PERFORMANCE OF NARROW STRIPS OF VETIVER GRASS (*Vetiveria zizanioides)* AND NAPIER GRASS (*Pennisetum purpureum*) AS BARRIERS AGAINST RUNOFF AND SOIL LOSS ON A CLAY LOAM SOIL IN KENYA.

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SOIL EROSION PROBLEM

- Soil loss
- Nutrient loss
- Pollution
- Physical damage to crops
- Reduced water holding capacity

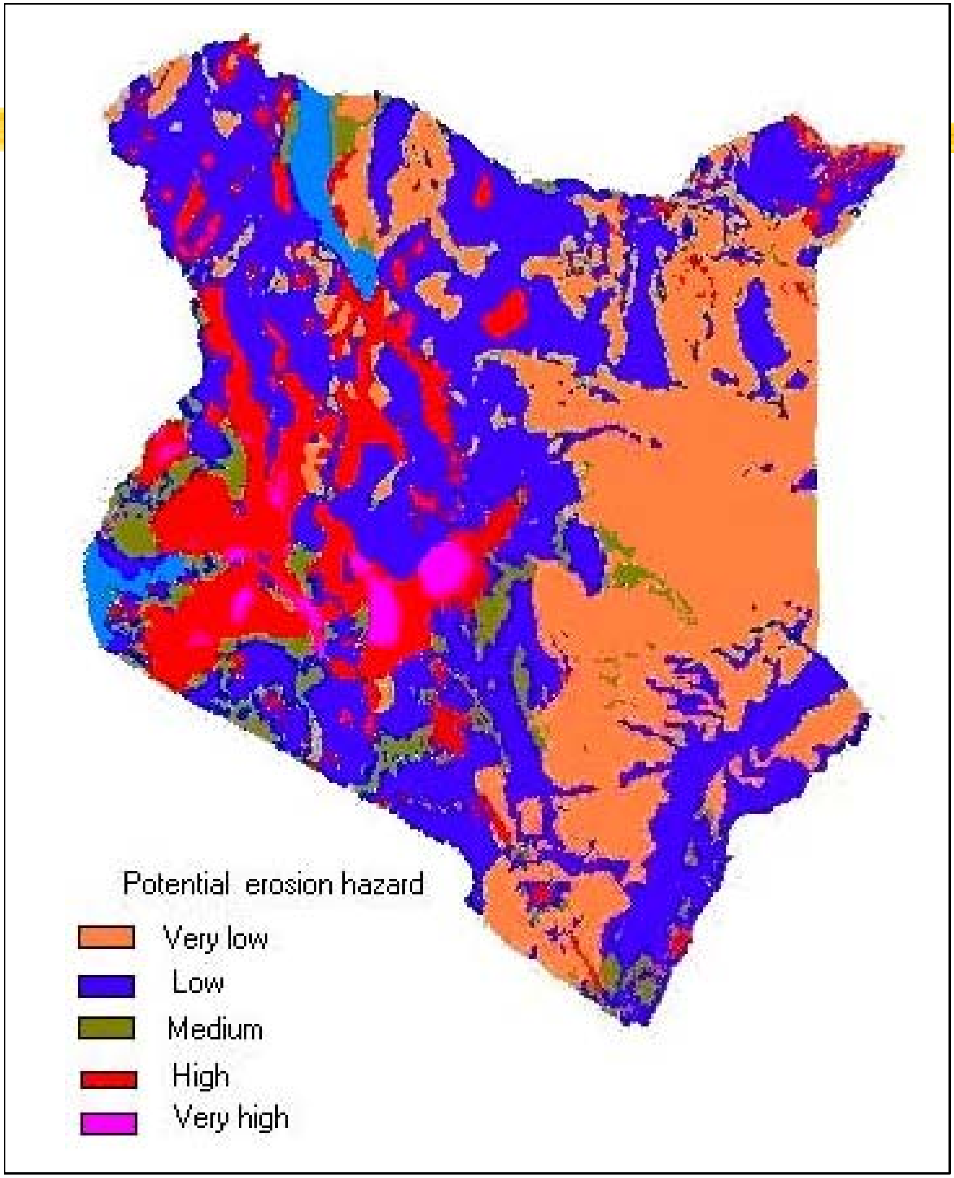
SOIL LOSS

Area	Soil loss in t $ha^{-1}yr^{-1}$
Europe	10-20
United States	16
Asia, Africa and South America	20-40
East African Highlands	50-70
East African coastal regions	10-25
Kenya	15-40

- In Kenya up to very high soil loss values have been reported on steep slopes
- 247 t $ha^{-1}yr^{-1}$(Gachene, 1995)
- 93.5 t $ha^{-1}yr^{-1}$(Schneider 1993)

