Paper ID: 787
Theme 2. Grassland production and utilization
Sub-theme 2.6. Interdependence of grassland and arable lands for sustainable cereal, forage and livestock production

Sustainable production of guava based hortipasture system with different in-situ soil and moisture conservation in semi-arid region of India

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Keywords: *Cenchrus ciliaris*, Guava, Hortipasture, *In-situ* moisture conservation, *Stylosanthes hamata*

Introduction

In India, about 60 % of net sown area is rainfed, contributing 40 % of the total food production; it supports 40% of human and 60% of livestock population. Under such situation, incorporation of fruit trees along with animal husbandry in common farming system is advisable to improve income and nutritional security of the farmers. Horti- pasture system is the most ideal strategy to provide food, nutrition and income security to the people living in rainfed areas. System is socially accepted, ecologically feasible and economically viable for this region (Singh, 1996; Sharma, 2004; Kumar and Chaubey, 2008).

Guava (*Psidium guajava* L.), is one of the most common and nutritious and hardy fruits of India, can thrive on all types of soil from alluvial to lateritic with pH value as low as 4.5 and on limestone with a value up to 8.2. It occupies about 1, 15,000-1, 62000 ha area in the country (Shikhamany, 2004). Two new cultivars *viz*., Lalit (CISH-G-3) and Shweta (CISH-G-4) were taken in this experiment. *Stylosanthes hamata* (Caribbean stylo) is an important range legume for semi-arid region (Chandra *et al*., 2006). Similarly *Cenchrus ciliaris* (Buffel grass) is most suitable species for arid and semi-arid region with rainfall range from 125-1250 mm (Trivedi, 2010). Establishment of hortipasture system is quite difficult task in rainfed region because of moisture stress. Providing regular irrigation is neither practically possible nor economical in rainfed region. Harvesting of rainwater and *in-situ* moisture conservation is only viable alternative to artificial irrigation. Shaping the surface in the immediate vicinity of the trees so that runoff collects at the root zone can enhance availability of moisture for long duration (Samra, 2010). Keeping these facts in view an experiment was conducted to sustain the productivity of guava based hortipastoral system with different in-situ soil and moisture conservation measures under rainfed situations.

Materials and Methods

Study was conducted at central research farm (latitude 25^0 26' 08" N, longitude 78^0 30' 21" E and altitude 216 m above msl) of the Institute, Jhansi India during 2007–2013. Grafted plants of Guava cultivars Shweta and Lalit were planted during October, 2007 at 6 X 6m in $1m^3$ pits filled with soil + 30 kg farmyard manure. The soil was clay loam; 38.55% clay, 32.5% sand and 29.5% silt with around 2 m depth. The initial soil composition was poor (Table 2) in available N,P, and K, low in organic carbon, neutral in pH. The plot size was 12m X 36m having 12 trees (6 trees Shweta and 6 trees Lalit) /plot (6m X 6m). The new seedlings of buffel grass (*Cenchrus ciliaris*) were transplanted in July, 2008 at 100 cm row- to- row and 50 cm plant to plant and Caribbean stylo (*Stylosanthes hamata*) @ 4 kg /ha sown in line between 2 rows of grass under guava tree and similar practice was adopted for pure pasture block. The experiment consisted 12 treatments *i.e.* 2 cultivars (Shweta and Lalit) with pasture (*Cenchrus ciliaris* + *Stylosanthes hamata*) under 6-treatment *viz*., (T_1) vegetative barrier (*P. maximum*), (T_2) staggered trenches , (T_3) stone mulch in basin, (T_4) guava + pasture (without soil and water conservation), (T_5) sole pasture and (T_6) sole guava replicated thrice under randomized block design. The data on pasture growth and yield data was recorded every year at every cut and harvesting of fruits during winter. After seven years of experiment the soil was analyzed for pH, organic carbon and available N, P, K using standard procedure.

Results and Discussion

Guava started fruiting in 3^{rd} year of plantation. Over the six consecutive years Lalit produced 10.1 % higher fruit (5.83 t/ha) as compared to Shweta (5.24t/ha).Among soil and water conservation treatments staggered trenches produced significantly higher fruit yield (Lalit 6.97 and Shweta 6.21 t/ha) as compared to control (Lalit 4.95 and Shweta 5.46 t/ha) (Table 1). Sole guava cv. Lalit and Shweta produced 5.34 and 5.87 fruit t/ha respectively. Over the six years of experiment forage production of *Cenchrus ciliaris* + *S. hamata* (1:1) ratio in association with tree was recorded higher (6.15t DM/ha) as compared to sole pasture (5.48 t DM/ha). Forage production with staggered trenches was significantly higher (6.89 t/DM ha) as compared to control (5.84 t DM/ha) (Table 1).

