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Research Article
Temporal Variation in Nutrient Element Losses in Fallows of Different Ages Southern Nigeria

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Abstract

Background and Objective: Understanding on the amount of nutrient element loss in vegetation fallows of varying ages particularly the temporal variation (monthly) is was not adequately documented in the literature. The study examined monthly nutrient loss in 10, 5, and 3 year old fallows in a part of the rainforest zone in southern Nigeria. **Materials and Methods:** Three runoff plots of 10×4 m were constructed in each fallow community and used to collect sediment from which nutrient loss was estimated using standard laboratory procedures. **Results:** Results obtained showed that the months of June, July, August and September yielded high nutrient losses on all the plots with September recorded the highest nutrients losses followed by August. High nutrient losses on the 10 year old fallow plot occurred in August; July on the 5 year fallow and September on the 3 year fallow plot. The amount of nutrient losses varied significantly among the plots ($p<0.05$). The order of nutrient loss for the study revealed the order: OC>Ca>TN>Mg>Na>P>K. **Conclusion:** The result revealed that substantial amount of nutrients was lost in sediment on fallow lands and that nutrient element losses decreased with increasing herbaceous cover.

Key words: Fallow vegetation, nutrient loss, monthly losses, agoi-ekpo

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Rainfall frequency and intensity mostly in the tropics have tremendous impacts on soil erosion (hydrology) which affect soil quality and plant health in agricultural systems[1], as a result of the depletion of soil nutrient. Its frequency and intensity results in soil erosion which is usually accompanied with the removal of large quantities of nutrients from the soil in both dissolved (runoff) and sediment-bound forms[2,3]. In agriculture, the movement of nutrients is impacted by the timing and intensity of rainfall[1]. Increased rainfall frequencies, amount and intensities may lead to increased soil loss and if unchecked can affect soil quality and agricultural productivity[4]. Thus, the overall productivity and potential of the soil to support agricultural production is affected as a result of the depletion of nutrient resources[5].

With the increasing human population and shortening in fallow period, a piece of land may not have the required nutrient base to enhance crop yield as a result of the constant loss of nutrient elements. The loss in organic matter laden topsoil degrades soil structure and could result in the depletion of essential nutrients contained in the organic matter[6,3]. In almost all environments, vegetation helps to suppress soil erosion mostly in abandoned farmlands during the process of natural nutrient restoration[7-9]. But fallow lands with sparse vegetation can affect the return of nutrient to the soil, as considerable nutrient could be lost in sediment during periods of heavy rainstorms thereby depriving the topsoil of essential nutrient[10,3]. This can have implication on crop cultivation and yield because the land may lack essential nutrients to support crop production.

The problem of soil erosion is thus a function of rainfall[11,4,12]. The seasonality of rainfall and its adequate timing by farmers enables proper planning to be carried out to reduce the loss of essential nutrients. Identifying the periods or months with increased nutrient loss will enable proper soil management practices to be put in place by farmers and land managers to reduce the quantities of essential topsoil nutrient loss mostly on farmland and areas with sparse or scanty vegetal and herbaceous cover. In African and Nigeria in particular, rainfall peaks usually occur in the months of July to August together with September[13,14]. These months with increased rainfall amounts and frequency have implications on soil nutrients particularly in areas with scanty vegetation.

For this reason, recognizing months with high nutrient element losses would enable farmers and land planners to employ measures to reduce the inherent effect. It will afford farmers to plan and employ soil management strategies in line with changing rainfall regime, to soil protection for increased agricultural productivity. Few documented studies[15,16] are available on nutrient loss in fallows of different ages. Recently in Africa, Kizza *et al.*[16] quantified runoff, soil and nutrient losses in six forest regrowths of 0-3, 10 -20, 20-30, 30-40, 40-50 and >55 years. The study did not examine the temporal pattern in nutrient loss. Majority of the available studies examined nutrient loss in cropping system and plantations[17] as well as nutrient loss of individual tree species in vegetation patches[18]. These studies did not give account of the monthly nutrient loss as well as identify months of high nutrient loss in fallows of different ages. This paper therefore contributed an understanding in this regard by examining the temporal variation (monthly) in nutrient loss in fallows of different ages of southern Nigeria. The present study assessed the rate of nutrient loss in fallows of 10, 5 and 3 year.

