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A Guava-Based Hortipasture System for Mitigating Climate Change and Sustaining Fodder & Fruit Supply in Semi-Arid Regions of India

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Presenter Information

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A guava-based hortipasture system for mitigating climate change and sustaining fodder & fruit supply in semi-arid regions of India

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Abstract

Hortipasture systems have huge potential to mitigate climate change via sequestering carbon along with sustaining fodder and fruit supply especially in semi-arid regions. Therefore to evaluate climate change mitigation, fruit and fodder production potential of 10 year old rainfed based Hortipasture system (*Psidium guajava* (Guava) + *Cenchrus ciliaris* + *Stylosanthes hamata*) established at Central Research Farm of ICAR-Indian Grassland and Fodder Research Institute (Bundelkhand region, Jhansi, Uttar Pradesh, India), carbon stock of tree and under storey pasture components was quantified along with fruit and forage production. The experimental site is drought prone semi arid region characterized by poor soil quality, harsh climate and erratic rainfall. Two cultivars of Guava (Lalit and Shweta) integrated with *C. ciliaris* + *S. hamata* were pruned to enhance fruit yield of 10 year old trees. The Cv. Lalit produced higher (10.40 %) fruit yield compared to Shweta and medium pruned trees produced highest fruit yield (Lalit: 15.46 t ha^{-1} & Shweta: 14.87 t ha^{-1}) compared to unpruned and highly pruned trees. The under storey pasture production (*C. ciliaris*+ *S. hamata*) was 5.6 t DM ha^{-1}. Total tree carbon stock in Guava ranged between 7.92 to 11.34 t ha^{-1} (Cultivar: Shweta-10.24 t $ha^{-1}$and Lalit-9.20 t ha^{-1}). Under storey pasture carbon stock ranged from 4.26 t ha^{-1} to 4.43 t ha^{-1}. Total carbon stock potential of system (in biomass) ranged from 12.23 t ha^{-1} to 15.77 t ha^{-1} with 78.90−84.70 % and 15.30−21.10 % contribution of above and below ground biomass respectively to total carbon stock. Therefore in semi arid regions of India, where 90% of people depend on livestock for their livelihood security, establishment of Guava + *C. ciliaris*+ *S. hamata* based hortipasture system can enhance economic returns of the farmers and mitigate climate change via carbon sequestration in biomass leading to the offsetting of green house gases emission from livestock sector.

Introduction

Semi-arid regions in India are facing critical challenges of poverty, malnutrition, low livestock productivity, quality fodder shortage, erratic as well as low rainfall, land degradation and top soil loss. Moreover, 90% people in the region depend on livestock for their livelihood and these regions are also very fragile as well as sensitive to climate change (Singh et al., 2018). Thus, intervention in the form of hortipasture is required to supply quality and nutritionally rich fruits; fodder to livestock, mitigate climate change via sequestering huge amount of atmospheric carbon dioxide and enhance economic status of people. Besides this, horti-pasture systems are capable of restoring the degraded lands of semi arid regions (Kumar et al., 2019).

Three species were selected for establishing a hortipasture system suited to the semi-arid conditions of central India: guava (*Psidium guajava* L., a highly nutritious, fruit-yielding and hardy tree species); the fodder grass *Cenchrus ciliaris* (buffel grass); and fodder legume *Stylosanthes hamata* (Caribbean stylo). The system was studied for its fruit production, under-storey fodder production and carbon sequestration potential. In its 10^{th} year, the hortipasture was assessed with three pruning treatments to document its pasture production, fruit production and carbon sequestration potential.

Methods and Study Site

A study to find out fruit yield, under storey pasture yield and biomass carbon sequestration potential of 10 years old Guava based hortipasture was carried out during the year 2018. The guava-based hortipasture was established at central research farm (longitude 25^0 26’ 08” N, latitude 78^0, 30’ 21” E and altitude 216 m above msl) of the ICAR-Indian Grassland and Fodder Research Institute during October, 2007. Guava cultivars Shweta and Lalit were planted in a 6 m x 6 m arrangement with each plot (12 m x 36 m) having 12 trees (6 trees Shweta and 6 trees Lalit) per plot. During the rainy season in 2008, *Cenchrus ciliaris* was planted in between tree rows (100 cm × 50 cm row- to- row & plant to plant) and *Stylosanthes hamata* @ 4 kg/ha was sown as a line between 2 rows of grass. Four pruning treatments [T1: pruning 15 cm top portion of one/more year-old shoot, T_2: 30 cm top portion of one/more year-old shoot, T_3: 45 cm top portion of one/more year-old shoot and T_4: No pruning] were imposed on trees to enhance the fruit yield. The treatments were replicated thrice under RCB design. Data on fruit as well as pasture yield were recorded and the biomass carbon stock of the system was calculated by way of the biomass equation for carbon content (for guava) given by Rathore et. al. (2018) and the methodology of IPCC (2006) for understorey pasture. The data were analysed statistically and mean values were compared at the P=0.05 level of significance using values for critical difference (CD).

