"Bandung … Uniting The tea world
For sustainable future"

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Carbon Sequestration Rate of Tea Plantations

by

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Introduction and Focus

•Environmental issues – Climate Change (CC) increasingly important.

•CC influences many sectors of the Sri Lankan economy including plantation agriculture

→ **Extreme weather events**.

Heavy rainfall

Severe droughts

- Greenhouse gases (GHGs) in the atmosphere, mainly CO_2, is the principal cause of global warming and CC.

- Solving CC problem
  → reducing and stabilizing GHGs to a level that prevents dangerous anthropogenic interference with the climate system

- Reducing GHGs in atmosphere →
  - one of the fastest,
  - most significant
  - and cost-effective options for slowing down CC

Carbon sequestration:

- The removal and storage of carbon from the atmosphere in carbon sinks (such as oceans, forests or soils) through physical or biological processes

- CO_2 concentration in atmosphere → reduced

⬇

Adverse impacts of CC would be minimized

Types of C Sequestration:

1. Geologic Sequestration:
2. Ocean Sequestration:

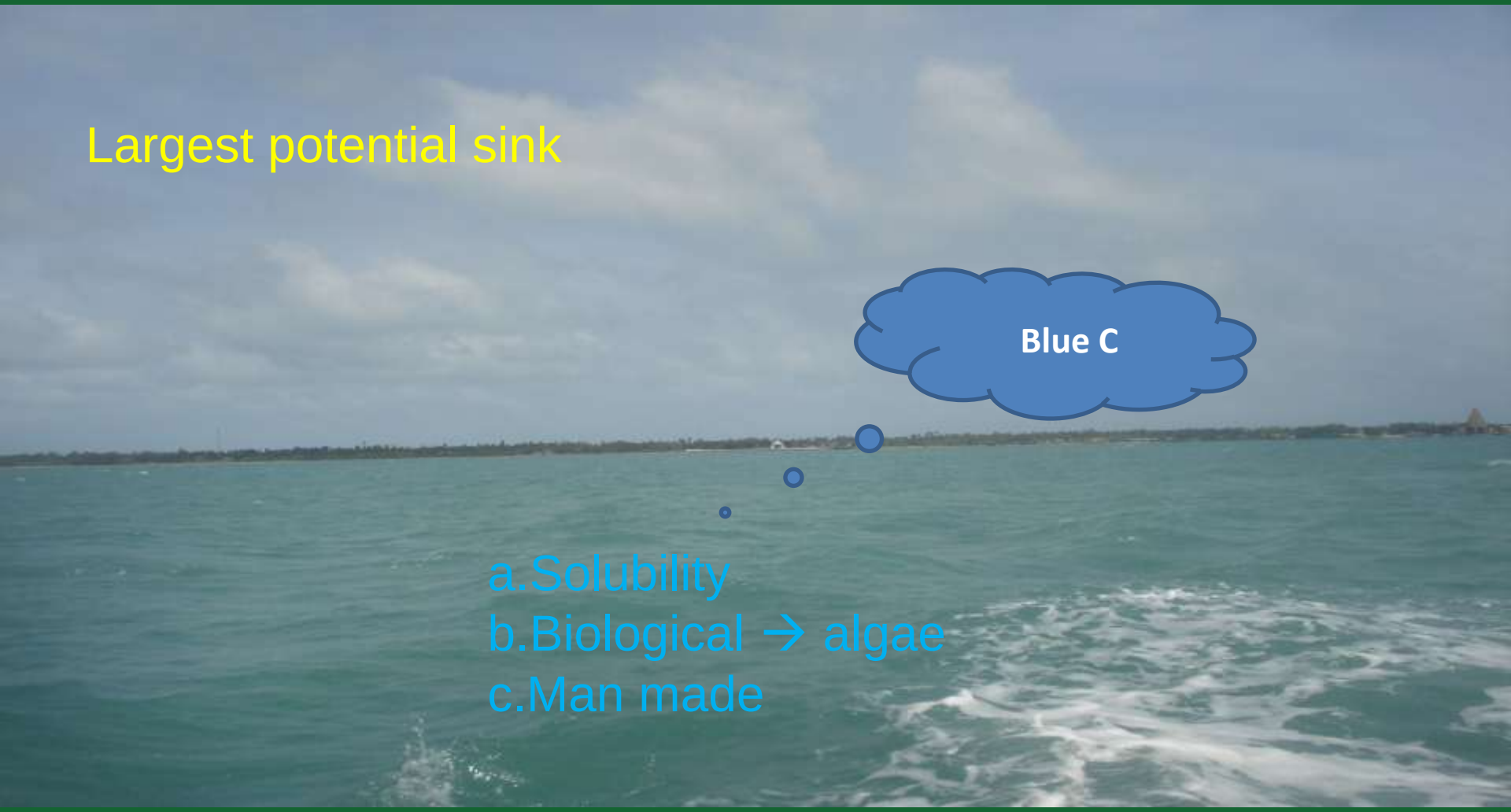
3. Terrestrial Sequestration

Significant opportunity to reduce CO_2 and obtain additional benefits

Geologic Sequestration

- Underground in rock formations
- Involves injecting carbon dioxide deep underground

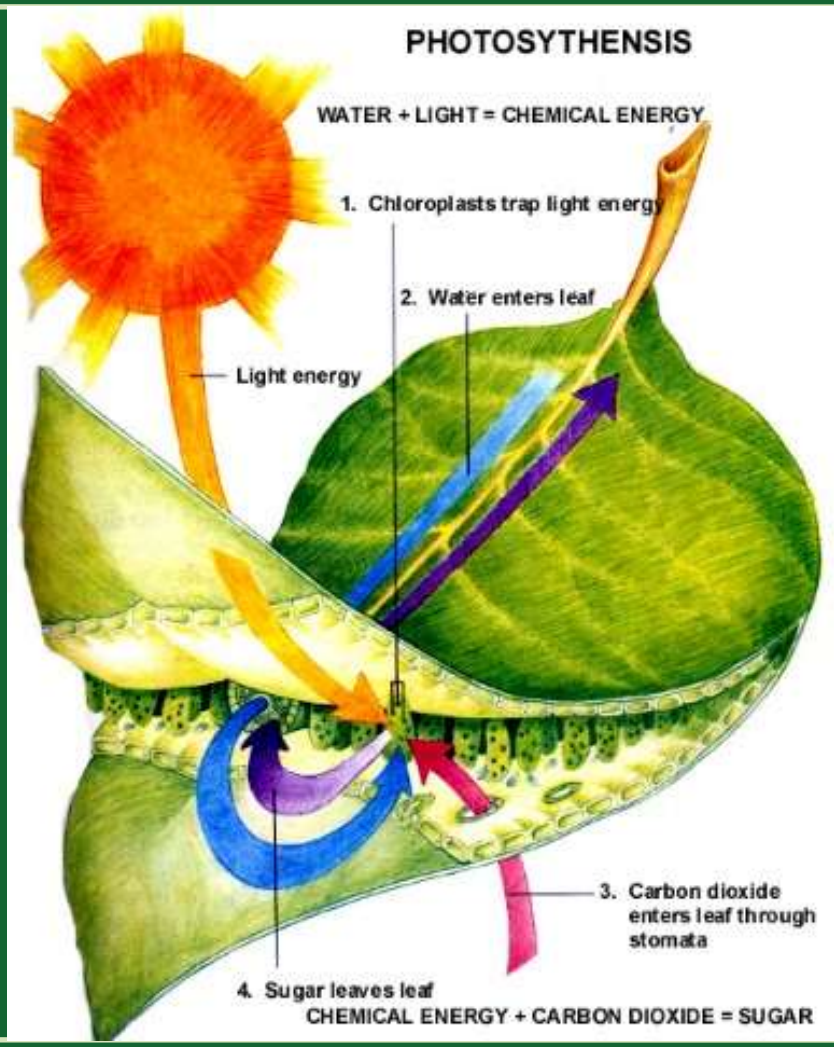
Ocean Sequestration



Terrestrial sequestration

a.Biosphere
b.Soil

Green C



Current Trend

- Information on carbon sequestration → already generated for
  several land use types
  plant species

