

Project title

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Background

It is widely accepted that organic matter addition, as manure or crop residues, is essential to maintain the soil physico-chemical health in the predominantly sandy topsoils with low activity clays of West Africa (Vanlauwe et al., 2001b). As a replacement of the natural fallow within the systems, researchers in the 1980's recommended the use of fast growing herbaceous legumes such as *Mucuna* spp. or *Lablab* spp. to be used as green manure (Giller, 2001b). Despite repeated demonstrations of their beneficial effects on soil fertility and on subsequent crop yields, the adoption of green manures by farmers remained limited; This is related to farmers' reluctance to invest land, labour and seeds in a technology that does not provide a quick economic return on their investments (Oyewole et al., 2001).

Grain legumes are infinitely more adoptable by farmers, although the benefits, in terms of soil improvement, from a grain legume rotation will be lower than that of a herbaceous legume fallow. Still, the nodulated roots and aboveground residues left after harvest of grain legumes can partially replenish the soil organic N and will benefit the following crop through positive N balance or through a "sparing effect" (Sanginga, 2003).

Facing the decrease in length of fallow and recognizing the little acceptability of green manures, new varieties of cowpea, soybean and groundnut with greater production of residues were bred by the International Institute of Tropical Agriculture (IITA) and the International Livestock Research Institute (ILRI) for utilization in West Africa. They are the so-called dual-purpose or feed-food legumes. They combine a strong production of leafy material and a fair production of grains. Their harvest index has been lowered in comparison to the common varieties (Singh et al., 2003). They represent an acceptable compromise between production of grain and production of residues. These residues are thought to be the key to the sustainability of the system. The residues, being returned to the soil directly or indirectly (as manure), benefit the following crop and regenerate fertility. These dual-purpose varieties are selected for production of quality forage, high in proteins, that can be used in cut carry systems to feed to animals when available proteins are scarce in the system (Tarawali, 2004).

Objective

Assess nitrogen input to the system resulting from adoption of dual purpose legumes and evaluate contribution of residue nitrogen to the following crop in the rotation.

Evaluate how the adoption of dual purpose legumes influence the production and quality of crop residues to be used as amendments or fed to the animals. Compare soil processes following cropping season where new lines of dual purposes legumes are used versus that of other legume technologies. Assess biological nitrogen fixation by the varieties and N-balance (N fixed – N removed in the seeds) of dual-purpose varieties versus that of other grain legumes varieties and against forage and green manure crops.

Evaluate the role of ruminants in returning crop residue N to the soil.

Compare the production and nutritional quality of residues from dual-purpose legumes against that of other varieties of the same grain legumes and against that of other crops. Compare the nutritional values of these residues and their impact on manure quality.

Progress - 2005

Experimental plots were established at two sites of the Guinea savanna of Nigeria and dual-purpose crops were grown. These will be followed in 2006 by a maize crop. Experiments were also started in the greenhouse. In 2005, the research mainly focused on below-ground nitrogen content of different legume technologies. The below-ground N (BGN) contribution from legume technologies was almost always ignored or roughly estimated when carrying N budget of cropping systems. Field and greenhouse experiments had the objective to quantify and compare BGN between different grain legume species and varieties. To estimate below-ground nitrogen, the growing plants are enriched with ^{15}N isotope by dipping the leaves in ^{15}N -enriched urea solution. The whole plant become enriched in ^{15}N isotope. The BGN (root N + rhizodeposition) fractions are thus enriched as well and can be traced in the soil. This technique is more reliable to measure BGN contribution of these crops than physical extraction techniques which do not take rhizodeposition into account and fail to recover the fine roots.

Plans - 2006

In 2006, all treatments of the crop rotation experiments will contain maize. The focus is therefore to measure contribution of legume residue N to maize. Legume N contributes to maize N nutrition both through the decomposition of the below-ground legume residues and through return of manure after the aboveground crop residues were fed to animals in the dry season. Both ^{15}N isotope dilution and direct ^{15}N methods will be used to determine contribution of legume BGN to maize N. Indirect techniques will be used to determine uptake of N in maize coming from manure produced after feeding animals with the dual-purpose soybean residues and from the forage legume stylo.

- 1) Subplots will be established within the main treatments and labelled with ^{15}N in the dry season. This will allow to determine, through isotope dilution, how much N is contributed to maize by the below-ground residues of the different legume technologies (compare ^{15}N dilution in maize following maize versus maize following the different legume). Maize will also be grown in cylinders where the legume BGN will have been enriched in ^{15}N (see 2005, 1.), their decomposition will lead to uptake of ^{15}N by maize which can be measured. These data are extrapolated to determine N derived from the labelled below-ground legume residues. Results obtained from the direct and indirect techniques will be compared.
- 2) The aboveground residues will be fed to stalled cows in the dry season and manure produced will be measured and kept. The chemical composition of the manure will then be determined. Again, subplots will be established within the main treatments and labelled with ^{15}N in the dry season. Some of these will receive manure and others not. The uptake of N from manure (different quantity and quality amongst the treatments) by maize
- 3) In the greenhouse, soils from the 2005 experiment will be kept, and upland rice will be grown in them (pots are too small for maize) to determine and compare uptake of legume BGN by rice between the different legume species.