Results

In both the varieties of guava, medium-pruned trees (T2) produced the highest fruit yield (Lalit: 15.46 t ha^{-1} & Shweta: 14.87 t ha^{-1}) compared to un-pruned and highly pruned trees (Table 1). The under-storey pasture (*C. ciliaris* + *S. hamata*) was not influenced by pruning treatments, producing 5.6 t ha^{-1} forage per year. The total hortipasture system stored 7.92 to 11.34 t ha^{-1} carbon in tree biomass (Cultivar: Shweta-10.24 t ha^{-1} and Lalit 9.20 t ha^{-1}) and 4.26 t ha^{-1} to 4.43 t ha^{-1} carbon in under-story pasture biomass. The total carbon stock of the system at the age of 10 years (in biomass) ranged from 12.23 t ha^{-1} to 15.77 t ha^{-1} (Table 2).

Table 1. Fruit and pasture yield of 10 year-old guava-based hortipasture as influenced by pruning treatments

	Fruit Yield (t/ha)		Pasture Yield (t DM/ha)	
Varieties / Treatment	*Lalit*	*Shweta*	*Lalit*	*Shweta*
T1	12.96	11.80	5.4	5.6
T2	15.46	14.87	5.7	5.4
T3	14.54	10.88	6.1	5.8
T4	9.58	9.94	5.3	5.4
Mean	**13.1**	**11.87**	**5.6**	**5.6**
Overall Means	12.51		5.58	
CD (V)	1.112		NS	
CD (T)	1.583		NS	
CD (V×T)	NS		NS	
SEM (V)	0.365		0.156	
SEM (T)	0.516		0.220	
SEM (V×T)	0.730		0.312	

Abbreviations: T = Treatment; SEM = Standard Error of Mean; DM = dry matter; NS =Non significant

Table 2. Biomass carbon stock under a 10 year-old guava-based hortipasture system

	Carbon stock TREE			Carbon stock PASTURE			Total carbon stock SYSTEM (Tree + Pasture)		
Varieties / Treatment	Lalit	Shweta	Mean	Lalit	Shweta	Mean	Lalit	Shweta	Mean
T1	7.88	7.97	7.92	4.19	4.42	4.30	12.07	12.39	12.23
T2	9.95	12.74	11.34	4.75	4.11	4.43	14.70	16.85	15.77
T3	8.20	9.95	9.09	4.34	4.18	4.26	12.57	14.13	13.35
T4	10.8	10.30	10.57	4.50	4.18	4.34	15.33	14.49	14.91
Mean	9.20	10.24		4.44	4.23		13.67	14.47	
Factors	C.D	SE (d)	SE (m)	C.D	SE (d)	SE (m)	C.D	SE (d)	SE (m)
Factor (Treatment)	NS	1.38	0.97	NS*	0.24	0.17	NS*	1.48	1.05
Factor (variety)	NS	0.97	0.69	NS	0.17	0.12	NS	1.05	0.74
Factor (Treatment × Variety)	NS	1.95	1.38	NS	0.34	0.24	NS	2.10	1.48

*NS = Non significant

Discussion

Thus, results demonstrate that a pruning regime for established guava trees of removing the 30 cm top portion of one/more year-old shoots should be followed to maintain fruit yields. Moreover, this system is capable of providing quality fodder under semi-arid conditions, where the livelihood of most of the people is dependent on livestock. The system is also capable of mitigating climate change by sequestering significant quantities of carbon dioxide in its biomass.

Conclusion

In semi arid regions of India, with more than 90% people dependent on livestock for their livelihood security, establishment of guava + *C. ciliaris*+ *S. hamata* based hortipasture system can enhance economic returns of the farmers by producing high yield of quality fruits and ensuring fodder supply to livestock. Besides this, a guava-based hortipasture can help in mitigating climate change via carbon sequestration in biomass leading to the offsetting of green house gases emission from livestock sector as well.

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