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PROGRAMME PLANNING

COUNTRY AND INTERCOUNTRY PROGRAMMES AND PROJECTS

CONSIDERATION AND APPROVAL OF GLOBAL AND INTERREGIONAL PROGRAMMES AND PROJECTS

Project recommendation of the Administrator

Assistance for a global project

Maximizing Crop Production through Biological Nitrogen Fixation (BNF)  
(GLO/84/004)

Estimated UNDP contribution: \$2 350 000

Duration: Three years

Executing agency: UNDP

I. BACKGROUND

1. Nitrogen is an essential element for plants and animals since, among other uses, it is vital for the formation of protein. Although nitrogen is the most abundant gas in the atmosphere, accounting for almost 80 per cent of the air, it cannot be assimilated directly by plants. It must be first fixed organically by microorganisms and transformed into compounds that can be readily absorbed by the roots; or alternatively supplied in the form of chemical nitrogenous fertilizers produced inorganically by industrial processes requiring large amounts of energy. Nitrates and ammonia are the principal compounds used by plants in the formation of amino acids, the building blocks of protein.

2. The process by which such organisms as free-living bacteria, blue-green algae, blue-green algae/azolla (a water fern) associations and symbiotic bacteria (e.g. Rhizobium) convert atmospheric nitrogen into forms easily utilizable by plants is called biological nitrogen fixation. BNF has taken on renewed importance in view of the escalating costs of petroleum crude and natural gas, which are the primary sources of energy, and hydrogen for the industrial production of inorganic nitrogen fertilizers. When crude oil was sold at \$2 a barrel on the world market, BNF was of limited interest. Now that oil is selling at \$35 a barrel and the price of natural gas is rising rapidly, more attention is being focused on the potential of biological systems to fix nitrogen.

3. UNDP has been supporting basic research in BNF at selected international agricultural research centres within the network of the Consultative Group on International Agricultural Research (CGIAR). UNDP involvement in this field began in 1976, and currently is supporting four large global research projects. The first of these projects is being implemented by the International Rice Research Institute (IRRI). The objective of this project is to investigate biological nitrogen fixation in flooded rice. Several rice growing countries in South-East Asia (and the Boyce Thompson Institute for Plant Research in the USA) are co-operating with IRRI on various aspects of this research. The amount of nitrogen that is fixed in flooded rice fields in the tropics has been determined as 35-50 kilograms per hectare. Other experiments under greenhouse conditions have indicated that the rice plant must be present in order to obtain the maximum amount of fixation. Recent data has now revealed that rice varieties vary in the ability to promote fixation. This opens the exciting possibility of genetically manipulating this important characteristic and including it in modern rice varietal improvement programmes. Other research has identified certain of the nitrogen-fixing bacteria that reside in the rice root zone. In addition, a network of azolla trials in flooded rice has been established in co-operation with scientists in eight countries in South-East Asia. IRRI scientists, in co-operation with the Philippine Government, have successfully introduced azolla into the rice growing region of Mindanao. The cultural system does not involve off-farm inputs. This is a major step in the introduction of azolla into the hot, humid tropics.

4. In addition to the research on nitrogen fixation involving rice paddy soils at IRRI, UNDP is supporting similar research on sorghum and millets at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India, cowpeas and soybeans at the International Institute of Tropical Agriculture (IITA), Nigeria, and the International Center for Agricultural Research in the Dry Areas (ICARDA) in Syria. Since microorganisms in association with crops, particularly the legumes, can fix atmospheric nitrogen into forms which can be easily assimilated by the plants, and in view of the escalating costs of artificially produced nitrogen fertilizers, the UNDP-sponsored research in this area can be expected to result in payoffs in the short term, and thereby assist resource-poor farmers who cannot afford to purchase expensive nitrogen fertilizers. A total sum of about \$15 million has been earmarked by UNDP for this research during 1979-1986. This effort is co-ordinated with many research programmes in developing as well as developed country institutions. The Administrator's Panel of eminent scientists and development specialists, which reviews the global programme, has highly commended the initiative taken by UNDP in launching the above-mentioned BNF programmes.

