



CONSIDERING CHANGES IN BIOMASS CARBON STOCKS ON
FRUIT AND WINE FARMS

Introduction

During the development and rollout of the fruit and wine industry's carbon footprint tool, the issue has frequently been raised whether the carbon sequestered by trees, vines and plants can be used to offset other carbon emissions. While the idea has intuitive appeal: "Surely the trees on my farm are growing and storing carbon which should be offset against the emissions generated through the use of electricity or combustion of diesel?" – the answer is not that straightforward. This document aims to summarise the basic concepts of carbon pools and flows and explain the processes at a farm and landscape scale.

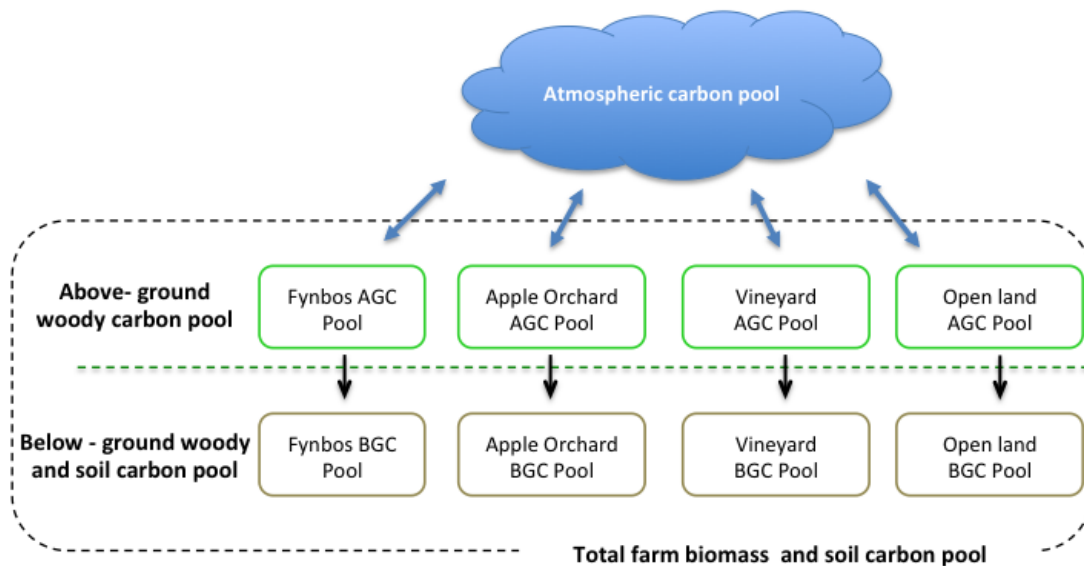
Considering carbon pools and flows over decades rather than individual trees

On a day-to-day basis plants absorb carbon dioxide during the process of photosynthesis. Most of it is released back into the atmosphere shortly thereafter through the process of respiration. A small fraction is however assimilated to form the 'building blocks' of plant matter. Biomass (or plant matter), be it in the form of living and dead plants or soil organic matter, is therefore generally between 42 to 45 percent carbon. Thus individual trees and plants form a temporary store of carbon which may be released back into the atmosphere at a later date, either through fire or when the biomass decomposes. The term "carbon sequestration" refers to such long-term storage of carbon in biomass, which has been derived from the atmosphere, for a period of 20 years or more.

When considering the long-term sequestration of carbon in biomass on a farm, it is impractical and often prohibitively expensive to track changes in the amount of carbon stored in each individual tree. On any particular farm, there may be new orchards that have younger trees that are growing and assimilating additional carbon each year, while other orchards may have reached maturity and are pruned back to the same size every year. Others orchards may have reached the end of their 20-30 year rotation and may be in the process of being removed and replanted. It is therefore appropriate to view the carbon stored in biomass as a system of pools and flows, rather than at the scale of individual trees.

