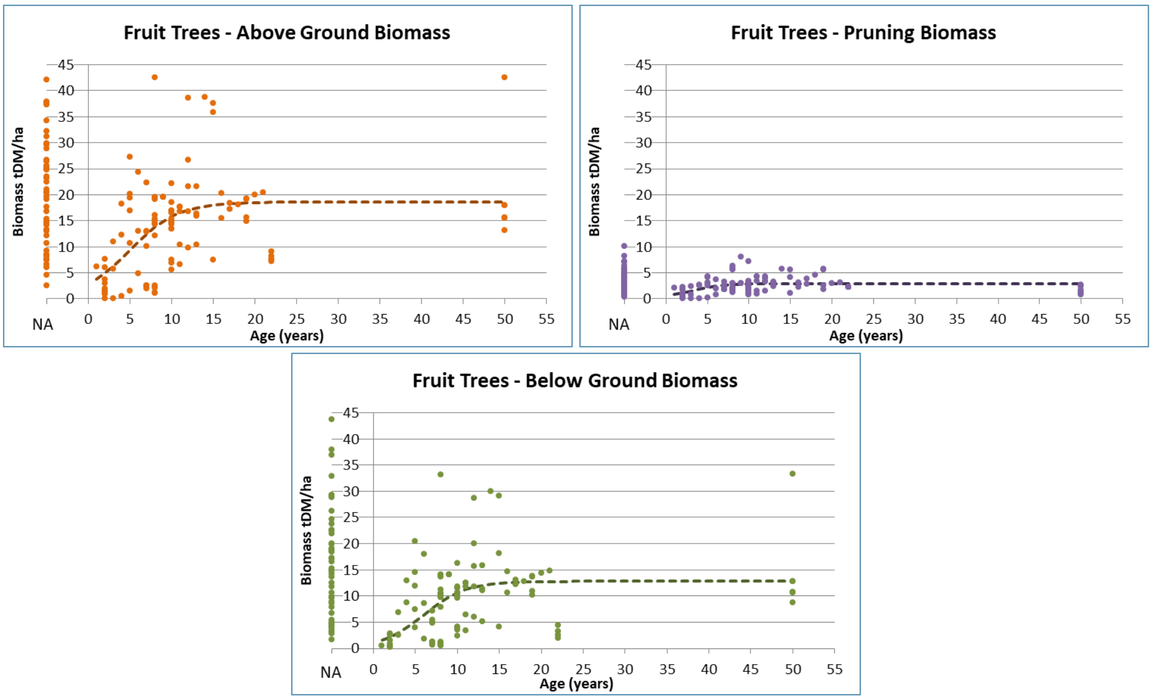
Table 20: References used in Vineyard Crops biomass

Crop Type	References
Permanent AGB	Aguilera et al. (2015b); Brunori et al. (2016); Chaves et al. (2007); Celano (2012); Colin et al. (2009); Cruz et al. (2012); Delpuech et al. (2015); Di Blast et al. (1997); Dias (2002); Gouveia et al. (2012); Juhos & Tokei (2012); Lardo (2012); Lopes et al. (2011); Magagnotti et al. (2013); Miranda et al. (2017); Monteiro et al. (2008); Morandé et al. (2017); Pérez-Bermúdez et al. (2016); Pou et al. (2011); Schreiner & Scagel (2006); Sebastián Nogués et al. (2010); Spanish NIR (2016); Spinelli et al. (2010); Velázquez-Martí et al. (2011c); Velázquez-Martí et al. (2012); Voivontas et al. (2001); Williams et al. (2011); Zanotelli et al. (2016)
Pruning biomass	Aguilera et al. (2015b); Bilandzija et al. (2012); Brunori et al. (2016); Celano (2012); Chaves et al. (2007); Colin et al. (2009); Cruz et al. (2012); Delpuech et al. (2015); Di Blast et al. (1997); Dias (2002); Gouveia et al. (2012); Juhos & Tokei (2012); Lardo (2012); Lopes et al. (2011); Magagnotti et al. (2013); Miranda et al. (2017); Monteiro et al. (2008); Morandé et al. (2017); Mota et al. (2010); Pérez-Bermúdez et al. (2016); Pou et al. (2011); Schreiner & Scagel (2006); Sebastián Nogués et al. (2010); Spanish NIR (2016); Spinelli et al. (2010); Velázquez-Martí et al. (2011c); Velázquez-Martí et al. (2012); Voivontas et al. (2001); Williams et al. (2011); Zanotelli et al. (2016)
BGB	Aguilera et al. (2015b); Brunori et al. (2016); Celano (2012); Chaves et al. (2007); Colin et al. (2009); Cruz et al. (2012); Delpuech et al. (2015); Di Blast et al. (1997); Dias (2002); Gouveia et al. (2012); Juhos & Tokei (2012); Lardo (2012); Lopes et al. (2011); Magagnotti et al. (2013); Miranda et al. (2017); Monteiro et al. (2008); Morandé et al. (2017); Pérez-Bermúdez et al. (2016); Pou et al. (2011); Schreiner & Scagel (2006); Sebastián Nogués et al. (2010); Spanish NIR (2016); Spinelli et al. (2010); Velázquez-Martí et al. (2011c); Velázquez-Martí et al. (2012); Voivontas et al. (2001); Williams et al. (2011); Zanotelli et al. (2016)

3.2.4 Fruit Trees

The Logistic Growth Model for Permanent AGB, PB and BGB was adjusted using 110 data entries (see Figure 13). An additional 50 data entries contained data on biomass stocks, but age was unknown, and were not used to adjust the function (shown for information only in Figure 13 as "NA"). Finally, 230 data entries were eliminated from the database, because it was not possible to calculate biomass stocks from the data provided by the respective study.

Figure 13: Biomass data and Adjusted Logistic Growth Curves for Fruit Trees



The estimated parameters for Equation 1 for Fruit Trees are shown in Table 21 (± denotes the 95% confidence interval of the parameters).

Table 21: Parameters for the Logistic Growth Curves for Fruit Trees

Biomass component	a	b	c	R^2	N
AGB	18.590 ± 3.378	2.906 ± 2.033	4.968 ± 2.084	23.2%	110
BGB	12.804 ± 2.614	2.561 ± 1.915	5.987 ± 2.072	23.4%	110
Pruning	2.949 ± 0.443	1.976 ± 1.957	2.893 ± 1.822	14.4%	110

The estimated biomass stocks for AGB, BGB and PB at reference ages are shown in Table 22.

Uncertainties for AGB, BGB and PB were estimated as the 95% confidence interval for parameter "a", which represents "biomass at equilibrium", expressed as percentage of the parameter value.

Implied RTS were calculated from the estimated BGB and AGB. Implied PR were calculated from the estimated PB and AGB. Uncertainties for RTS and PR were estimated using the IPCC 2006 Guidelines Approach 1 for error propagation[7].

