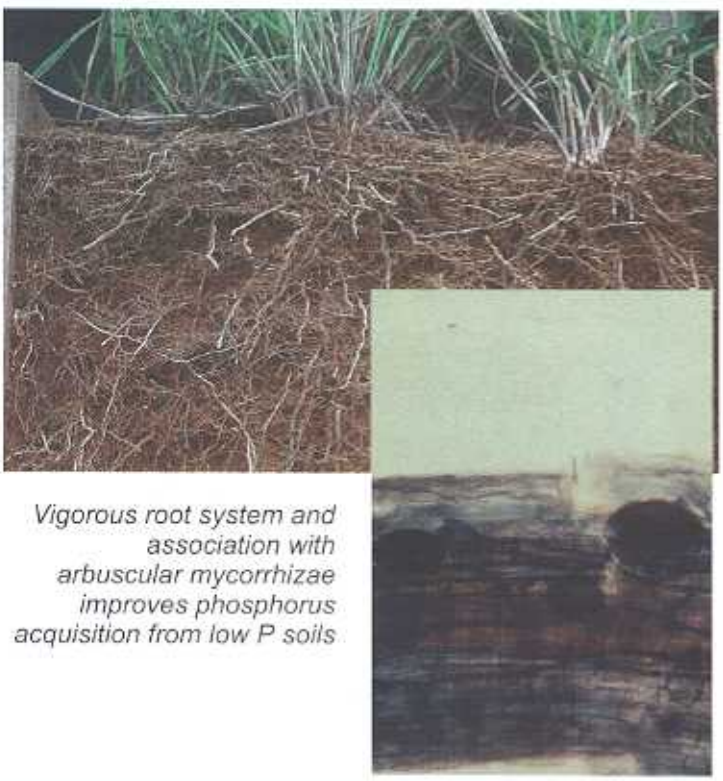
Agroecology Highlights
Centro Internacional de Agricultural Tropical (CIAT)

Opportunities for increasing the efficiency of phosphorus use in tropical agroecosystems

Phosphorus (P) deficiency is a widespread nutrient constraint to agricultural productivity in tropical soils. However, correcting soil P deficiency with large applications of P fertilizer is not a viable option for most resource-poor farmers. Plants grow poorly in low-phosphorus soil, mostly because roots cannot acquire adequate amounts of the element from soil solutions that are low in P supply. Plant adaptation to low-P soils can be maximized by at least three approaches:

- Improving the genetic characteristics related to P acquisition and use;
- Enhancing symbiosis with mycorrhizal fungi, which increase the soil volume from which P can be acquired; and
- Increasing P supply from the soil through strategic application of P fertilizers.



Vigorous root system and association with arbuscular mycorrhizae improves phosphorus acquisition from low P soils

Strategic P inputs are an essential component to increased and sustained agricultural production in low-P soils. More P-efficient cultivars can extract the greatest benefit from applied P and provide resource-poor farmers with more incentive to apply P fertilizer. Uptake of P by most tropical crop cultivars is unlikely to exceed much more than 20% of the total fertilizer P applied to low-P soils. Small strategic P applications based on soil P availability and reduced crop P requirements will gradually build up the level of available P in the soil. Consequently, the frequency and amounts of P applications required to sustain production will decrease with time.

Field and glasshouse studies on forage grass and legume components have indicated that legumes are more efficient in acquiring P per unit root length than grasses. Field evaluation of common bean germplasm in P-fixing andisols resulted in identification of several landraces and bred lines that are less demanding in fertilizer P inputs. Acquisition and recycling of P were quantified in crop-pasture (agropastoral) systems experiment in the Llanos of Colombia. Results showed that legume-based pastures maintain higher organic and available P levels more consistently than the grass alone or native pastures.

Less phosphorus demanding common bean landraces and bred lines

Agricultural land-use systems replacing native savanna on oxisols affect the partitioning of P among inorganic and organic P fractions. Indicators of organic P mineralization suggest that organic P is more important for delivering available P in improved grass-legume pastures than in continuously cropped soils. In cultivated soils, much higher P fertilizer doses significantly increase available inorganic P contents with lesser impact on organic P pool sizes. The amount and turnover of P that is held in the soil microbial biomass is increased when native savanna is replaced by improved pasture while it was lowered when soils are cultivated and cropped continuously. Therefore, strategic application of lower amounts of P fertilizer to crops and planting of grass-legume pastures are recommended to promote P cycling and efficient use of P inputs in low P oxisols of tropical savannas. Studies on the impact of improved fallows indicated that *Tithonia diversifolia* improves soil P availability in P-fixing soils of tropical hillsides.

Crop-pasture rotations are superior to monocropping in improving P cycling in tropical savannas

Improved fallows contribute to greater availability of phosphorus in soils of tropical hillsides

Identifying differences among crop, forage and fallow components in their capacity to acquire P from different P sources and soil P pools in P-limited soils (tropical savanna and hillsides) is essential for designing crop/pasture/fallow systems that will optimize the use of strategic P inputs. Introducing forage, cover legume or fallow components with crop components could stimulate soil P transformations and P cycling, thus improving the profitability of P applications to P-limited tropical soils. Economically viable and ecologically sound P management in tropical soils will not only sustain crop/animal production but will also reduce soil degradation.

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