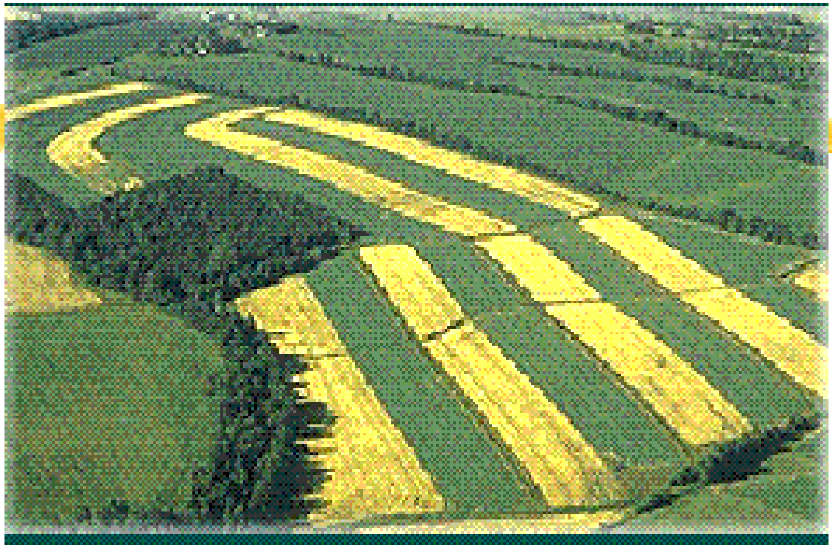
POTENTIAL WATER EROSION HAZARD IN KENYA

- Rainfall
- Soil type
- Topography
- Cropping & management
- Control practice



SOIL CONSERVATION MEASURES

- Agronomic measures
- Structural measures
- Vegetative measures
- Management measures



Strip cropping

Check dam-Gabion

Grass strip

ADVANTAGES OF VEGETATIVE MEASURES

- Cheap but effective
- Easy to establish
- Causes less soil disturbance during
- Grows stronger with time as vegetation becomes established
- Self-repairing by regeneration and growth

EFFECTIVENESS OF VEGETATIVE MEASURES

Effect of different conservation techniques in reducing soil loss at different locations in Ethiopia

Treatment	Percent (%) soil loss reduction
Control	0
Graded bunds	32
'Fanya juu'	54
Grass strips	**66**
Level bunds	80
Level 'fanya juu'	89

SOURCE: Berhe (1993)

EFFECTIVENESS OF VEGETATIVE MEASURES

Relative gross effectiveness of sediment control measures

Practice category	Percent (%) reduction		
	T. Phosphorous	T. Nitrogen	Sediment
Reduced tillage system	45	55	75
Diversion system	30	10	35
Terrace system	70	20	85
Filter strips	**75**	**70**	**65**

SOURCE: Pennsylvania state university (1992)

COST OF VARIOUS CONSERVATION MEASURES

Type of measure	Horizontal Interval (m)	Height of riser (m)	Initial cost			Annual Maintenance cost (man day/ha)	Proportion of land taken out of Agric-ulture (%)
			Construction (man day/ha)	Grass Planting (man day/ha)	Fertiliser (Kg/ha)		
Cut-off drains	-	-	27	-	-	3	-
Narrow based Terraces	10	1.6	200	51	15	20	15
Bench Terraces	12	2.0	18.0	58	16	186	8
Converse Terraces	8	1.3	250	44	12	44	13
Grass strip	10	-	-	35	10	5	10
Trash lines	10	-	3	-	-	3	10
Stone terraces	10	0.4	125	-	-	13	6

(Kassam *et al.*, 1992)

NARROW GRASS STRIPS AND SOIL EROSION CONTROL

- They are less than 1.5 m in width
- They comprise of perennial stiff stemmed vegetation
- They tiller more densely than those grown in sward => greater hydraulic resistance
- Various grass species have been used including Vetiver grass, Napier grass, Donkey grass, Signal grass, Lemon grass, Switch grass, etc
- Vetiver has shown good performance in Countries such as India, Thailand, China, Fiji, Australia, etc.
- Limited research work has been done to evaluate the performance of narrow grass strips (Gilley et al.,2000; Eghball et al.,2000; Rafaelle Jr. et at., 1997)
- Napier grass is native to Africa while Vetiver is native to India (NRC, 1993)

THEORETICAL FRAMEWORK: HOW VEGETATIVE BARRIERS WORK

- Lead to formation of hydraulic jump and region of hydraulic adjustment (Ghadiri et al., 2001)

$$L = 1.228e^{-0.8065S}$$

$$(1.5\%S) \Rightarrow L = 12.95 + 1.563d$$

$$(3.5\%S) \Rightarrow L = -5.21 + 1.003d$$

- The Eqns could be used to predict where the bulk of sediment is likely to be deposited
- Runoff velocity can be expressed by Manning's Eqn.