Table 22: Estimated Biomass Stocks, Root-to-shoot Ratio (RTS) and Pruning Ratio (PR) from Fruit Trees

Age *years*	AGB *tDM/ha*	RTS *%AGB*	BGB *tDM/ha*	PR *%AGB*	Pruning *tDM/ha*
5	9.3	56%	5.2	24%	2.2
10	15.8	67%	10.6	18%	2.9
20	18.5	69%	12.8	16%	2.9
30	18.6	69%	12.8	16%	2.9
Uncertainty	***18%***	***27%***	***20%***	***25%***	***15%***

[7] 2006 IPCC Guidelines, Volume 1, Chapter 3, Equation 3.1

The references used are presented in Table 23.

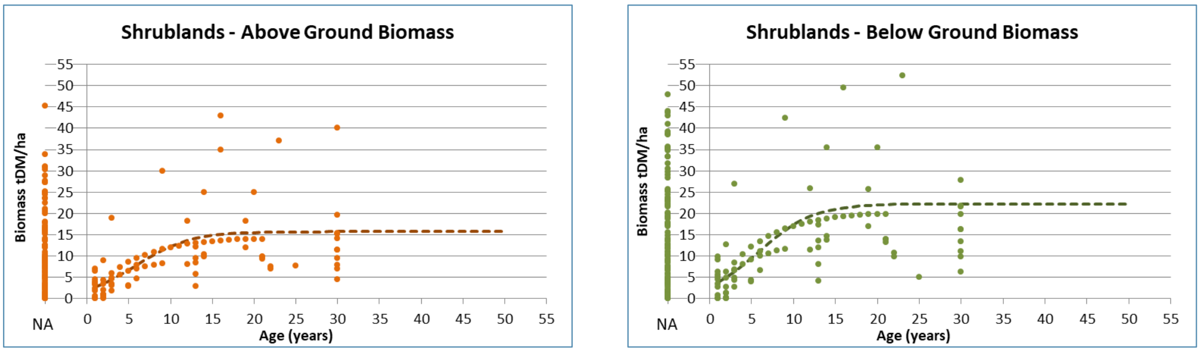
Table 23: References used in Fruit Trees Crops biomass

Crop Type	References
Permanent AGB	Abdel-Razik & El-Darier (1991); Aguilera et al. (2015b); Bécel (2010); Bonomelli & Artacho (2014); Celano (2012); Colin et al. (2009); Di Blast et al. (1997); Dias (2002); Giacinto et al. (2014); Grossman & Dejong (1993a); Juhos & Tokei (2012); Magagnotti et al. (2013); Montanaro et al. (2016); Panzacchi (2008); Panzacchi et al. (2012); Picchi et al. (2016a); Picchi et al. (2016b); Quiñones et al. (2013); Rufat & DeJong (2001); Scandarelli et al. (2010); Sebastián Nogués et al. (2010); Sofo (n.d.a); Sofo et al. (2004); Sofo et al. (2005); Spanish NIR (2016); Velázquez-Martí & Fernández-González (2010); Velázquez-Martí et al. (2011b); Velázquez-Martí et al. (2012); Velázquez-Martí et al. (2013); Voivontas et al. (2001); Xiloyannis et al. (2007); Zanotelli et al. (2013); Zanotelli et al. (2015); Zanotelli et al. (2016)
Pruning biomass	Abdel-Razik & El-Darier (1991); Aguilera et al. (2015b); Bécel (2010); Bilandzija et al. (2012); Bonomelli & Artacho (2014); Celano (2012); Colin et al. (2009); Di Blast et al. (1997); Dias (2002); Giacinto et al. (2014); Grossman & Dejong (1993a); Juhos & Tokei (2012); Liguori et al. (2009); Magagnotti et al. (2013); Montanaro et al. (2016); Mota et al. (2010); Panzacchi (2008); Panzacchi et al. (2012); Picchi et al. (2016a); Picchi et al. (2016b); Quiñones et al. (2013); Rufat & DeJong (2001); Scandarelli et al. (2010); Sebastián Nogués et al. (2010); Sofo (n.d.a); Sofo et al. (2004); Sofo et al. (2005); Spanish NIR (2016); Velázquez-Martí & Fernández-González (2010); Velázquez-Martí et al. (2011b); Velázquez-Martí et al. (2012); Velázquez-Martí et al. (2013); Voivontas et al. (2001); Xiloyannis et al. (2007); Zanotelli et al. (2013); Zanotelli et al. (2015); Zanotelli et al. (2016)
BGB	Abdel-Razik & El-Darier (1991); Aguilera et al. (2015b); Bécel (2010); Bonomelli & Artacho (2014); Celano (2012); Colin et al. (2009); Di Blast et al. (1997); Dias (2002); Giacinto et al. (2014); Grossman & Dejong (1993a); Juhos & Tokei (2012); Liguori et al. (2009); Magagnotti et al. (2013); Montanaro et al. (2016); Panzacchi (2008); Panzacchi et al. (2012); Picchi et al. (2016a); Picchi et al. (2016b); Quiñones et al. (2013); Rufat & DeJong (2001); Scandarelli et al. (2010); Sebastián Nogués et al. (2010); Sofo (n.d.a); Sofo et al. (2004); Sofo et al. (2005); Spanish NIR (2016); Velázquez-Martí & Fernández-González (2010); Velázquez-Martí et al. (2011b); Velázquez-Martí et al. (2012); Velázquez-Martí et al. (2013); Voivontas et al. (2001); Xiloyannis et al. (2007); Zanotelli et al. (2013); Zanotelli et al. (2015); Zanotelli et al. (2016)

3.2.5 Shrubland

The Logistic Growth Model for Permanent AGB and BGB was adjusted using 95 data entries (see Figure 14). An additional 141 data entries contained data on biomass stocks, but age was unknown, and were not used to adjust the function (shown for information only in Figure 14 as "NA"). Finally, 136 data entries were eliminated from the database, because it was not possible to calculate biomass stocks from the data provided by the respective study. PB was not considered as it is not a general practice in shrublands.

Figure 14: Biomass data and Adjusted Logistic Growth Curves for Shrubland



The estimated parameters for Equation 1 for Shrublands are shown in Table 24 (± denotes the 95% confidence interval of the parameters).

Table 24: Parameters for the Logistic Growth Curves for Shrublands

Biomass component	a	b	c	R^2	N
AGB	15.738 ± 2.563	0.309 ± 2.368	5.913 ± 2.716	35.9%	95
BGB	22.292 ± 3.635	0.309 ± 2.365	5.935 ± 2.720	36.0%	95

The estimated biomass stocks at reference ages are shown in Table 25. Implied Root-to-Shoot Ratios are also shown and were calculated from the estimated BGB and Permanent AGB.

