MODEL PROJECT INFORMATION SHEET

BIOFERTILIZERS FOR INCREASED LEGUME PRODUCTION

BANGLADESH - BGD/5/017

SUMMARY

Large scale application of biofertilizer (rhizobium inoculum) would increase production of grain legumes, important food in Bangladesh, by at least 25%, leading to self-sufficiency in legumes and saving about US $31 million per year. It is proposed to utilize the ^{15}N technique developed by the Joint IAEA/FAO Division of Nuclear Techniques in Food and Agriculture. A pilot scale plant capable of producing 100 tonnes of biofertilizer per year would be established and large scale field trials undertaken, with a view to laying the foundations for large scale application by the farming community. The model project would contribute to sustainable agricultural development and would have a significant impact on the recipient institute (the Bangladesh Institute of Nuclear Agriculture (BINA)), the farmers (the end users) and the national economy.

Project duration: 3 years. Total budget: US $151,650.

INTRODUCTION

Grain legumes such as lentil, chickpea and groundnut are popular and are an important source of food in Bangladesh. However, owing to low yields coupled with high demand, these legumes often have to be imported. One method of increasing yields to meet the demand is the use of chemical fertilizers, but the high costs involved are forcing farmers to look for alternative ways to increase and sustain yields. Recently, biological nitrogen fixation, a process by which legumes can fix atmospheric N_2 into forms usable by the plant, has been seen as an attractive alternative. Legumes that fix atmospheric nitrogen can provide high protein for human and animal consumption and also increase nitrogen in soils.

With a view to exploiting this gift of Nature, a project on Nuclear Techniques in Agriculture (BGD/5/013) was initiated in 1988, implemented at the Bangladesh Institute of

Nuclear Agriculture (BINA) in Mymensingh. The project assisted in establishing national capacity in R&D in rhizobiology. Field studies carried out under that project have resulted in the identification of elite genotypes of grain legumes which, in combination with appropriate strains of rhizobia, can fix greater amounts of nitrogen than the traditionally used local cultivars. More importantly, it has been possible to increase the yields of lentil, chickpea and groundnut by 30-40%. Studies conducted at BINA using ^{15}N have also shown that the use of biofertilizer containing appropriate strains of rhizobium bacteria for lentils, chickpea and groundnut can contribute 70-100 kg per hectare of atmospheric nitrogen through biological fixation. The savings on this alone would be equivalent to approximately 150-200 kg urea per hectare ($20-$25 per hectare compared to $3-$4 using biofertilizer) in addition to reducing the harmful effects on the environment of commercial nitrogen fertilizer. In Bangladesh lentil, chickpea and groundnut at present cover 357,000 hectares (out of an area of 730,000 hectares used for all pulses). The present need of biofertilizer in the country is about 750 tonnes/year. The project is expected to generate its own funding through a contract mechanism with a private company to sustain its future activities.

In 1990, the production of these grain legumes (280,000 tonnes) could not meet the national demand and 70,000 tonnes were imported at a cost of about US $25 million. Thus even a modest average yield increase of say 25% could raise production to offset the deficit. Further improvement could lead to surplus production for export.

Biofertilizer and its technology in Bangladesh are essential for sustainable legume production and would have a significant social and economic impact on farmers and the agricultural sector in general. Biofertilizer production is the first of seven biotechnologies listed in a Biotechnology Product Development report prepared by the National Committee for Biotechnological Product Development, chaired by the Minister of Science and Technology. On the basis of BINA's rhizobiology experience and infrastructure, the project seeks to establish a pilot scale biofertilizer production facility and to undertake large scale field trials as bases for large scale commercial production and utilization of biofertilizer. BINA, the primary recipient and direct beneficiary, is the leading counterpart organization.

NUCLEAR TECHNOLOGY

Many methods are available for measuring N_2 fixation, with both limitations and advantages. The Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture has developed a technique using the isotope ^{15}N which has proven to be a unique tool to estimate the amount of nitrogen derived from the atmosphere versus that derived from the soil and applied fertilizer. The technique is relatively simple and requires growth of the nitrogen fixing crop together with a non-fixing crop in soil labelled with ^{15}N. A major advantage of this method is that it provides an integrated measure of N_2 fixed for desired periods of time. This technique has therefore been used in preference to other non-isotopic methods to measure the progression of N_2 fixation in various legumes, providing a better understanding of factors that influence N_2 fixation and therefore the yield, particularly the effects of inoculation with an elite strain of rhizobia. The potential for increasing yields of lentil, chickpea, groundnut and mungbean, through greater contribution of nitrogen from the atmosphere, can be more conveniently examined

by means of ^{15}N as a tracer. In this project, ^{15}N will be used as a tool to identify strains of rhizobia efficient in N_2 fixation and cultivars of grain legumes capable of producing higher yields.

OBJECTIVES

1. To establish a demonstration plant for the production of 100 tonnes of biofertilizer (rhizobium inoculum) as a technological base for development of a biofertilizer industry.

2. To undertake larger scale field trials to demonstrate the effectiveness of the biofertilizer in increasing legume production.

