TROFACO
Tropical Farmer Connect

# ASSESSING THE AMOUNT OF $CO_2$ IN A PLANTING

2020

## INTRODUCTION

Knowing the amount of carbon, we sequester in trees is a key element in measuring the effectiveness of our work.

Achieving this knowledge is quite tricky though and assessing the amount of carbon stored in a planting site is quite an intricate process with many measurements, calculations and complications.

First, we find the height of the trees, then we calculate the amount of carbon stored in each tree, and finally, we use this information to estimate the total amount of $CO_2$ captured in a planting site. Read the full description below.

### FINDING THE SIZE OF THE TREES

First of all; what you usually talk about in climate compensation is the amount the trees will absorb during the first 20 years of their life. That is a kind of a standard for tree-based climate mitigation set by the IPCC, (The Intergovernmental Panel on Climate Change). So, we have to predict how big the different kind of trees will be when they are 20 years old. Unfortunately, there are many, many kinds of trees, and people have only bothered measuring those they plant for money, in other words: trees that are used in plantations.

Most of the species the local communities working with TROFACO choose are local - and not used in plantations. In order to know their size in 20 years, we use the following approach:

1. Get information from published data, how large may the tree become at maturity. And if we are lucky, we also get information on how many years it takes to get there.
2. Ask anybody we meet who may be growing one or more kinds of 'our' trees; How big are they, at which age?
3. Take measurements of trees we see in the landscape, especially if we can get an idea when they may have been planted.
4. Get our own data, from trees planted through TROFACO. That takes a while, as trees take long time to mature. But for some species, we now have a lot of data for their first five years.

When you have that, and hopefully a data from point 1 above, you may get a pretty good idea of how the tree grows.

Let us give you an example of how this prediction may play out:

Probably the biggest tree we plant is Mvule (*Milicia excelsa*). Timber Research and Development Association [1] tells us: 'The species is a large deciduous tree growing up to 50 meters (160 ft) high. The trunk is bare lower down with the first branch usually at least 20 meters (66 ft) above the ground.'

World Agroforestry Centre says: ' *Milicia excelsa* is a large deciduous tree 30-50 m high, with a diameter of 2-10 m"

Then the issue (in this context) is: How big is the tree when it is 20 years old? The faster-growing species may be mature at this point. Larger trees, like the *Milicia* are just getting into their fast-growing phase. In this case, the exact size at 20 years is based on a bit of guesswork: The information about how large they are at maturity is not very valuable as they grow incredibly fast in this phase. They are like early teenagers; maturity still is far in their future and for the trees, we have little information about when they reach it.

# CALCULATING THE CARBON IN THE TREES

In order to calculate the amount of carbon stored in a tree, we find the estimate the biomass stored above ground, calculate the amount of solid carbon stored in the biomass, and finally, we can calculate how much atmospheric $CO_2$ is captured from the atmosphere.

Above ground (dry) biomass (AGB) of standing trees is calculated using the formula:

$AGB = DBH^2 \times \pi / 4 \times H \times d \times$ factor for shape

Where DBH is 'Diameter of the trunk at Breast Height', H is the height of the tree and d is the wood density, which is variable among tree species; i.e. some wood is heavier than other. The value for many species can be found in databases. $\pi / 4$ 'translates' the square ($DBH^2$) to a circle, as the trunk of the tree is round. Finally, f is a factor for the shape of the tree, depending for example whether its trunk is straight, or it has many branches already from low above the ground.

Below we give some estimates, applying the formula above, based on knowledge about trees TROFACO commonly plant:

| | Age | Height (m) | DBH | p /4 | Factor for shape | AGB | Wood density | Carbon (tonnes) | $CO_2e$ (tonnes) |
|---|---|---|---|---|---|---|---|---|---|
| Big species (*Milicia excelsa*) or Musizi, (*Maesopsis emini)* | 50 | 40 | 1.2 | 0.79 | 0.7 | 31.03 | 0.98 | 15.52 | 56.95 |
| Big species (*Milicia excelsa*) or Musizi, (*Maesopsis emini)* | 20 | 20 | 0.8 | 0.79 | 0.5 | 6.90 | 0.9 | 3.45 | 12.65 |
| Smaller species (*Gevillea robusta*) | 20 | 25 | 0.6 | 0.79 | 0.8 | 5.65 | 0.7 | 2.83 | 10.38 |
| Teak (*Tectona grandis*) | 22 | 25 | 0.65 | 0.79 | 0.6 | 4.98 | 0.6 | 2.90 | 10.66 |

One ton of dry wood biomass (AGB) roughly equivalates 0.5 tons of carbon, so using this fact we can calculate the amount of solid carbon stored in the AGB. Each tonne of carbon then equals 3.66 tonnes$CO_2$, because the molecular weight of $CO_2$ is 3.66 times the atomic weight of C (Carbon), which leads us to the amount of $CO_2$ captured from the atmosphere.

How do you, for example, measure the DBH? That is straightforward in a plantation on flat ground with trees each of which one has only one stem/trunk. You take a tape measure and measure around the tree.

Then you convert this circumference, as measured with the tape measure, to diameter. But not all trees stand in plantations, and not all on flat ground. And how do you measure height? When the trees are small, we measure by a measuring stick (and show you the stick next to the tree on our pictures on the webpage). When the trees are larger, one can use an app on the smartphones. It can do the trigonometry. We will spare you the equations here, but feel free to ask! When the trees get really big and the canopies close, we will use our drone

## MOVING FROM TREE TO PLANTING SITE

We know the composition of trees in each planting site, and we factor in thinning of the planting (thinning is often done two times (in order to give the remaining trees space to grow to full size), each halving the number of trees). So, let us say we have agreed with a sponsor/client to plant 700 trees and thin the planting twice. We could suggest using teak (*Tectona grandis*) in such a planting - and the local would like it, as teak is valuable. 700 trees, thinned twice, give us 175 trees at maturity. 175 teak trees yield slightly more than 1,700 tonnes of $CO_2e$, according to the calculation above.

And this is only what is above ground. Actually, the roots have about 20-30% additional biomass, to the above-earth part of the tree, but we do not count that. Furthermore, the estimate does not include the $CO_2$ in the younger trees that were cut during thinning. In the case of timber-species, the wood will have been used for stakes, construction or similar, so most $CO_2$ is not released.

But how permanent is this storage of $CO_2$? If you look in the list of trees we plant (under 'Documentation) and check at the records of each planting site, you will see that the large majority of trees we plant are useful timber-species. When harvested, their wood will be used in furniture or timber for construction. The UNFCC (UN Framework Convention on Climate Change) recognize timber as a 'semi-permanent sink' and say that approximately half of the $CO_2$e stays in the wood used for these purposes for at least 100 years.

## AND THE 'FREE BONUS'

All of the above is about calculating CO2e at 20 years of age of the trees. But communities will leave the trees longer, as they want to enjoy the benefits of doing so. So many trees will become MUCH bigger. That bonus is free to any client/sponsor. Communities also usually mix several species of trees, and plant crops under the trees. Both has been shown to increase CO2 uptake. And we strongly encourage both this mixing and wide spacing, giving more room for each tree and removing the need for thinning. So bigger trees and more trees will stand.

A *Milicia excelsa* in Hoima town, Uganda. Probably 80-100 years old (May 2019)