Table 25: Estimated Biomass Stocks and Root-to-shoot Ratio (RTS) from Shrublands

Age *years*	AGB *tDM/ha*	RTS *%AGB*	BGB *tDM/ha*
5	6.8	140%	9.5
10	12.3	141%	17.4
20	15.5	142%	22.0
30	15.7	142%	22.3
Uncertainty	***16%***	***23%***	***16%***

The references used are presented inTable 17 Table 26.

Table 26: References used in shrubland biomass

Crop Type	References
Permanent AGB	Almagro et al. (2010); Basanta (1982); Cerrilo & Oyonarte (2016); Correia et al. (2014); Fernandes & Pereira (1993); Fernandes (1998); Fernandes et al. (1998); Fernandes et al. (2000); Fernández et al. (1995); Fonseca et al. (2007); García-Plec et al. (1989); Kummerow et al. (1981); Loissant (1973); Manso (2006); Merino et al. (1990); Monteiro (2017); Navarro (2004); Passalodos-Tato et al. (2015); Ramos (2010); Rosa (2009); Terradas (2001)
BGB	Almagro et al. (2010); Correia et al. (2014); Fonseca et al. (2007); Kokkinidis (1989); Kummerow et al. (1981); Martínes & Rodriguez (1988); Merino et al. (1990)

4 Development and Proposal of New Default Coefficients for Biomass

4.1 Proposed Values for the Mediterranean Region

4.1.1 Default Carbon Stocks at Maturity

Project MediNet proposes the default carbon stocks at maturity presented in Table 27 and the respective uncertainties presented in Table 28, which are based on the carbon stocks at 20 years calculated using the biomass equations described in the previous sections.

Table 27: Proposed Default Carbon Stocks at Maturity

	Above Ground Biomass AGB (1)			Below Ground Biomass BGB			Total	Maturity cycle (2)
	tDM/ha	%C	$tC.ha^{-1}$	$tDM.ha^{-1}$	%C	$tC.ha^{-1}$	$tC.ha^{-1}$	years
Olive Trees	19.4	47%	**9.1**	5.8	45%	**2.6**	**11.7**	20
Vineyards	11.5	48%	**5.5**	9.7	45%	**4.4**	**9.9**	20
Fruit Trees	18.5	46%	**8.5**	12.8	45%	**5.8**	**14.3**	20
Shrublands	15.5	50%	**7.8**	22.0	50%	**11.0**	**18.8**	20

Notes: (1) "*Above Ground Biomass*" refers to biomass after pruning, which corresponds, in Mediterranean conditions, to the carbon stocks in the winter; (2) "*Maturity Cycle*" refers to the time needed for biomass to reach a stable level and not the normal replanting cycles of different crops.

Table 28: Proposed Uncertainty for the Default Carbon Stocks at Maturity

	Above Ground Biomass AGB (1)			Below Ground Biomass BGB			Total	Maturity cycle
	$tDM.ha^{-1}$ (1)	%C (2)	$tC.ha^{-1}$ (3)	$tDM.ha^{-1}$ (1)	%C (2)	$tC.ha^{-1}$ (3)	$tC.ha^{-1}$ (3)	Years (4)
Olive Trees	13%	6%	**15%**	13%	4%	**14%**	**12%**	23%
Vineyards	18%	4%	**18%**	17%	4%	**18%**	**13%**	18%
Fruit Trees	18%	4%	**19%**	20%	4%	**21%**	**14%**	42%
Shrublands	16%	6%	**17%**	16%	10%	**19%**	**13%**	46%

Notes: (1) uncertainty of model parameter a (biomass at maturity) see Table 15, Table 18, Table 21 and Table 24; (2) based on Table 7 and Table 8; (3) combined uncertainty ; (4) uncertainty of model parameter c (age at 50% of equilibrium biomass) see Table 15, Table 18, Table 21 and Table 24

Where the age of plantation/establishment is known, the values from Table 29 can also be used.

Table 29: Proposed Default Carbon Stocks at Specific Ages

	Age	Above Ground Biomass AGB (1)			Below Ground Biomass BGB		
	years	$tDM.ha^{-1}$	%C	$tC.ha^{-1}$	$tDM.ha^{-1}$	%C	$tC.ha^{-1}$
Olive Trees	1	1.9	47%	**0.9**	0.4	45%	**0.2**
	5	9.4	47%	**4.4**	2.8	45%	**1.3**
	10	18.1	47%	**8.5**	5.5	45%	**2.5**
	15	19.4	47%	**9.1**	5.7	45%	**2.6**
	20	19.4	47%	**9.1**	5.8	45%	**2.6**
Vineyards	1	0.2	48%	**0.1**	0.5	45%	**0.2**
	5	0.9	48%	**0.4**	1.8	45%	**0.8**
	10	5.3	48%	**2.5**	5.6	45%	**2.5**
	15	10.3	48%	**4.9**	8.7	45%	**3.9**
	20	11.5	48%	**5.5**	9.7	45%	**4.4**
Fruit Trees	1	3.8	46%	**1.7**	1.6	45%	**0.7**
	5	9.3	46%	**4.3**	5.2	45%	**2.3**
	10	15.8	46%	**7.3**	10.6	45%	**4.8**
	15	18.0	46%	**8.3**	12.4	45%	**5.6**

	Age	Above Ground Biomass AGB (1)			Below Ground Biomass BGB		
	years	tDM.ha^{-1}	%C	tC.ha^{-1}	tDM.ha^{-1}	%C	tC.ha^{-1}
	20	18.5	46%	**8.5**	12.8	45%	**5.8**
Shrublands	1	2.8	50%	**1.4**	4.0	50%	**2.0**
	5	6.8	50%	**3.4**	9.5	50%	**4.8**
	10	12.3	50%	**6.2**	17.4	50%	**8.7**
	15	14.8	50%	**7.4**	21	50%	**10.5**
	20	15.5	50%	**7.8**	22	50%	**11.0**

Notes: (1) "*Above Ground Biomass*" refers to biomass after pruning, which corresponds, in Mediterranean conditions, to the carbon stocks in the winter.

4.1.2 Default Coefficients for Net Carbon Gains in Land-Use Conversions

Stock data at maturity can be used to derive coefficients to estimate net carbon gains following conversion from other land-uses to permanent crops (CRF 4.B.2) or other land-uses to shrublands (CRF 4.C.2). The default coefficients proposed in Table 30 have been derived from the biomass stocks in Table 27 divided by the number of years considered for the conversion period.

The default IPCC assumption of no net-gains/losses in living biomass following the conversion period is maintained, but, based on the estimated maturity cycle, the conversion period is changed from 30 to 20 years.

