Bacteria may boost crop yields

BELTSVILLE, Md. — Some farmers' best friends are bacteria - a type called rhizobia. Agricultural researchers want to get better acquainted with the one-celled microbes, and introduce them to more farmers.

In fact, a current surge of interest in rhizobia by scientists around the world has prompted officials of the U.S. Department of Agriculture (USDA) to establish a special rhizobia project at the Beltsville Agricultural Research Center in Maryland. Scientists there will collect and study strains of rhizobia and similar "friends", and distribute them to other USDA and non-USDA labs where rhizobia investigations are underway.

Just what is so friendly about these bacteria?

"Rhizobia have the natural ability to provide crops with nitrogen, an element that plants need for growth and to make proteins," explains USDA microbiologist Deane F. Weber who will supervise the new USDA Rhizobium Collection and Study Project at Beltsville. "In their own way, rhizobia fertilize certain crops. This happens without applications of commercial nitrogen fertilizers, which require enormous amounts of natural gas to manufacture. Farmers simply coat seeds with rhizobia before planting to increase harvests."

Scientists discovered the plant-rhizobia association some 90 years ago. Since then, they have found the soybeans, alfalfa, clover and other members of the protein-rich legume family of plants could each be inoculated with a specific strain of rhizobia to increase yields. The bacteria work in small root nodules, combining nitrogen atoms from air in the soil and hydrogen atoms from sugars in plant tissues to make ammonia, the basic ingredient of nitrogen fertilizer, whether natural or manufactured by industrial means.

The natural process is called "biological nitrogen fixation". It often leaves fields more fertile after harvest than before the legume crop was planted. Before widespread use of artificial nitrogen fertilizer in developed countries, the traditional way of adding nitrogen to the soil for succeeding crops was to use legume crops, such as soybeans or clover, in crop rotations.

Since 1912, scientists at USDA's Beltsville Agricultural Reserach Center have been studying nitrogen fixation and adding superior nitrogen-fixing bacteria to what is now this country's largest public collection of rhizobia and other (less significant) nitrogen-fixing microorganisms. Each year, Weber sends hundreds of rhizobia cultures to scientists around the world. Laboratories in 53 foreign countries have so far received rhizobia from the Beltsville collection.

With financial support for the Rhizobium Project from USDA and the State Department's Agency for International Development, Weber and a group Beltsville colleagues trained in related fields of "rhizobiology" will expand their efforts to collect, characterize, test and distribute strains of rhizobia that are effective on different types of legume plants. Of an estimated 13,000 species of legumes, only 50 are domesticated. Of the possible legume-rhizobia associations, Weber estimates that sceintists have identified only 10 per cent that form nodules and benefit the plant.

The expanded collecting and testing, however, "will not be a numbers game," says Weber. "Nor are we interested in keeping this valuable resource as a museum piece. It is a working collection. The future will likely bring a high demand for bacterial fixation of nitrogen for crops, and there is great need for scientists to know what Rhizobium genes or characteristics are available."

Current research being conducted in many of the world's agricultural research labs includes identifying genes in rhizobia that control nitrogen fixation in order to develop bacteria that work harder and more efficiently. Scientists are also trying to stimulate plants to contribute more energy to rhizobia so that the bacteria will fix more nitrogen. Other scientists are attempting to extend nitrogen-fixing associations to nonlegume crops, such as corn, wheat and other cereals and grasses.

While such "pioneering" research continues, applied research devoted to improving rhizobia inoculation techniques has been largely ignored, according to Weber. "When commercial fertilizer became cheap in the late 1950's," he says, "research on rhizobia inoculation and the training of rhizobia technicians sharply declined, and have never recovered. Now, just when the need is perhaps greatest, there is a troubling shortage of qualified scientists and technicians. The USDA Rhizobium Project should help to fill this void."

From countries where knowledge of rhizobia is in short supply, research labs will send technicians to Beltsville to learn how to isolate, purify and culture rhizobia suited to particular growing conditions, and how to make and apply rhizobia inoculum to seed. In addition, Weber and other members of Beltsville's Cell Culture and Nitrogen Fixation Laboratory will provide guidance and advice to rhizobia workers in less developed countries so that they can start their own rhizobia training programs.