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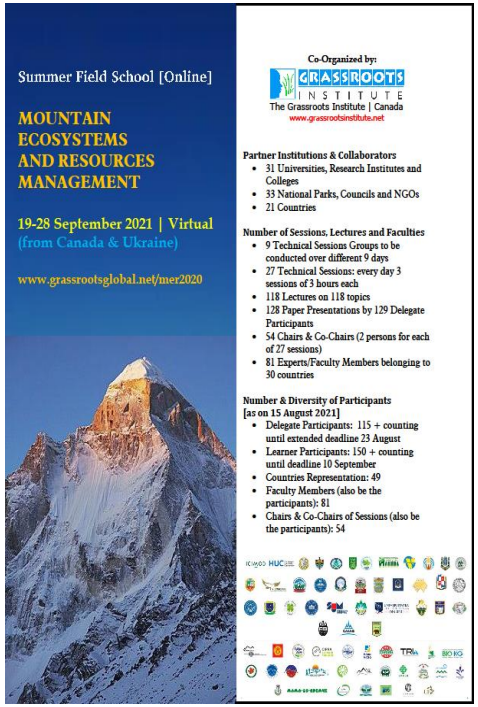

Impact of removal of rubber plantation – high altitude ecosystem for urbanization on CO_2 mitigating capacity by loss of carbon sink.

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INTRODUCTION

- Urbanization is aggressive now a days for the purpose of developmental activities. Most of the agricultural areas, especially rubber plantations undergoes construction activities.

- Among the green house gases (GHG's), the major portion contributes by carbon dioxide (CO 2).

- The vegetation especially big trees in the form of plantations and forests acting as large sink of carbon by the fixation of atmospheric carbon in its biomass by the process of photosynthesis (Anjali *et al*. 2020).

- Urban development and the resultant removal of land becoming a cause for near future loss of carbon storage (Sallustio *et al*. 2015) which exponentially increasing the CO2 in the atmosphere, GHG's and global warming if the land take is in the form of tree plantations.

- Rubber tree (*Hevea brasiliensis*), the major source of natural rubber and economic returns is a long duration (25-30 years) quick growing immature phase upto seven years having high biomass (1.2t/tree) accumulation.

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- **The carbon sequestration capacity of natural rubber plantation reported - 142 t/ha (RRII 105) in tree biomass and 23 t/ha in the soil (Jacob, 2003).**

- **Karthikakutty amma (1997) studied the biomass accumulation of clone RRII 105 at 20 years age which accounts 192 t/ha C in the dry biomass.**

- **Jessy (2004) estimated the biomass of the clone PB 217 at 19 years and this comes to 155 t/ha C.**

- **Annamalainathan *et al* (2011) reported rubber plantation is a potential sink for sequestration of atmospheric CO_2 .**

- **The carbon sink loss by removal of rubber plantation was not estimated.**

- **The present study was an estimate of carbon sink loss by the removal of rubber plantation for urbanization in the scenario of CO_2 mitigating capacity of tree plantations.**

Results & Discussion

Table 2. Biomass, carbon stock (kg tree^{-1}) / carbon sink loss (t ha^{-1}) of RRII 400 series clones at 23 years age at RRII

Clone	Total dry biomass (kg tree^{-1})	C- stock/tree (kg tree^{-1})	C- sink loss by tree removal (t ha^{-1})
RRII 414	736	302	106
RRII 430	419	172	60
RRII 429	793	325	114
RRII 417	713	292	102
RRII 422	377	154	54
RRII 105	407	163	57
CD	41.35	14.47	5.06

Adopted from Ambily *et al*, (2012)

Table 2. Biomass, C- stock (kg tree^{-1}) and C- sink loss (t ha^{-1}) of RRII 400 series clones (20 years) in diverse environments

Clone	Total dry biomass(kg/tree) (Above ground)			Carbon stock (kg/tree)			Carbon sink loss by tree removal (t/ha)		
	PD	CES	KK	PD	CES	KK	PD	CES	KK
RRII 414	346.1 ±29.1	627.6 ±47.8	427.8 ±29.1	145.3 ±7.2	263.6 ±20.1	179.7 ±12.9	50.9 ±2.5	92.3 ±7.1	62.9 ±4.26
RRII 430	290.8 ±13.6	472.7 ±32.5	319.6 ±13.6	122.1 ±2.1	198.5 ±13.6	134.3 ±5.7	42.7 ±0.7	69.5 ±4.8	47.1 ±2.1
RRII 429	290.7 ±109.3	695.8 ±26.6	598.1 ±109.3	122.1 ±6.6	292.3 ±11.2	251.2 ±45.9	42.8 ±2.3	102.87 ±3.9	87.9 ±16.1
RRII 417	327.6 ±37.9	615.8 ±40.3	448.2 ±37.9	137.6 ±9.2	258.6 ±41.4	188.3 ±15.9	48.2 ±3.2	90.5 ±5.92	65.9 ±5.6
RRII 422	281.7 ±40.5	515.3 ±20.3	406.7 ±40.5	118.3 ±8.9	216.4 ±8.5	170.8 ±17.1	41.4 ±3.2	75.8 ±2.98	59.8 ±5.95
RRII 105	285.1 ±20.9	465.63 ±24.3	412.1 ±20.9	119.7 ±6.3	195.8 ±10.9	173.1 ±8.8	41.1 ±2.2	57.9 3.05±	58.7 ±4.52

