

many tropical pastures. If productivity can be sustained, the high economic reward per unit area of well-managed pastures might reduce demand for large-scale clearings of forests and savannas to meet local agricultural and economic needs. A globally significant carbon sink is, however, unlikely to be a virtue of this land use and cannot be used to justify it. Moreover, the effect of invading exotic species on native vegetation must also be considered before singing the praises of this new trend.

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FISHER *ET AL.* REPLY — The comments by Davidson *et al.* about the rainforests and the wooded communities of the cerrados are not relevant to our paper¹, which was about the 35 million hectares (MHa) of treeless grasslands in Colombia and Venezuela and the 50 MHa (24%) of the cerrados of central Brazil that have no significant woody component (*Campo limpo* and *Campo sujo*¹⁴). It is on the latter, which have less fertile soils, that most of the 35 MHa of introduced pastures¹⁵ have been sown in the past 30 years. The plant communities of the cerrados with a significant tree component are on more fertile soils, and when cleared have normally given way to cropping, largely because the economics of cattle production will not support the high cost of mechanical clearing.

We did not forecast that the rates of C sequestration will continue indefinitely. We measured rates of C sequestration of 2.9–14.7 t Ha⁻¹ yr⁻¹ in the soil under pastures of introduced grasses compared with the native savanna on a farmer's fields and at Carimagua research station in the eastern plains of Colombia. We hypothesized that if this process is general in sown pastures in the neotropical savannas, then the amount of C sequestered could be large enough to be important.

We do not yet know the dynamics of C in the soil under our pastures. In the same samples from Carimagua that we reported in our paper, not only are the C:N ratios of the soil under savanna unusually high at 21.5, but also we measured a shift to 33.2 after nine years of introduced grass pasture, five of them with a legume (s.e. of difference ±6.57, $n=7$, $P<0.001$). For this to occur, the C:N ratio of the newly accumulated soil organic matter must be very high. We do know that the C:N ratios of litter of the African grasses are unusually

high. For above-ground litter of *Brachiaria decumbens*, *B. dictyoneura* and *B. humidicola* and *Andropogon gayanus* they are 74.8–193.5 (ref. 16), and for fine and coarse roots of *B. dictyoneura* and *B. humidicola* they are 158 and 224 (ref. 17). It would be dangerous to apply conventional wisdom to organic matter derived from this litter because it is likely to be less easily broken down by soil biota, and therefore the soil C may have longer residence times. We accept that there will be a new equilibrium, but at what level and when is an open question.

With regard to management, we have measured C sequestration of 2.9 t Ha⁻¹ yr⁻¹ in a 17-yr-old pasture of *A. gayanus* that had been subjected to mismanagement by burning, over- and undergrazing at least as bad as the worst farmers' fields. This rate is the same as in pure grass pastures reported in our paper, whereas our data also show that well-managed pastures with a good legume balance can sequester C at up to five times this rate.

All grasses lose some nutritional value during the dry season, but the introduced ones at all times have higher quality than the savanna species they replace¹⁸. This, and their deep-rootedness, which allows them to grow longer into the dry season, are the main reasons farmers have sown 35 MHa in the Brazilian savannas¹⁹. There have been some problems with persistence of tropical legumes sown with introduced grasses, in part due to their different photosynthetic pathways²⁰. But *Arachis pintoi*, the legume in one of our experiments, has persisted in mixture with contrasting grasses in the Colombian Llanos under differing managements for as long as 13 years²¹. The Brazilian experience is shorter, but there are no recorded failures once the legume is well established. Spittlebug has been a problem in some *Brachiaria* spp. in some humid areas of the neotropical savannas.

Conserved cell and organelle division

STR — The process of organelle division in eukaryotes is poorly understood and no genes involved in this process have yet been isolated. In prokaryotes, from which both chloroplasts and mitochondria probably evolved¹, several genes essential for cell division have been identified. The best characterized encodes the protein FtsZ, which forms a ring at the leading edge of the cell division site². It has been proposed that FtsZ is a prokaryotic cytoskeletal element and possibly an evolutionary progenitor of tubulin³. The role of FtsZ in prokaryotic cell division suggested to us that a similar protein might be involved in the division of eukaryotic organelles.

We used the amino-acid sequence of *Escherichia coli* FtsZ as a probe in a homology search of the Expressed

Breeding for resistance to it in *Brachiaria* spp. is a major objective of plant improvement both at CIAT and by the Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA) in Brazil²².

We share the concern about the conservation issues raised by Davidson *et al.*, but to address them was outside the scope of our paper. *Panicum maximum*, *Hyparrhenia rufa* and *Melinis minutiflora*, African grasses introduced to the neotropics almost 100 years ago, do invade native savanna¹¹, particularly in the absence of fire. We have looked for, but not found, invasion of undisturbed savanna by *A. gayanus* or *Brachiaria* spp., the species in our experiments and the main ones sown over the past 20 years in the neotropics.

A large portion of the neotropical savannas has been replaced by sown pastures and crops for economic and other reasons. Our point is not that savannas and grasslands ought to be replaced by introduced pastures, but that, when they are, the pastures can have beneficial effects in terms of C sequestration in the soil.

We agree with Nepstad *et al.*⁷ that there is a need to understand the dynamics of soil-plant processes associated with C sequestration in tropical American soils. We would extend this to include the introduction, degradation and reclamation of pastures based on African grasses in tropical America and the trade-offs involved.

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Sequence Tag database dbEST⁴. Complementary DNA from *Arabidopsis thaliana*, with no assigned matches in the database but exhibiting a small stretch of homology to *E. coli* FtsZ, was identified, obtained from the Arabidopsis Biological Resource Center, and sequenced fully. The open reading frame encoded a protein of 433 amino acids (M_r 45,600) with significant homology to FtsZ sequences from several prokaryotes (Fig. 1). Noteworthy in the *Arabidopsis* sequence are conservation of the glycine-rich 'tubulin signature' motif which is common to both FtsZs and tubulins and is important for GTP binding⁵. All but one of the residues identical in bacterial FtsZs and tubulins⁶ are also conserved.

The *Arabidopsis ftsZ* gene seems to be most closely related to the prokaryotic