



Manual for field measurements on APPR biomass productivity

Corresponding to task 6.1

uP_running

Take-off for sustainable supply of woody biomass
from agrarian pruning and plantation removal

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Prepared by: CIRCE and CERTH

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1. INTRODUCTION

The present guidelines show how to perform measurements of the wood produced by hectare in vineyards, olive and fruit plantations, *i.e.*, the biomass productivity, also called biomass yield or biomass potential. The methods are valid for both pruning and plantation removal wood.

The measurement's result (amount of prunings/plantation removed, in t/ha) has to be introduced in the Questionnaire for the field sampling of prunings or plantation removal respectively (available on the Observatory website at: www.up-running-observatory.eu) along with some more information that affects quite much this data (how was the field, the crop, the agrarian practices, the last year, etc.). Although the Questionnaire seems to be large, questions should be easily answered by the field owner.


We encourage reading Annex 1 in order to understand the variability of APPR biomass productivity and why it is necessary to collect information from a series of factors since all of them may influence the productivity of APPR biomass that will be measured thanks to these guidelines.

Note that in these guidelines we recommend to make several measurements per field. However, only the average will be shown in the observatory tool.

2. CONTACT POINTS

For any doubt you can contact the responsible persons in charge of organizing the data collection. If you are interested in performing an APPR biomass productivity measurement in a third country and you would like some technical assistance or you are interested in supplying your data to the up_running Observatory, please contact CERTH or CIRCE.

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3. SELECTING A MEASUREMENT METHOD

HOW TO PERFORM MEASUREMENTS?

First of all, a method has to be selected in order to carry out the biomass productivity measurement. Three methods are proposed, applicable to both pruning and full tree biomass. Their main features are presented in Table 1.


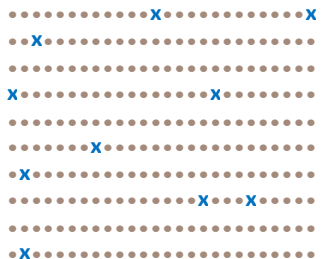
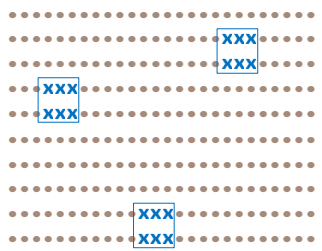


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Table 1. Main features of the methods to be utilised in the measurement of biomass productivity (kg/tree or t/ha)

Measurement methods				
	Visual depiction	General description	PROS	CONS
Option 1. Weight of biomass by tree:		<p>Several trees must be selected (e.g. as marked in figure as x). All biomass is collected manually. Measuring the biomass from 10 or more trees is advisable. Selection of trees must be a random process.</p>	<ul style="list-style-type: none"> - Simple to execute. - Weight to be measured is small (no need of industrial scales). - Easy to be carried by 1 or 2 persons. 	<ul style="list-style-type: none"> - High deviations from tree to tree (depending size, health, vigour, but also on how pruning was performed last years) - Need of a large sample of trees to capture reality of the field (e.g. 5% of trees in a field with 600 trees/ha implies a samples size of 30 trees). A minimum of 10 trees is recommended.
Option 2. Weight of biomass in parcels:		<p>Several parcels of 4 to 10 trees (50 to 200 m²) are selected. All biomass is collected manually. <u>Only the branches inside the parcel are collected.</u> Outside the limits the biomass is not gathered, no matter to which tree belonged.</p>	<ul style="list-style-type: none"> - More precise than option 1 (more trees measured). - Allow including several parts of a field (parcels can be selected in flat, slope, basin areas). - Effects of single to large or small tree production is buffered (deviation with respect to average of several parcels is smaller). 	<ul style="list-style-type: none"> - More effort in weighting than option 1, even though 1 or 2 persons can carry it out. - In case of plantation removal wood, the work may be too heavy to be done manually.
Option 3. Weight of biomass in whole field or along several rows		<p>The biomass of a large area is collected. It can consist on the biomass along one or several rows (2 rows collected according to scheme). Even the whole field can be collected.</p>	<ul style="list-style-type: none"> - Harvesting a larger area implies obtaining a more reliable value of t/ha. - It should be done with mechanised means. Therefore farmer is already learning on the collection of pruning or full tree wood. - The collection efficiency (%of losses) can be measured. 	<ul style="list-style-type: none"> - For plantation removal it may imply an important weight, and so, need of large trucks where the biomass is loaded. - If the collection is mechanised, not all branches are collected. The losses (wood not compiled) have to be measured, which is an extra work (to be done by parcels, not in the whole area collected).



