Journal of the National Institute of Plantation Management, (2013),27(01)

CARBON SEQUESTRATION AND STORAGE POTENTIAL IN COCONUT PLANTATIONS

C S Ranasinghe[1]

One of the options to mitigate the effects of global warming (climate change) is to increase the sinks for Green House Gasses (GHGs). Coconut, being a perennial tree crop with 50-60 years of economic lifespan, has a potential to act as a carbon sink. However, little attention has been paid to collect scientific data on C sequestration potential and carbon stocks in coconut based systems. Therefore, studies were conducted at the Coconut Research Institute to fill this gap.

Carbon Sequestration Rate (net C Balance) (Mg C ha^{-1} month^{-1}):

The study estimated the net Carbon balance of 25 year old Tall x Tall coconut (*Cocos nucifera* L.) plantations under S_2 (highly suitable for coconut) and S_4 (moderately suitable for coconut) soils in wet (WL_3), intermediate (IL_{1a}) and dry (DL_3) agro-climatic conditions during periods with moderate rain fall (May to August) and heavy rainfall (October to January). Total carbon input (measured as Gross Primary Production of coconut, GPP), total carbon output (measured as plant and soil respiration, $R_{tot-eco}$) and net carbon balance of ecosystems were assessed.

Coconut plantations under all tested growth conditions have the potential to sequester carbonwhile the carbon sequestration rates were variable, depending on the agroclimatic and soil conditions (Table 1). On S_2, GPP (total C input) and $R_{tot-eco}$ (total C output) do not show a reduction from WL_3 to DL_3, whilst on S_4, only GPP shows a reduction from WL_3 to DL_3 in both seasons. The net C balance on S_4 reduces from WL_3 to DL_3 during the period of moderate rainfall whilst it does not reduce during the period of high rainfall. The net C balance on S_2 does not vary with the AER or season except the high C balance recorded by the plantation in DL_3 during heavy rainfall season. Accordingly, a 25 yr old Sri Lanka Tall plantation have the potential to sequester carbon in the range of 0.4-1.9 Mg C ha^{-1} month^{-1} which is equivalent to 17-80 MT of Carbon dioxide ha^{-1} yr^{-1} depending on the agro-climatic and soil conditions of the plantation.

Table 1: Summary Carbon balance of the ecosystems: GPP (Gross Primary Production, total C input to the system), palm, soil and total respiration of the ecosystem ($R_{tot-eco}$,total C output) and Carbon Sequestration Rate (CSR, net C balance) of Plantations under S_2 and S_4 LSC in WL_3, IL_{1a} and DL_3 AERs during May –Aug and Oct-Jan periods.