$$v = \frac{r^{2/3} s^{1/2}}{n}$$

- Detachment rate / rill erosion rate can be expressed by the the following Eqn. used in WEPP

$$D_f = D_c\left(1 - \frac{G}{T_c}\right)$$

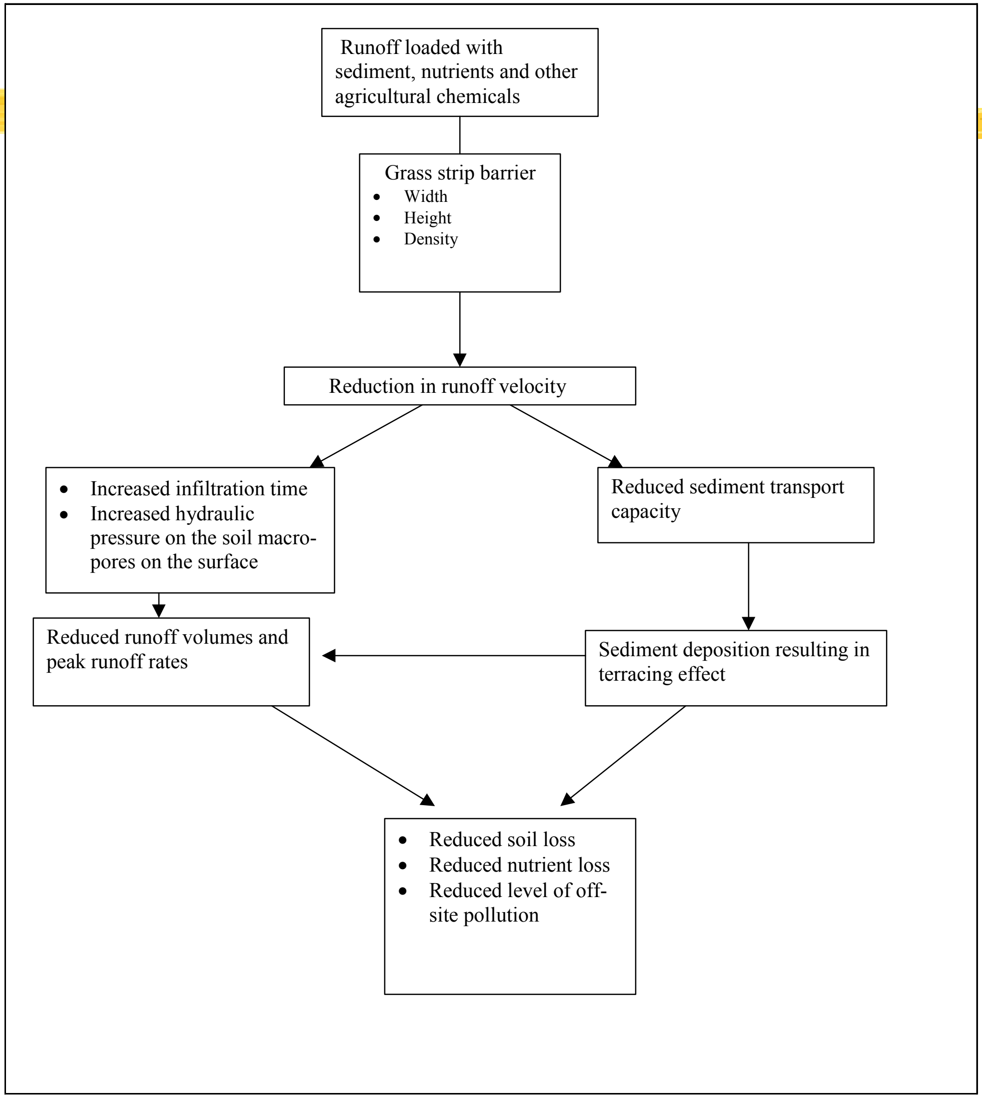


Figure 6. Conceptual framework showing the processes involved in soil erosion control by grass strips