Table 30: Proposed Default Coefficients for Net Carbon Gains in Permanent Crops and Shrublands in the Mediterranean Region (unknown age)

	Biomass Carbon Accumulation Rate *conversions from other uses to permanent crop*							
	Conversion period		AGB		BGB		**Total**	
	years	U	tC.ha^{-1}.y^{-1}	U	tC.ha^{-1}.y^{-1}	U	tC.ha^{-1}.y^{-1}	**U**
Olive Trees	20	23%	0.46	27%	0.13	27%	**0.59**	**22%**
Vineyards	20	18%	0.28	26%	0.22	26%	**0.50**	**18%**
Fruit Trees	20	42%	0.43	46%	0.29	47%	**0.72**	**33%**
Shrublands	20	46%	0.39	49%	0.55	50%	**0.94**	**36%**

Notes: Assumes no-net change in biomass stocks after conversion period

Where the age of plantation/establishment is known, the values from Table 31 can also be used.

Table 31: Proposed Default Coefficients for Net Biomass Gains in Permanent Crops and Shrublands in the Mediterranean Region (known age)

	Biomass Carbon Accumulation Rate			
	conversions from other uses to permanent crop			
	Age range	AGB	BGB	**Total**
	years	$tC.ha^{-1}.y^{-1}$	$tC.ha^{-1}.y^{-1}$	$tC.ha^{-1}.y^{-1}$
Olive Trees	[1-5]	0.88	0.26	**1.14**
	[6-10]	0.82	0.24	**1.06**
	[11-15]	0.12	0.02	**0.14**
	[16-20]	0.00	0.00	**0.00**
	≥21	0.00	0.00	**0.00**
Vineyards	[1-5]	0.08	0.16	**0.24**
	[6-10]	0.42	0.34	**0.76**
	[11-15]	0.48	0.28	**0.76**
	[16-20]	0.12	0.10	**0.22**
	≥21	0.00	0.00	**0.00**
Fruit Trees	[1-5]	0.86	0.46	**1.32**
	[6-10]	0.60	0.50	**1.10**
	[11-15]	0.20	0.16	**0.36**
	[16-20]	0.04	0.04	**0.08**
	≥21	0.00	0.00	**0.00**
Shrublands	[1-5]	1.36	1.90	**3.26**
	[6-10]	1.10	1.58	**2.68**
	[11-15]	0.50	0.72	**1.22**
	[16-20]	0.14	0.20	**0.34**
	≥21	0.00	0.00	**0.00**

4.1.3 Default Coefficients for Gross Carbon Losses in Land-Use Conversions

Stock data at maturity can be used to derive coefficients to estimate gross carbon losses following conversion from other permanent crops to other land-uses (CRF 4.A.2.1, 4.C.2.2, 4.D.2.2.2, 4.E.2.2, 4.F.2.2) or shrublands to other land-uses (CRF 4.A.2.2, 4.B.2.3, 4.D.2.2.3, 4.E.2.3, 4.F.2.3). The default coefficients proposed in Table 32 have been derived from the biomass stocks at maturity in Table 27 assuming that all carbon is lost / emitted in the year of conversion (i.e. conversion period equals one year).

Table 32: Proposed Default Coefficients for Gross Carbon Losses in Permanent Crops and Shrublands in the Mediterranean Region (mature plantations)

	Biomass Carbon Loss Rate							
	conversions from permanent crop to other uses							
	Conversion period		AGB		BGB		**Total**	
	years	U	$tC.ha^{-1}.y^{-1}$	U	$tC.ha^{-1}.y^{-1}$	U	$tC.ha^{-1}.y^{-1}$	**U**
Olive Trees	1	0%	9.14	15%	2.59	14%	**11.73**	**12%**
Vineyards	1	0%	5.52	18%	4.37	18%	**9.89**	**13%**
Fruit Trees	1	0%	8.51	19%	5.76	21%	**14.27**	**14%**
Shrublands	1	0%	7.75	17%	11.00	19%	**18.75**	**13%**

Where the age of plantation/establishment is known, the values from Table 33 can also be used.

Table 33: Proposed Default Coefficients Gross Carbon Losses in Permanent Crops and Shrublands in the Mediterranean Region (known age)

	Biomass Carbon Loss Rate			
	conversions from permanent crop to other uses			
	Age range	AGB	BGB	**Total**
	years	$tC.ha^{-1}.y^{-1}$	$tC.ha^{-1}.y^{-1}$	$tC.ha^{-1}.y^{-1}$
Olive Trees	[1-5]	2.44	0.65	**3.09**
	[6-10]	7.27	2.14	**9.41**
	[11-15]	8.96	2.56	**11.52**
	[16-20]	9.13	2.59	**11.72**
	≥21	9.14	2.59	**11.73**
Vineyards	[1-5]	0.23	0.50	**0.73**
	[6-10]	1.51	1.77	**3.28**
	[11-15]	4.16	3.45	**7.61**
	[16-20]	5.39	4.25	**9.64**
	≥21	5.52	4.37	**9.89**
Fruit Trees	[1-5]	2.95	1.45	**4.40**
	[6-10]	6.23	3.89	**10.12**
	[11-15]	7.99	5.37	**13.36**
	[16-20]	8.44	5.70	**14.14**
	≥21	8.51	5.76	**14.27**
Shrublands	[1-5]	2.34	3.29	**5.63**
	[6-10]	5.11	7.22	**12.33**
	[11-15]	7.02	9.94	**16.96**
	[16-20]	7.67	10.86	**18.53**
	≥21	7.75	11.00	**18.75**

4.1.4 Default Coefficients for Pruning Residues

The amount of pruning (and the treatment of such biomass) is relevant to estimate a number of emission pools and sources:

- Gross C gains to the litter pool (CRF 4.B);
- N_2O emissions from incorporating pruning residues into the soil (CRF 3.D);
- CH_4 and N_2O emissions from field burning of crop residues (CRF 3.F);
- CH_4 and N_2O emissions from usage of pruning biomass for energy production (CRF 1.A);
- CH_4 and N_2O emissions from composting pruning residues (CRF 5.B).

Based on the biomass equations described in the previous sections, Project MediNet proposes the default annual gross carbon losses from pruning at maturity presented in Table 34.

Table 34: Proposed Default Annual Gross Carbon Losses from Pruning (mature plantations)

	Pruning Carbon Loss Rate *annual production*					
	Biomass		Carbon Fraction		**Total**	
	$tDM.ha^{-1}.y^{-1}$	U	%C	U	$tC.ha^{-1}.y^{-1}$	U
Olive Trees	4.20	21%	47%	6%	**1.97**	**22%**
Vineyards	1.90	13%	48%	4%	**0.91**	**14%**
Fruit Trees	2.90	15%	46%	4%	**1.33**	**15%**

Where the age of plantation/establishment is known, the values from Table 33 can also be used.

