Physical Characteristics of Soil under Different Cropping and Natural Systems on the Plain of Jars, Xieng Khouang Province, Laos

Florent Tivet, Pascal Lienhard, André Chabanne, Vilasack Saphanthong, Thammakham Sosomphou, and Lucien Séguy

Context and objective

Altitude plains in Xieng Khouang province are characterized by large areas of infertile savannah grasslands. A large range of species have been used to improve the land to diversify farming production. Strategies include: i) testing rotational sequences between improved pasture and edible/cash crops direct-seeded onto forage mulch; and ii) improvement of fodder resources to increase the productivity of cattle production. The present study attempts to analyse physical parameters under different cropping and natural systems to identify the beneficial functions of each species or system in soil improvement.

Materials and method

Sampling was carried-out on the Plain of Jars from beginning of October to end of November 2005. Four main systems were analyzed: i) savannah grasslands; ii) pine forest; iii) rice crop after tillage; and iv) improved pasture lands with two forage species (*B. ruziziensis* and *Stylosanthes guianensis)* established in June 2004 by direct sowing. Samples were extracted at three depths (0-10 cm, 10-20 cm, and 20-30 cm) with six replicates per depth. For on-site sampling three-compartment cylinders were used and various parameters were recorded on the same sample as water-stable aggregate (WSA), bulk density (Da), and soil permeability.

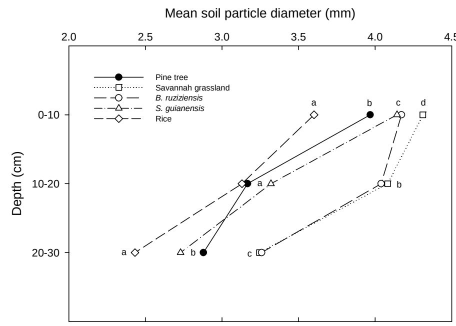

Figure 1: Aggregate-mean diameter under different systems (Duncan test, P<0.05).

Results

Water-Stable Aggregate

Significant WSA differences were recorded between savannah grassland and others non-fertilised treatments at each depth (Fig. 1), although *B. ruziziensis* showed similar results for 10 cm-20 cm and 20 cm-30 cm depths. *B. ruziziensis* showed a very similar distribution of macro water-stable aggregates to savannah grassland (Fig. 2), and a slight increase in medium-sized particles (2 mm to 0.250 mm) at 0 cm-10 cm and 10 cm-20 cm. *S. guianensis* showed a surprising drop in macro aggregates.

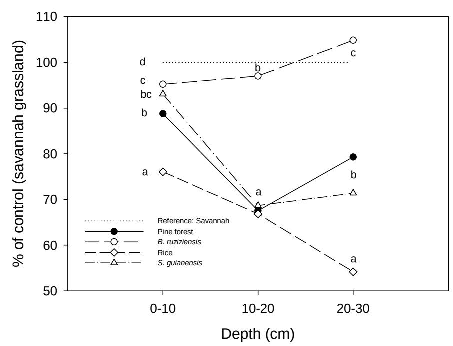

Figure 2: Evolution of water-stable macro aggregates (>4 mm), in percentage of savannah grassland (Duncan test, P<0.05).

Bulk density

Relative reduction (in percentage of savannah) of Da was, for *B. ruziziensis* and *S. guianensis,* respectively, 17.7% and 3.6% for 0 cm-10 cm, 18.6% and 8.5% for 10 cm-20 cm, and 17.6% and 9.6% for 20 cm-30 cm. After one season, *B. ruziziensis* shows a strong ability to decrease bulk density and to create a favourable environment for future root penetration.

Soil permeability vs. bulk density

In comparison with the situation on savannah grassland, these regressions (Fig. 3) show great modification after one year of growth for both *B. ruziziensis* and *S. guianensis*, providing evidence of a strong and multi-factored effect by fodder species on soil permeability against bulk density.

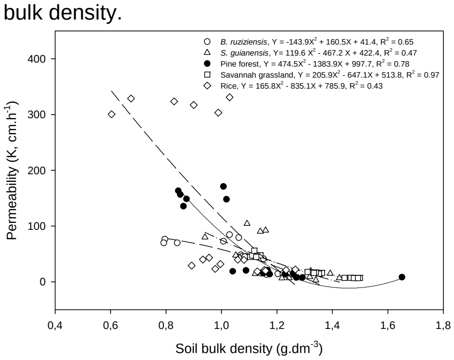

Figure 3: Soil permeability against bulk density for different treatments

Discussion and Conclusion

The results of the WSA analysis are promising, highlighting the positive features of forage species like *B. ruziziensis* and *S. guianensis*, which seem able to aggregate smaller soil particles. Annual records should be made for *B. ruziziensis*, *S. guianensis* and others systems, and linked with analysis of microbial activities to show the beneficial functions of each species or system in soil aggregation.

It is difficult to interpret the positive features of species in regard to bulk density and soil permeability as interaction is complex and various parameters are involved. At the same value of bulk density, this parameter will be affected by particle size and arrangement, and organic content.

In the case of rice and pine forest, the lower bulk density is mainly related to macro-porosity (high level of permeability). In contrast, *B. ruziziensis* and *S. guianensis* showed, for lower Da, a lower value of permeability probably related to an increase of micro-porosity. This characteristic has to be analysed during subsequent measurements of Da and soil permeability data as micro-porosity is a main component influencing water retention.

Lao National Agro-Ecology Programme

PO Box 10990, MAF-NAFRI, Lao PDR. email: pronae-pcadr@nafri.org.la. Tel/Fax: (856 21) 770027