# I. Introduction

## 1. The Biofertilizer Manual

This biofertilizer manual is the product of the Biofertilizer Project in FNCA (Forum of Nuclear Cooperation in Asia). Eight countries, China, Indonesia, Japan, Korea, Malaysia, Philippines, Thailand, and Viet Nam participate in this project. The Editor-in-Chief is Dr. Pham Van Toan, the Project Leader of Viet Nam. The activities of this project are introduced in FNCA homepage (http://www.fnca.jp/english/index.html) in English.

This project is aimed at improving and disseminating biofertilizer technology to increase the yields of grain legumes and other crops which are important food and animal feed sources in Asia, and to enhance environmental friendly sustainable farming practices by reducing excessive amount of chemical fertilizer application.

The project formulation meeting was held in Bangkok, Thailand in August, 2001. In this meeting, members agreed that this project deals with biofertilizers involving microorganisms which promote nutrient acquisition of the plants, such as $N_2$ fixation by rhizobia or free living bacteria, arbuscular mycorrhizal fungi and phosphorous solubilizing bacteria which improve phosphorous nutrition, and other microorganisms that help nutrient uptake. These biofertilizers can be expected to reduce the use of chemical fertilizers. Sometimes the term biofertilizer is used for various types of materials such as composts, agro-waste, and some liquid cultures of unidentified miscellaneous microbes. However, we do not include them in this project, because the evaluation of effectiveness of such products and their quality control is quite difficult as compared with biofertilizers from identified microbes under controlled conditions.

We agree the definition of biofertilizer proposed by Prof. Dr. Zulkifli Hj. Shamsuddin, University Putra Malaysia, in Inaugural Lecture of 17th June 2005. “Biofertilizer is a substance which contains living microorganisms which, when applied to seed, plant surfaces, or soil, colonizes the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant(Vessey, 2003) (Vessey, J.K. 2003. Plant growth promoting rhizobacteria as biofertilizers. Plant Soil 255, 571-586). This definition separates biofertilizer from organic fertilizer. The latter contains organic compounds which directly, or by their decay, increase soil fertility. Likewise the term biofertilizer should not be used interchangeably with the terms, green manure, manure, intercrop, or organic-supplemented chemical fertilizer. Not all plant growth promoting rhizobacteria (PGPR) can be considered biofertilizers. Bacteria that promote plant growth by control of deleterious organisms are biopesticides, but not biofertilizers. Similarly bacteria can enhance plant growth by producing phytohormones and are regarded as bioenhancers, not biofertilizer. Interestingly, some PGPR can promote growth by acting as both biofertilizer and biopesticide or bioenhancer.”

The production and use of biofertilizer is proposed, to improve yield of crops by using root nodule bacteria (rhizobia), mycorrhizal fungi, and other microorganisms that are able to increase availability of plant nutrients from the soils. For this purpose, the most effective microorganisms for each specific crop will be identified, for example, by measuring $N_2$ fixation activity by using nitrogen-15 isotope as tracer and using other methods too. Ionizing radiation is used to sterilize the carriers of the rhizobia and other biofertilizer

microorganisms.

These microorganisms are selected by pot and field experiments, cultured and packed with carrier materials, and provided commercially for the agricultural crops and reclamation of forest and devastated lands. Quality control is extremely important, especially for the population of infected effective microbes and other contaminants, which may often give adverse effects. The carrier sterilization by ionizing radiation is one of the best ways to keep biofertilizers in storage for a long period.

The working plan for the project was formulated as the following: Selection of effective microorganisms (2002), Improvement of inoculant (2003), Improvement of soil microbial activities (2004), Field trials (2005), Economic analysis including assessment of impact on cost savings (2006).

This biofertilizer manual is written by project members and other experts to share information and experiences of biofertilizer use in Asian countries, their effectiveness, efficient production processes, storage and application on different crops. The field demonstration was proposed in the 2002 Workshop. Each country carried out the field experiments using various biofertilizers. Some examples of field experiments are shown in this manual.

This manual has the following chapters: 1) Introduction, 2) General methods to evaluate microbial activity, 3) Carriers for biofertilizers, 4) Inoculant for biofertilizers including rhizobia, non-symbiotic nitrogen fixers, mycorrhiza, phosphorous solubilizers, and 5) Quality control of biofertilizers, from advanced basic information to practical methods in each participating country.

We try to write as easy as possible for scientists and technicians involved in biofertilizers in Asia. However, we admit that this manual may be quite difficult for farmers. It is our hope that scientists and technicians will translate some part of this manual into the respective mother language in some brochures or pamphlets for farmers. Each chapter was written by expert of this field. Please feel free to contact FNCA for enquiries on this manual.