Table 35: Proposed Default Annual Gross Carbon Losses from Pruning (known age)

	Pruning Carbon Loss Rate *annual production*	
	Age range	**Total**
	years	$tC.ha^{-1}.y^{-1}$
Olive Trees	[1-5]	**0.28**
	[6-10]	**0.75**
	[11-15]	**1.50**
	[16-20]	**1.88**
	≥21	**1.97**
Vineyards	[1-5]	**0.91**
	[6-10]	
	[11-15]	
	[16-20]	
	≥21	
Fruit Trees	[1-5]	**0.37**
	[6-10]	**1.01**
	[11-15]	**1.33**
	[16-20]	**1.33**
	≥21	**1.33**

4.1.5 Default Coefficients for Wildfires

Wildfires affect all land-uses, including croplands and grasslands. The methodology for estimation of fire emissions (CRF 4(V).B and 4(V).C) requires the estimation of biomass stocks present at the time of fire, which are theoretically available for combustion.

Forest fires in the Mediterranean occur mostly during the dry season (summer) and so the values of carbon stocks presented in 4.1.1 Default Carbon Stocks at Maturity (representing biomass stocks in winter / post-pruning) may not be the most adequate for this purpose, and the sum of Permanent Above Ground Biomass (as presented in section 4.1.1) and Pruning Biomass (as presented in section 4.1.4) is probably a better estimate of the amount of biomass present at the time when most wildfires occur (see Table 36).

Table 36: Proposed Default Biomass Stocks Available for Wildfires (mature plantations)

	Biomass Carbon Stock Available for Wildfires *annual production*					
	AGB		Pruning		**Total**	
	$tC.ha^{-1}$	U	$tC.ha^{-1}$	U	$tC.ha^{-1}$	U
Olive Trees	9.10	15%	1.97	22%	**11.07**	**13%**
Vineyards	5.50	18%	0.91	14%	**6.41**	**16%**
Fruit Trees	8.50	19%	1.33	15%	**9.83**	**16%**
Shrublands	7.80	17%	0.00	0%	**7.80**	**17%**

Where the age of plantation/establishment is known, the values from Table 37 can also be used.

Table 37: Proposed Default Biomass Stocks Available for Wildfires (known age)

	Biomass Carbon Stock Available for Wildfires *annual value*			
	Age range	AGB	Pruning	**Total**
	years	$tC.ha^{-1}$	$tC.ha^{-1}$	$tC.ha^{-1}$
Olive Trees	[1-5]	0.90	0.28	**1.18**
	[6-10]	4.40	0.75	**5.15**
	[11-15]	8.50	1.50	**10.00**
	[16-20]	9.10	1.88	**10.98**
	≥21	9.10	1.97	**11.07**
Vineyards	[1-5]	0.10	0.91	**1.01**
	[6-10]	0.40		**1.31**
	[11-15]	2.50		**3.41**
	[16-20]	4.90		**5.81**
	≥21	5.50		**6.41**
Fruit Trees	[1-5]	1.70	0.37	**2.07**
	[6-10]	4.30	1.01	**5.31**
	[11-15]	7.30	1.33	**8.63**
	[16-20]	8.30	1.33	**9.63**
	≥21	8.50	1.33	**9.83**
Shrublands	[1-5]	1.40	NA	**1.40**
	[6-10]	3.40		**3.40**
	[11-15]	6.20		**6.20**
	[16-20]	7.40		**7.40**
	≥21	7.80		**7.80**

5 Information Gaps and Possibilities for Further Improvement

The revised MediNet defaults constitute an improvement to the existing IPCC 2006 default values (see Table 38).

Table 38: Comparison Between MediNet and IPCC 2006 Default Values

	MediNet	IPCC 2006 Guidelines
Cropland types	• Olive trees • Vineyards • Fruit trees	• Cropping systems containing perennial species
Grassland types	• Shrublands	• No default value provided
Further disaggregation of default data	• Age of plantation	• None

However, although we believe that the use of the proposed values will constitute an improvement there are still limitations in the current values and opportunities for further improvements that should be explicitly acknowledged (see Table 39).

Table 39: Main Improvements to the Default Values to be Further Elaborated

Limitation	Description *Recommendation*
Data consistency	The values proposed are based on the values published in the literature on the topic and related topics. However, it should be noted that the studies have not been conducted using comparable definitions and methodologies and this may limit the comparability of the results. ***Develop and implement a protocol for data collection which improves comparability.*** ***Make coordinated data collection surveys between different countries using common methodological approaches***
Stratification	The stratification in only 3 sub-categories is probably still insufficient. Some species within the same group (e.g. fruit trees) are very different in size and other characteristics (e.g. evergreen/deciduous) which will likely result in different biomass values. ***Collect sufficient data on each of the main species and varieties in the Mediterranean area using a common approach to data stratification***
Training system / Tree density	The current values are meant to represent average forms of pruning and tree densities within the same species/group of species. However, different training systems and tree densities will likely result in different levels of biomass accumulation and those characteristics should be better reflected in the default emission factors. ***Ensure that the data collection protocols record training system and tree densities. Collect sufficient data on combinations of crop type / density / training system***
Site quality	The current values are meant to represent average site conditions (soil type and productivity, altitude, precipitation, etc.) on which the crops are grown. However, biomass productivity is likely to differ substantially with site quality for the same crop, and those characteristics should be better reflected in the default emission factors. ***Ensure that the data collection protocols record site characteristics.*** ***Collect sufficient data on combinations of crop type/site characteristics.***
Management practices	The current default values are adequate to account for changes in crops/land-uses, but are not sensitive to changes in management practices (e.g. tillage, fertilization, cover crops, etc.) within the same crop type. ***Survey farmers to identify the most common practices. Collect data that allows quantification of management changes.***
Fate of pruning residues	The current values describe the amount of pruning residues produced, but do not provide information on how the residues are processed and disposed of by the farmers. ***Survey farmers to identify the most common practices related to pruning residues***
Land-use history	The current values ignore the land-use history of different plots. Farmers will differ in the way they approach plantations reaching the end of their production cycle and how they handle disturbances like forest fires. ***Survey farmers to identify the most common land-use histories related to end-of-life plantations and post-fire management***

Annex I: List of References

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Annex II: IPCC Protocol for expert elicitation

[text taken from 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 1: General Guidance and Reporting; Chapter 2: Approaches to Data Collection; Annex 2A.1 A protocol for expert elicitation]

Wherever possible, expert judgement should be elicited using an appropriate protocol. An example of a well-known protocol for expert elicitation, Stanford/SRI protocol, has been adapted and is described below.

• Motivating: Establish a rapport with the expert, and describe the context of the elicitation. Explain the elicitation method to be used and the reason it was designed that way. The elicitor should also try to explain the most commonly occurring biases to the expert, and to identify possible biases in the expert.

• Structuring: Clearly define the quantities for which judgements are to be sought, including, for example, the year and country, the source/sink category, the averaging time to be used (one year), the focus activity data, emission factor or, for uncertainty, the mean value of emission factors or other estimation parameter, and the structure of the inventory model. Clearly identify conditioning factors and assumptions (e.g., resulting emissions or removals should be for typical conditions averaged over a one-year period).