5. The UNDP project at IITA referred to above, which is being carried out in close collaboration with the Boyce Thompson Institute for Plant Research (BTI) and Cornell University in the USA, has contributed a great deal in the understanding of the biological nitrogen fixation by cowpeas and in developing soybean varieties which fix nitrogen in association with indigenous Rhizobia. Cowpeas fix up to 240 kilograms of nitrogen per hectare in the soil. Cowpeas nodulate freely with indigenous Rhizobia, and are more tolerant to acid soils. They can, therefore, grow in poor soils under different agro-ecological conditions. Soybean varieties have been found to fix nitrogen effectively with indigenous Rhizobia without artificial inoculation. This characteristic is heritable and can be transferred to improved materials adapted to different environmental conditions.

6. Significant advances have also been made in the development of cowpeas with resistance to various insects and diseases. Another great achievement is the development of preferred colours in cowpeas and early maturity. Several new varieties which mature in 55 to 66 days are being enthusiastically received in Africa, Latin America and Asia. IITA is collaborating its cowpea improvement with 50 countries covering Africa, Asia and Central and South America. IITA has posted in Asia (Philippines) and South America (Brazil) a cowpea specialist in each of these two regions to co-ordinate the research. IITA's future plans call for greatly expanded training programmes in cowpeas and soybean improvement, especially for countries in Africa.

7. The Centro Internacional de Agricultura Tropical (CIAT) was established to develop improved technology to increase the quality and quantity of specific basic food commodities in the tropics, particularly in Latin America and the Caribbean. The principal food crops being investigated are cassava, field beans and rice. CIAT also conducts a large programme related to the better utilization of the acid and infertile soils of tropical America through improved pasture legumes and grasses and associated animal production systems. Some of the soils of the region have characteristics similar to the humid tropical region of Africa covered by IITA. Modest achievements have been made in BNF programmes relating to beans and pasture legumes. A great deal still remains to be done, especially for strengthening national programmes through training and to liaise with IITA so as to facilitate the transfer of technology between regions of the two continents with more or less similar agro-ecological conditions.

## II. THE PROJECT

8. The main objectives of the project are as follows:

(a) To train developing country personnel in BNF technology associated with cowpeas and soybeans in Africa and beans and pasture legumes in Latin America and the Caribbean with a view to increasing the yields of these crops; and

(b) To carry out limited research in Latin America on pertinent aspects of BNF.

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9. The activities to be entrusted to IITA will center mainly around strengthening of national programmes through training programmes (both at IITA and at regional levels), workshops and monitoring tours and provision of on-the-spot technical guidance and improved cowpeas and soybean varieties through IITA's main core programme on these two crops. IITA will organize training programmes in breeding, entomology, pathology, as well as in general production techniques for cowpeas and soybeans suited to various categories of national research and development staff. These specialized training programmes would be organized at IITA headquarters. In addition, training of field workers for conducting validative research and field demonstrations will be conducted at regional or national levels by IITA staff in collaboration with selected scientists of that region. There will be three types of training as follows:

(a) Training for adaptive research: In addition to the existing cowpea and soybean production course being organized annually at IITA, an additional course will be organized every year utilizing funds from this project to quickly fulfill the need for trained researchers in different countries. Thus, during the three-year span of this project, a total of six courses will be organized. Each of these will run for 8 weeks and train about 35 participants. The courses will be organized in January-February and October-November every year beginning 1985;

(b) Training for validative research: Training for validative research and extension personnel will be conducted within different regions. During the life span of the project, two such training programmes will be organized in each of the four regions located at Sri Lanka and the Philippines in Asia; United Republic of Tanzania and Botswana in Eastern and Southern Africa; Upper Volta and Nigeria in West Africa; and Brazil and CIAT, and Colombia in Central and South America; and

(c) Specialized training: Selected candidates from different countries would be trained at IITA for four to six months' duration in the specialized areas such as breeding, entomology, pathology and agronomy.

10. As an integral part of IITA's core programme, improved cowpea and soybean varieties generated by IITA scientists, along with the improved lines from national programmes, will be tested every year at various locations by the national programme scientists within each region under the technical guidance of IITA scientists based in that region. The elite materials would be subsequently tested in agronomic and on-farm trials by the national scientists with technical backstopping of IITA scientists. These activities will be complementary to the UNDP project, and with the funds being provided by UNDP exclusively for training, it is expected that it would be possible to train a large number of technical and research staff on priority basis from those national programmes which are presently deficient in trained personnel.