- Such experiments continue
  to gain more attention
  &
  high priority among the other areas of research

due to the urge of the global trend

C Sequestration of different plants

Vegetation type	C sequestration (Mg of C $ha^{-1}yr^{-1}$)	Reference
Teak	1.1 - 466.4	Abayasiri & Ranasinghe, 2000
Mesic Savannas	2.8	Williams *et. al*., 2004
Silver oak	2.09	Niranjana & Viswanath, 2005
Rubber plantations	7.69	Tillekeratne, 2007
Shaded Coffee plantations	5.3	http://www.coffeehabitat.com, 2008
Smallholder Agroforestry Systems	1.5 - 3.5	http://www.coffeehabitat.com, 2008
Coconut plantations	4.8 – 22.8	Ranasinghe and Thimothias, 2012

•Tea industry contributes a major share to the Sri Lankan economy,

In year 2013 contributed 0.9% of GDP
annual production around 340 million kilograms
US dollars 1.5 billion foreign exchange earning

it is important to estimate the impacts of climate change and take precautions to minimize its adverse effects.

•Also it is necessary to find way forward for a greener industry.

Payments for Environmental Services (PES)

•Payments for Environmental Services (PES) is an emerging concept

•PES →designed to provide economic compensation for the services supply to society including:

carbon sequestration,
biodiversity conservation,
scenic beauty,
and watershed protection etc.

•C sequestration is an environmental service which helps to minimize the environmental risks while leading to sustainable development

Worthwhile to investigate the C sequestration capacity

&

Generate the baseline data

Proper documentation in REDD+

(i.e. efforts to Reduce Emissions from Deforestation and forest Degradation, and promote conservation, sustainable management of forests, and enhancement of forest carbon stocks)

&

GHG Inventory

Additional income for Environmental Services of Tea Plantations

Tea Plantations

High Shade

Medium Shade

Community of tea plantations

+

External Environment

Ecosystem

The magnitude of the C sequestration depends on:

- Plant physiological characteristics
  - rate of growth,
  - growth stage,
  - age etc.
- Environmental parameters
  - availability of soil moisture and nutrients,
  - temperature (both atmospheric as well as soil),
  - solar radiation,
  - rainfall
- Managerial aspects
  - planting density,
  - pruning, coppicing and pollarding etc

C sequestration of tea plantations

- Less compared to natural forest species

Way forward

- Tea plantations as a community

- Resemble natural forests:
  - Tea plants
  - Shade trees
  - Wind belts, weeds etc

Biological CO_2 scrubbers

- Contribution of these species to store atmospheric CO_2 :
  Great importance to mitigate global climate change

- Very little reliable information on C sequestration of tea and these tree species

Case study in Sri Lanka

➢ Site selection

Representative samples :

- ❑ tea growing region
  - ▪LC
  - ▪MC
  - ▪UC

  } Main stratum

- ❑ Genotype
  - ▪ Seedling
  - ▪ VP

  } Sub stratum

❖ Stratified Random Sampling

➢IPCC Stock Change Method, 2000

Initial sampling in 2009

Final sampling in 2012

} C gain rate per unit area

Community of tea Plantations

tea + high shade + medium shade

C sequestration of tea plants





C sequestration of shade trees

Allometric equations using CBH

C content = Biomass content *50%

(De Costa et al., 2008)

Shade tree species	Allometric equation	Reference
Grevillea robusta		Jangra et al., 2010
Branches	$\log_{10}Y = -1.9583+1.9585 \log_{10}X$	
Bole	$\log_{10}Y = -0.2055+1.221 \log_{10}X$	
Roots	$\log_{10}Y = -0.5337+1.2607 \log_{10}X$	
Albizia moluccana	$Y=EXP\{[2.591*\ln D]-3.003\}$	Dharmaparakrama, 2006
Gliricidia sepium	$Y=5.079*e^{(0.151D)}$	Dharmaparakrama, 2006
Erythrina lithosperma	$Y=8.8087*e^{(0.1087*D)}$	Dharmaparakrama, 2006