MATERIALS AND METHODS

Study area: The study was carried out in Agoi-Ekpo, Yakurr Local Government Area of Cross River State. The relief of the area is gentle except in places where granite rises above the general level of the surface. The area is characterized by high temperature, heavy rainfall and high relative humidity. Vertisol were the main soils type found in the area. The area has luxuriant forest vegetation.

Site characteristics and sampling: The runoff plots were established on areas of uniform topography. Vegetation on the 10 year-old fallow plot was basically trees with few stands of shrubs. The 5 year-old fallow plot was composed principally of shrubs with few stands of trees, while the 3 year-old fallow plot was composed solely of herbs with few stands of shrubs. In each identified fallow community, a plot of 10×4 m was constructed from which sediment loss was obtained. All plots were 10 m long and 4 m wide giving a total area of 40 m^2 (0.004 h). At the tail end of each plot, a gutter for runoff collection was constructed at the outlet and storage container (i.e., a 250 L container drum) was installed to collect runoff after each rainstorm. The collection container was installed in a pit of 5 by 5 m wide and 3.5 m deep. The PVC pipe helped to convey runoff and sediment into the collection container. Sediment at the bottom of the container was emptied into polythene bags with labels.

Laboratory analysis and estimation of nutrient loss: The sediment was air dried sediment and taken to the laboratory for analysis of organic carbon (OC), total nitrogen (TN), phosphorus (P), calcium (Ca), magnesium (Mg) and potassium (K). Organic carbon by the Walkley and Black[19] method; total nitrogen by the Kjeldahl method[20]; available phosphorus was determined by the method of Bray and Kurtz[21]. The soils were leached with 1 M neutral ammonium acetate to obtain leachates used to determine exchangeable bases and soil cation exchange capacity, while pH values were determined using a glass electrode testronic digital pH meter with a soil: water ratio of 1:2. Nutrient loss in kilogramme per hectare (kg ha^{-1}) is given by Ijaz *et al.*[22] and Munodawafa[23].

Data analysis: Data collected from the field waere statistically treated using tables, averages and One-Way Analysis of Variance (ANOVA). Results were considered significant at 5% significance level.

Experimental time period: In the literature, there was no generally acceptable time period for soil erosion studies. Soil erosion and nutrient loss studies had over the years considered different experimental time periods. The present study assessed nutrient losses in vegetation fallows from March 2012-March 2013. However, analysis was performed on 54 rainstorms with eroded sediment and nutrient loss.

RESULTS

Nutrient element losses on the fallow plots: Nutrient element losses from eroded sediment in the respective plots are summarized in Table 1. The amount of organic carbon (OC) loss in eroded sediment was shown in Table 1. The highest total OC losses were realized on the 5-year old fallow, while the lowest OC loss was recorded on the 10-year old fallow plot. Total OC loss varied significantly among the different treatments. Information on the total TN loss also showed that the highest nitrogen loss was recorded on the 5-year old fallow, while the lowest TN loss was obtained on the 10-year old fallow followed by the 3-year old fallow. Total nitrogen loss varied significantly among the treatments. This implied that the existence of adequate canopy and herbaceous cover (as was the case on the 10-year old and 3-year old fallow plots) reduced sediment loss which was also directly related to lower N losses. Hence, the low TN loss on the 10 and 3 year old fallow plots were attributed to the existence of adequate surface cover which made soil erosion less effective on these fallow plots.

The proportion of phosphorus losses in Table 1 revealed that the amount of total phosphorus loss varied among the plots, with high and low losses recorded on the 5 and 10 year old fallow plots respectively. The highest P loss was recorded on the 5-year old fallow plot. The lowest P losses were recorded on the 10 and 3 fallow plots. However, the proportion of total P loss varied significantly among the fallow treatment. Similar trend of P loss was also observed for Ca, Mg, Na and K losses on all the plots with high and low values obtained on the 5 and 10 year old fallows, respectively. The analysis therefore showed that nutrient element loss was minimized with the availability of