*PD- Padiyoor(North); CES- Chethackal(Central); KK- Kanyakumari(South); ± mean SE

Table 4. Biomass, C- stock (kg tree^{-1}) and C- sink loss (t ha^{-1}) of RRII 203, GT 1 & RRII 105 at 30 years age at CES Chetackal.

Clone	Total dry biomass (Above-ground) kg/tree)	Carbon stock/tree	Carbon sink loss by tree removal (t/ha)
RRII 105	1254	527	148
RRII 203	1140	479	138
GT 1	2045	860	258
Mean	1479.7	622	188
SE	285.1	119.9	31.8

Adopted from Ambily and Ulaganathan, 2015) ± SE

Table 5. C- sink loss from soil (t ha^{-1})

Depth (cm)	Average SOC (%)	Bulk density	Carbon sink loss from soil (t ha^{-1})
0-30	1.2	1.2	43.2
„	1.5	„	54.1
„	2.0	„	72.2
Average			56.5

Table 6. Annual C- sink loss (t ha^{-1}) through litter fall in rubber plantation

Annual litter fall (t ha^{-1})	Carbon content (%)	Carbon addition Annual litter fall (t ha^{-1})	Total carbon sink loss from litter fall (t ha^{-1})	
			(23 years)	(30 years)
Range - 5-6*	42.8	2-3	46-69	60-90
Average(5.5)		(2.5)	(57.5)	(75)

*Adopted from Philip *et al* (2005); values in parenthesis are average values

Table 7. Annual C- sink loss (t ha^{-1}) through rubber sheet

Carbon content (%) (sheet rubber)	Sheet rubber production (t/ha/year)	Carbon stock in sheet rubber (t/ha/year)	Total carbon stock/sink loss from sheet rubber(t/ha)	
			23 years	30 years
85.38*	3.2	2.7	43.2	62.1

*Adopted from Jacob (2003)

Table. 8. Total carbon sink loss from the removal of one hectare rubber plantation (RRII 105)

Carbon sink sources	Carbon content (%)	Carbon stock (t/ha)	Carbon sink loss 23 years (t/ha)	Carbon sink loss 30 years(t/ha)
Tree biomass	42	57	57.0	148
Soil	1.2	56.5	56.5	56.5
Litter fall	42.8	2.5	57.5	75.0
Rubber sheet	85.38	2.7	43.2	62.1
Total	-	-	214.2	341.6

Soil carbon stock – Soil carbon taken generally for both years.

Conclusion

- **The observations from the study pointed out the serious carbon sink loss from the removal of rubber plantation for urbanization, one of the major development activities which is causing damages of the self-sustained carbon friendly and economically sound perennial rubber ecosystem.**

- **The present popular clone (RRII 105) existing in major share (85 %) of the total rubber cultivation in India accounts carbon sink loss 57t/ha , 57.5t/ha, 43.2t/ha for 23 years and 148t/ha, 75t/ha and 62.1t/ha from biomass, litter fall and sheet rubber respectively.**

- **The total C-sink loss is 214.2t/ha for 23 years and 341.5t/ha for 30 years**

- **The establishing modern clones RRII 414, RRII 429 and RRII 417 having higher growth rate and biomass recorded still higher (44-50 per cent) carbon sink loss compared to the existing popular clone RRII 105.**

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- **The carbon sink loss in the form of stored carbon in soil is 56.5 with soil carbon content between 1.2 to 2 per cent.**

- **Due to the growth variation in extreme climatic conditions, the clones recorded differences in carbon stock and thereby carbon sink loss.**

- **Among this the central region of Kerala (CES-Chethackal) showed higher loss and lower loss was in the drought affected northern region (Padiyoor) than Kanyakumari region.**

Recommendation

- **The implications of the study pointed out the loss of huge reservoir of carbon in tree crop ecosystem and environment issues related to CO_2 mitigating capacity.**

- **It implies the need of close and strategic policies to the removal of long duration tree plantations with higher carbon sequestration potential especially in high altitude to maintain the environment sustainability.**

- **Also maintenance of simulated tree ecosystems with biodiversity rich and economically feasible green spaces must be a policy decision during urbanization.**

- **Maintenance of green spaces/areas including vegetation having higher C-sequestration potential and trees having higher lignin content to increase carbon capture for mitigating the impact of removal of plantations to some extent in the scenario of inevitable developmental activities and urban developments.**

Thank you