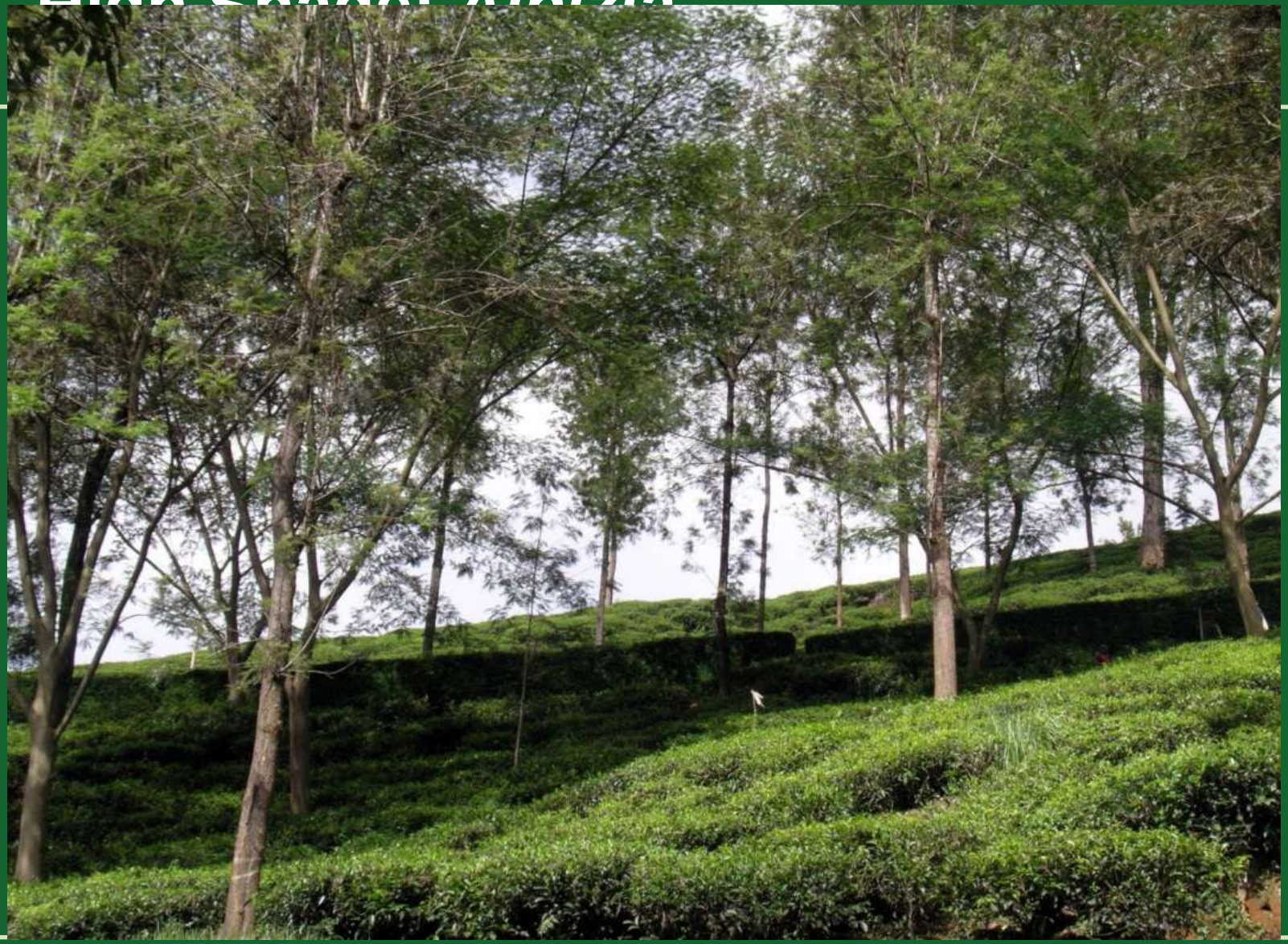
Data Analysis:
SAS v9
ANOVA
DNMRT

Calculation of C sequestration potential

Plant Species	Management
Camellia sinensis	Recommended practices of the TRISL
Grevillea robusta	
Albizia moluccana	
Gliricidia sepium	
Erythrina lithosperma	

