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Sustaining productivity in *Aonla* based hortipasture system through *in-situ* soil moisture conservation in semi-arid region of India

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Introduction

Globally land degradation affects about one sixth of the world population. In India, about 120 m ha area is affected with different kinds of land degradation. Under such situation, horti-pasture system provides best and economic alternative in conjunction with *in-situ* soil moisture conservation in general and semi-arid tropics in particular. India supports 55% buffaloes, 16% cattle, 20 % goats and about 4% sheep with deficit of 35% green fodder (525.51 mt), 10% dry fodder (453.28 mt) and 44% feed (28.4 mt) (IGFRI Vision, 2050). The per capita/day availability of fruits is 85 g as compared to average requirement of 120 g (CISH Vision, 2050). The above target could be achieved through adopting horti-pasture system in degraded land in combination of in-situ moisture conservation practices with suitable fruit and forage specie. Aonla (*Emblica officinalis* Gaertn.) is an important fruit crop and grown commercially because of its high economic return, therapeutic and neutraceutical value and its suitability for marginal lands (Kumar and Chaubey, 2008). Stylosanthes seabrana is perennial legume having good persistency under semi-arid condition and well adapted to tropical and subtropical environments with summer-dominant rainfall between 500-1,000 mm and very drought tolerant (Maass and Mannetje, 2002). Cenchrus ciliaris is also an important pasture easy to establish and provides comparatively high value forage suitable for direct feeding as well as quality hay (Trivedi, 2010).

Establishment of hortipasture system in semi-arid tropicsis challenging task due to topography, soil and water related constraints. In-situ soil moisture conservation facilitates surface water to concentrate in one area, around the base of a newly planted tree (Samra, 2010 and Singh *et al*., 2008). Keeping above facts in view an experiment was conducted to evaluate different soil and moisture conservation measures for sustaining productivity with Aonla based hortipasture system at experimental farm of IGFRI, Jhansi, U. P. India.

Materials and Methods

A study on sustaining productivity with aonla based hortipastoral system under different soil and water conservation practices was conducted at central research farm (longitude 25^0 26' 08" N, latitude 78^0, 30' 21" E and altitude 216 m above msl) of the IGFRI, Jhansi during 2007–2013. This region experiences mean annual rainfall varying from 700 to 1250 mm with potential evapo-transpiration ranging 1400-1900 mm and about 85% rain falling from June to September (Singh *et al*., 2014). The soil of experimental site was coarse gravelly and light textured with poor water holding capacity. The aonla based horti-pastoral system was laid in RBD design with following in-situ soil and water conservation practices *viz*., contour staggered trenches (T_1), continuous contour trenches (T_2), deep basin stone mulch (T_3), vegetative barriers of Panicum maximum (T_4) and control (without soil and water conservation) (T_5).The experiment had 5 treatments and 4 replications with plot size of 24 m x 40 m with 3 per cent slope in only one direction. Each plot had 15 plants with 8m x 8m spacing.

All treatments, contain grafted aonla (cv N.A.- 7) planted at 8m x 8m spacing and in inter space two rows of grass (rooted slips of *Cenchrus ciliaris*) and two rows of forage (*S. seabrana*) were planted alternatively at an spacing of 0.5m. Grafted Krishna, Chakaiya and Kanchan cultivars as pollinator. Observation on plant growth in term of height, collar diameter, canopy spread, fruit and pasture yield recorded since 2008. However, runoff and soil loss were recorded since 2009.

Results and Discussion

The plant growth in term of height, collar diameter and canopy spread was significantly affected with in-situ moisture conservation measures in each consicutive years of experiment. Contour staggered trenches exhibited significantly higher plant growth followed by continuous contour trenches and vegetative barrier (Figs.1 to 3). Significant differences in pasture production were also observed with different in-situ soil and water conservation practices. Forage production gradually increased in 1st year (0.87 t DM/ha), 2nd year (4.12 t DM/ha), 3rd year (5.29 t DM/ha), 4th year (6.18 t DM/ha), 5th year (7.24 t DM/ha) and 6th year (8.80 t DM/ha). Over the six years of experiment forage production of *Cenchrus ciliaris* + *S. seabrana* (1:1) ratio ranged from 4.12-6.80 t DM/ha. Highest forage production was recorded with contour staggered trenches (0.81-8.70 t DM/ha) followed by continuous contour trenches and deep basin stone mulch (Table 1). Aonla started fruiting in 3rd year of plantation (Table 2). Over four consecutive years of fruiting, contour staggered trenches produced significantly higher fruit yield (4.3 t/ha) followed by continuous contour trenches (3.79 t/ha) and vegetative barrier (3.29 t/ha).

Higher growth of aonla plants under contour staggered trenches and continuous contour trenches may be attributed to better moisture regime as compared to vegetative barrier and control. Moisture content was lowest under vegetative barrier due to exploitation of moisture by barrier itself during the month of October and November during 2008-2012. Runoff from continuous staggered trenches was 3.5 to 11.8% of annual rainfall during the 2009 to 12. However, it was 7.99 to 21.21% during corresponding period in control. Minimum runoff was recorded from continuous staggered trenches followed by continuous contour trenches, vegetative barrier, deep basin and control (Fig. 4).

