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Soil biodiversity: genetic resources to enhance nitrogen fixation in agriculture and forestry

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Leguminosae is the third largest family of flowering plants. Although about 75% of the extant 20.000 Leguminosae species are unknown regarding their ability to establish a mutualistic symbiosis with nitrogen fixing bacteria, near 3.500 species around the world are already known to present this characteristic. Leguminosae is an important family in Brazilian ecosystems both in diversity and density. It is estimated around 2.000 native species. Hence, they represent an important source for new species and strains of Leguminosae nodulating bacteria (LNB) to be explored and to enhance symbiotic nitrogen fixation. Until now, 55 LNB species were described. Among them, five were described considering Brazilian native strains (*Rhizobium tropici, Mesorhizobium plurifarium, Sinorhizobium adherens, Azorhizobium doebereinerae, Burkholderia mimosarum*). Results of intensive surveys on soil LNB diversity indicate these figures can be much higher. Bacterial species/strains and plant species vary regarding the establishment of their symbiosis from highly specific, i.e., they are able to form symbiosis with just a narrow range of partner species/strains, to highly promiscuous, when they are able to establish symbiosis with a large range of partners. Regarding functionality, strains efficiency usually exhibit a large range even within the same species in symbiosis with a given host species. *Azohizobium doebereinerae* & *Sesbania virgata* specific symbiosis seems to be an exception, as all strains tested until now were highly efficient. Siratro (*Macroptilium atropurpureum*), common beans (*Phaseolus vulgaris*) and cowpea (*Vigna unguiculata*) are very well known promiscuous hosts establishing symbiosis with a large number of species and genera which vary a lot regarding nitrogen fixation efficiency. These plant species has been used as traps for the study of LNB diversity and the last two are important crops which could better benefit from symbiotic nitrogen fixation. Specificity/promiscuity, efficiency and adaptation to environment conditions must be considered for both strain selection and inoculant efficiency. *Lotus* spp. establish symbiosis the high promiscuous strain *Rhizobium* spp. NRG234, *Rhizobium etli Bradyrhizobium* sp. and with *Mesorhizobium loti*. Strain *M. loti* MAFF 303099 was the first LNB genome already sequenced. Comparison of its genome to other LNB genomes revealed that genes and regions involved in symbiosis and nitrogen fixation exhibited a high diversity in their organization. Efficient strains have been selected and recommended for inoculant production of 109 leguminous species, including those used for multi-purpose trees, grains, forage (e.g. *Lotus* spp.), and green manure. According to MAPA (Ministério da Agricultura, Pecuária e Abastecimento), 26,4 million doses of inoculant were produced and commercialised in 2003, the vast majority, i.e. 99%, being for

soybeans. Thus, the remaining 1% was for the other 108 species, indicating diffusion of this biotechnology need to be improved. BNF in soybeans was estimated in 2,60 million Mg N in 2006/2007. This figure is greater than the 2,34 million Mg used in 2006/2007 by all crops in the same year, from which 64 % were imported. If inoculants were applied intensively to the other legume species, direct and indirect (e.g. green manure to non-legumes) benefits of nitrogen fixation could enhance crop productivity in an environmentally sound way. RELARE (Rede de laboratórios para recomendação, padronização e difusão da tecnologia de inoculantes microbiológicos de interesse agrícola) is a laboratory network responsible for recommendation, standardization and diffusion of inoculant technology relevant to agriculture. Usually one to four strains are recommended as inoculant to each one of the 109 plant species without considering yet the large variability of climatic and edaphic conditions in Brazil. Although, a great progress was made until now, it is obvious, much more is needed to be done in order the important biological process of nitrogen fixation can totally replace agriculture and forestry requirements. Improving soil biodiversity knowledge implies not only enhancing genetic resources conservation but also better ecology knowledge for improvement of management practices, including inoculation.