High Shade: *Albizia*

12 years



High Shade: *Grevillea*

30 years

Medium Shade: *Gliricidia*

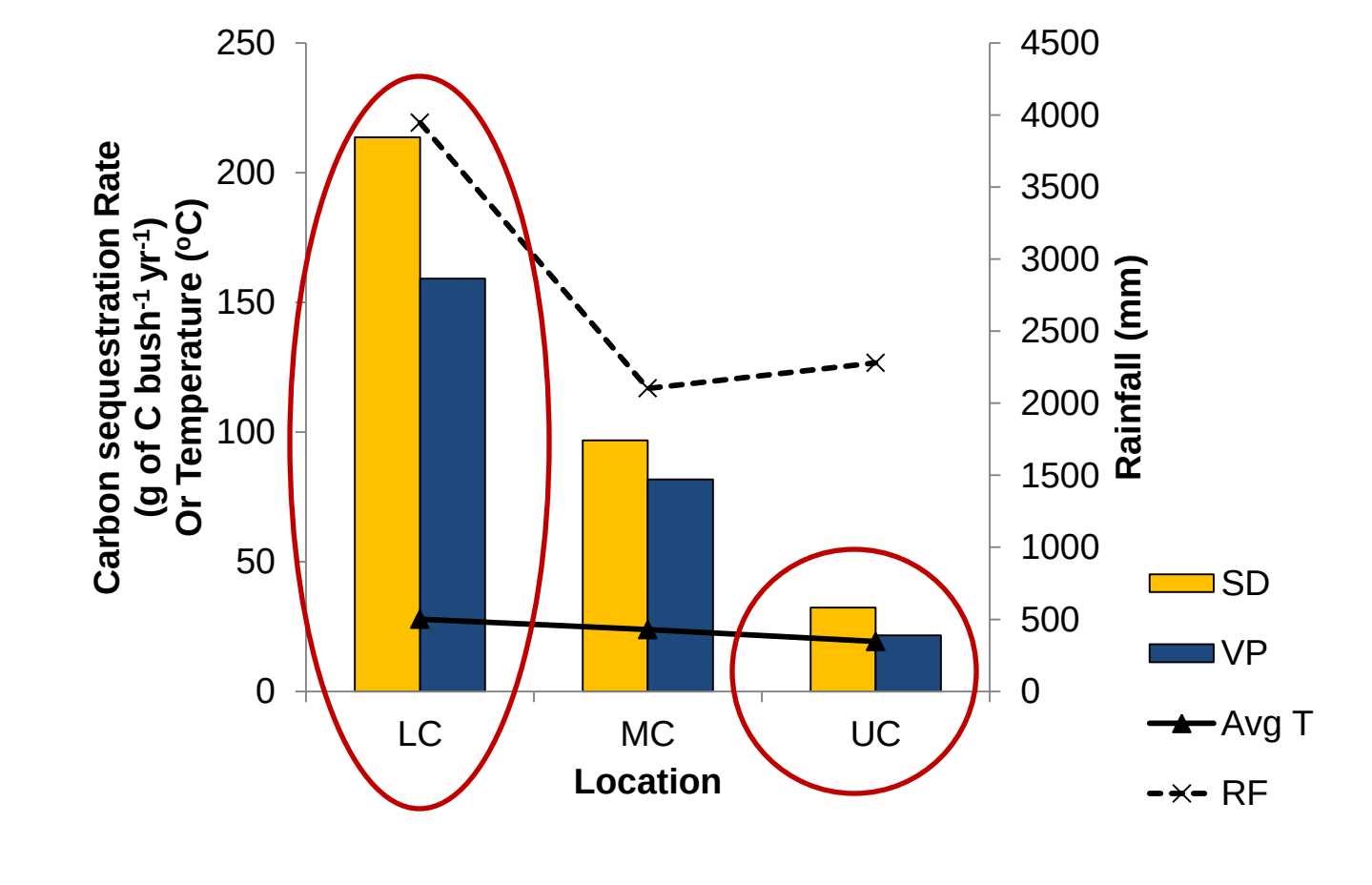
20 years

Medium Shade: *Erythrina*

20 years


Results

Per plant C sequestration of tea



RGR followed the same pattern of variation

Differences in biomass partitioning between SD and VP tea