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Before selecting a measurement method, it is important to think on the PROS and CONS, the time to be invested and the necessary materials. Here some ideas to select the measurement method.

PROS AND CONS


They make some appraisals on personnel efforts and some materials needed. In general, when a one person is carrying out the measurement alone, Option 1 (by tree) is by far the most appropriate. Carrying out the collection of all the biomass in a large area (several rows, Option 3) involves the use of mechanised methods. It is more kind of a machinery field test, than just a sampling of biomass. So, unless the owner belongs or hires a pruning harvester (with pick-up and chipper, e.g.) or contracts an external service to carry out the work, the option has just non sense. In terms of results Option2 can be a good compromise of efforts and quality of the results.

TIME REQUIRED

Table 2 shows an estimation of time to be invested for measurements. The time depends much on the amount of biomass, the weighting method, and also if the big pieces need to be crosscut (with a chainsaw or an axe). Table 2 is provided just to give a hint to uP_running partners and to farmers for decision making on which method to be utilised. For estimating the measurement time, it is assumed that branches just need a small preparation work. In case of plantation removal it is assumed that one of the persons involved in the measurements is handling a chainsaw to crosscut the wood. In case of the option 3, the time includes the loading of a trailer or a truck, but not the trip to the vehicle scale.

Table 2. Summary of estimated times for 2 persons performing the weighting of biomass in a fruit tree plantation





Weight and estimated times for measurement						
	Pruning (annual)		Pruning (structural)		Plantation removal	
	biomass	time	biomass	time	biomass	time
Option 1 – by tree	2-5 kg/tree	<10 min (manual)	5-10 kg/tree	<20 min (manual)	50-100 kg/tree	<40 min (manual)
Option 2 – by parcel (100 m²)	20-50 kg/parcel	<30 min (manual)	50-100 kg/parcel	<60 min (manual)	50-100 kg/parcel	<120 min (manual)
Option 3 – large area (1000 m²)	200-500 kg/field	<15 min (mechanised) + 30 min (losses)	500-1000 kg/field	<20 min (mechanised) + 30 min (losses)	500-1000 kg/field	200 min + 60 min losses


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MATERIALS NEEDED

The measurement methods are as exposed next in Table 3. The cells of those items necessary are shaded in green, those optional in yellow, and those non compatible in red.


Table 3. Materials needed per method







Materials needed (suitability by method)				
		Option 1	Option 2	Option 3
DISTANCE and LOCATION TOOLS	<u>GPS or mobile phone</u> 	Needed to capture field coordinates	Needed to capture field coordinates	Needed to capture field coordinates. In case of large fields, can be useful to take positions of the vertices of the area collected (to measure actual area harvested)
	<u>Laser distance measurer</u> 	Not needed	Can be used to measure parcel size	Suitable to measure actual distances of collected area
	<u>Measuring tape</u> 	To measure distance between trees	To measure size of parcel. To measure distance between trees	To measure distance between trees
WEIGHTING SYSTEMS	<u>Electronic lab scale</u> 	Suitable.	Suitable, but branches may need a crosscut	Unsuitable

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Materials needed (suitability by method)				
		Option 1	Option 2	Option 3
WEIGHTING SYSTEMS	Hanging scale 	Suitable	Suitable	Suitable
	Roman scale 	Suitable (but accuracy less than 100 grams)	Suitable	Unsuitable
	Vehicle scale 	Unsuitable	Unsuitable	Needed
MOISTURE (optional)	Sampling bags 	Suitable	Suitable	Suitable
	Moisture meter¹ 	Unsuitable	Unsuitable	Suitable

