PERFORMANCE OF VEGETATIVE BARRIERS IN CONSERVING SOIL AND MOISTURE AT DIFFERENT LEVELS OF PLANTING

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Abstract

The baseline survey conducted under the World Bank-aided Integrated Watershed Development Program for the development of the Vellar watershed in the Salem district of Tamil Nadu in India indicated that one third of the watershed alone is arable and the slope varies from 2 to 7%. As there have been no soil and moisture conservation measures in the arable area of the watershed, experiments were conducted for three years, from 1995/96 to 1997/98, to study the relative performance of different vegetative barriers. Three grasses, viz. *Vetiveria zizanioides*, *Cenchrus ciliaris* and *Cymbophogan martinii*, were planted along the contour in two rows at 10- and 15-m distance and sorghum was grown in between the vegetative barrier line as well as without the barrier. The experiments were conducted in a randomized block design, replicated thrice.

V. zizanioides planted at 10 m distance recorded the maximum height, widest basal spread and highest biomass. The test crop sorghum under *V. zisanioides* at 10-m distance recorded higher values of germination, higher population and higher plant and registered a 35.5% increase in yield over control. Comparable results were obtained for *C. ciliaris* at 10-m distance, whereas *C. martineii* recorded inferior values. The retention of high available soil moisture coupled with lesser runoff soil loss under *V. zizanioides* at 10-m distance may be the reason for the better performance of sorghum in these experiments.

Introduction

The state government of Tamil Nadu in India with World Bank aid sponsored an integrated watershed development program for the development of the watershed of the Vellar River in Salem district for a seven-year period, from April 1992 to March 1998. The Vellar watershed lies between 78°20' and 78°15' E longitude and between 11°30' and 11°45' N latitude. The geographical area of the project is 150 932 ha, out of which 43 795 ha are under forest. The Tamil Nadu Agricultural University has been asked to conduct development-oriented research for improvement of the watershed.

A baseline survey was made for one year, and from it research work was conducted first in non-arable areas and then in arable areas. This experiment is related to work carried out in arable areas. The baseline survey showed that the watershed has arable land of 2 to 3-percent slope, most of it under dry land cultivation. There were no soil and moisture conservation measures, and the stone embankment and bunds with trees that existed were for boundary delineation purposes only, resulting in poor yield. Grewal and Samra (1996) stated that soil erosion is the single largest factor responsible for the degrading quality and productivity of land in India; they estimated that 56% of arable lands suffer from erosion-related problems Due to the high cost and questionable performance of mechanical measures, the emphasis has shifted to biological measures of land improvement. Sachan and Uttam (1992), while reviewing the yield potential and utility of various grasses, reported that the grass cover is the first defence against erosion. Hence to get stable yields and to satisfy food and fodder requirements in the watershed, three experiments were laid out in arable areas using three grasses as vegetative barriers with sorghum as test crop.

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Material and Methods

The soil of the experiment field was of a sandy loam nature and had a 2 to 3-percent slope. The trials were laid out in a randomised block design replicated thrice with the following treatments:

T_1 – *Vetiveria zizanioides* at 10-m distance
T_2 – *Vetiveria zizanioides* at 15-m distance
T_3 – *Cenchrus ciliaris* at 10-m distance
T_4– *Cenchrus ciliaris* at 15-m distance
T_5 – *Cymbophogan martinii* at 10-m distance
T_6 – *Cymbophogan martinii* at 15-m distance
T_7 – Control (crop without vegetative barrier)

The slips of *V. zizanioides*, *C. ciliaris* and *C. martinii* were planted along the contour in two rows as vegetative barriers. The field crop sorghum, cultivar Co. 26 was grown in between the vegetative barrier line in all the years at a spacing of 45 cm x 15 cm. The soil characteristics of the experimental site are given below:

Table 1. Soil characteristics

Characteristic	1995-96	1996-97	1997-98
Organic carbon (%)	0.39	0.42	0.45
Bulk density (g cc^{-1})	1.38	1.43	1.42
Water holding capacity (mm m^{-1})	116.7	108.7	128.6
Available N (kg ha^{-1})	249.0	256.0	245.0
Available P (kg ha^{-1})	17.2	18.6	18.2
Available K (kg ha^{-1})	272.0	286.0	282.0

The plant height and basal spread of vegetative barriers grown at different levels of planting were measured in cm and presented. The germination (%), population (m^{-2}), grain and straw yield (kg ha^{-1}) and economics of sorghum were worked out and presented. Core soil samples were taken at 30 and 60 days after sowing and at harvest of the sorghum, and available soil moisture was estimated using the gravimetric method. A trench of 2.0 m x 0.5 m x 0.4 m was dug on the lower side of each plot and lined with polythene sheets (800 gauge) which could hold 0.4 m^3 of water. Accordingly, rainfall below 25 mm which could produce runoff of less than 0.4 m^3 was alone considered for recording runoff and soil loss. Based on the recorded events, the annual runoff and soil loss were computed by correlation with the annual rainfall recorded during the year under observation.