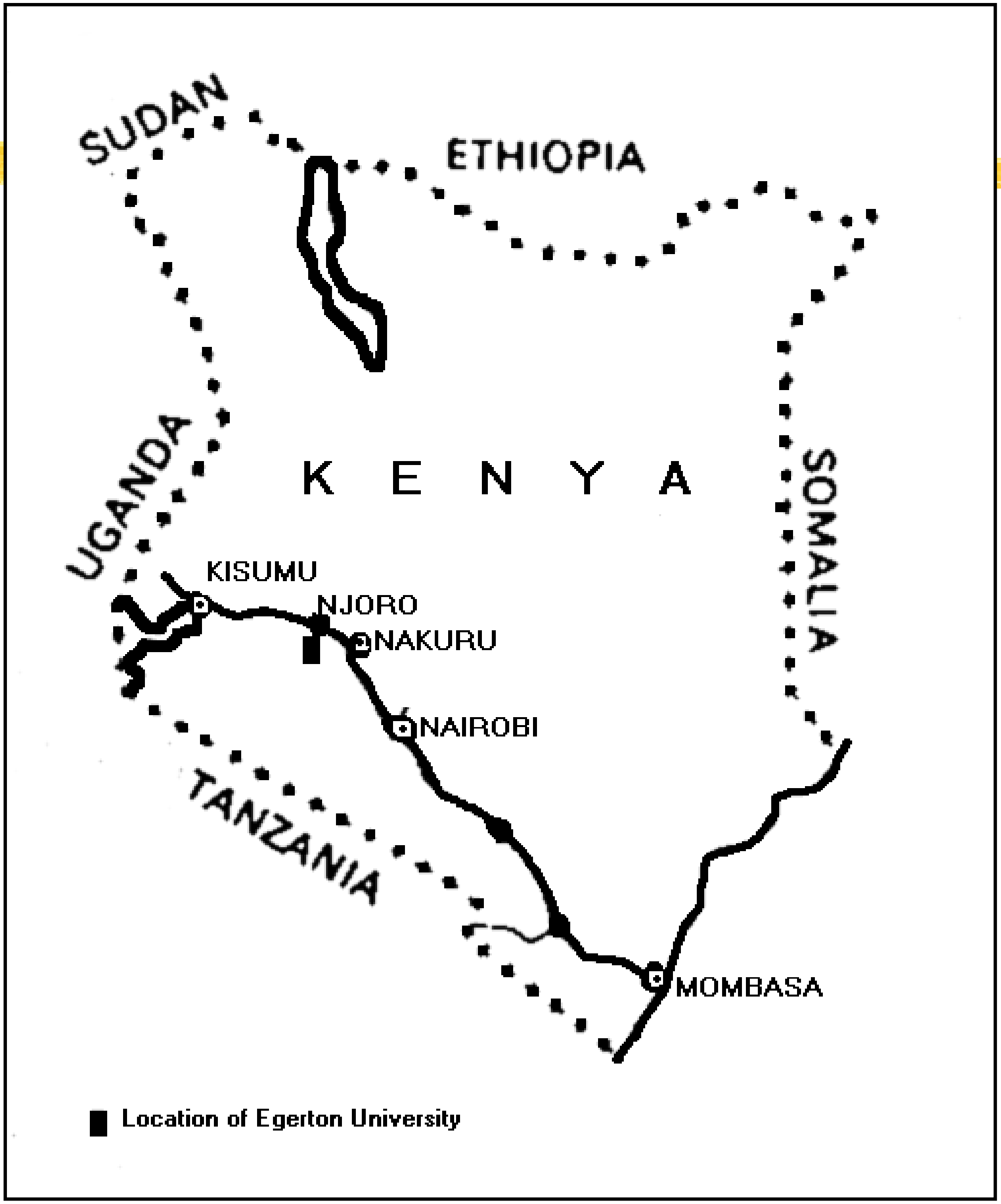
OBJECTIVES OF THE STUDY

- Determine the efficiency of Napier and Vetiver grass strips as barriers against runoff and soil loss
- Evaluate the effect of growth rate of Napier and Vetiver grass strips on their performance as barriers against runoff and soil loss
- Evaluate the potential of Napier and Vetiver grass strips to cause terrace formation on a slope

LOCATION OF STUDY SITE

- This study was carried out in field 18 of Tatton farm at Egerton University, Njoro, Kenya

- Tatton farm lies 0º22´S and 35º55´ E at an elevation of 2,240 m above seal level



DESCRIPTION OF STUDY SITE

The mean annual rainfall is 1,150 mm and is unimodal, starting from March to September

Topsoil is clay loam texture with friable consistence and a weakly to moderately developed sub-angular blocky structure. Subsoil texture range from silty clay loam to clay loam and clay

