Strategies and Opportunities for Intensifying and Diversifying Livestock-based Systems in the Neotropical Savannas of Colombia

J. Voss, I. Rao, C. Lascano, E. Amezquita and L. Rivas*

The world's tropical savannas represent almost 43% of its total arable land, of which 27% is located in tropical America. The savannas of South America cover approximately 270 Mha, distributed as follows: 207 Mha in Brazil, 28 Mha in Venezuela, 17 Mha in Colombia, 14 Mha in Bolivia and 4 Mha in Guyana. These areas represent one of the last frontiers for agricultural expansion in the world. Starting in the 1970s, native grasses were replaced to a large extent by improved *Brachiaria*-based pastures in Brazil, Colombia and Venezuela, and this resulted in a two-fold increase in liveweight gain per animal and up to10 to 15-fold increases in liveweight gain per unit area.

In the absence of proper management, however, including maintenance fertilization, these grass-alone pastures eventually underwent widespread degradation. This was further aggravated by the susceptibility of widely planted grasses to an insect known as spittlebug. A major effort was made to introduce acid-soil adapted forage legumes to increase nitrogen supply in the system and to achieve and sustain higher levels of livestock production. However, the legume-based pasture technology was not widely adopted by farmers, because the legume component lacked persistence over time and availability of forage seed in the market was limited.

Over the last decade, research has focused on the development of improved grass cultivars (specifically *Brachiaria* hybrids) adapted to major biotic and abiotic constraints in combination with crops, such as upland rice, maize, sorghum and soybean, with adaptation to acid soils (i.e., resistance to high levels of aluminum and tolerance to low levels of phosphorus). This research has required a major collaborative effort, involving various CGIAR centers (CIAT, CIMMYT, and ICRISAT) and national partners, such as the Colombian Corporation for Agricultural Research (CORPOICA) and the Universidad de los Llanos.

Improved forage and crop components have offered entry points for the development of more intensive and diversified agropasotoral systems. Monocropping systems, with high levels of inputs and excessive cultivation (i.e., disc harrowing) have proved unsustainable, because they result in the deterioration of soil physical, chemical and biological properties as well as in the escalation of pest and disease problems. Hence the need for alternative systems incorporating components that attenuate or reverse the deleterious effects of monocultures. Also important is the use of biophysical measures of sustainability, which can serve as "predictors" of system "health" and as guides to interventions aimed at maintaining agricultural production at high levels while minimizing soil degradation. Grain legumes, green manures, intercrops and leys are

*J. Voss, Director General; I Rao, Plant Nutritionist; C. Lascano, Manager, Tropical Forages Project; E. Amezquita, Soil Scientist; and L. Rivas, Agricultural Economist. Internacional Center for Tropical Agriculture (CIAT), Colombia.

among the system components that can enhance the stability of systems involving annual crops. However, for these more intensive systems to be productive and sustainable, better soil management strategies had to be developed.

Soils in the Eastern Plains (or *Llanos Orientales*) of Colombia are classified as Oxisols and Ultisols, characterized by low levels of soil nutrients, low exchangeable ion capacity and high levels of soil acidity and aluminum saturation. Available phosphorous levels are very low and limit pasture and crop productivity. When these soils are subject to mechanized agriculture, they rapidly lose their initial physical structure. The only way to manage these soils in a productive and sustainable way is by developing an arable layer using vertical tillage (i.e., chisels) to correct the physical conditions, adding lime and fertilizers to correct the chemical conditions and using improved forage and crop components adapted to these conditions, so that the fertilizers and amendments added can promote vigorous root growth in pastures, thus improving soil biological activity and stabilizing soil physical structure.

Results from long-term field experiments in the Colombian *Llanos* indicate that agropastoral systems, based on deep-rooted tropical forage grasses adapted to acid soils, are markedly superior to crop rotation for building an arable layer in infertile savanna Oxisols. Using this integrated soil management technology, it is possible to improve the profitability and sustainability of agropastoral systems in the Colombian Llanos. The costs and benefits of different options for introduced livestock-crop systems were evaluated *ex-ante* at the farm scale to quantify the impact of diversified production systems. The economic impact of the improved systems, with the buildup of an arable layer at the regional level, was estimated at US$239 million.

The tools and technologies are thus available to farmers for achieving agricultural transformation in the Colombian savannas And these are based on the concepts of building an arable layer and combining this soil management technology with acid soil-adapted cultivars of both forages and crops in agropastoral systems. However, the current social unrest and lack of infrastructure in the region limit adoption of those innovations. A major challenge is to encourage national decision makers and the international community to continue supporting research efforts for sustainable development of acid soil savannas.