The data were statistically analysed for their significance, using the methods suggested by Gomez and Gomez (1984). Wherever the treatment differences were found to be significant by the 'F' test, the critical difference was worked out at five-% probability level and the values provided.

Result and Discussion

Biometric Observations on Sorghum

The germination percentage of sorghum was significantly influenced by vegetative barriers and the maximum (89.0%) was recorded in vetiver planted at 10 m, which was comparable with *Cenchurs ciliaris* planted at 10-m row spacing. Consequently the population of sorghum (88.2%) was also higher above vegetative barriers with 12.0 plants per m^2. Higher germination and population observed might be the result of more moisture by vegetative barriers.

The mean plant height of sorghum recorded at 30 and 60 days after sowing and at harvest in all the three years was maximum with *V. zizanioides* planted at 10-m distance. This was comparable with that of plots where *C. ciliaris* was planted at 10m distance. *V. zizanioides* at 10 m recorded maximum

sorghum plant height of 37.6, 76.6, and 128.5 cm while the least values were recorded in control with 32.4, 71.5, and 118.0 cm for 30 and 60 days after sowing and at harvest, respectively. The basal spread of the vegetative barrier runoff which allowed greater time and thus opportunity for the infiltration of rainfall may explain the favourable difference observed in plant height for sorghum. All the biometric observations recorded in these experiments are in conformity with similar studies by Rangaraju et al. (1998) in a separate watershed.

Available Soil Moisture

Higher available soil moisture regimes prevailed in the vegetative barrier planted fields than that in control. The maximum available soil moisture was recorded by *V. zizanioides* at 60 days after sowing and at harvest in all the three years and was on a par with *C. ciliaris*, both planted at 10m distance. The difference between the treatments at 30 days after sowing on available soil moisture was insignificant and the reason may be due to the extraction of moisture by the field crop and the vegetative barrier for their early growth. The increased retention of available soil moisture by the vegetative barrier ranged from 9 to 22% at different times of observation. This was in conformity with the results of Patil et al. (1995a), whose vegetative barrier was tried with a sorghum crop. On average an about 16-percent increase in moisture content was observed in this experiment by vetiver at 10 m compared to control. However, Nagendar Rao et al. (1996) recorded an increase of only 5.13 to 8.55% over control in 2.5-% slope.

Runoff and Soil Loss

The data on computed mean annual runoff showed that the runoff was reduced by 24.8% compared to control by *V. zizanioides* planted at 10-m distance. A similar effect was produced by *C. ciliaris*, which recorded a mean annual computed runoff of 202.6 mm compared to the runoff of 248.9 mm produced by control. This is in conformity with the results of Patil et al. (1995b), who recorded 41.4% lesser runoff for vetiver over control.

The effect of vegetative barriers in controlling the soil loss was significant in all the three years. The mean annual computed soil loss was at its maximum (5 536.9 kg/ha^{-1}) in the control plot. This was reduced to 2 895.7 kg/ha^{-1} by *V. zizanioides* planted at 10-m spacing. The reduction was of 91.2% by vetiver at 10 m less than control confirming the results obtained by Tangtumniyom et al. (1996) for a cassava crop on a 5-percent slope where vetiver grass was used as vegetative barrier. The effect produced by *C. ciliaris* planted at 10-m spacing was also comparable to that of vetiver at 10 m, which recorded a mean annual soil loss of 3 392.6 kg ha^{-1}