11. The activities to be implemented by CIAT will consist of two components:

(a) Training of personnel mainly from Latin America and the Caribbean for three to six months at CIAT and selected centres (such as Microbiological Resources Centers Programme (MIRCEN) jointly sponsored by the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the United Nations Environment Programme (UNEP)

at Porto Allegre, Brazil). The training will consist of agronomic experiments relevant to the maximization of BNF, including production and testing of inoculants. The trainees will be linked to previously established legume selection programmes within the area covered by CIAT, and will carry out a small research project under the supervision of senior specialists. They will be provided with limited supplies, not available locally, so as to enable them to successfully carry out the experiments at the national institutions concerned. Training for inoculant production will be conducted at CIAT, MIRCEN and NIFTAL (Nitrogen Fixation by Tropical Agriculture Legumes project of the University of Hawaii); and

(b) The modest research component of the project will consist of:

(i) Testing of seeds, fertilizers and Rhizobium at CIAT experimental stations within the present framework of CIAT's approved core programme, the scope of which could be expanded if funds are available from sources other than UNDP. The training co-ordinator/agronomist to be provided with UNDP funds under this project, as well as CIAT microbiology staff will ensure that all relevant field and laboratory tests are properly conducted and evaluated;

(ii) Evaluation of the persistence of Rhizobium strains in the soil after inoculation. In order to distinguish inoculated strains from indigenous rhizobia, special screening techniques are required. This work will be done as a collaborative programme with the Boyce Thompson Institute which has already developed serological methods for characterizing cowpea rhizobia as part of the work this institution carried out with the present UNDP BNF project at IITA referred to in paragraph 5. It is expected that the proposed CIAT/BTI research will permit the characterization of Rhizobium strains and the selection of highly effective strains for beans and pasture legumes; and

(iii) Testing of the survival of rhizobial strains by coating rhizobial inoculants onto seeds of the appropriate legume and fertilizer pellets. Since the International Fertilizer Development Center (IFDC) has successfully developed the technology for coating bean and groundnut rhizobia, using fertilizer as a carrier, CIAT will enter into a small collaborative contract with IFDC to develop fertilizer pellets, including South American sources of rockphosphates and feldspars. The expertise and well-equipped laboratories of IFDC will design pellets in such a way that they could be easily made in developing countries.

12. The Administrator intends, through contractual arrangements between IITA and UNDP on the one hand, and between CIAT and UNDP, to entrust the implementation of this project to IITA and CIAT, respectively, under separate contracts with the clear understanding that the Directorates of IITA and CIAT will seek the advice of the Food and Agriculture Organization of the United Nations (FAO). As in the past,

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UNDP will follow closely all the developments in this global project and, together with FAO, will participate in a joint Project Advisory Committee which will be established for the project. The Committee will meet once during the middle of the project and again towards the end of the project. It will appraise ongoing training and research activities and to advise on their future direction. Specialists from other international centres will be invited, as appropriate, to serve on this Committee.

13. Midway in the course of the project, UNDP, in consultation with IITA and CIAT, might decide to schedule an evaluation of project activities to be undertaken by a team of two or three independent consultants. Such an evaluation, if needed, could be undertaken in conjunction with one of the Project Advisory Committee meetings mentioned in paragraph 12. In any event, towards the completion of the project, a thorough evaluation of the results and accomplishments of the project will be mounted by UNDP, in consultation with IITA and CIAT, to be carried out by independent and prestigious consultants.

14. The proposed support to be extended to IITA and CIAT by UNDP during the project's three years represents 28 per cent of the total running core budget of the grain legumes programme of IITA, which is estimated at \$5.3 million, and 4 per cent of the total running core budgets of the bean and pasture programmes of CIAT, which are estimated at \$18 million. The balance of IITA's and CIAT's budgets is being financed by other members of the CGIAR. UNDP will not contribute towards any capital expenditures which might be made by IITA and CIAT in addition to their regular budgets.

15. The expenditure component of the proposed UNDP contribution is:

	\$
Subcontract (IITA)	1 500 000
Subcontract (CIAT)	750 000
Direct costs	<u>100 000</u>
Total	<u>2 350 000</u>

The project is submitted for approval by the Governing Council, subject to the approval of the Administrator's proposal for limited borrowing from the fourth programming cycle for the global programme as outlined in document DP/1984/20/Add.1.

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