---

[1] Plant Physiology Division, Coconut Research Institute, Lunuwila

AER	LSC		May -Aug	Oct-Jan
WL_3	S_2	GPP (Mg C ha^{-1} $month^{-1}$)	2.310±0.25	2.370±0.34
		Palm Resp (Mg C ha^{-1} $month^{-1}$)	0.782±0.06	0.777±0.06
		Soil Resp (Mg C ha^{-1} $month^{-1}$)	0.778±0.03	0.665±0.01
		$R_{tot-eco}$ (Mg C ha^{-1} $month^{-1}$)		
		CSR (Mg C ha^{-1} $month^{-1}$)	**0.896±0.30**	**0.928±0.32**
	S_4	GPP (Mg C ha-1 $month^{-1}$)	2.880±0.19	2.690±0.15
		Palm Resp (Mg C ha^{-1} $month^{-1}$)	0.637±0.02	0.726±0.03
		Soil Resp (Mg C ha^{-1} $month^{-1}$)	0.298±0.06	0.202±0.01
		$R_{tot-eco}$ (Mg C ha^{-1} $month^{-1}$)	0.936±0.04	0.928±0.03
		CSR (Mg C ha^{-1} $month^{-1}$)	**1.94±0.17**	**1.762±0.20**
IL_{1a}	S_2	GPP (Mg C ha-1 $month^{-1}$)	2.070±0.17	2.649±0.22
		Palm Resp (Mg C ha^{-1} $month^{-1}$)	0.661±0.08	0.833±0.04
		Soil Resp (Mg C ha^{-1} $month^{-1}$)	0.814±0.03	0.940±0.01
		$R_{tot-eco}$ (Mg C ha^{-1} $month^{-1}$)	1.475±0.08	1.773±0.05
		CSR (Mg C ha^{-1} $month^{-1}$)	**0.595±0.21**	**0.876±0.18**
	S_4	GPP (Mg C ha-1 $month^{-1}$)	2.08±0.19	2.396±0.27
		Palm Resp (Mg C ha^{-1} $month^{-1}$)	0.811±0.06	0.810±0.05
		Soil Resp (Mg C ha^{-1} $month^{-1}$)	0.751±0.02	0.701±0.01
		$R_{tot-eco}$ (Mg C ha^{-1} $month^{-1}$)	1.562±0.06	1.510±0.05
		CSR (Mg C ha^{-1} $month^{-1}$)	**0.518±0.25**	**0.896±0.23**
DL_3	S_2	GPP (Mg C ha-1 $month^{-1}$)	2.040±0.14	2.958±0.25
		Palm Resp (Mg C ha^{-1} $month^{-1}$)	0.958±0.04	0.916±0.04
		Soil Resp (Mg C ha^{-1} $month^{-1}$)	0.349±0.02	0.576±0.02
		$R_{tot-eco}$ (Mg C ha^{-1} $month^{-1}$)	1.307±0.03	1.492±0.05
		CSR (Mg C ha^{-1} $month^{-1}$)	**0.733±0.27**	**1.466±0.29**
DL_3	S_4	GPP (Mg C ha-1 $month^{-1}$)	1.190±0.08	1.963±0.22
		Palm Resp (Mg C ha^{-1} $month^{-1}$)	0.473±0.05	0.466±0.05
		Soil Resp (Mg C ha^{-1} $month^{-1}$)	0.303±0.03	0.343±0.01
		$R_{tot-eco}$ (Mg C ha^{-1} $month^{-1}$)	0.789±0.08	0.809±0.03
		CSR (Mg C ha^{-1} $month^{-1}$)	**0.401±0.19**	**1.154±0.21**

Carbon Sequestration and Storage

Values are means ± standard error of means.

Carbon Stocks (Mg C ha^{-1}):

The C stocks of the same plantations were measured. On S_2, the C stock in above-ground biomass of coconut palms (B_{palm}) does not reduce from WL_3 to DL_3. However, on S_4, B_{palm} is greater in IL_{1a} which has intermediate moisture availability compared to other two AERR. The values of B_{palm} vary between 17 and 25 Mg C ha^{-1} depending on the growth condition and coconut stem is found to be the main C storage organ which stores about 56-70% of the total C stock of palms (Fig 1).

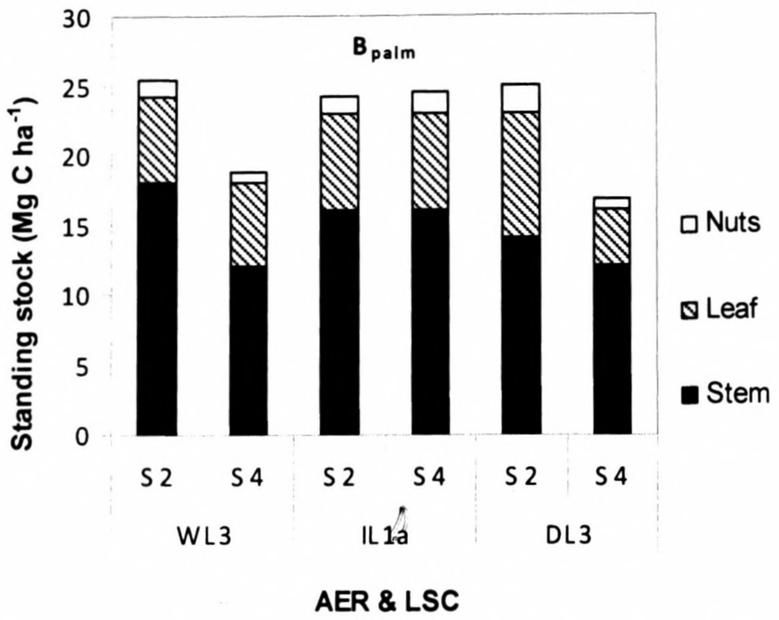

Fig 1: C stock of coconut palms (B_{palm}) (Mg C ha^{-1}) in terms of its components (stem, leaf, nuts) of a coconut-grass system on S_2 and S_4 land suitability classes in WL_3, IL_{1a} and DL_3.