Table 1: Nutrient loss (kg ha^{-1}) on the fallow plots

Nutrients	Plots	N	Sum	Mean	SE	F-ratio
OC (kg ha^{-1})	10-year old	54	22.09	0.41	0.19	10.49*
	5-year old	54	330.22	6.12	1.54	
	3-year old	54	79.30	1.47	0.47	
TN (kg ha^{-})	10-year old	54	4.96	0.09	0.04	10.66*
	5-year old	54	79.84	1.48	0.37	
	3-year old	54	19.05	0.35	0.11	
P (g ha^{-})	10-year old	54	1.30	0.02	0.01	9.64*
	5-year old	54	14.00	0.26	0.07	
	3-year old	54	3.20	0.06	0.02	
Ca (kg ha^{-})	10-year old	54	5.53	0.10	0.05	6.48*
	5-year old	54	82.77	1.53	0.48	
	3-year old	54	25.88	0.48	0.16	
Mg (kg ha^{-})	10-year old	54	2.78	0.05	0.02	6.74*
	5-year old	54	49.06	0.91	0.30	
	3-year old	54	11.81	0.22	0.07	
Na (kg ha^{-})	10-year old	54	1.12	0.02	0.01	7.89*
	5-year old	54	17.54	0.32	0.10	
	3-year old	54	4.05	0.08	0.02	
K (kg ha^{-})	10-year old	54	0.44	0.01	0.00	8.96*
	5-year old	54	6.73	0.12	0.03	
	3-year old	54	1.85	0.03	0.01	

*Significant at 5% confidence level, OC: Organic carbon, TN: Total nitrogen, P: Available phosphorus, Ca: Exchangeable calcium, Mg: Exchangeable magnesium, Na: Exchangeable sodium, K: Exchangeable potassium and SE: Standard error adequate cover (canopy and herbaceous cover). This was evident, as the increase in herbaceous species on the 3 year-old fallow with the rains gave the considerable protection to the soil layer thereby reducing the enrichment of nutrient loss in sediment.

Monthly total nutrient losses (kg ha^{-1}) on the fallow plots

Nutrient losses in March to May: The Table 2 showed the amount of nutrient eroded from the soil from March to May in the fallow plots. March was the month the experiment commenced and it experienced a single rainfall of 12.7 mm that resulted in the loss of exchangeable cations basically calcium (Ca) and potassium (K) on the 5-year old. Since, it was the first rain of the experiment, very low quantities of nutrient was lost from the soils. In April, there was a significant increase in the quantities of nutrients eroded on the cultivated farmland and fallow soils as the eroded soils were enriched with nutrients (Table 2). Seven rainfall events with a cumulative total of 125.6 mm resulted in considerable quantities of nutrients eroded from all the plots. Similar pattern in OC, Ca and TN losses was observed on the 10 and 3 year old respectively. On the 5-year old plot, high losses were observed for OC, P and TN. The information provided in Table 2 indicated that OC suffered the highest losses in the respective plots.

In May, there was also a substantial increase in the quantities of nutrients eroded in the soil with the frequency of rainfall and amount of rainfall. There was a significant increase in the quantities of OC, TN, P and Ca washed away from the topsoil mostly on the 3 and 5 year old plots. Also, seven rainfall events with a cumulative total of 156 mm resulted in large amount of surface nutrients eroded from the soils (Table 2). On the 10 year-old fallow, high nutrient losses were recorded for OC, Ca and magnesium. The highest nutrient losses on the 5 year old fallow were observed in OC, Ca and magnesium. The pattern of nutrient loss (OC, Ca and TN) in May followed similar pattern with those recorded in April.

Nutrient losses in June to August: In June, 5 rainfall events with a cumulative total of 121.5 mm were recorded resulting in varying quantities of nutrients eroded from the fallow soils (Table 3). Total nutrient loss in the month of June followed the pattern reported for April and May with 84.7 and 93.8%

Table 2: Total monthly nutrients loss in on all the plots

		Plots		
Months	Nutrients	10-year	5-year	3-year
March*	OC (kg ha^{-1})	0.00	0.01	0.00
	TN (kg ha^{-1})	0.00	0.00	0.00
	P (g ha^{-1})	0.00	0.00	0.00
	Ca (kg ha^{-1})	0.00	0.002	0.00
	Mg (kg ha^{-1})	0.00	0.00	0.00
	Na (kg ha^{-1})	0.00	0.00	0.00
	K (kg ha^{-1})	0.00	0.00	0.00
April**	OC (kg ha^{-1})	0.72	8.83	4.15
	TN (kg ha^{-1})	0.16	2.14	1.01
	P (g ha^{-1})	0.00	2.30	0.10
	Ca (kg ha^{-1})	0.27	2.97	1.37
	Mg (kg ha^{-1})	0.12	0.95	0.58
	Na (kg ha^{-1})	0.05	0.53	0.16
	K (kg ha^{-1})	0.01	0.27	0.10
May***	OC (kg ha^{-1})	0.66	13.19	5.91
	TN (kg ha^{-1})	0.15	3.18	1.55
	K (g ha^{-1})	0.10	1.30	1.10
	Ca (kg ha^{-1})	0.29	5.73	1.52
	Mg (kg ha^{-1})	0.16	3.28	0.75
	Na (kg ha^{-1})	0.07	0.87	0.31
	K (kg ha^{-1})	0.02	0.51	0.14