¹ Image source: <http://www.humimeter.com>

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Materials needed (suitability by method)				
		Option 1	Option 2	Option 3
OTHER MATERIALS	<u>Barrier tape</u> 	May be useful to mark the selected trees	Suitable to mark limits of parcels	May be useful to mark initial and final points of harvest
	<u>Bag / canvas</u> 	Suitable	Suitable	Unsuitable
	<u>Ropes</u> 	Recommended to tie branches in bunches, or to hold whole tree (weighted with dynamometer hanging in a lift)	Recommended to tie branches in bunches, or to hold whole tree pieces (weighted with dynamometer hanging in a lift)	Can be useful for preparing bunches with the losses.
OTHER MATERIALS	<u>Lift</u> 	Suitable (not needed)	Recommended	Necessary if whole tree or large pieces to be measured
	<u>Agrarian trailer or truck</u> 	No need	No need	Needed
	<u>Harvester</u> 	No need	No need	Needed

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4. ABOUT MOISTURE


The biomass weight contains a relevant amount of water (moisture), especially if the weighting of biomass is carried out same day or few days after the operations of pruning or plantation removal are carried out. **It is advisable to have a measurement of biomass moisture** and to introduce the result in the Questionnaire for field sampling of prunings or uprooting material. Here are some suggestions for measuring moisture:

- In case of moisture meters, they have to be inserted into a pile of woodchips. It must be checked if the device is compatible and is calibrated with the type of biomass being measured.
- In case samples are taken to be sent to laboratory, they must be placed in sealed containers or bags (like the zip plastic bags) to ensure there is no loss of moisture until the samples are analysed.
- If no moisture samples are gathered and no moisture meter measurements is done, it is crucial to ask the farmer how long were the branches on soil, to make an estimation of the moisture. This estimation is to be done by CERTH and CIRCE.

5. LIST OF TYPICAL BAD PRACTICES TO BE AVOIDED

Here a series of advices to avoid some bad practices when executing the measurements.


Ensure random process	Avoid selecting trees (Option 1) just visually. Unconsciously we may just discard trees with few branches, or looking different to others. Choose a random method to select trees (e.g. with aleatory numbers you choose the position of the trees to be sampled).
Ensure pruning done "as usual"	Go to the field after the pruning is done. You shall avoid the farmer to make the pruning only for the selected trees, just for you. The intensity is directly influenced by the fact he was not just doing it as usual, tree after tree, in a sequence, but tailored to you.
Record type of pruning and intensity.	Pruning of different types can be carried out. Be sure to ask it to the farmer. Do not just assume it was an annual pruning. Ensure also to ask if the farmer was doing this year more or less severe pruning work than rest of years.
Are all branches / stems there?	Has the farmer already removed part of the wood (e.g. for self-consumption)?
Biomass per tree	For Option 1, be sure that the branches weighted corresponds to the tree. Ask farmer if he leaved all as they fall, or if he moved, or launched some branches (e.g. to the centre of lane between rows).
Biomass per parcel	Before collecting branches mark the limits of the area. It is believed it is not necessary. But during the performance of the work it is easy to get lost and pick up branches outside the limits. Marking the limits is important.
Are branches touching the floor during measurements?	The branches have an irregular shape, and it is easy that, when performing the weight some more branches touch the floor. This leads to an incorrect value of the weight. These branches must be bent or cut, to ensure the weight is correctly measured.
Weight of bag, boxes or ropes	In order to measure the biomass, bags, boxes or ropes may be useful to gather branches in small bunches. Note that when performing the measurement the weight of this element is being taken. Note-up its weight.
Truck or trailer	In case a truck or a trailer is filled in with biomass, and weighted in a vehicle scale, the total weight (vehicle + load) is taken. It is necessary to know the weight of the vehicle,

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weight	to get the value of the load (it is evident, but it is easy to have a miss communication and put the wrong number in the templates).
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6. TEMPLATES FOR FIELD MEASUREMENT OF BIOMASS PRODUCTIVITY

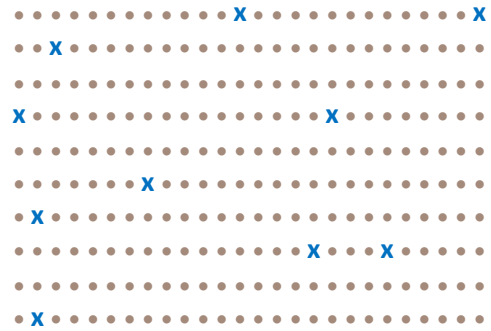
Next fact sheets include all needed to perform the measurement of the weights for pruning and/or plantation removal wood productivity in agricultural fields. They include a short description, simple checklist of actions, and simple tables to retrieve and record the data.