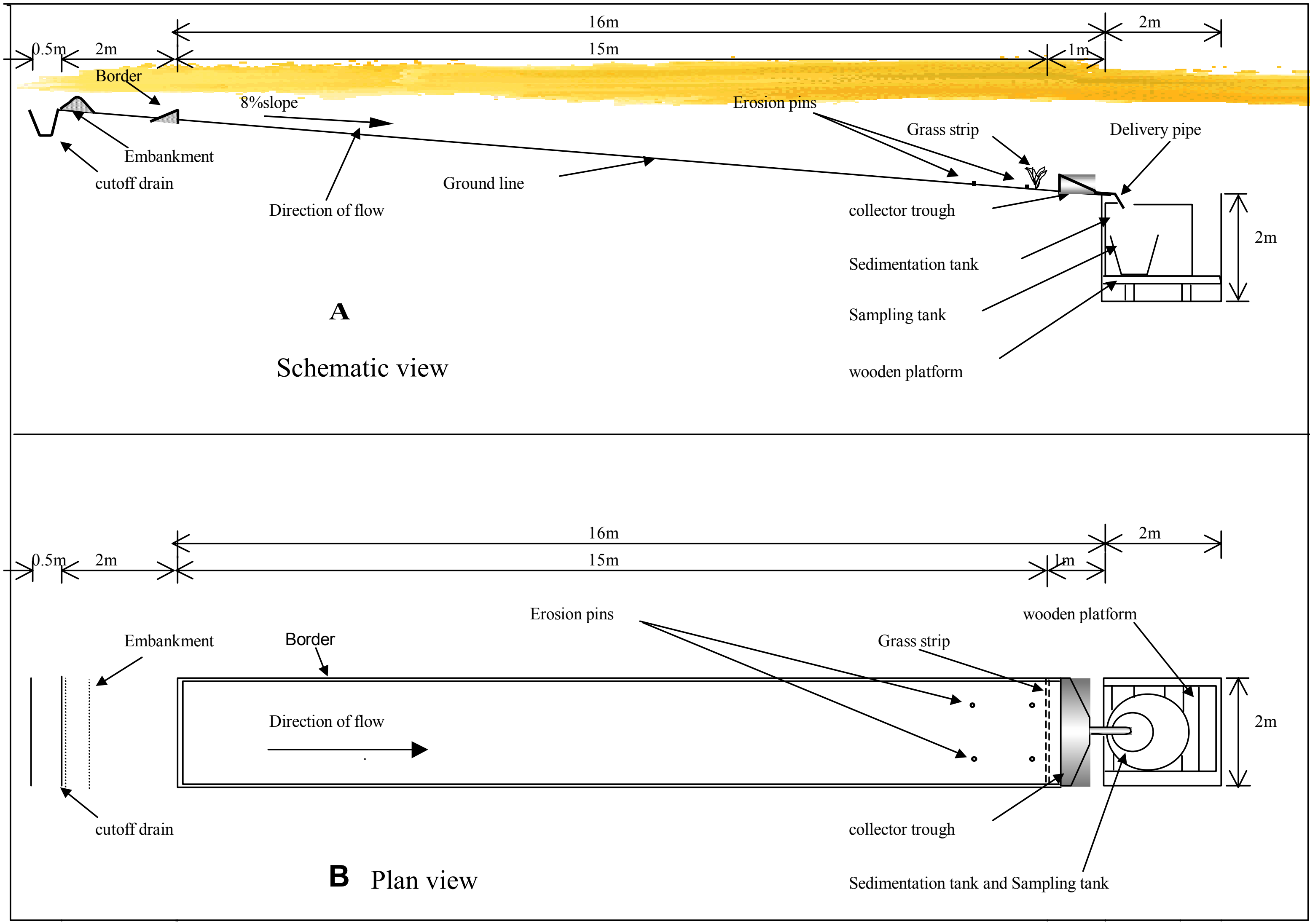
The study site had an average uniform slope of 8%, sloping in the north east direction