*: Rainfall amount = 12.7 mm, Rainfall frequency = 1, **: Rainfall amount = 125.6 mm; Rainfall frequency = 7, ***: Rainfall amount = 156 mm; Rainfall frequency = 7, OC: Organic carbon, TN: Total nitrogen, P: Available phosphorus, Ca: Exchangeable calcium, Mg: Exchangeable magnesium, Na: Exchangeable sodium, K: Exchangeable potassium

Table 3: Total nutrients loss in June to August

		Plots		
Months	Nutrients	10-year	5-year	3-year
June*	OC (kg ha^{-1})	1.33	37.72	5.38
	TN (kg ha^{-1})	0.31	9.09	1.29
	P (g ha^{-1})	0.30	2.40	0.80
	Ca (kg ha^{-1})	0.36	9.18	2.27
	Mg (kg ha^{-1})	0.17	3.91	1.20
	Na (kg ha^{-1})	0.06	1.47	0.36
	K (kg ha^{-1})	0.03	0.82	0.21
July**	OC (kg ha^{-1})	2.07	98.77	26.63
	TN (kg ha^{-1})	0.51	23.81	6.20
	P (g ha^{-1})	0.10	4.40	0.60
	Ca (kg ha^{-1})	0.44	20.36	5.42
	Mg (kg ha^{-1})	0.27	12.77	3.26
	Na (kg ha^{-1})	0.13	3.50	0.74
	K (kg ha^{-1})	0.02	1.63	0.34
August***	OC (kg ha^{-1})	8.37	73.28	9.85
	TN (kg ha^{-1})	2.05	17.89	2.38
	P (g ha^{-1})	0.50	1.70	0.30
	Ca (kg ha^{-1})	2.39	31.03	7.61
	Mg (kg ha^{-1})	1.16	18.67	2.44
	Na (kg ha^{-1})	0.44	5.07	1.16
	K (kg ha^{-1})	0.20	1.96	0.59

*: Rainfall amount = 121.5 mm, Rainfall frequency = 5; **: Rainfall amount = 267.4 mm, Rainfall frequency = 11; ***: Rainfall amount = 236.3 mm, Rainfall frequency = 7; OC: Organic carbon, TN: Total nitrogen, P: Available phosphorus, Ca: Exchangeable calcium, Mg: Exchangeable magnesium, Na: Exchangeable sodium, K: Exchangeable potassium

increase in OC and TN losses respectively on the 10-year old fallow plot (Table 3). High nutrient losses in June were recorded on the 5-year old fallow, while the 10-year old fallow experienced the lowest losses in nutrient elements. Again, OC, Ca and TN experienced the highest losses on all the plots in June. The month of July displayed a distinct pattern in nutrient losses in the respective plots, as high nutrient losses was experienced on the 5-year old fallow plot, followed by the 3-year old fallow (Table 3). The rapid growth in herbaceous species had implications on the reduced quantities of nutrient eroded from the 3-year old fallow. It was the month with the highest frequency of rainfall events (11) and highest rainfall amount (267.4 mm). The losses in OC and TN as well as Ca on the 5-year old showed a considerable increase. As usual, OC, TN and Ca suffered the highest losses on all the plots. This means that OC, TN and Ca suffered high losses in July. The losses in these nutrients far exceeded the values recorded in April, May and June. This further implies that nutrient loss from the soil increases with the rains. However, low losses in OC, TN and Ca were recorded on the 10 and 3 year old fallow plots due to the existence of dense crown cover and ground cover percentage respectively that afforded the soil protection against the direct effect of raindrops.

