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Biofertilizer Technology

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BIOFERTILIZERS TECHNOLOGY

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FOREWORD

The major challenge in the 21st Century is to sustain the increase in productivity forever decreasing per capita land and water resources. So far, the mankind has successfully managed to provide the basic necessities with the increase in production of food, fuel and fibre. Their basic weapon has been non – renewable fossil fuel for energy intensive agricultural management. But the impact has began to show its teeth. There is urgent need for environment friendly, economically viable but sustainable technologies to satisfy the requirement of huge population of this planet. Sustainable agriculture requires the management of resources in a way to fulfil changing human needs without damaging or deteriorating the quality of environment and conserving vital natural sources.

Lowlands comprise of 87% of the 145 M ha of world rice area. Lowland rice – based cropping system are characterized by soil flooding during most of the rice growing season. Rainfall distribution, availability of irrigation water and prevailing temperatures determine when rice or other crops are grown. Nitrogen is the most required nutrient in low-land rice based cropping system. Reducing fertilizer N use in these cropping systems, while maintaining or enhancing crop output, is desirable from both environmental and economic perspectives. This may be possible by enriching the soil N through biological nitrogen fixation (BNF), minimizing soil N losses and by improved recycling of N through plant residues.

Favourable conditions for BNF is one of the reasons for the relatively stable yield of rice in the rice based cropping system. The reduced soil conditions favour heterotrophic nitrogen fixation. The flood water is the site for photodependent nitrogen fixation by free-living cyanobacteria, photosynthetic bacteria and symbiotic cyanobacteria with *Azolla*. The rhizosphere of rice also provides favourable conditions for microaerophilic bacterial N₂ fixation. In addition, the inclusion of legumes for grain, forage and green manure production might increase the total N output from the cropping system and further add to soil N through BNF. Though, BNF by individual systems in different crops has been investigated in detail, the BNF in a cropping system has not been studied well. As a result, the relation between the different N₂ fixing system, especially indigenous ones, are not fully understood and it is not clear if their activities are independent or related. Moreover, because of technological and socioeconomic limiting

factors, the agronomic potential of BNF is still largely underutilized in the rice based cropping system. Methodological progress and comprehensive evaluations of BNF in rice fields are still needed to develop and test agricultural practices that take advantage of BNF in this important agroecosystem.

In this context, this book entitled '**Biofertilizers Technology**' gives a clear insight into the potentials and prospects various nitrogen fixing systems, both conventional and novel, that could be exploited for the maximum advantage of the diverse crops grown in the rice based cropping systems. Due importance has been given for other microbial systems which are involved in making available phosphorus and micronutrients to the crops raised in this major cropping system. Any technology, which has commercial implications, could be sustained only through appropriate and viable quality control programmes. It is interesting to note that attempts have been made to throw much light on the recent approaches in the quality control of biofertilizers through molecular biological and biotechnological methods. I am sure, that, the readers of the book will get a new dimension of thinking on the beneficial role of biofertilizers in a cropping system as a whole. I congratulate and compliment the editors of the book, Prof. Dr. S. Kannaiyan, Dr. K. Kumar, and Dr. K. Govindarajan and all the scientists who have contributed research papers, for their sincere efforts to bring out this most useful and productive volume. I am proud to note, that, this book is an outcome of the National Workshop on 'Recent Developments in Biofertilizer for Rice Based Cropping System' held at Tamil Nadu Agricultural University, Coimbatore as per the mandate of the National Agricultural Technology Project sponsored by Indian Council of Agricultural Research, New Delhi. I sincerely hope, that, this piece of work will have a long lasting impact in the field of BNF and biofertilizers technology.