3. To assist in establishing large scale production of biofertilizer with a view to sustainable legume production.

PROJECT IMPLEMENTATION AND MONITORING

A Project Co-ordination Committee will be established at the outset composed of representatives from BINA, the Ministry of Agriculture, the National Committee of Biotechnology Product Development and farmers, chaired by the National Co-ordinator nominated by the Ministry of Agriculture. The committee will undertake co-ordination, implementation details, evaluation and monitoring and establish communication with the media. Its first meeting will take place in early 1995, and periodic meetings will be held at least twice a year for the duration of the project. The committee can also undertake follow-up activities after the conclusion of the project.

During the first year, BNI will select elite strains of rhizobia using the ^{15}N isotope technique, which requires greenhouse and field experiments. The strains of rhizobia identified will be multiplied by means of inoculum fermentors. Mixing rhizobia with the carrier peat, packaging and storage will be carried out by BINA. Distribution will be undertaken in collaboration with the Extension Services Division of the Department of Agriculture. Field trials will be conducted in farmers' fields to assess the yield responses of lentils, chickpea, groundnut and mungbean to applications of inoculum. For this purpose, trainers will be trained at BINA who will in turn train farmers in the methods of application of rhizobium inoculum to grain legumes. BINA, in collaboration with the Department of Agriculture, will collect the data from field trials and make suitable analyses for yield gains. These results will provide the background information for follow-up field trials in 1996-97. Inoculum fermentors, equipment, chemicals and ^{15}N labelled fertilizer will be supplied.

In the second year (1996) inoculum production and field trials will continue in order to confirm data obtained in 1995 and to test the technology of inoculum application in different agroclimatic regions in the country. Expert services, fellowship training and supplies (mainly ^{15}N labelled fertilizer) will provided.

In 1997 data from field studies conducted during the first two years will be analysed and a cost-benefit analysis undertaken. Recommendations will then be made to

the Government on large scale production of biofertilizer and a large scale programme for sustainable legume production.

Monitoring progress of the project will be undertaken by the Project Co-ordination Committee, which will prepare an annual progress report showing the degree of implementation and the most important results, identifying the problems and recommending the action needed for further progress. This report will be discussed at the annual meeting of the committee, which will be attended by representatives of the Agency, FAO and other interested national and international organizations. Upon completion of the project, a seminar will be held for final evaluation of project activities, including discussion of the results, a quantitative assessment of its impact and its contribution to sustainable development, and a cost-benefit analysis. A model project final report will be prepared by the Agency on the basis of the seminar papers.

NATIONAL COMMITMENT

The Government is committed to introduce a biofertilizer industry in Bangladesh. In view of its good infrastructure, BINA, in Mymensingh, is the most appropriate institute to implement the project. However, adequate buildings, laboratory space and man-power would be required to accommodate the production plants and provide packaging and storage facilities. BINA and the Extension Services Division of the Department of Agriculture, with the help of the Agency, will conduct demonstration trials in 4000 fields of 400 square metres each in the first year and a similar number in the second year in order to demonstrate to a large number of farmers the effectiveness of biofertilizer to increase the yield of grain legumes.

BINA will be responsible for the establishment of the pilot plant and, in co-operation with the Ministry of Agriculture and farmers (the end users), will undertake large scale field trials. It is hoped to attract private investors in setting up a manufacturing plant for production of biofertilizer with technical and scientific support from BINA.

THE AGENCY'S INPUT

Experts will provide technical support to ensure production of high quality biofertilizer at BINA. Some equipment and supplies, mainly inoculum fermentors (100 litre capacity) and ^{15}N labelled fertilizer for field testing of superior cultivars of legumes and biofertilizer strains, will also be provided. Agency support will cover partially the demonstration trials on farmers' fields in collaboration with the Extension Services Division of the Department of Agriculture. The Agency will also provide expert advice on large scale production of inoculum and the use of ^{15}N in field experiments, in addition to fellowships and scientific visits.

IMPACT

A 100-tonne capacity pilot plant for biofertilizer production will help to establish the capability to create a successful biofertilizer industry in Bangladesh. Further, it will establish the R&D capability needed to sustain and further develop this dynamic industry.

Field demonstrations of the application of this technology will establish a market for the industry. Increasing legume production by about 25% through the use of biofertilizer will lead to savings of about US $25 million on imported legumes and about US $6 million on chemical fertilizers. This represents an important saving for Bangladesh. The use of biofertilizers instead of chemical fertilizers will eliminate chemical pollution of soil and water resources. The establishment of a biofertilizer industry based on sound cost-benefit analysis will create employment opportunities and contribute to sustainable development in Bangladesh as well as contributing significantly to sustainable agriculture.

FINANCES

The budget allocation for the project is US $151,650, distributed as follows:

Year	Experts		Equipment	Fellowships		Scientific visits		Grp trg.	Sub-contr.	Misc. Comp.	Total
	M/D	US $	US $	M/D	US $	M/D	US $	US $	US $	US $	US $
1995	1/0	11,400	35,000	3/0	9,900	-	-	-	18,000	-	74,300
1996	1/0	12,000	35,000	3/0	10,350	-	-	-	-	-	57,350
1997	-	-	20,000	-	-	-	-	-	-	-	20,000
Total	2/0	23,400	90,000	6/0	20,250	-	-	-	18,000	-	151,650

Source of funding: TACF