Soil Nutrient Redistribution Pattern About the Tree in a Silvopastoral System

L C. Nwaigbo
University of Aberdeen

H G. Miller
University of Aberdeen

A R. Sibbald
Macaulay Land Use Research Institute, UK

G Hudson
Macaulay Land Use Research Institute, UK

SOIL NUTRIENT REDISTRIBUTION PATTERN ABOUT THE TREE IN A SILVOPASTORAL SYSTEM.

L. C. Nwaigbo[1], H. G. Miller[1], A. R. Sibbald[2] and G. Hudson[2]
[1]Department of Forestry, University of Aberdeen, Aberdeen, UK.
[2]Macaulay Land Use Research Institute, Craigiebuckler, Aberdeen, UK.

ABSTRACT
The objective of this paper is to report the effect of animal-tree interactions on soil nutrient redistribution pattern in a grazed silvopastoral experiment site at Glensaugh, in NE Scotland. Scots pine (*Pinus sylvestris* L) tree species were planted in square lattice arrangements at 5 m x 5 m, spacing (400 stems/ha) on plots replicated over three blocks in Randomized Complete Block design on a predominantly rye grass (*Lolium perenne* L) pasture which was grazed by sheep yearly from April to October. Included in the design were grazed pasture plots without trees (Control). Soil samples were collected from around two randomly selected trees in each plot in four directions N, E, S and W at 1 m interval starting at 0.5 m from the tree base up to mid point of the separation distance between trees. In the Control plots, soil samples were collected as above from two hypothetical tree positions chosen randomly. The analysis of variance result showed that soil total N, %C and Organic matter (OM) increased significantly with horizontal distance from the tree in the grazed Scots pine plots whereas soil nutrients did not vary significantly with horizontal distance from the tree in the Control plots.

KEYWORDS
Silvopastoral system, grazing, trees, animals, soil nutrient, horizontal distance

INTRODUCTION
Trees and animals are principal components of a silvopastoral system and tree/animal interactions influence many processes taking place in a silvopastoral system. In a managed grassland system most of the nutrients ingested by grazing animals are eventually returned to the soil in the form of faeces and urine (Barrow, 1987). Animals are attracted to trees for shelter (Byington, 1990, Sibbald *et al*. 1995). In the course of sheltering itself the animal may influence nutrients distribution around the trees through the deposition of ingested materials. Dung and urine are potentially significant sources of N, P, K, S, Mg and Ca in grazed silvopastoral system (Spedding, 1976). The distribution of animal dung and urine has been reported to be uneven and patchy in managed pasture (Newbould and Rais 1990) and the presence of trees in a grazed silvopastoral system has been found to influence the spatial distribution pattern of nutrients in this system (Nwaigbo, 1996). The objective of this work is to report the spatial variation pattern of soil nutrients in silvopastoral system with respect to horizontal distance from the tree in a grazed silvopastoral system.

MATERIALS AND METHODS
Scots pine (*Pinus sylvestris* L) trees species were planted in square lattice arrangements at 5 m x 5 m, spacing (SP400) on plots replicated over three blocks in Randomized Complete Block design on a predominantly rye grass (*Lolium perenne* L) pasture which was grazed by sheep yearly from April to October. Included in the design were grazed pasture plots without trees (Control). The plots received 160 kg N/ha/yr in four equal applications. Soil samples were collected from around two randomly selected trees in each replicate plot in four directions of the compass N, E, S and W at 1 m interval starting at 0.5 m from the tree base up to mid point of the separation distance between trees. In the Control plots soil samples were collected as in the Scots pine plots from two hypothetical tree positions chosen randomly. This gave 12 soil samples from each tree position and total of 72 soil samples from each treatment - SP400 and Control plots. The soil samples were analysed for soil total N, available P, K, Ca, Mg including pH in water (pHWt) and Calcium Chloride ($pHCaCl_2$), %C, OM and C:N ratio. The soil total %N and %C were determined using a CHN analyser (dry combustion) while available P, K, Ca and Mg were extracted using 0.43M Acetic acid. These methods are used by the Macaulay Land Use Research Institute (MLURI), Aberdeen and the Acetic acid leachate was analysed by Inductively Coupled Mass Spectrometry (ICP-MS). Data collected were analysed by Analysis of Variance test (ANOVA) using GENSTAT 5, (1990) to determine soil nutrient variation with respect to the horizontal distance from the tree. Treatment means were separated by least significant difference (LSD) test (Steel and Torrie, 1980).