Table 2. Runoff and soil loss as influenced by vegetative barriers

	Observed					Computed			
Treatment	Events (No.)	Rain fall (mm)	Runoff (mm)	Annual (%)	Soil loss (kg ha^{-1})	Rainfall (mm)	Events (No.)	Runoff (mm)	Soil loss (kg ha^{-1})
			1995-96						
Vz 10m	15	277	63.2	22.8	863.0	740.9	16	872	305.0
Vz 15m	15	277	67.0	24.2	916.6	740.9	17	912	448.7
Cc 10m	15	277	73.7	25.3	1045.7	740.9	18	722	786.0
Cc 15m	15	277	73.7	26.6	1088.2	740.9	19	682	907.0
Cm 10m	15	277	77.2	27.2	1215.2	740.9	20	053	549.5
Cm 15m	15	277	79.0	28.5	1421.4	740.9	21	093	796.2
Control	15	277	80.1	31.2	1650.9	740.9	22	944	413.0
			1996-97						
Vz 10m	17	270	70.3	26.2	1241.6	1011.0		264.8	4 646.9
Vz 15m	17	270	74.5	27.7	1306.4	1011.0		275.0	4 892.0
Cc 10m	17	270	80.1	29.4	1212.2	1011.0		297.2	5 287.2
Cc 15m	17	270	81.4	30.1	1509.2	1011.0		304.3	5 650.4

Cm 10m	17	270	84.4	31.4	1820.8	1011.0	317.5	6 815.0
Cm 15m	17	270	88.0	32.5	1914.7	1011.0	328.6	7 167.0
Control	17	270	95.5	35.3	2377.0	1011.0	350.9	8 675.9
			1997-98					
Vz 10m	15	232	61.9	26.7	844.0	477	127.3	1 735.3
Vz 15m	15	232	61.9	26.5	896.1	477	126.4	1 842.2
Cc 10m	15	232	64.5	27.8	1024.0	477	123.6	2 105.3
Cc 15m	15	232	67.2	29.0	1084.5	477	138.3	2 229.8
Cc 10m	15	232	69.3	29.2	1206.9	477	139.2	2 479.6
Cc 15m	15	232	72.5	31.0	1429.7	477	148.8	2 939.5
Control	15	232	81.1	34.9	1713.4	477	166.5	3 522.0

Note: Vz - *Vetiveria zizanioides* Cc – *Cenchrus ciliaris* Cm – *Cymbopogan martini*

Yield

The sorghum grain and straw yield were significantly increased in all the three years by vegetative barriers of the species tried. The control plots registered a lower mean yield of 2 244.3 kg ha^{-1} for sorghum grown in between rows of 35.5 and 31.2%, respectively, than control. An about 6.3% increase in yield over control was recorded by CRIDA (1996) in their experiments with finger millet planted in between vetiver at 15m interval as observed here. In another experiment comparing *V. zizanioides* and *C. ciliaris*, CRIDA (1996) revealed a significant difference in yield of groundnut, which is in contrast to this experiment, where comparable results were obtained between these two grasses.

Economics

The vetiver planted at 10-m distance recorded a highest net income of Rs 7 154 (mean of three years) with a cost-benefit ratio of 2.23 (Table 3). However, the control recorded the lowest net income of Rs 4 747 with a cost-benefit ratio of 1.95. This was possible due to the higher yields obtained by vetiver planted at 10-m distance. Patil et al. (1995b) in their evaluation of different barriers for sorghum recorded a cost-benefit ratio of 2.07 for vetiver as vegetative barrier and 0.93 for control, which is in conformity with the results observed in this experiment.

Table 3. Economics of sorghum as influenced by vegetative barriers (mean of three years)

Treatment	Gross income (Rs)	Expenditure (Rs)	Net income (Rs)	CB ratio
Vz 10m	12 978.75	5 825.0	7 153.75	2.23
Vz 15m	11 980.10	5 600.0	6 380.10	2.14
Cc 10m	12 603.80	5 825.0	6 778.80	2.16
Cc 15m	11 874.95	5 600.0	6 274.95	2.12
Cm 10m	11 229.45	5 825.0	5 404.45	1.93
Cm 15m	10 493.05	5 600.0	4 893.05	1.87
Control	9 689.10	4 975.0	4714.10	1.95

Vz – *Vetiveria zizanioides*, Cc – *Cenchrus ciliaris*, Cm – *Cymbopogan martinii*
Rs44 = US$1

Conclusion

The experiments showed that employing grasses as vegetative barriers along the contour, with field crops irrespective of the distance at which they are planted, brought out favourable results. As the germination, population, plant height, available soil moisture at random time, runoff, soil loss and grain yield and straw yield of the test crop sorghum were better under *V. zizanioides* and *C. ciliaris* planted at 10-m distance, they could be used for arable lands with 2 to 3-percent slope.

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