Significant improvement in chemical composition of soil (0-30 cm depth) was observed after six years of land use under guava based hortipasture system with different in-situ moisture conservation measures. The improvement in organic carbon, available N, P and K were higher in different in-situ moisture conservations as compared to without moisture conservations (Table 2). This might be due to the fact that guava fall leaves as well as residues of pasture crop and legumes decomposes quickly and added nutrients to the soil. Soil moisture was recorded during 2008 to 2013 in the month of October to February at 0-30 cm soil profile (Fig. 1). Results showed that staggered trench technique was the best among other soil moisture techniques in conserving *in-situ* soil moisture. The order follows as $T_2 > T_5 > T_3 > T_4 > T_6 > T_1$. During the winter season (Nov-Feb) *in-situ* soil moisture was found higher side than October due to occurrence of rainfall during winter season

Table 1: Effect of different in-situ soil and moisture conservation measures on fruit and forage production in guava based hotipasture system (mean of six years)

Treatment	**Fruit yield (t/ha)**		**Pasture production (t DM/ha)**
	Shweta	**Lalit**	
T_1	5.40	6.17	6.54
T_2	6.21	6.97	6.89
T_3	4.32	4.71	5.33
T_4	4.95	5.46	5.84
T_5	5.34	5.87	-
T_6	-	-	5.48
Mean	5.24	5.83	5.38
CD at 5%	0.42	0.43	0.32

T_1- Vegetative barrier, T_2- Staggered trenches, T_{3-} Stone mulch in basin, T_{4-} Guava+ pasture without soil and moisture conservation, T_5 -sole guava, T_6 -sole pasture

Table 2: Effect of different in-situ soil and moisture conservation measures on soil buildup (after six year)

Treatment	**pH**	**OC (%)**	**EC(mhos/cm)**	**Available N (kg/ha)**	**Available P (kg/ha**	**Available K (kg/ha)**
T_1	6.98d	0.47ab	0.038a	197.27a	12.70b	243.83a
T_2	7.15a	0.53a	0.039a	197.25a	14.19a	249.46a
T_3	7.09b	0.46ab	0.044a	184.50abc	12.04bc	239.39a
T_4	7.91e	0.53ab	0.030a	177.49bc	12.70b	243.09a
T_5	7.15a	0.42b	0.046a	170.59c	11.04c	217.91b
T_6	7.05c	0.51ab	0.052a	190.65ab	12.84ab	235.24a
Initial value	6.94±0.17	0.29±0.09	0.07±0.01	165.41±16.95	5.87±0.21	243.85±23.67

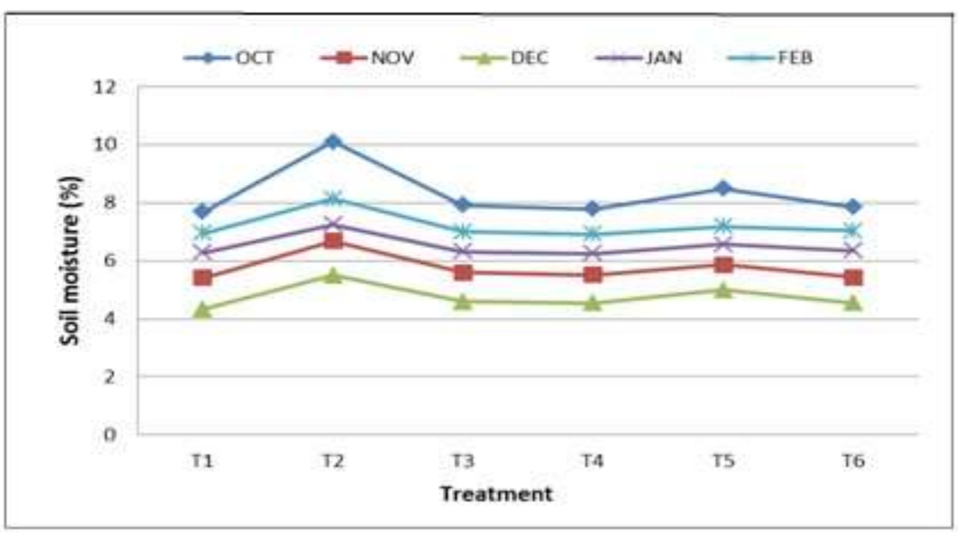

Figure1. Available soil moisture (%, mean of six years) with different in-*situ* soil moisture conservation techniques

Conclusion

Harvesting of rainwater through staggered tranches and vegetative barrier as in-situ moisture conservation sustaining production of guava based hortipasture system in semi-arid region of India that improve income and nutritional security of the farmers.

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