Like in the months of April and May, 7 rainfall events resulted in substantial quantities of nutrients eroded from the plots in August (Table 3). There was a significant increase in the quantities of nutrients eroded from the soils, with high and low nutrient losses experienced on the 5-year old fallow and 10-year old fallow plots respectively (Table 3). Similar pattern in OC, Ca and TN losses recorded in April, May, June and July was also observed on the fallow plots plot respectively in August. On the 5-year old fallow plot, high losses were observed on OC, Ca and TN. As usual, the lowest nutrient element loss was recorded on the 10 year-old fallow plot with losses in OC, Ca and TN. The information provided in Table 3 revealed that OC, Ca and TN suffered the highest losses. It also revealed that the 5-year old fallow suffered the highest nutrient element loss, followed by the 3-year old fallow, while the lowest loss in surface nutrient in August was recorded on the 10-year old fallow.

Nutrient losses from September to November: In September, 7 rainfall events with a cumulative total of 264.4 mm were recorded across the treatments. High nutrient loss in the month of September followed the pattern reported for other months. High nutrient losses in September were recorded on the 5-year old fallow followed by the 3-year old fallow, while the 10-year old fallow experienced the lowest losses in nutrient elements. The quantities of topsoil nutrient lost in September showed that OC, Ca and TN experienced the highest losses (Table 4). In comparison with the nutrient losses recorded in other months, there was a drastic reduction in the quantities of soil nutrients eroded from the soils in October. This reduction could be attributed to the decrease in rainfall amount. Though, 8 rainfall events with a cumulative total of 124.3 mm were recorded across the plots (Table 4), the rainstorms were not heavy to greatly enrich sediment the eroded sediment. The rainfall events in this month signaled the gradual end of the rainy season. Nevertheless, high nutrient loss in the month of October followed the pattern reported for other months. High nutrient losses in October were recorded on the 5-year old fallow, while the 10-year old experienced the lowest losses in nutrient elements. The quantities of topsoil nutrient lost in October showed that OC, Ca and TN suffered the highest losses (Table 4). In November, a single rainstorm with measurable runoff and eroded sediment was recorded. Though, there were sporadic rainstorms, the rainstorms did not generate runoff across the plots as the amounts were >5 mm. The only rainfall event of 10.0 mm caused considerable losses in soil nutrient across the plots (Table 4). This month therefore was the end of the field experiment and the end of the 2012 rainy season in the study

Table 4: Total nutrients loss from September to November

		Plots		
Months	Nutrients	10-year	5-year	3-year
September*	OC (kg ha^{-1})	8.91	96.20	27.24
	TN (kg ha^{-1})	1.78	23.18	6.58
	P (g ha^{-1})	0.30	1.90	0.30
	Ca (kg ha^{-1})	1.77	13.03	7.57
	Mg (kg ha^{-1})	0.89	9.22	3.51
	Na (kg ha^{-1})	0.36	6.04	1.31
	K (kg ha^{-1})	0.14	1.51	0.47
October**	OC (kg ha^{-1})	0.03	2.19	0.16
	TN (kg ha^{-1})	0.00	0.54	0.04
	P (g ha^{-1})	0.00	0.00	0.00
	Ca (kg ha^{-1})	0.01	0.44	0.12
	Mg (kg ha^{-1})	0.01	0.25	0.05
	Na (kg ha^{-1})	0.00	0.07	0.02
	K (kg ha^{-1})	0.00	0.03	0.01
November***	OC (kg ha^{-1})	0.00	0.03	0.00
	TN (kg ha^{-1})	0.00	0.01	0.00
	Ca (kg ha^{-1})	0.00	0.01	0.00

*Rainfall amount = 264.4 mm, Rainfall frequency = 7; **Rainfall amount = 124.3 mm, Rainfall frequency = 8; ***Rainfall amount = 10.0 mm, Rainfall frequency = 1; OC: Organic carbon, TN: Total nitrogen, P: Available phosphorus, Ca: Exchangeable calcium, Mg: Exchangeable magnesium, Na: Exchangeable sodium, K: Exchangeable potassium area. There were no nutrient losses on the 10 and 3 year old fallows, while losses in OC and Ca were recorded on the 5-year old plot.