Total C stock in the top soils (0-20 cm depth) (B_{soil}) of the coconut-grass system reduces from WL_3 to DL_3 and from S_2 to S_4, though the magnitude of difference between S_2 and S_4, vary with the AER. Furthermore, B_{soil} is lowest in DL_3, irrespective of the LSC, compared to the respective values in $WL_3$and IL_{1a}. The values of B_{soil} in a coconut-grass system vary between 14 and 44 Mg C ha^{-1} depending on the growth condition (Fig 2).

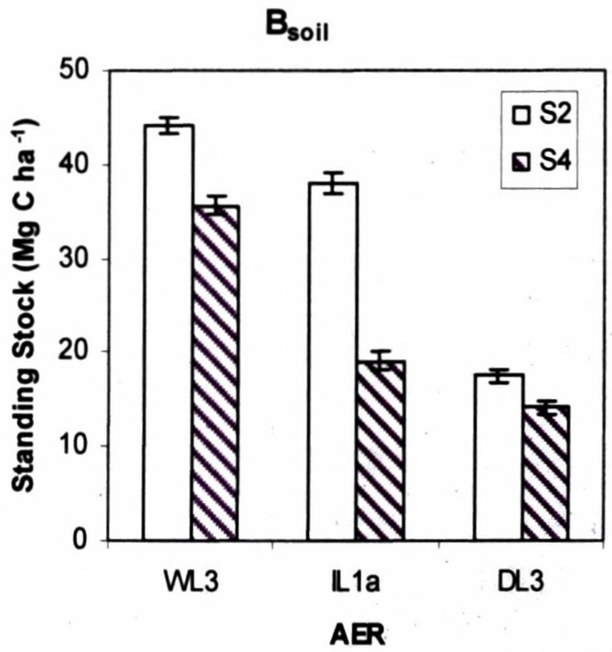

Fig 2: C stock (Mg C ha^{-1}) in top soil (B_{soil}) of a coconut-grass system on S_2 and S_4 land suitability classes in WL_3, IL_{1a} and DL_3 (values are means ± std. error of mean).

Consequently in a coconut-grass system the total ecosystem carbon stock ($B_{tot-eco}$) reduces along a decreasing moisture gradient from WL_3 toDL_3 and decreasing soil fertility gradient from S_2 to S_4. $B_{tot-eco}$ vary between 32 and 72 Mg C ha^{-1} and this wide range is mainly attributed to variations in agro-ecological condition of the region, physical, chemical and biological factors of soils therein resulting differences in palm growth, litter production and litter decomposition (Fig 3).

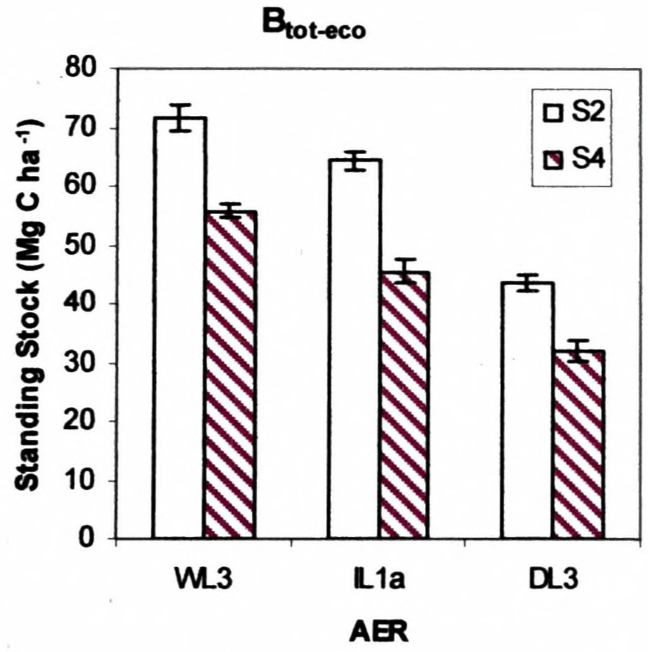

Fig 3: The totalecosystem C stock ($B_{tot-eco}$) (Mg C ha^{-1}) of a coconut-grass system the total on S_2 and S_4 land suitability classes in WL_3, IL_{1a} and DL_3 (values are means ± std. error of mean)