Site had been under Rhodes grass for over three years

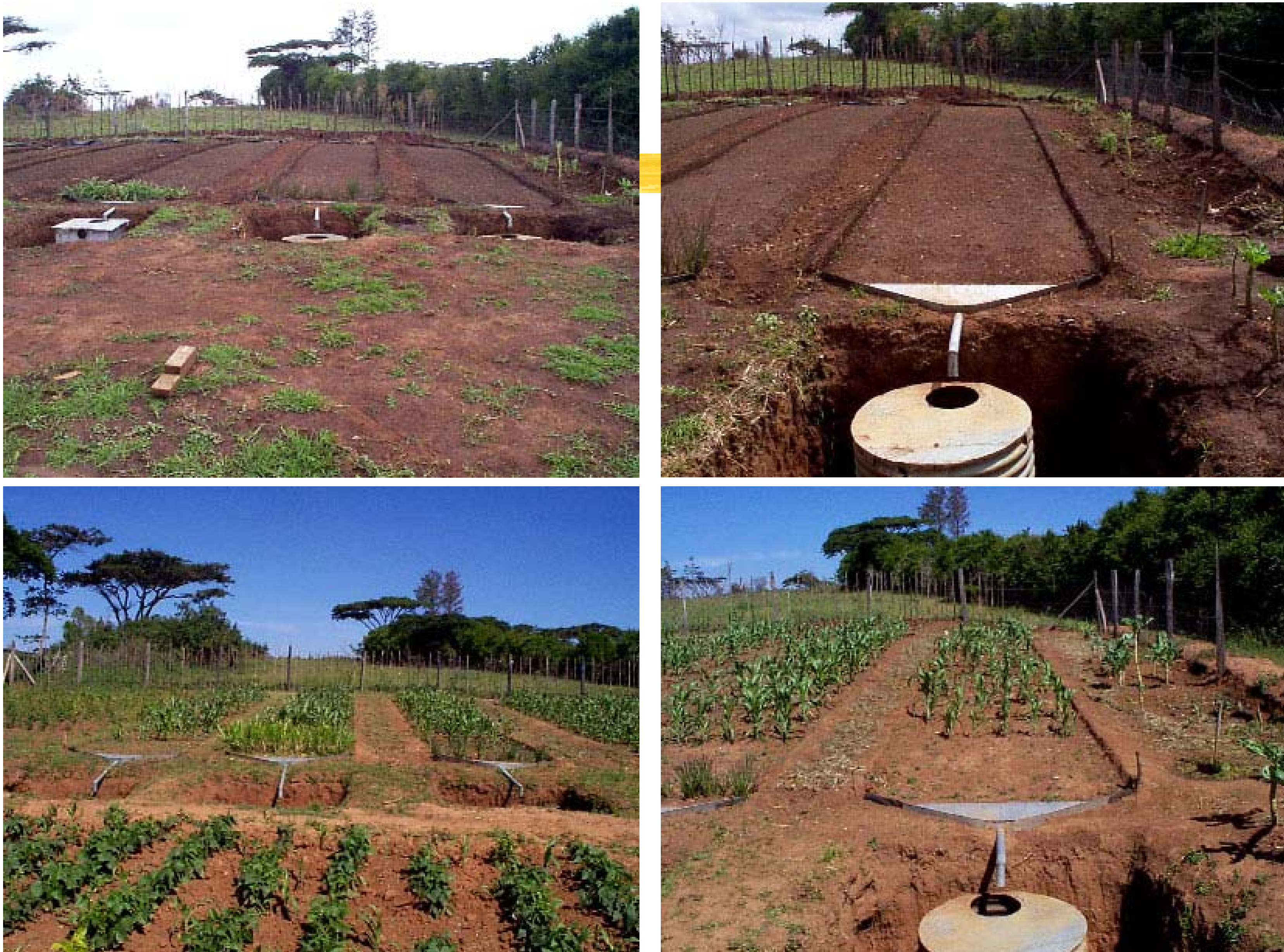
EQUIPMENT AND PROCEDURE

- Nine runoff plots - 16 m long by 2 m wide
- Randomised compete block design; - three blocks - three treatments - control (no grass strip), Vetiver grass strip, and Napier grass strip
- Collector troughs made of plane galvanised iron sheets
- Plot border made of earthen banks; 20 cm high- lined with polyethylene paper up to 30 cm deep
- Vetiver and Napier planted at a spacing of 15 cm within the row
- Maize planted in each plot across the slope
- Four erosion pins fixed, forming a grid on each plot
- Width and the height of the grass strips measured every two months, and then strip trimmed down to 15 cm

LAYOUT OF THE RUNOFF PLOT



PHOTOGRAPHS OF THE RUNOFF PLOTS



A B C D

Runoff plots, picture A&B taken in April 2000 and C&D in August 2000

PHOTOGRAPHS OF THE RUNOFF PLOTS

E

F

G

H

Runoff plots , pictures taken in Jan2001 (E&F) and June 2001(G&H)

RESULTS AND DISCUSSION(RUNOFF)

Compared with the control Napier grass reduced the depth of runoff by 40% and 70% during the year 2000 and 2001 respectively and by a mean value of 54% for the two study periods.

Compared with the control the Vetiver grass reduced the depth by -1% and 28% during the year 2000 and year 2001 respectively and by a mean value of 12% for the two study periods (Fig.4.4).

Rao *et al*., (1991) at ICRISAT, India found that Vetiver grass strip could reduce runoff by up to 57%.

At CIAT, Colombia (Liang and Rupenthal, 1991) found that at 11 months Vetiver hedges reduced runoff from 11.6% to 3.6%

Table 4.2. Comparison of means of the runoff depth from the treatments using least significant difference (LSD) test at P<0.05% level of significance

Treatment	Runoff in millimetres*		
	2000	2001	Mean
Control	78.9a	64.0a	71.5a
Vetiver grass	79.9a	46.3a	63.1a
Napier grass	47.2b	18.9b	33.0b

*Means with the same letter are not significantly different

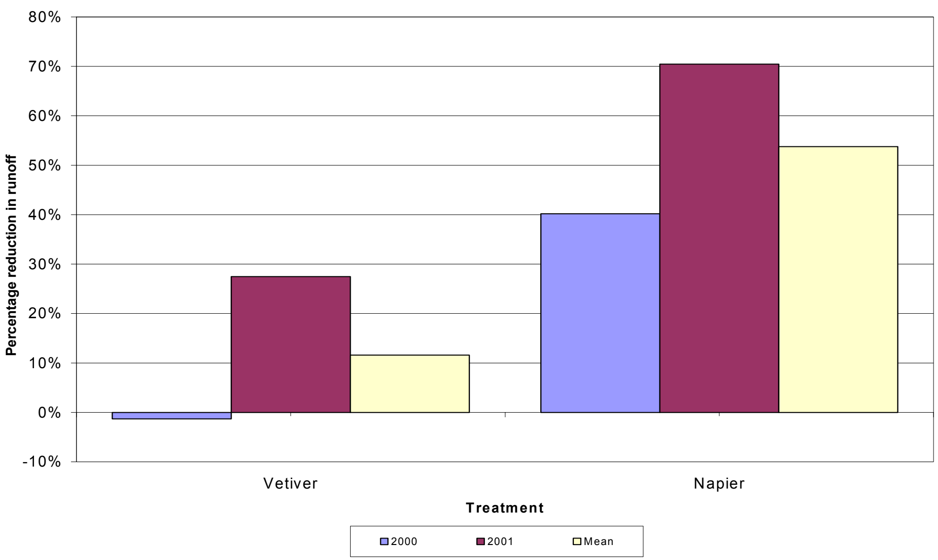


Figure 4.4. Percentage reduction in runoff from treatments during the study periods (Negative value indicates an increase)

RESULTS AND DISCUSSION (SEDIMENT YIELD)

Compared to the control Napier grass treatment reduced sediment yield by 88% and 96% during the year 2000 and 2001 respectively and by a mean value of 92% during the two periods.