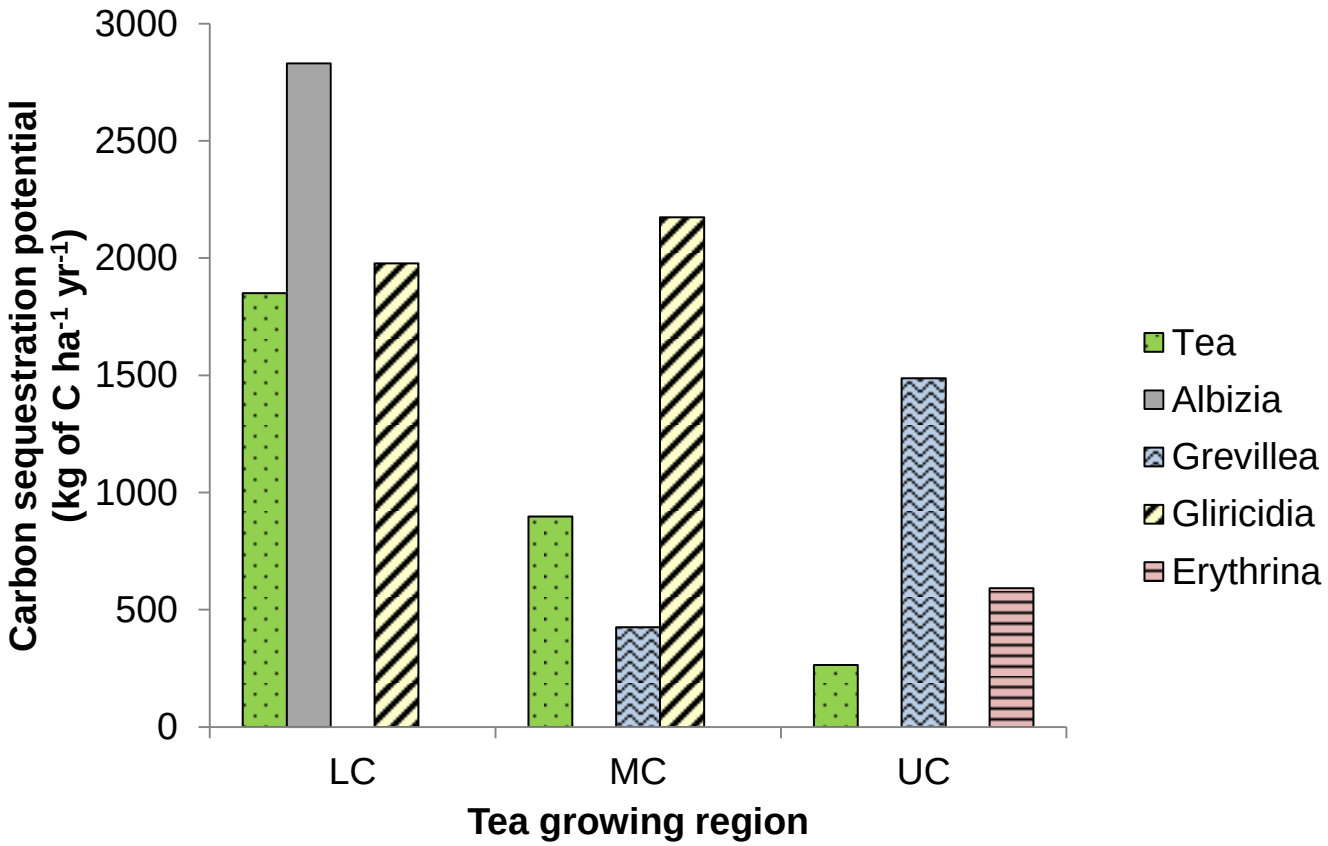
C sequestration potential of tea without shade trees

Location	Type of tea	Bush densities (# of bushes ha^{-1})	Adjusted C gain Rate (g $bush^{-1}$ yr^{-1})	C sequestration (kg ha^{-1} yr^{-1})
LC	SD	8000	213.6	1708.8
LC	VP	12500	159.3	1991.3
MC	SD	8000	96.9	775.2
MC	VP	12500	81.6	1020.0
UC	SD	8000	32.4	259.2
UC	VP	12500	21.6	270.0