New Delhi

Dr. Panjab Singh

Secretary, DARE &

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PREFACE

In India, the compulsion of increasing crop yield per hectare is simply a matter of necessity to achieve production target of atleast 240 million tonnes to feed over 1 billion people in the ever deteriorating land : man ratio. Our nation is fourth largest user of chemical fertilizers (18.7 million tonnes of NPK nutrients) in the world and its soils are still being depleted of their inherent nutrients reserve as a result of wide gap between additions and removals. One tonne of produce removes from soil on an average 32 kg nitrogen, 12 kg phosphorus and 58 kg potash. At present, India produces about 210 million metric tonnes of food grains for its growing population of more than one billion people. In the recent plan, the target is to produce an additional 30 million tonnes food grains and 5 million tonnes of pulses and oil seeds. In order to meet the food requirement of ever increasing population, the present nitrogen fertilizer requirement for crop production is estimated to be about 11.4 million tonnes as against the supply of 3.9 million tonnes. At present, this vast gap cannot be filled-up merely through the production of synthetic nitrogenous fertilizers due to scarcity of high cost raw materials such as fossil fuels. Biological nitrogen fixation is the key to sustain agricultural productivity and application of biofertilizers in the field is the viable alternative.

Biofertilizer technology enables the use of living organisms for the nourishment of the plants either by fixation of atmospheric nitrogen through the process of BNF or by solubilization of mineral nutrients like phosphorus. Biofertilizers are apparently environment and farmers friendly renewable sources of non – bulky and low cost organic agro – input. While *Rhizobium*, Blue Green Algae (BGA) and *Azolla* are crop specific, bio – inoculants like *Azotobacter*, *Azospirillum*, Phosphorus Solubilizing Bacteria (PSB), Vesicular Arbuscular Mycorrhiza (VAM) etc. could be regarded as broad spectrum biofertilizers.

Rice based cropping system is the major cropping system practised in India which includes the rotation of crops involving rice, pulses, oil seeds, cotton, sugar cane, green manures etc., Rice – rice is the most dominant cropping system under irrigated conditions in South and Eastern India, while rice – wheat, rice – groundnut, rice – legumes, rice – mustard and rice – potato are some of the predominant rice based cropping systems with 200 per cent cropping intensity in different North Indian States. Various rice based

cropping systems with 300 per cent cropping intensity have been reported from different parts of India, ranging from rice – rice – rice to rice followed by different cereals, pulses, oil seeds, vegetables and fibre crops. Rice – rice – pulse (green gram / black gram) is the predominant cropping system of major rice growing areas of Tamil Nadu.

Rice based cropping systems may include lowland rice and upland crop. So far, research had been focussing attention on individual crops disregarding the fact that each crop was only a component of a cropping system. Hence, the nutrient management practices for the individual crops were based on the responses of individual crops to the major nutrients without considering the system as a whole. Under these circumstances, there is urgent need for developing integrated nutrient management practices for the cropping system as a whole rather than for individuals crops. Integrated use of organic manures, biofertilizers and crop residues in rice based cropping system not only could substitute a portion of the costly fertilizer N but also could help to maintain fertility in intensively cultivated rice soils. The practice of using green manures, biofertilizers, including pulses in the cropping system and incorporating their haulms integrated with inorganic fertilizers has received a great deal of attention for efficient and economic management of N for rice based cropping system.

This book entitled '**Biofertilizers Technology**' is the outcome of the discussions and deliberations of the National Workshop on 'Recent Developments in Biofertilizers for Rice Based Cropping System' held at Tamil Nadu Agricultural University, Coimbatore during August 16 -18, 2001 to develop a strong, workable and compatible package of nutrient management through organic and inorganic sources exclusively for rice based cropping system. Leading scientists and experts from different parts of India working on the basic and applied aspects of various biofertilizers used in rice based cropping system have shared their valuable experiences and useful informations in this area of research in their research papers. This book is first of its kind in focussing the application of biofertilizers technology in the major cropping system of India *viz.*, rice based cropping system. We hope, that, the book will be a very good resource material for people in different walks of life *viz.*, agricultural policy makers, crop management scientists, researchers, students, extension workers and literate farmers. We profusely thank all the authors, who have richly contributed research papers to this very productive volume. We gratefully acknowledge the financial assistance extended by Indian Council of Agricultural Research, New Delhi under National Agricultural Technology Project-Team of Excellence on Biofertilizers for Rice Based Cropping System, for conducting the National Workshop from which the focal theme and the idea of publishing this book emanated.

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