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Influence of different *in-situ* soil moisture conservation techniques in aonla based hortipasture system on water yield in semi-arid region of India

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Introduction

Land degradation, mainly because of lack of permanent vegetal cover, is major challenges to feed the ever increasing population of the world. As of now, one-sixth population is affected by land degradation. India is also suffering by land degradation as it's having detrimental impact on production and productivity. The Bundelkhand region, located in Central India, is amongst the most degraded ecosystems characterized by undulating and rugged topography, highly eroded and dissected land, poor soil fertility and low water holding capacity, scarce ground water resources, erratic distribution of rainfall, lack of assured irrigation facilities, heavy biotic pressure on forests, inadequate vegetation cover and frequent crop failures, resulting in scarcity of food, fodder and fuel (NRCAF, 2009; 2012)

Agroforestry is only answer to increase the permanent vegetal cover without demanding additional land. Agricultural land in India is 142 million hectare and cropping intensity is 135%. Out of this, 60% area is under rainfed condition which is characterized by water scarcity, land degradation, low inputs use and low productivity. Agricultural productivity of these areas oscillates between 0.5 to 2.0 ton ha^{-1} with average of one ton per hectare. The productivity of these areas could be enhanced through inclusion of woody perennials in field or bunds. These could be fruit plants, timber, fodder or fuel wood spp and its sustainability could be enhanced through in-situ moisture conservation techniques. The 56% area of Bundelkhand region comes under red soil (Alfisols and Entisols), which is characterized by coarse gravelly and light textured with poor water holding capacity. Therefore, establishment of woody perennials is very difficult without soil and water conservation measures, particularly in red soils of the region.

Keeping above facts, an experiment was conducted to evaluate impact of different soil and moisture conservation measures in aonla based hortipasture system on water yield at Experimental farm of Indian Grassland and Fodder Research Institute, Jhansi, U.P. India.

Materials and Methods

It has been observed that annual average rainfall has decreased from 950 mm between 1944 and 1973 as compared to an average of 847 mm between 1974 and 2004. This reduction was mainly due to decreased number of low (0-10 mm) and medium rainfall (30-50 mm) events (Singh *et. al.*, 2014). A Study on water yield of aonla based hortipastoral system, established in 2007, under different *in-situ* moisture 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 Institute (Indian Grassland and Fodder Research Institute, Jhansi),during 2007–2012. The aonla based horti-pastoral system was laid in conjunction with staggered contour trenches (T_1), Continuous Contour Trenches (T_2), Deep Basin (Stone Mulch) (T_3), Vegetative Barriers (*P. maximum*) (T_4) and Control (T_5).

The experiment was conducted in RBD design with 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. The staggered contour trench of 0.75 m^3 (3m x 0.5m x 0.5 m) capacities and 25 m^2 catchment was excavated at 2 m inter-spacing with 5 m horizontal and 0.15 m vertical interval. These trenches can easily accommodate 25 per cent of runoff generated from one day maximum rainfall with 3 years return period. Total 35 such trenches (@ 400 ha^{-1}) was excavated in each plot with T_1 treatment. It had generated surface storage of about 273 m^3ha^{-1}. In case of second treatment (T_2), 7 continuous contour trenches of 24m x 0.5m x 0.5 m was excavated at 5m horizontal and 0.15 m vertical interval and trenched were tied at a distance of every 5m. It had generated surface storage of about 438 m^3ha^{-1}. In 3rd treatment (T_3), seedlings were planted at a depth of 40 cm below ground level. The average diameter of the basin was 1.25 m (1.5 m diameter at top and 1.0 m at bottom). After plantation, stone mulch (pebbles of 10 to 40 mm in size) was put upto 20 cm height and remaining 20 cm was left for water storage during rainy season. Vegetative barrier of *P. maximum* was raised at 5m and 0.15m horizontal and vertical intervals in two rows at 0.5m apart. In all five treatments, aonla (cv N.A.- 7) seedling were 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. Water yield were recorded from different treatments using automatic stage level recorder and sharp crested V-notch weir during 2009 to 2012. To see the impact of in-situ moisture conservation techniques on residual moisture during October and November, soil samples were taken from two depths (0-15 and 15-30 cm) in all treatments. These samples were collected at a distance of 0.5 and 1.0 m from the base of the tree in all directions.

Results and Discussion

Moisture content was greatly influenced with different in-situ moisture conservation techniques. Higher moisture content was recorded in case of contour staggered trenches (CST) at both depths (0-15 and 15- 30 cm) followed by continuous contour trench (CCT), deep basin stone mulch (DB), vegetative barrier (VB) and control during the course of investigation (2009-2012). During the year 2009, moisture content in CST was 51 and 49% higher in 0-15 and 15-30 cm depth, respectively as compared to control. However, it was 34 and 53% during 2012 (five years old plantation). In case CST, moisture content in 2009 was 40 and 38% higher at two depths than control and was 24 and 39% higher in 2012. . Moisture content was lowest under vegetative barrier due to exploitation of moisture by barrier itself during the month of October and November during 2009-2012. Higher moisture content in CST was recorded due to better moisture distribution efficiency as compared to other treatments. The plant growth in term of height, collar diameter and canopy spread was significantly affected with in-*situ* moisture conservation measures in each successive years of experiment. Contour staggered trenches exhibited significantly higher plant growth followed by continuous staggered trenches and vegetative barrier. The better moisture regime under CST and CCT is the main reason behind higher growth in these treatments. Runoff from each treatment was also recorded during rainy season. Minimum runoff was observed from CST followed by CCT, vegetative barrier, deep basin with stone mulch and control. Runoff from continuous staggered trenches was 3.5 to 11.8% of annual rainfall during the 2009 to 2012 and it was 4.37 to 13.39% in CCT. However, it was 7.99 to 21.21% during corresponding period in control. The peak discharge from CST and CCT was significantly reduced and delayed by the peaks received from control.

Conclusion

The moisture content in all the treatments, except CST and CCT goes below than ultimate wilting point where plants need watering. It indicates that aonla based hortipasture system along with CST and CCT had more resilient against climate change. Water yield received from different treatments showed more resilience during deficit rainfall condition.

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