Compared to the control Vetiver grass treatment reduced sediment yield by 17% and 78% during the year 2000 and 2001 respectively and by a mean value of 48% during the two periods.

Vetiver grass thus showed a tremendous improvement in it performance during the year 2001 with an increase of 61% in its efficiency while Napier grass increased by only 8% (Fig 4.7).

In a study by Rao *et al*., 1991 where Vetiver grass was compared with lemon grass and stone bunds, Vetiver reduced soil loss by 80%.

Table 4.3. Comparison of mean sediment yield from the treatments using LSD test at P<0.05 level of significance

Treatment	Sediment yield in tons per ha*		
	2000	2001	Mean
Control	13.77a	13.93 a	13.87a
Vetiver grass	11.47a	2.97b	7.23ab
Napier grass	1.57b	0.5 b	1.07b

*Means with the same letter are not significantly different

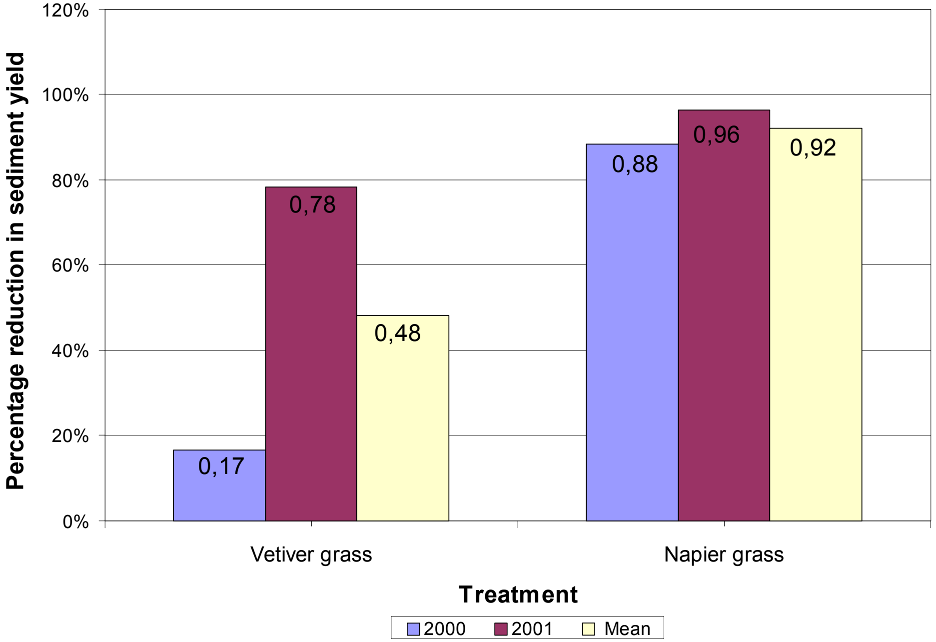


Figure 4.7. Percentage reduction in sediment yield from treatments during the study periods

RESULTS AND DISCUSSION (SEDIMENT DEPOSITION)

The comparison of means of the treatments using LSD test at P<0.05 significance level revealed that in the year 2000 study period the deposition of sediment on the front pins in the Napier grass treatment was significantly higher than the Vetiver grass and control treatments.

In the year 2001 study period the deposition of sediment on the front and the rear pins in the Napier and Vetiver grass treatments were significantly higher than the control. However the difference between Napier grass and Vetiver grass treatments was not significant (Table 4.5, Fig 4.9).

Table 4.5 Comparison of mean sediment deposition depths of the treatments using LSD test at P<0.05 level of significance

Treatment	Mean sediment deposition depth in cm*			
	Front00	Rear00	Front01	Rear01
Control	-0.5b	-	-1.33b	-0.70b
Vetiver grass	0.38b	-	5.83a	2.63a
Napier grass	2.03a	-	6.03a	3.80a