• Conditioning: Work with the expert to identify and record all relevant data, models, and theory relating to the formulation of the judgements.

• Encoding: Request and quantify the expert's judgement. The specific qualification will differ for different elements and be present in the form of a probability distribution for uncertainty, and an activity or emission factor estimate for activity data and emission factors. If appropriately managed, information on uncertainty (probability density function) can be gathered at the same time as gathering estimates of activity or emission factor. The section on encoding in Chapter 3 describes some alternative methods to use for encoding uncertainty.

• Verification: Analyze the expert's response and provide the expert with feedback as to what has been concluded regarding his or her judgement. Is what has been encoded really what the expert meant? Are there inconsistencies in the expert's judgement?

Possible Biases in Expert Elicitation

Elicitation protocols should be designed to overcome the biases that can be introduced by the rules of thumb (sometimes called heuristics) that experts use when formulating judgements. The most common unconscious biases introduced by rules of thumb are:

• Availability bias: This is basing judgements on outcomes that are more easily remembered.

• Representativeness bias: This is basing judgements on limited data and experience without fully considering other relevant evidence.

• Anchoring and adjustment bias: This is fixating on a particular value in a range and making insufficient adjustments away from it in constructing representative estimate.

To counteract the first two potential sources of biases, elicitation protocols should include a review of relevant evidence. In order to counteract the third potential source of bias, it is important to ask the expert to make judgments regarding extreme values first, before asking for judgments regarding the best estimate or central values for an uncertainty distribution.

There is also the possibility of more conscious biases:

• Motivational bias: is a desire by an expert to influence an outcome or to avoid contradicting prior positions on an issue.

• Expert bias: arises from an unqualified expert's desire to appear as a true expert in the field. This would typically lead to overconfident estimates of uncertainty.

• Managerial bias: is a situation in which an expert makes judgements that achieve organisational goals, rather than judgements that reflect the actual state of knowledge regarding an inventory input.

• Selection bias: occurs when the inventory compiler selects the expert who tells it what it wants to hear.

The best way to avoid these biases is to be careful in the selection of experts. Expert judgments can be elicited from individuals or groups. Groups can be useful for sharing knowledge and hence could be part of the motivation, structuring, and conditioning steps of the elicitation. However, group dynamics occasionally introduce other biases. Thus, it is usually preferable to elicit judgement on an individual basis. When eliciting judgments independently for a given quantity from two or more experts, it is possible that different views on distributions (or ranges) will be obtained. In some cases, the differences may not lead to a significant difference in the overall estimate for the inventory, such as when the inventory is not sensitive to the particular quantity. Thus, in these cases, disagreements among experts do not matter significantly to the overall assessment. However, when judgments differ, and when the quantity for the judgments is made is important to the overall inventory, there are two main approaches that can be used. One is to estimate resulting emissions or removals and perform the uncertainty analysis separately for each set of judgments and compare the results. The other is to ask the experts to weight the judgments and combine them into one assessment. The former approach is preferred where possible, but the latter is acceptable provided that the judgments are weighted and not averaged. The difference is that weighting enables sampling from each of the expert's estimations, whereas averaging can produce intermediate values that are not supported by any of the expert's judgement. A similar situation can occur when comparing predictions with alternative models, as described in the section of 'Combining Data Sets Numerically' in Section 2.2.3. The distinction between weighting and averaging is explained there. Although the development of weighting schemes can be complex, it is reasonable to start with assuming equal weights for each expert and refine the development of weights only as needed or as appropriate for a given situation.

Expert judgement documentation

The subjective nature of expert judgment increases the need for quality assurance and quality control procedures to improve comparability of emission and uncertainty estimates between countries. It is recommended that expert judgments are documented as part of the national archiving process, and inventory compilers are encouraged to review expert judgments, particularly for key categories. Table 2A.1 below shows an example of the document elements necessary to provide transparent expert judgment (Column 1) and an example of the data to record (Column 2).

Such documentation will save the compiler a considerable amount of time in reporting and documenting the inventory through the enhanced transparency of the inventory. More general text on documentation, checking and review of methods is included in Chapter 6, QA/QC and Verification, of Volume 1. These principles should also be applied to the use of expert judgement in inventory compilation and uncertainty assessment.

TABLE 2A.1 EXAMPLE OF DOCUMENTATION OF EXPERT JUDGEMENT	
Documentation Element	**Documentation Example**
Reference number for judgement	*EJIPPU2005-001*
Date	*14th January 2005*
Name of expert(s) involved	*Dr Anne N Other*
Experts' background (references, roles, etc.)	*Nitric Acid Process emissions and abatement industrial expert*
The quantity being judged	*National emission factor for emissions of N_2O from Nitric Acid Plant*
The logical basis for judgement, including any data taken into consideration. This should include the rationale for the high end, low end, and central tendency of any uncertainty distribution	*An absence of measurement data for 9 out of the 10 Nitric Acid plant. The single plant estimate has been recommended as the basis for a national factor to be applied to national nitric acid production.*
The result: e.g., activity value, emission factor or for uncertainty the probability distribution, or the range and most likely value and the probability distribution subsequently inferred	*8.5 kgN_2O/tonne nitric acid produced for 1990 – 2003*
Identification of any ***external reviewers***	*Nitric Acid Trade Association*
Results of any external review	*See document: e:/2003/ExpertJudgement/ EJIPPU2005-001.doc*
Approval by inventory compiler specifying date and person	*25th January 2005, Dr S.B Else*

Annex III: WS Report

MediNet Participatory Workshop on Activity Data and Biomass Emission Factors for Cropland

The first workshop of Project MediNet was held in Hotel Sana Malhoa in Lisbon, Portugal, on the 4th and 5th of December 2017.

The general objective of the workshop was to receive feedback from participants on the methodologies and results used by the project and to receive guidance on the refinement of the deliverables and main conclusions of the project.

Participants were selected and invited on the basis on their personal capacity and on the basis of their expertise in one or more of the following fields: experience in estimation of emissions and removals in cropland and in inventory compilation; experience in statistics compilation; knowledge in biomass in cropland; involvement in the IPCC work on guidance for reporting. A list of participants is provided at the end of this report.

It focused on the work already carried out under MediNet related to the collection of activity data, and the development of biomass emission factors for cropland.

The workshop was designed to allow as much interaction between participants as possible, so as to maximise their input and contribution. Participants were asked to participate freely and, to facilitate that, were given guarantees that the workshop report would contain references to the discussions held, but not contain attribution of opinions or views (Chatman House rules).

The main results of the work done are summarised below. All documents mentioned in this report are available at the site of Project MediNet (http://www.lifemedinet.com). The summary is of the responsibility of the Project Team and does not necessarily reflect the views of each of the participants.

