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Outlines of Microbiology Programme at International Crops Research Institute for the Semi-Arid Tropics

By

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Our emphasis will be on biological nitrogen fixation by pulse and forage legumes, and by bacteria closely associated with the roots of the cereals, sorghum and millet. We will examine the numbers of rhizobia in the soils of Semi-arid tropics capable of nodulating the legumes in the ICRISAT crop improvement programme, namely pigeon pea, groundnut and chickpea, and will look at the effect of season and cropping sequence on these numbers and their distribution through the soil profile. After selecting effective and competitive strains for these legumes, their ability to form nodules in the field after seed inoculation will be followed by serological typing of the nodules including fluorescent antibody techniques, and by identifying the cultural properties of the isolates from the nodules (using inoculum strains with defined responses to growth factors, antibiotics and antimetabolites.)

The types of carriers for *Rhizobium* inoculants in the Semi-arid tropics, and the numbers of rhizobia surviving at the various stages of inoculant production and use will be examined. ICRISAT will collect from all over the world, maintain and distribute *Rhizobium* cultures for the three pulse legumes.

ICRISAT holds the world germplasm collections for these three legumes and we will attempt to screen the collections for ability to nodulate and their effectiveness in fixing nitrogen with different *Rhizobium* populations. We will evaluate the ability of the plants to continue forming nodules throughout their growth cycle, particularly in soils where the surface layers dry as the season progresses, as often in chickpea cultivation.

Nodulation and nitrogen fixation by the three pulse legumes can be poor in some localities. We will be trying to identify the reasons for this—perhaps *Rhizobium* numbers are limiting or the population is ineffective, or soil nutrients are limiting or salt levels are inhibitory or the soil physical environment unfavourable for nodule formation. Having established the likely limiting factors involved we

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will be in a better position to assess the extent and location of these and to recommend ways to ameliorate them. Mycorrhizal associations can help in phosphorus and zinc uptake from soils where available levels of these nutrients are low. The potential for enhancing the mycorrhizal infections of plants in the Semi-arid tropics will be explored.

Legumes fix nitrogen but not all legume crops enrich the soil nitrogen content. The amounts of nitrogen fixed and the amounts returned to the soil, and the amount taken off in grain and lost through leaching and denitrification will be measured under different cropping systems.

Between 20-30 per cent of the land in the Semi-arid tropics appears suitable for pasture or forage production. The *Rhizobium* requirements of legumes suitable for improved pastures will be studied so that inoculants can be produced where necessary. Factors limiting nodule production and nitrogen fixation by suitable pasture legumes will be assessed.

Millet and sorghum form associations with nitrogen fixing bacteria. We will be evaluating the difference between genotypes in stimulating this activity and its heritability so that breeding methods can be developed to incorporate this activity into elite material and populations. The amounts of nitrogen fixed, the amounts transferred to the plant, and effect of agronomic practices such as nitrogen fertilising on this activity will be studied.

Soil nitrogen is a major factor limiting yields in Semi arid tropics. When nitrogen fertilisers are little used, the nitrogen available for crop growth of non-nodulated plants is mostly derived from mineralisation of organic matter. We will look at the effect of cropping sequence and quantity and quality of organic residues returned to soil, or the amount of nitrogen available for crop uptake.

This outline sketches the directions we plan our work to take. Not all aspects can be started at once. We will be co-operating closely with the Crop Improvement and Farming Systems Programmes at ICRISAT in this work, and hopefully can extend this cooperation to National Institutions in India, and other parts of the Semi-Arid Tropics. An integral part of our programme will be training people where needed so that National programmes can also work effectively in the areas described above.