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OPTION 1: WEIGHT OF BIOMASS PER TREE


Method

The biomass around a tree is collected and weighted.
 Several trees must be selected (>10).
 Selection of trees must be a random process (avoid visual selection).



Execution protocol

- Contact farmer before visiting, to be sure things are ready.
- Abort measurements in case it rained the day before (or something that alters too much measurement).
- Make an aleatory selection of the trees to be measured. If any of them is too much a singular case, discard it (e.g. death olive tree, too young, etc.).
- Mark the trees (e.g. with barrier tape).
- Before weighting, make sure that you can clearly identify the branches belonging to the tree.
- Note up in the table below the weight of the box/bag/rope (materials utilised to gather the wood together to facilitate its weight).
- Measure the weight of the biomass bunches (below option till 5 weights per tree, should be sufficient). Note each weight in table below.
- Go to next tree.
- Before leaving make pictures of field and measurements.

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OPTION 1: WEIGHT OF BIOMASS PER TREE

Field Data

Position	Latitude:		Longitude:	
Density	Trees/ha:	Width between rows (m):	Distance between trees in same row (m):	


Tree	Weight of equipment (box, bag, etc.) kg	Gross weight of each bunch					Total per tree [*] (gross kg)	A = Total per tree [**] (net kg)
		1	2	3	4	5		
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
12								
...								

[*] calculated as sum of gross weight (box/bag + biomass) of all bunches weighted
 [**] calculated as Total gross weight minus Nr of bunches weighted multiplied by the weight of box/bag/rope

The final result to be implemented in the WP6 questionnaire is:

Biomass productivity (t/ha) [*] =**

[***] AVERAGE of [A (kg/tree) * density (tree/ha)] * 0.001 (kg/t)

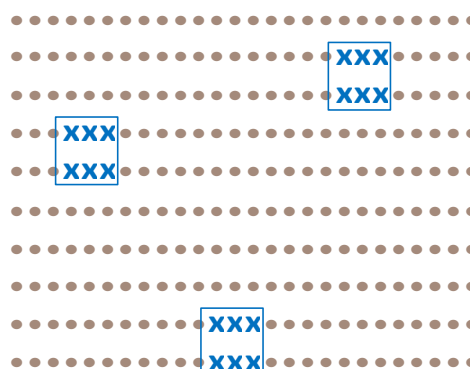
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OPTION 2: WEIGHT OF BIOMASS IN PARCELS

Method


The biomass from the trees in an area is weighted. In this case only the branches inside the parcel are collected. Outside the limits the biomass is not gathered, no matter to which tree belonged. Parcels containing at least 4 trees are advisable.

2 or 3 parcels per field have to be sampled. It is interesting to select parcels in different zones of the field, with different features (slope, basin, etc.).



Execution protocol

- Contact farmer before visiting, to be sure things are ready.
- Abort measurements in case it rained the day before (or something that alters too much measurement).
- Make an aleatory selection of the parcel size and the location of parcels (indifferent parts of the field).
- Mark the limits of the parcel (with barrier tape, or other method). Take position of the parcel (lat; long)
- Before weighting, make sure that you can clearly identify the branches belonging to the parcel. Put away those being too close to the boundary, to avoid they are weighted by mistake.
- Note up in the table below the weight of the box/bag/rope (materials utilised to gather the wood together to facilitate its weight).
- Measure the weight of the biomass bunches (below option till 5 weights per parcel). Note each weight in table below.
- When a parcel is finished move to next parcel.
- Before leaving, make pictures of field and measurements.

