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A NEW LOOK AT DATA OF SOIL ORGANIC MATTER AND INTRODUCED PASTURES

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Introduction: There are 250 million hectares of savannas in the neotropics. We have recently reported that introduced pastures in the savannas of the Eastern Plains of Colombia have the ability to sequester large amounts of carbon at depth in the soil. If this is a general phenomenon in the 35 million hectares of introduced pastures in Brazil alone, this sequestration could be of global importance in moderating the rise of atmospheric carbon dioxide, and consequent global warming. Here we summarize data of the original report and present data from a broader range of introduced pastures compared with native savanna.

Materials and methods: A number of introduced pastures of varying ages and histories were chosen at Matazul Farm (lat. 4°9'N, long. 72°39'W, alt. 160 m) and 200 km ENE at Carimagua Research Station (lat. 4°37'N, long. 71°19'W, alt. 175 m) on the Colombian Eastern Plains. The pastures were based on different introduced grass species in which the grasses were either grown alone or in association with a legume. Samples of soil were taken at random with a soil auger to the depths indicated. Each sample consisted of 8 to 10 cores, and four to eight samples were taken in each plot. In most cases the plots sampled were part of a formal randomized block experiments with 3 or 4 replicates, in which case all the replicates of a particular treatment were sampled. The plots were 0.5 to 1 ha in area, and had been grazed since establishment. Concurrent samples were taken from immediately-adjacent savanna. The samples were milled to pass a 1 mm sieve, and subsamples were digested in hot sulphuric acid-potassium dichromate. Carbon concentration was determined colorimetrically against calibration standards.

Results: All pastures showed considerable accumulation of carbon compared with the savanna (Table 1). Most of the carbon accumulation is deeper than 20 cm, below the depth of normal ploughing. It should therefore be less vulnerable to oxidation and loss in any cropping that might be undertaken in mixed crop-pasture systems. We believe that these systems could accommodate cropping and still contribute to sequestration of carbon.
It is particularly noteworthy that although its rate of fixation appears to be lower, the *A. gayanus* pasture at Carimagua Research Station was subjected to mismanagement, at least as bad as that in poorly-managed farmers' fields, including excessive accumulation of forage, overgrazing and burning. Yet it still had fixed almost 50 tons ha^{-1} more carbon than the native savanna in 16

years. The well-managed *A. gayanus* pasture at Matazul Farm fixed this same amount in 3½ years.
In all cases, the legume component stimulated a substantial enhancement in the amount of carbon sequestered, almost trebling the amount in the case of *B. humidicola*/*A. pintoi* at Carimagua.

Conclusions: We suggest that the sequestration of carbon by introduced grass-legume pastures in the neotropical savannas is of global importance. The use of deep-rooted grass-based pastures, especially with an associated legume can be exploited by both the farmer and the community at large for the mutual benefit of both.

Table 1. The effect of introduced pastures on the accumulation of carbon in oxisol soils of the eastern plains of Colombia.

Matazul Farm (Soils sampled December, 1992, 0-100cm)				
Pasture	Savanna	*A. gayanus/ S. capitata*	*B. dictyoneura* alone	*B. dictyoneura/ C. acutifolium*
History	**1989.** Cropped from savanna with upland rice undersown with mixed grass legume or grass alone pasture. **1989-93.** Rotationally grazed with cattle at 2 head ha^{-1}.			
Carbon in profile ($t\ ha^{-1}$)	186.5	237.2	203.1	214.6
Increase compared to savanna ($t\ ha^{-1}$) ± SE	-	50.7±11.4 ***‡	20.0±10.8 n.s. (P=0.08)	28.1±10.6 *
Percentage of increase that is below 20 cm	-	86.0%	79.5%	95.5%

Carimagua Research Station (Soils sampled April, 1993, 0-80 cm)			
Pasture	Savanna	*B. humidicola* alone	*B. humidicola/A. pintoi*
History	**1984.** Sown to *B. humidicola* from savanna, with the legume *Desmodium ovalifolium*, which failed. **1987.** Resown to *B. humidicola* alone or in association with *A. pintoi*. **1988-93.** Rotationally grazed with cattle at 3 head ha^{-1}.		
Carbon in profile ($t\ ha^{-1}$)	197.1	228.8	267.5
Increase compared to savanna ($t\ ha^{-1}$) ± SE	-	25.7±7.7 **	70.4±15.5 ***
Percentage of increase that is below 20 cm	-	78.0%	74.7%

Carimagua Research Station (Soils sampled May, 1994, 0-160 cm)			
Pasture	Savanna	*A. gayanus* alone	*A. gayanus/S. capitata*
History	**1978.** Sown to *A. gayanus* alone or in association with *S.capitata* from savanna. **1979-94.** Grazed as commercial pastures, varying from no grazing to severe overgrazing, combined with periodic burning.		
Carbon in profile ($t\ ha^{-1}$)	207.3	228.4	256.4
Increase compared to savanna ($t\ ha^{-1}$) ± SE	-	21.1±11.2 n.s. (P=0.10)	49.1±10.9 **

Percentage of increase that is below 20 cm	-	138.5%[†]	97.8%

[†] The savanna had more carbon in the surface 20 cm and less below this level than did the *A. gayanus* pasture. [‡] ***, $P<0.001$; **, $P<0.01$; *, $P<0.05$; n.s., $P>0.05$.