Agenda 4th of December	*Documents and Presentations Distributed at the Workshop*
09:00-09:20	**Welcome to Participants**  
09:20-09:40	**Project MediNet** A brief presentation (Tommaso Chiti – MediNet Team) about the MediNet project was made with the objective to familiarise the participants with the project. *01 Project MediNet - general presentation.pdf*

Agenda 4th of December — *Documents and Presentations Distributed at the Workshop*

09:40-10:00

IPCC Methodologies: part 1 – Land Representation

A brief presentation (Lucia Perugini) about key IPCC reporting concepts was made with the objective to familiarise the participants with the reporting approaches that Member States are required to use for the purpose of estimating Emission and Removals in cropland and grassland. This presentation was split in 2 parts. Part 1 focused on Land Representation approaches and concepts such as Land-Use Categories, Definitions of cropland and grassland, Reporting and Accounting, Land-Use conversion Matrix and Approaches to Land Representation.

A report on the same topic was prepared and sent to participants in advance of the Workshop.

MediNet Background Report - IPCC Reporting.pdf
02 IPCC Reporting Methods Part 1.pdf

10:30-12:30

National Experiences in Activity Data for Cropland

Representatives from participant countries were asked to make a brief presentation about their country experiences in reporting cropland and grassland emissions and removals.

Presentations from Cyprus (Melina Menelaou), Slovenia (Boštjan Mali) and Italy (Marina Vitullo) were made.

A presentation (Sara Manso – MediNet Team) on the State of the Art in Emission and Removals Reporting of cropland and grassland in Mediterranean Countries was also made.

03 Experience of Cyprus.pdf
04 Experience of Slovenia.pdf
05 Experience of Italy.pdf
06 State of the Art in Emission Reporting in CL and GL in Med Countries.pdf

14:00-15:30

MediNet Report on Activity Data

MediNet's report on activity data was presented (Paulo Canaveira – MediNet Team). It identifies statistical and cartographical datasets that can be used to assist emissions reporting of cropland and grassland and discusses the potentials and limitations the project found for each of those datasets.

A report on the same topic was prepared and sent to participants in advance of the Workshop.

MediNet Discussion Report - Activity Data.pdf
07 Activity Data Review.pdf

15:30-16:30

Group Work on Activity Data

16:30-17:00

Report Back and Conclusions

Participants were divided in groups and asked to comment on the potential and limitations of different data sets for use as activity data to report cropland and grassland.

The following questions were made to guide de discussions:

1. Are you aware of any additional sources of data that we should have considered? (including data sources at European and national level)
2. Do you agree with the assessment made for the use / limitations of the data sets analysed?
3. Discuss and propose research or further work needs (beyond this project)

A rapporteur from each of the groups presented the conclusions of his or hers group. This was followed by a "plenary" group discussion on possible WS conclusions and/or recommendations

Agenda 4th of December	*Documents and Presentations Distributed at the Workshop*
	On additional sources (question 1), participants commented/suggested the following: • Data from satellites could be used to complement information. Some products that could be used for this purpose include: Open Foris Collect Earth (FAO); CCI Land Cover (ESA); COPERNICUS/Sentinel including HRL - Pan European High Resolution Layers; better use of INSPIRE Directive; better use of LPIS data combined with Sentinel images; explore the use of CAP evaluation data • Additional national data available included: use of nursery sales data (Portugal); use of the energy biomass survey (Italy); IUTI (National Inventory of land-use / Italy); use of FotoFija and Map of Crops and Uses (Spain); use of LIDAR sampling points (Spain); use of National Cadastre data where available. On the assessment made by MediNet on the datasets identified (question 2), participants commented/suggested the following: • There was general agreement on the assessment made by the project team • There could be value in splitting shrublands into transition shrubland (vegetation that develops after fire) from more permanent shrublands/maquis • On datasets that rely on replies by farmers, there could be declaration biases • On cartographic products, there could be problems that result from overlapping different maps • Statistical data could be preferred to wall-to-wall maps and there is a need to combine better stratification and sampling with ground data; the use of maps should be complementary to the use of statistics • Some of the considerations may be valid in most countries, but not at individual country level On research and further work (question 3), participants commented/suggested the following: • Improve collaboration between different data providers at country and EU Levels • Develop methodologies for combining and refining existing products • Develop automatic learning algorithms for image classification • Improve complementarity and consistency of different products (e.g. through use of MAUP) • Provide platform for sharing experiences, methodologies and models, including data users and data providers • Develop more information on uncultivated lands • Combine land data with other dynamic indicators (albedo, NDVI, …) and with other socio-economic indexes • Improve definition and systematization of management systems
20:00-22:00	**Workshop Dinner**

Agenda 5th of December	*Documents and Presentations Distributed at the Workshop*
9:00-9:30	**IPCC Methodologies: part 2 – Biomass Data** A brief presentation about key IPCC reporting concepts was made (Lucia Perugini) with the objective to familiarise the participants with the reporting approaches that Member States are required to use for the purpose of estimating Emission and Removals in cropland and grassland. This presentation was split in 2 parts. Part 2 focused on approaches and concepts for estimating emission factors such as: Carbon Pools and Carbon Flows and the IPCC approaches to emission and removals estimation, i.e. "Stock-Change" and "Gains-Losses". A report on the same topic was prepared and sent to participants in advance of the Workshop. *MediNet Background Report - IPCC Reporting.pdf* *08 IPCC Reporting Methods Part 2.pdf*
9:30-10:30	**MediNet Report on Biomass Data** MediNet's report on activity data was presented (Paulo Canaveira – MediNet Team). It describes the methodology and results of a literature survey on data for Biomass in permanent crops in Mediterranean Countries. A report on the same topic was prepared and sent to participants in advance of the Workshop. *MediNet Discussion Report - Biomass Data.pdf* *09 Biomass Data Review.pdf*
10:30-12:30	**Group Work on Biomass Data**   
14:00-15:30	**Report Back and Conclusions** Participants were divided in groups and asked to assist the project team in developing default emission factors for permanent crops in the Mediterranean. The process was organising taking into account the IPCC Elicitation Process. Each group received a graphical summary of the database that was developed by MediNet containing the values of Biomass per hectare found in literature for different permanent crops. Crops were aggregated in three crop categories: Olive Trees, Vineyards and Fruit Trees; and three pools: stock of permanent above ground biomass; stock of below ground biomass; biomass harvested in annual pruning. To assist group discussions data was presented as biomass as a function of age. Additional graphs highlighted the [possible] relevance of other factors such as country; irrigation, species (fruit trees only), intensive/extensive (olive only); training method (vineyard only). An additional graph showed which data plots had been (re)calculated by MediNet and which plots came directly from the literature. A rapporteur from each of the groups presented the conclusions of his or hers group. This was followed by a "plenary" group discussion on possible default values, WS conclusions and/or recommendations.