RESULTS AND DISCUSSION
The results showed that the distribution of some soil nutrients around the tree varied significantly with respect to horizontal distance from the tree. The quantity of soil total N, %C and OM in the SP400 treatment varied significantly with horizontal distance from the tree ($P < 0.05$) whereas other soil nutrients such as P, K, Ca, and Mg in this treatment were not significantly affected (Table 1). Also, the distribution patterns of soil total N, %C, OM including the C : N ratio were found to be significantly linear in their distribution ($P < 0.05$) while soil pH in water and Calcium Chloride were significantly quadratic in their distribution patterns in SP400 ($P < 0.05$) [Table 1]. In the grazed plots without trees (Control) the mean values of soil nutrients assessed were not significantly influenced by the horizontal distance from the tree (Table 2) instead the regression of available P and Ca were significantly linear while that of available Mg was significantly quadratic in their distribution patterns ($P < 0.05$) [Table 2]. The likely reasons why the means of N, %C and OM increased significantly and were also significantly linear in their distributions around the tree in the grazed pasture plots with tree (SP400) [Table 1], while no soil nutrient means were significantly influenced in the grazed pasture plots without trees (Control) [Table 2] may be due to the presence of trees in SP400 and the resultant animal-tree relationship which influenced the quantities of some of the nutrients through the deposition of ingested materials around the tree by the animals. The tree probably was the rallying point of the animals and in the course of this the areas around the tree may have received excess animal dung and urine thereby causing the heterogeneity in soil total N, %C and OM (Gillingham and During 1973; Spedding; 1976). It may be, also, that the significant differences in soil nutrient distribution between grazed pasture plots with trees (SP400) and those without trees (Control) were caused by the high uptake and subsequent immobilisation of soil N by trees than pasture since trees make significant demands on soil nutrients (Chijioke, 1980; Armstrong et al. 1986).

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Table 1
Spatial variation of soil nutrients with horizontal distance from the tree in Scots pine 400 stems/ha

Distance (m)	%N	P	K	Ca	Mg	pHWt	$pHCaCl_2$	%C	OM	C:N
mg/kg	mg/kg	mg/kg	mg/kg							
0.5	0.408b **!**	40.8a	114.1a	1258a	161.4a	5.23a	4.75a	4.93b	8.48b	12.14a
1.5	0.438a	35.5a	116.9a	1442a	182.4a	5.36a	4.90a	5.32a	9.16a	12.29a
2.5	0.444a	35.8a	143.5a	1327a	174.5a	5.27a	4.80a	5.44a	9.36a	12.34a
Grand mean	0.430	37.4	124.8	1342	172	5.28	4.82	5.23	9.00	12.26
SEM	0.010	1.82	12.4	65.20	8.40	0.039	0.045	0.104	0.179	0.071
Response										
Linear	*							*		**
Quadratic						*	*			

! Values with the same letters within a column are not significantly different ($P < 0.05$)
* indicates significant linear or quadratic regression of distribution of means ($P < 0.05$)
SEM : Standard Error of the Mean

Table 2
Spatial variation of soil nutrients with horizontal distribution from the tree grazed pasture without trees (Control)

Distance (m)	%N	P	K	Ca	Mg	pHWt	$pHCaCl_2$	%C	OM	C:N
		mg/kg	mg/kg	mg/kg	mg/kg					
0.5	0.396a **!**	32.22a	131.4a	1257a	134.4a	5.17a	4.72a	4.85a	8.34a	12.37a
1.5	0.407a	34.95a	130.5a	1188a	153a	5.18a	4.76a	4.96a	8.52a	12.25a
2.5	0.410a	34.20a	155.0a	1253a	161.5a	5.2a	4.78a	5.0a	8.6a	12.23a
3.5	0.408a	37.35a	148.9a	1360a	171.2a	5.24a	4.82a	5.03a	8.64a	12.36a
4.5	0.410a	38.55a	146.9a	1133a	149.9a	5.16a	4.69a	5.04a	8.66a	12.4a
Grand mean	0.406	35.45	142.5	1238	154	5.19	4.76	4.97	8.55	12.32
SEM	0.009	1.64	8.5	67	8.99	0.04	0.04	0.098	0.17	0.16
Response										
Linear		*	*							
Quadratic					*					

! Values with the same letters within a column are not significantly different ($P < 0.05$)
* indicates significant linear or quadratic regression of distribution of means ($P < 0.05$)
SEM : Standard Error of the Mean