Table 1: Pasture production (t/DM/ha) in Aonla based horti-pasture system with different *in-situ* moisture conservation measures

Treatment	1st year	2nd year	3rd year	4th year	5th year	6th year	Mean
T_1	0.81	4.70	7.01	8.28	8.95	8.70	6.41
T_2	0.71	4.41	6.16	7.27	8.00	7.70	5.70
T_3	0.99	4.66	4.99	6.77	7.25	6.70	5.23
T_4	0.91	2.90	4.70	5.49	6.85	6.20	4.71
T_5	0.84	3.92	3.64	4.07	5.15	4.70	3.72
Mean	0.87	4.12	5.29	6.18	7.24	6.80	5.08
CD at 5 %	NS	0.27	0.35	0.73	0.91	0.95	

T_1 -contour staggered trenches, T_2 -continuous contour trenches, T_3 -deep basin stone mulch, and T_4 -vegetative barrier T_5 -control

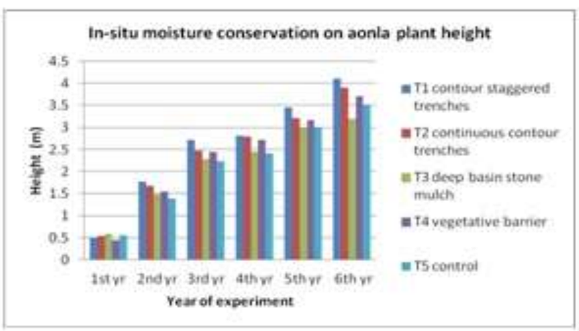

Fig.1: Effect of *in-situ* moisture conservation measures on Aonla plant height

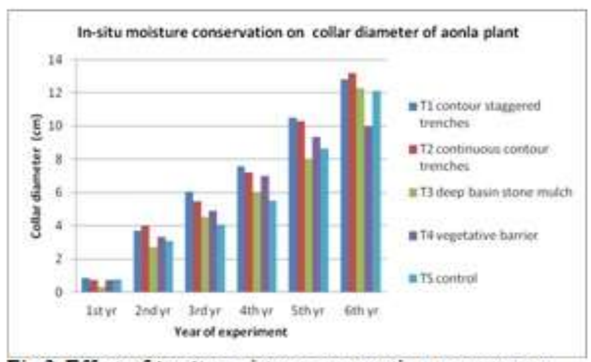

Fig.2: Effect of *in-situ* moisture conservation measures on Collar dimeter of Aonla plant

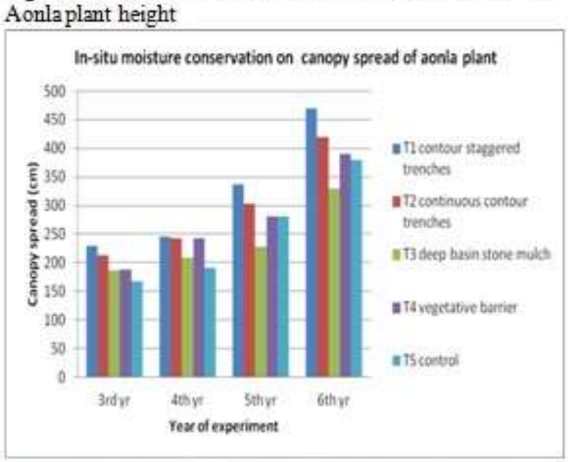

Fig.3: Effect of *in-situ* moisture conservation measures on canopy spread of aonla plant

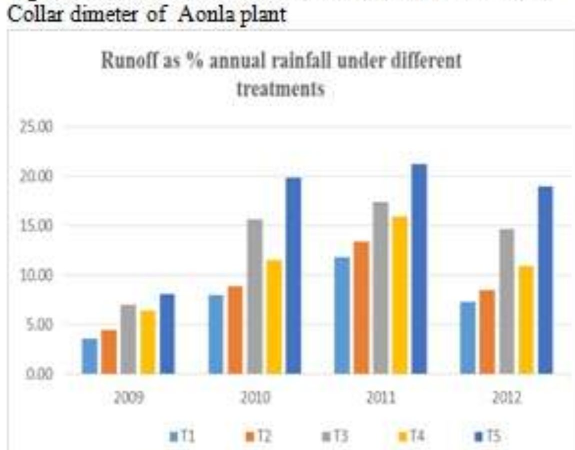

Fig.4: Impact of different *in-situ* moisture conservation measures on annual runoff

Table 2: Fruit yield (t/ha) in Aonla based horti-pasture system with different *in-situ* moisture conservation measures

Treatment	**3rd year**	**4th year**	**5th year**	**6th year**	**Mean**
T_1	0.48	3.41	3.91	9.4	4.30
T_2	0.42	3.23	3.31	8.2	3.79
T_3	0.23	1.65	1.86	5.2	2.24
T_4	0.28	2.64	3.04	7.2	3.29
T_5	0.08	2.07	2.37	6.6	3.78
Mean	0.30	2.60	2.99	7.3	3.30
CD at 5 %	NS	0.75	0.74	1.72	

Conclusion

Degraded land could be utilized through adopting in-situ soil and moisture conservation techniques with Aonla based horti-pasture system for sustaining productivity in long duration support livestock and livelihood improvement in India.

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