The diagram illustrates an example of the main carbon pools and flows on a theoretical farm. The carbon stocks in individual plants have been bundled into 'pools' of carbon. For example, all the carbon stored in the apple trees in orchards on the farm has been bundled into a single 'apple orchard carbon pool'. The pool however, should not be seen as a static stock of carbon, but rather as a dynamic store with continual in- and out- flows of carbon. Despite the amount of carbon in the pool continually changing as a result of the growing cycle, the total size of the apple orchard carbon pool and the average carbon stock per hectare can be determined at a point in time.

The average amount of carbon stored in the carbon pool per hectare will differ based on the growth form and physical characteristics of commodity; for example vineyard compared to orchard, as well as the planting density, the size to which trees or vines are pruned, and rotation cycle. As a result, a farm can generally be separated into a number of distinct land-use types based on the size and nature of their carbon pool, for example, orchards, vineyards, grazing fields, bare land, fynbos, riverine thicket and so forth. This has been done in the diagram below, where the carbon in plant matter has been bundled into pools based on land-use or commodity types.



(The diagram of carbon pools and flows is a simplistic description for illustration purposes. A comprehensive illustration would include additional pools (e.g. litter) and flows (e.g. from soils back into the atmosphere).

It is also important to not only to view carbon pools at a larger spatial scale, but to also consider a time dimension. As already highlighted, in a particular season, there may be certain trees that are still growing to mature size, whereas others are getting pruned or removed at the end of their rotation. The amount of carbon accumulated in growing trees in a particular year would thus have to be adjusted by the amount of carbon released into the atmosphere at the end of the orchard’s rotation when attempting to calculate the net greenhouse gas emissions of the farm.

Focusing on the change in the carbon pool over one season may therefore not make sense and may be impractical from a measurement and account point of view. In the case of orchards where the rotation cycle of trees is 20-30 years, it would be appropriate to consider the average size of the carbon pool over that period. Over such a period, the net change in carbon pool of the orchard is essential zero or ‘neutral’. Alternatively, in the case of indigenous fynbos areas that burn on average once every seven years, one would estimate the average size of the carbon pool over a seven year period. Whereas there may be an occasional annual increase or decrease, the average size of the carbon pool should remain relatively constant unless the total area covered by the land-use type is changed or a different type of land-use is implemented.

When is there a case for additional carbon sequestration?

When considering potential additional sequestration, as described above, it may not be appropriate to focus on annual changes within a particular land-use. Larger scale changes in land-use type or management over longer time periods may be more appropriate. If for example, a manager decided to establish a new orchard on a previously farmed, barren area of land that would remain in place over several decades, it would be appropriate to measure and report on the average change in carbon stocks on that area of land. Alternatively, if it were decided to remove dense orchards from a section of a farm and replace it with vineyards, again there may be a considerable reduction in the average size of the carbon pool over the long term, which should be measured and accounted for.

Aside from complete changes in land-use or the commodity type being farmed, there may be alternative ways in which management can significantly change the size of either the above- or below-ground carbon pools over the long-term. For example, initial indications show that a change from conventional farming methods to an organic approach including *in-situ* composting and mulching, may lead to an increase in soil carbon from less than one percent to between two to four percent. Depending on the potential change in bulk density and the depth of the effect, this may lead to a significant increase in soil carbon stocks over the long-term. In addition to organic practices and in-situ mulching, the use of Biochar may lead to a gradual net increase in the size of the soil carbon pool over time as well as lead to better water infiltration, lower irrigation costs, enhanced soil fertility and improved soil properties. The magnitude of the benefits however is dependent on the particular type of Biochar, and the particular soils and crop under consideration. An initial introductory Biochar fact-sheet compiled by the CSIRO is attached to this document and a more in-depth review of the realities of Biochar implementation can be found at:

- <http://www.csiro.au/resources/Biochar-climate-change-and-soil.html>
- http://www.terraglobalcapital.com/press/Soil_Sequestration_Biochar_Issue_Paper1.pdf

In conclusion, the key issue when considering change in the biomass carbon stocks of a particular farm is to focus on larger scale changes in the average size of carbon pools over the long term rather than small scale and short-term fluctuations. If one is considering such a potential change in land-use type or management and would like further information on the particular change in carbon stocks that can be expected, please feel free to contact the Confronting Climate Change project team member Tony Knowles: tonyknowles@gmail.com, tel: 083 4156239.