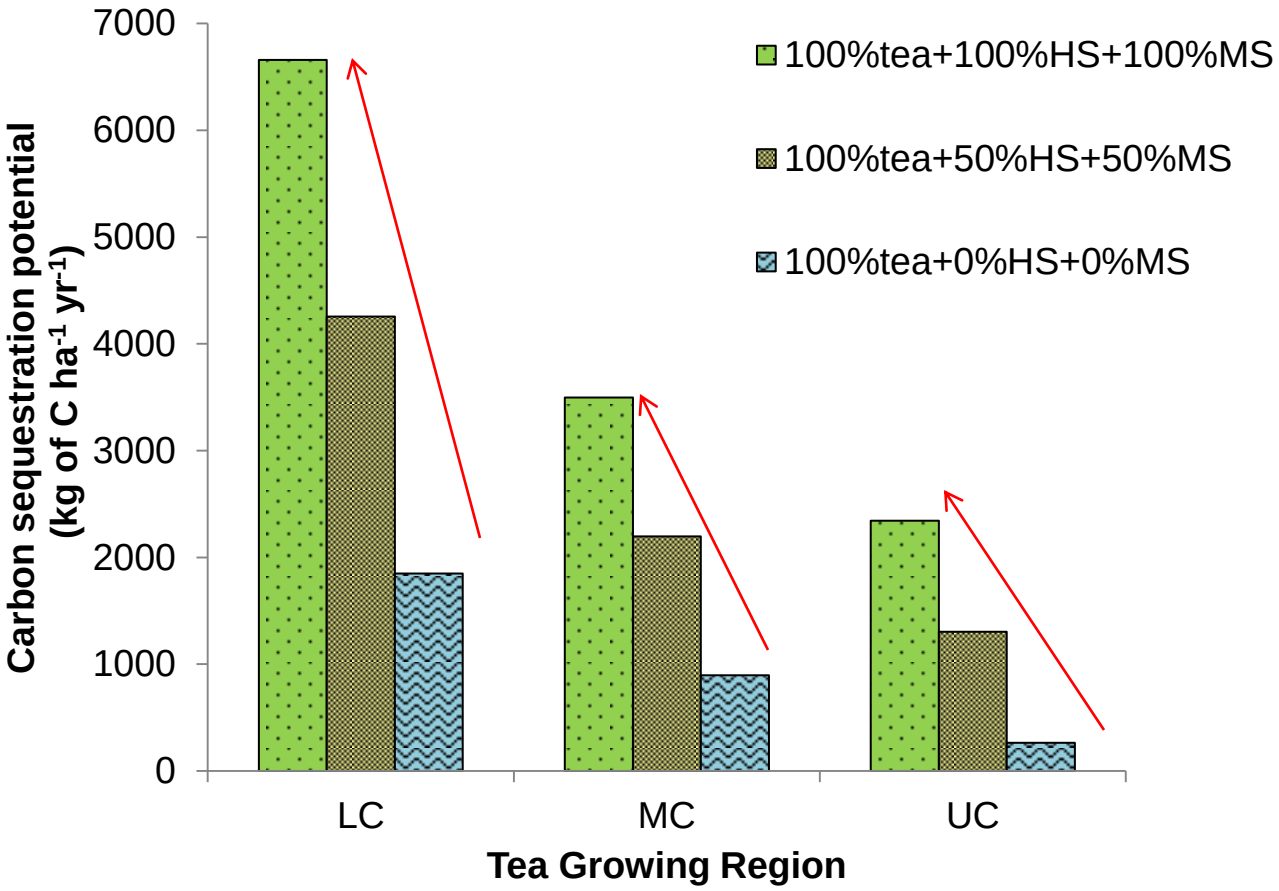
Calculation of C sequestration potential

Plant Species	Plant density (No. of plants ha^{-1})		Region used for the calculation
Camellia sinensis	SD	VP	LC, MC and UC
	8000	12500	
Grevillea robusta	62		MC and UC
Albizia moluccana	62		LC
Gliricidia sepium	208		LC and MC
Erythrina lithosperma	208		UC

C sequestration potential of different trees in a tea plantation community



C sequestration potential of tea lands with varying density of shade trees



Future scenario

Crop simulation model predictions

LC tea yields → negatively affected

Obtaining additional income for C sequestration via PES

Will help to compensate the yield lose

Tea industry remain as a profitable venture

Tea plants accumulate less biomass carbon than the other C3 crops, when considering as a

community;

based on their

management,

the extent of cultivation

&

the duration of the availability in the field,

the C sequestration ability of tea plantations

→considerable importance in a greener economy.


THANK YOU!!!