*Means with the same letter are not significantly different

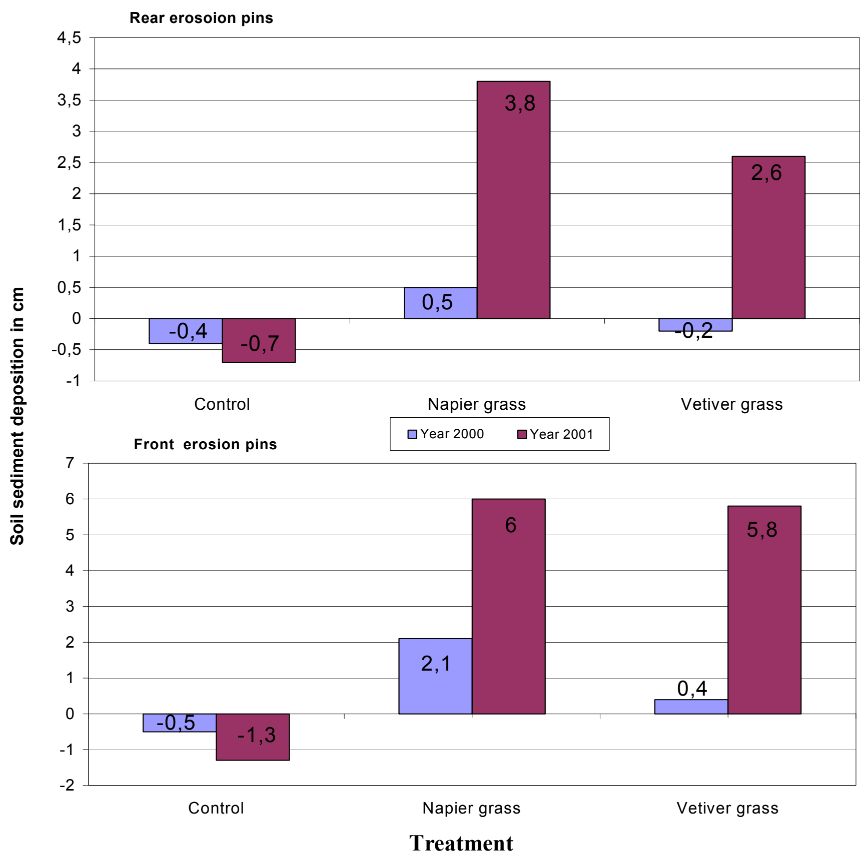


Figure 4.9. Soil sediment deposition on the erosion pins in the treatments during the study periods (Negative values indicate reduction in soil surface depth)

RESULTS AND DISCUSSION (WIDTH AND HEIGHT GROWTH RATE)

The comparison of the means of the treatments using the LSD test at P<0.05 level of significance showed that growth rate of Napier grass in width and height was significantly higher than Vetiver grass by 78% and 36% respectively (table 4.11)

Table 4.11. Comparison of the width and height growth rate means of the treatments using LSD test at P=0.05 level of significance.

Treatment	Mean growth rate in cm per month*	
	Width	Height
Control	0a	0a
Vetiver grass	1.8b	41.2b
Napier grass	3.2c	55.9c

* Means with the same letter are not significantly different

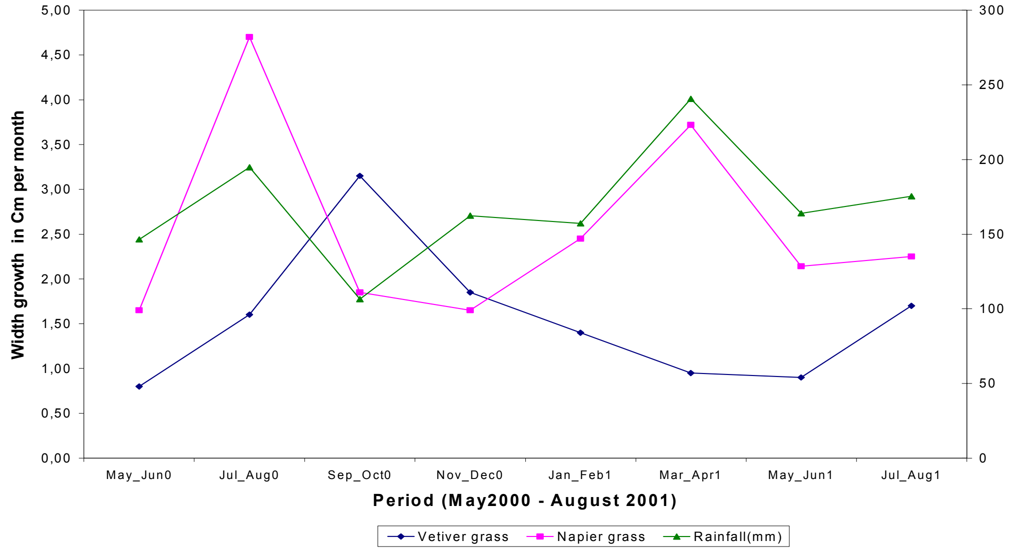


Figure 4.17. Width growth rate in cm per month and amount of rainfall in mm

CONCLUSION

The results showed that under the conditions at the study site, Napier grass was more effective than Vetiver grass in reducing runoff, sediment and nutrient loss.

The growth rate of Napier grass was higher than that of Vetiver grass thus enabling it to develop a more effective barrier.

Due to slower growth rate, the Vetiver grass strip had gaps during the year 2000 study period that did not allow it to form and effective hydraulic adjustment region.

However the Vetiver grass barrier showed a much better performance during the year 2001-study period and it is most likely that it could improve further as the gaps closed.

In general the sediment deposition results showed that both Vetiver and Napier grass strip have the potential to cause terracing.

Following our observations on the growth rate of the Vetiver grass under the study conditions we recommend that further studies be done to compare the two grasses under the same conditions but for a period exceeding two years.