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OPTION 2: WEIGHT OF BIOMASS IN PARCELS

Field Data

Position	Latitude:		Longitude:	
Density	Trees/ha:	Width between rows (m):	Distance between trees in same row (m):	

Measured weights

Parcel	Weight of equipment (box, bag, etc.) (kg)	Gross weight of each bunch (kg)					Total per parcel [*]	B= Total per parcel [**]
		1	2	3	4	5	(gross kg)	(net kg)
1								
2								
2								
4								
5								

[*] calculated as sum of gross weight (box/bag + biomass) of all bunches weighted.

[**] calculated as (Total gross weight) minus (Nr of bunches weighted) multiplied by (weight of box/bag/rope).


Characteristics of the parcels where measurements were done

Parcel	C= Size of parcel (m ²)	Total Nr trees in parcel
1		
2		
3		
4		
5		

The final result to be implemented in the WP6 questionnaire is:

Biomass productivity (t/ha) [*] =**

[***] AVERAGE of [B (kg/parcel) / C (m²/parcel)] * 10 (m²/ha) (kg/t)

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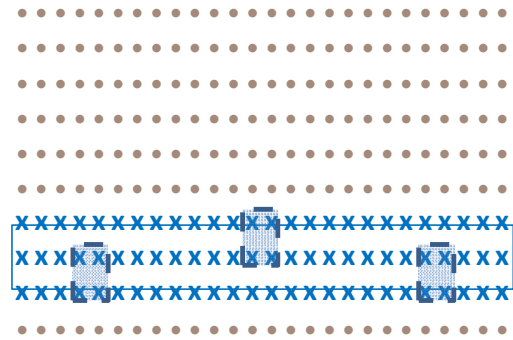
OPTION 3: WEIGHT OF BIOMASS IN WHOLE FIELD OR ALONG SEVERAL ROWS

Method

The biomass of a large area is collected with a mechanised method. It can consist on the biomass along one or several rows. Or even all the biomass obtained in a field. Outside the limits the biomass is not gathered, no matter to which tree belonged.


The whole biomass is weighted.

After the biomass is gathered (by mechanised method), losses are measured manually, in 2-3 different parcels of the area, and according to option 2.



Execution protocol

- Contact farmer before visiting, to be sure things are ready.
- Abort measurements in case it rained the day before (or something that alters too much measurement).
- Make an aleatory selection of the area of field to be object of measurement.
- Mark the limits of the area (with barrier tape, or other method) and measure it. If area is large, taking position of vertices is advisable.
- Follow the harvest of wood.
- Once the truck driver has performed the weight in a vehicle scale, note up the weight of truck / trailer and the weight of the load. In the table below.
- After the mechanised collection, a part of the branches remain on the soil. Select few parcels and measure the weight of the losses (not harvested wood). A roman scale, dynamometer or electronic scale can be utilised.
- Note up in the table below the weight of the box/bag/rope (materials utilised to gather the wood together to facilitate its weight).
- Measure weight of the biomass bunches (below option till 5 weights per parcel). Note each weight in table below.
- When a parcel is finished move to next parcel.
- Before leaving make pictures of field and measurements

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OPTION 3: WEIGHT OF BIOMASS IN WHOLE FIELD OR ALONG SEVERAL ROWS

Field Data

Position	Latitude:	Longitude:	
Density	Trees/ha:	Width between rows (m):	Distance between trees in same row (m):

WOOD HARVESTED WITH MECHANISED METHODS

Weight of empty vehicle (kg)	Gross weight of each truck / trailer (kg)					Total [*]	D= Total [**]
	1	2	3	4	5	(gross kg)	(net kg)

E = Measured field area (m²):

[*] calculated as sum of gross weight (truck + biomass) of all trucks weighted.

[**] calculated as Total gross weight minus Nr of trucks weighted multiplied by the weight of the truck.

