Contribution of beneficial plant-associated microorganisms in crop-livestock-forest systems: how far can we go?

Mariangela HUNGRIA[1], Robert.M. BODDEY[2]
[1] Embrapa Soja, CP 231, 86001-970, Londrina, PR, Brazil; [2] Embrapa Agrobiologia, Rod. Br 465, km 07, Seropédica, 23890-000, RJ, Brazil.
E-mail address of presenting author*: mariangela.hungria@embrapa.br

Research funding and farmer use of inoculants to promote biological nitrogen fixation (BNF) have been inversely related to economic and logistic facilities to get N-fertilizers. In countries such as Brazil, where about 70% of the N-fertilizers are imported and quoted in foreign currency, research aimed at increasing the contribution of BNF to plant nutrition has been persistent and often very successful, in contrast to countries with low-cost N-fertilizers. However, a new horizon has been raised, relying on the global interest in mitigating greenhouse gases (GHG) emissions.

BNF with legumes used for pastures may be very successful, with examples including both temperate/subtropical species as alfalfa (*Medicago sativa*) and clover (*Trifolium* spp.) with reported annual contributions of up to 480 and 260 kg N/ha, respectively, and tropical species as *Stylosanthes* spp. and *Desmodium* spp.contributing with up to 260 and 380 kg N/ha, respectively (Ormeño-Orrillo et al., 2013). The challenge has been to introduce and maintain these legumes as pastures. There are encouraging reports of forage legumes mixed or not with grasses in temperate/subtropical regions, but they are rare in the tropics. However, a positive scenario for inputs of BNF in integrated crop-livestock-forest (ICLF) systems should increase the number of successful experiences.

In Brazil, an important component of many ICLF systems is the soybean (*Glycine max*). The soybean-*Bradyrhizobium* might be considered as the "perfect symbiosis", adapted to a variety of edaphoclimatic conditions and reaching rates of 300 kg of N/ha, in addition to about 30 kg N/ha left over for the following crop (Hungria & Mendes, 2015), which in ICLF is often maize or *Brachiaria* spp. Considering the prices in Brazil, this "leftover" implies in an economy of about US$ 30/ha, besides the mitigation of 135 kg CO_2eq (considering 4.5 kg of CO_2eq/kg of N-fertilizer). The economic and environmental impacts in millions of hectares of pastures in Brazil can be easily realized. Another important contribution of BNF in ICLF can come from legume trees and may reach hundreds of kg of N/ha, e.g. with *Gliricidia* spp., but the adoption by farmers is still modest.

Relevant results can also be achieved with the use of other plant-growth promoting rhizobacteria (PGPR), encompassing contributions by a variety of mechanisms including BNF, production of phytohormones, increased stress tolerance, antibiosis against pathogens, among others. The use of *Azospirillum* spp. with the maize crop, also a component of many ICLF systems is increasing exponentially in Brazil. Finally and probably even more exciting are the results that have been obtained by our group with PGPR applied to *Brachiaria* spp., resulting in impressive increases in plant biomass production and nutrient content.

How far can we go with microbial inoculants in ICLF systems? Here we gave some few examples that can be expanded to several other annual and perennial crops and forest species used in ICLF systems. All can be benefited—in lower or higher degree—by microbial inoculants. Apparently, we are reaching an era of "microgreen revolution", with deep impacts on sustainable food production.

References cited

Ormeño-Orrillo et al. (2013). Berlin Heidelberg. Springer-Verlag
Hungria & Mendes (2015). New Jersey, John Wiley & Sons.

Acknowledgements

To Embrapa and CNPq.

GO TO
KEYNOTE SPEAKERS
ORAL PRESENTATIONS
POSTERS