Agenda 5th of December *Documents and Presentations Distributed at the Workshop*

The default values suggested by the participants are shown in the tables below:

Default Value		Olive Trees (int | ext)	Vineyards	Fruit Trees
Permanent Aboveground Biomass	At 5 years	Average 0-5 3-7|5-8 5-8 5	Average 0-5 8-12 1-5 7	Average 0-5 10-20 5-15 10
	At 10 years	Average 6-10 12-17|10-20 10-20 15	Average 6-10 18-22 5-10 10	Average 6-10 10-20 12-20 15
	At 20 years	Average 10-15 X|25-35 18-30 20	Median +10 18-22 10-15 12	Median +10 10-20 15-25 18
	At 30+ years	Average? X|25-35 30-35 30	18-22 10-15 15	18-22 10-20 25-30 10-15

Default Value		Olive Trees (int | ext)	Vineyards (trellis | vase)	Fruit Trees
Pruning	At 5 years	- 2-2.5|0.5-1 0.8-1 2	- 2.5-3-5 1.5-2|1.5-2.5 1.5	- 3-5 1.5-2.5 2.5
	At 10 years	- 3-5|2-3 1.5-2.5 3	- 4-5 1.5-3.5|1.5-2.5 2.5	- 3-5 2.5-3-5 4
	At 20 years	- X|5-7 2-4 4	- 4-5 1.5-3.8|1-2 4	- 2-4 3-4 4
	At 30+ years	- X|5-7 2-4 5	- 4-5 1.5-2.5|1-2 4	- 2-4 3-4 2.5

Default Value		Olive Trees (int | ext)	Vineyards	Fruit Trees
Belowground Biomass	At 5 years	- 2-5|1-2 1.5-2 (20-30%) 2	- 9-13 2.4-4.2 8	- 7-15 0.5-18 5
	At 10 years	- 10-12|1-3 3-6 (20-30%) 3	- 13-25 4.5-9.8 10	- 7-15 2-22 10
	At 20 years	- X|9-12 4.5-10 (25-35%) 3	- 20-30 5-12 15	- 8-14 8-30 15
	At 30+ years	-[2] X|9-12 12-20 (40-60%) 5	- 20-30 5-12 10	- 8-14 8-30 8-10

Agenda 5th of December	*Documents and Presentations Distributed at the Workshop*
	In addition, and following the general discussion of the exercise, the following comments and suggestions were made: • One group suggested age 15 and 25 instead of, respectively, 10 and 20; • Another group mentioned that for the age class 30+ could be further disaggregated in the case of olive trees, since some olive groves reach much higher ages; • Results for Olive trees should be disaggregated between intensive and extensive systems; • Results as a function of plant density should also be presented as an additional variable. This is particularly relevant for olive groves and vineyards; • Rather than doing a "visual approximation" of the default values, one group suggested that the defaults could be calculated as the median or an average. These should maybe be divided by age range, instead of a single value; • Substitute "training method" by "training system"; • Citrus trees should be separated from remaining fruit trees, as they have different physical and biological characteristics, such as permanent leafs; • The maximum age in above ground biomass should be no more than 20 years for fruit trees; • Ideal default values for Olive groves should be further stratified. The main variables most likely to affect biomass values are: density (including differentiation between extensive, intensive and super-intensive); annual pruning vs. biannual pruning; and age; • Data on chestnuts and walnuts should be removed from fruit tree category, as the trees are very different in size and shape from the other fruit trees and should not be considered in the same category; • Ideal default values for Vineyards should be further stratified. The main variables most likely to affect dry matter values are: density; training system; and age; • It would be preferable to present root-to-shoot ratios instead of below ground biomass; • BGB: in absence of values for BGB or root-to-shoot, default values defined as averages of AGB values should be used rather than averages from BGB from other studies • Ideal default values for root-to-shoot should include the effects of factors influencing root development; soil types (e.g., % of clay, existence of stones; etc.); and irrigation; • The focus of the project should not be on an agreement on biomass values, but it should be on an agreement on the methodology for sampling instead; • The National Statistics Offices from each Member-state will most likely have enough data on orchards to allow for the definition of a significant sample of trees where data collection could be focused on in future projects; • Is necessary to include an estimate the standard deviation or the % of "uncertainty" of the data collected and produced; • Is necessary to complete information and data on fruit categories; • For future data collection priority should be given to more representative species and training systems in terms of area; • The final report should explain data limitations for the proposed default values; • Agree on a methodology to collect and refine biomass data • More data/measurements is needed, especially for mature classes and to reflect differences in age, plant density, training system. A methodology to collect and refine biomass data should be proposed; • Ideal default values for Fruit Trees should distinguish between different species. Ex, nut trees, citrus, apples, pears, etc. • A scientific paper should be published containing the main results and gaps identified by the project. This publication would: reach a higher proportion of the scientific community and provide background/ rationale for research projects focused in addressing the gaps identified by the project. The Carbon Management journal, from Taylor & Francis was suggested as an option for such publication.

Agenda 5th of December	*Documents and Presentations Distributed at the Workshop*
15:55-16:30	**Other LIFE Projects dealing with topics relevant for MediNet** Participants representing other related projects were invited to share their project's experiences and to identify areas where possible cooperation with project MediNet could be reinforced. Two LIFE projects, Olive4Climate (Antonio Brunori) and ClimaTree (Kostas Bithas), and one Horizon 2020 project, Diverfarming (Raul Zornoza) presented their views.    *10 LIFE Olive4Climate.pdf* *11 LIFE Climatree.pdf* *12 H2020 Diverfarming.pdf*
16:30-17:00	**Closure of the Workshop and Next Steps** The workshop was closed with a note acknowledging and thanking all participants for their active engagement. It was agreed that a Workshop Summary Report would be produced distributed to all participants and posted on the project's website and that the MediNet reports on Activity Data and Biomass Data will be updated to reflect the contributions made during the Workshop. 

WS List of Participants

Country	Name
Cyprus	Melina Menalaou
FAO	Sandro Federici
France	Robert Colas
Greece	Angelos Mimis
Greece	Kostas Bithas
Greece	Myrsini Christou
Italy	Antonio Brunori
Italy	Giuseppe Montanaro
Italy	Guido Pellis
Italy	Lucia Perugini
Italy	Marina Vitullo
Italy	Paolo De Angelis
Italy	Tommaso Chiti
JRC	Simone Rossi
Portugal	Ana Pina
Portugal	Carlos Carvalho
Portugal	Carlos Lopes
Portugal	Clara Lopes
Portugal	Eduardo Santos
Portugal	José Paulino
Portugal	Lúcio do Rosário
Portugal	Paulo Canaveira
Portugal	Ricardo Vieira
Portugal	Sara Manso
Slovenia	Bostjan Mali
Spain	Borja Velázquez Martí
Spain	Carlos Miranda
Spain	Cristina Garcia
Spain	Magdalena Galvez
Spain	Mar Ferrero
Spain	Maria Jose Sanz
Spain	Paz Fuentes
Spain	Raul Zornosa

Annex IV: 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 above ground 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 then 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 above ground 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.