MEASUREMENT OF LOSSES (manually) – same as option 2

Parcel	Weight of equipment (box, bag, etc.) (kg)	Gross weight of each bunch (kg)					Total per parcel	F = Total per parcel
		1	2	3	4	5	(gross kg)	(net kg)
1								
2								
3								
4								
5								

Characteristics of the parcels where LOSSES measurements were done

Parcel	G = Size of parcel (m ²)	Total Nr trees in parcel
1		
2		
3		
4		
5		


The final result to be implemented in the WP6 questionnaire is:

Biomass productivity (t/ha) [*] =**

[***] [D (kg) / E (m²)] * 10 (m²/ha) (t/kg)

Biomass losses (t/ha) [**] =**

[****] AVERAGE of [F (kg) / G (m²)] * 10 (m²/ha) (t/kg)

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7. ANNEX 1: WHY SHOULD YOU MEASURE?

We encourage reading this section for a better understanding of the APPR biomass variability.

The annual accumulation of biomass in the living structure of a tree is the result of a series of factors: tree age, variety and vigour, adaptation to the local climate, weather during last year, soil conditions and adaptation of plant rooting system, impact of pests and diseases, among others.

When moving to agrarian eco-systems, two main factors are added: variety selection and agronomic practices. About varieties, they are the result of a genetic selection done by human beings along centuries. Grape, olive and fruit varieties are quite diverse, and sometimes they exist in very local zones. Other cause of variability in the species and variety growth is the result of grafting living pieces of a fruit variety on the rootstock of former fruit variety. The new plant includes the soil adaptation of the rootstock, fruit properties related to the variety and a mixture of properties respect crop growth, vigour, resistance to pests, etc.

About agronomics, the density, the agronomic practices preferred by the farmers, the intensification degree, the specific human factors (an early spring may cause the farmers to hurry and perform a “softer” pruning, e.g.) or the type of operation (yearly pruning, structural pruning, hedging, topping, etc.) cause that the APPR biomass obtained after a treatment in a field is quite variable.


EuroPruning project (www.europruning.eu) recently studied the influence of different factors in the productivity of pruning biomass (t/ha of pruning wood). EuroPruning found that climate can explain only a portion of the pruning biomass yield. It was evident that other factors, more relevant, and not identified during the assessment, were affecting much the APPR yield.

The conclusion is that knowing the biomass productivity (t/ha) from pruning or plantation removal operations (APPR biomass), is just quite a rather partial information. In order that the values of the biomass yield can be appropriately utilized, it is necessary to understand the whole picture (variety, agronomics, how farmer did the operation, etc.).

Example on how knowing the value of t/ha is just insufficient

Feature a farmer belonging 200 ha of olive traditional plantation in Southern Spain (let’s call it Farmer-S). Trees are older than 150 years old, planted in a density of 80 trees/ha. Let’s assume he performs a sampling and obtain the fields produce 3 t/ha/yr of biomass (fresh matter) pruning wood. Imagine that the results are published in a magazine, explaining generic things about biomass, and about a productivity of 3t/ha found in southern Spain.

Now imagine a farmer in northern Spain (Farmer-N) who exploits 100 ha of 10 year old olive groves planted at 1200 trees per hectare and under drip irrigation (super-intensive regime). He reads that biomass from olive trees pruning can be about 3 t/ha in Southern Spain. If Farmer-N used the ratio of 3 t/ha for exploring a productivity business, it would be clearly a very risky practice (not a good practice). Now you shall imagine Farmer-N makes some thoughts. Even if he has not much info on how was the plantation in Southern Spain, he may argue that probably the article referred to an extensive plantation of olive trees. Then he may think, “*well here in the fresher northern Spain, and with irrigation, my trees may produce*”

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more". And be tempted to think their plantations may yield 4 or 5 t/ha and year. But probably he realises: *"my olive tree variety is an intensive variety, so wood accumulation per plant is lower than in traditional varieties. But well, my fields have 1200 trees/ha, and not 100 or 150 trees/ha, as it is usual in southern Spain. So... even if my plantation is less vigorous, maybe the total production of woody biomass is similar"*.

Up to the moment Farmer-N has done a right thinking. But the problem is that the question "how much biomass per hectare can I get in my plantation" remains unsolved for him.

This example illustrates why it is so important to not just declare the t/ha, but the details of the field. And also to provide a couple of pictures of it: "a picture is worth a thousand words".