Since coconut stem is the main component in terms of long-term C storage in coconut palms, potential of C storage in coconut stem with age was estimated on S_2 soils in the intermediate dry zone (IL_{1a}). The study revealed that coconut plantations (monocrop) on suitable soils (S_1-S_2) with correct density (160 palms per ha) have the potential to store up to 40 Mg C per ha^{-1} until their age of maturity at a rate of about 3.25 Mg C ha^{-1} yr^{-1} from four years up to about 65 years of age (Fig 4).

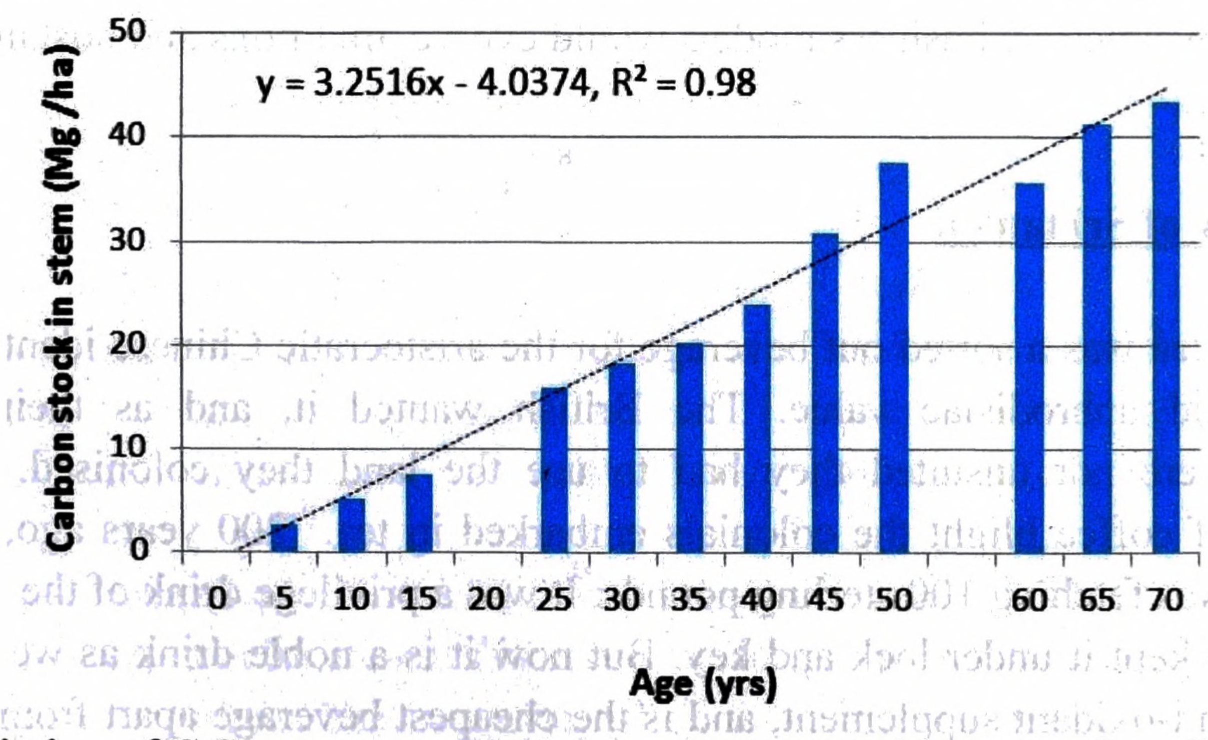

Fig 4: Variation of C Storage potential of coconut stem with age on S_2 soils in IL_{1a}

C sequestration potential of coconut plantations (eco-system) may vary with the age of plantation, cover crop, inter-crop, variety, type of management etc. Therefore, if the data of C sequestration rates are available for series of coconut-based eco-systems, the eco-systems with higher carbon sequestration indices can be screened for each land use and those can be prioritized in new planting programmes.