

## Appendix 2. Method for calculating time-averaged carbon stocks of a land-use system.

Time-averaged carbon for the different land-use systems at the ASB sites was calculated as follows: 1) calculation of the C accumulation rates ( $I_c$ ) for each land-use system based on the carbon stock and the average age of each system sampled, and 2) calculation of time-averaged C stocks for the duration (rotation time) of each land-use system based on the C accumulation rates and duration of each of the phases in that particular land-use system.

Carbon accumulation rates ( $I_c$ , t C ha<sup>-1</sup> yr<sup>-1</sup>) for fallow regrowth were determined according to the method described by van Noordwijk (ICRAF, 1996) where the average C stock value of the fallows sampled ( $C_s$ ) was divided by the average age ( $T_s$ ) of the plots sampled (Figure 2). It is assumed that the carbon increase rates ( $I_c$ ) are linear throughout the time period of fallow regrowth ( $T_f$ ). The carbon stored in fallows ( $C_m$ ) of specific ages ( $T_f$ ) can then be determined as:  $C_m = I_c * T_f$ . The time-averaged C stock for a crop-fallow system that has little time in the cropping phase and negligible C stored over that time is essentially the C stored in the fallow vegetation at the time of reclearing ( $C_m$ ) divided by 2 or the C accumulation rate ( $I_c$ ) time the number of years of fallow ( $T_f$ ) divided by 2 (Figure 2).

For tree crop plantations, however, the carbon accumulation rates may not be linear throughout the entire rotation age of the system. The system may reach a maximum carbon stock ( $C_{max}$ ) at a time ( $T_{max}$ ) before the end of the rotation ( $T_r$ ). As an example, a coffee plantation may reach the maximum carbon stock in 7 years but production continues for an additional 5 years, giving a rotation time ( $T_r$ ) of 12 years, at which time the plantation is cut and re-established. In such cases the C accumulation rate ( $I_c$ ) is determined by dividing  $C_{max}$  by  $T_{max}$ . This can only be determined if plantations that have reached maximum biomass have been sampled, and the age at which maximum biomass attained is known. For such systems, the time-averaged C stock for a land-use system is determined as the weighted average of the C stocks for the different phases of the rotation (Figure 3).

Calculation of the time-averaged carbon stock of the coffee plantation described above, with an establishment phase of 7 years to reach maximum biomass followed by 5 years of production before cutting and re-establishment will serve as an example (Figure 3). The values of  $I_c = 2.2$  t C ha<sup>-1</sup> y<sup>-1</sup> and  $T_{max} = 7$  were established from field data. The time-averaged C ( $C_{ta1}$ ) for the establishment phase is equal to:  $(I_c * T_{max})/2$  or 7.7 t C ha<sup>-1</sup> for the 7 years. The time-averaged C for the remaining production phase ( $C_{ta2}$ ) of 5 years is simply equal to  $C_{max}$  or 15.4 t C ha<sup>-1</sup>. The time-averaged C for the entire system rotation ( $LUSC_{ta}$ ) is the weighted average for the two phases:

$$[C_{ta1} * T_{max}] + [C_{ta2} * (T_r - T_{max})] / T_r = [53.9 + 77] / 12 = 10.9 \text{ t C ha}^{-1}.$$

It is possible to compare the time-averaged C stocks of the different land-use systems within a site to that of the forest as a simple fraction or percentage of the forest biomass. To make cross-site comparisons of the systems it is necessary to include the original forest biomass at each site.