DISCUSSION

The results showed a clear variation in the amount of nutrient losses among the plots. The 5-year plot yielded the highest nutrient loss, while the 10-year plot had the lowest. The variation in nutrient loss among the plots lends support to earlier and related studies, like those of Vasquez-Mendez *et al.*[17] and Iwara *et al.*[24] that an area of land with vegetation helped to reduce erosional losses. The 5-year plot experienced the highest nutrient losses, followed by the 3-year plot, while the 10-year plot experienced the lowest losses. The nutrient loss for the study indicated the following order OC>Ca>TN>Mg>Na>P>K. Also, losses of organic carbon, total nitrogen, available phosphorus and other nutrients were of the order 5-year fallow >3-year fallow >10-year fallow. This indicated that the 5-year fallow was most susceptible to soil erosion and lost the most nutrients. The scanty herbaceous cover observed on the 5-year fallow could be responsible for the high nutrient losses[25].

Among the three essential nutrients (N, P, K), N (nitrogen) suffered the most loss on all the plots, this was followed closely by phosphorous (P), while potassium (K) was the least nutrient lost on all the plots. This result is consistent with the finding of Zheng[18] and Flanagan and Foster[26] who found that N and P in eroded sediment are significantly enriched. The low nutrient loss recorded on the 10 and 3-year fallow plots is an indication that increases in surface cover (mostly herbaceous cover) effectively reduced sediment loss. Similar resulted was reported by De Almeida *et al.*[8] when they reported that fallow management significant reduced nutrient losses. The variation in nutrient loss among the treatments underscores the importance of vegetation especially herbaceous cover in reducing the rate of sediment loss. Herbaceous cover according to Lal[27], breaks the raindrop impact, traps transported soil particles and dissipates the energy of raindrop more effectively than tall canopies thereby favouring the prevention of upland erosion caused by splash and overland flow. Similarly, Morgan[28] observed that herbaceous cover helps to absorb some of the energy of the falling raindrops, running water and wind such that less of the rain drop energy is directed at the soil. Thus, soil erosion is decreased with an increased herbaceous cover as observed on the 3-year.

In addition, the monthly losses in nutrient elements show that there is a continuous loss in topsoil nutrient with the rains and across the months. This is because the quantities of nutrient lost from the fallow soils depend on the frequency and amount of rainstorms recorded monthly. The highest nutrient losses on the 10, 5 and 3 year plots occur in August. Nutrient losses on all the plots increased with rainfall from the months of April-September, thereafter; there was gradual reduction in nutrient losses on the entire plot with the reduction in rainfall frequency and amount. Remarkably, the months of June, July, August and September yielded high losses of total nutrients on all the plots. Individually, August and September experienced the most loss of nutrients on all the plots. This is expected as these months are usually associated with heavy rainstorms and more frequent rainfall events.

The total nutrient loss in the later period of the year shows a decreasing trend, as a result of the increase in the density of herbs and herbaceous cover with the rains mostly on the 3-year. In concise, the change in vegetation characteristics was observed to have substantial effects on the amount of soil erosion and it associated losses experienced on all the plots, as there was a gradual reduction in soil erosion with the growth in vegetation (herbaceous cover) mostly on the 3-year fallow plot. The rapid increase in herbaceous cover as a result of the increase in the density of herbs following the full commencement of the rains helped to reduce nutrient element loss in the latter stage of the experiment[9]. The growth in herbaceous cover (undergrowth) on the 5-year fallow plot was slow, with almost no noticeable difference between the ground cover in March and those in November. Also, it is worthy of note that the scanty herbaceous cover and litter depth noticed on the 5-year fallow is blamed on its previous land use history of unintended bush fire which resulted in the burning of undergrowth and available litter. The bush fire may have burnt the seedlings or propagules which probably affected the rapid establishment of herbaceous species that would have provided cover to the soil as obtained on the cultivated farmland. This reason could be responsible for the very high erosional losses experienced on the 5-year fallow plot.

CONCLUSION

The study revealed that soil erosion occurs in vegetation fallows even with greater canopy cover resulting in the loss of topsoil nutrients. The significant reduction in nutrient losses on the 10-year plot is indicative of the importance of vegetation in promoting hydrological functioning in the environment. July and August experience the highest amount of nutrient losses. This implies that surface mulching on fallows with scanty undergrowth and vegetation cover should be carried out in these months.

SIGNIFICANCE STATEMENT

This study discovers that fallows with dense herbaceous cover other than crown cover can be beneficial in the conservation of soil nutrient during fallowing and in months of heavy rainstorms. This study has empirically identified months of substantial nutrient loss during vegetation fallows that earlier studies were not able to explore and quantify.

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