CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

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TO: Members of the Technical Advisory Committee and Members of the Consultative Group

FROM: Executive Secretariat

SUBJECT: Eighth Meeting of the Technical Advisory Committee, IBRD Headquarters, Washington, D.C.
July 24 - August 2, 1974

To ensure prompt receipt of certain documents with respect to Item 11 (a) of the Revised Provisional Agenda of TAC, the Secretary of TAC has asked the Secretariat to circulate the attached cover note and paper prepared by the United States Agency for International Development on "An International Plant Nutrition Institute."

Attachment

INTRODUCTION TO

"AN INTERNATIONAL INSTITUTE FOR PLANT NUTRITION"

The attached paper was assembled rather quickly by AID staff to provide a notion of the broad scope of the array of research that is relevant to the problem of increasing radically the nutrition of the principal LDC crops. As the paper implies, we feel that breakthroughs in this area probably are the most significant steps that can be made towards production of adequate world food supplies for the decades ahead. Indeed, they may be a sine qua non for reaching a satisfactory food/population balance.

It was not intended to convey the notion that the whole array of research mentioned should become the function of a new international institute. Rather, the full array should be examined carefully to identify what could best be done where, how coordination and the best balance of effort is best assured, how adequate intensity of effort can be mobilized on the highest priority lines of effort, and so forth -- based on careful assessment of the broad problem, of who is doing what work on it, of the apparent promise in the various lines of research, and of relevant organizational considerations.

We start with a hypothesis for examination, viz., that an important segment of work on plant nutrition could be carried forward more productively by concentrating high quality and intensive interdisciplinary work on specific research targets through some variant of the international institute form of organization. For example, this segment might include:

-- work to accelerate nitrogen fixation, integrated with work on cropping systems that make high yielding uses of the nitrogen fixing agents under typical LDC conditions;

-- work to design better chemical fertilizers for the typical tropical or semi-tropical conditions of LDCs, as well as better distribution and marketing technology (done at a branch of the institute located at Muscle Shoals, for reasons explained in the paper);

-- continuing monitoring and analysis of the progress being made worldwide on all aspects of the problem of plant nutrition, with provision of information services, opportunities for conferencing and programming coordination among involved parties, and program or policy recommendations to action bodies; this function would include analysis of the comparative economic value and social fit of alternative lines of effort;

-- training and advisory services ("outreach") to build LDC capabilities.

Or some of this work might drop out, or other components enter.

Presumably such an institute would want to make substantial use of work in specialized facilities of developed countries -- perhaps partly through arrangements analogous to those of the International Potato Center and partly through sub-contracting or collaborative programming of independently financed efforts, or by other means. Another substantial set of collaborative arrangements might be sought with research organizations in the LDCs (including the other international institutes), particularly for agronomic trials of various kinds or supportive plant breeding in areas of specialization of the collaborating institution.

The forthcoming World Food Conference and the strong international attention being focused on world food problems at the political level, with specific emphasis on fertilizer, provide an extraordinary opportunity to mobilize attention and support for research work of the type mentioned here. Thus there is a premium on CGIAR/TAC seizing some significant initiative quickly, in whatever way makes sense to it, in order to channel energies wisely and gain maximum support for any new venture and the quickest feasible progress on the problems addressed.

AA/TA
6/26/74

April 29, 1974

AN INTERNATIONAL PLANT NUTRITION INSTITUTE

Problem:

Food production in most of the LDCs will have to be doubled by the end of this century, just to maintain the present inadequate level of human nutrition. Most of the necessary increased production will have to come from increased yields from lands already in use. Undeveloped arable lands are mostly remote from centers of population and industry or are marginal. The assurance of better yields is required before these will be developed. One of the major constraints to increased yield is the lack of essential elements for plant growth in an available form. In developed countries supplementary plant nutrients are usually applied in the form of fertilizer, lime or nutrient sprays. While commercial chemicals are an important source of supplementary plant nutrients for many of the LDCs as well, there is not enough fertilizer to meet the needs of the vast areas of farming land in these countries now or in the foreseeable future; nor would there be sufficient foreign exchange to purchase the fertilizers if they were freely available. Thus the whole problem of plant nutrient supply must be looked at from many aspects. No reasonable means to overcome the plant nutrient deficit should be overlooked.

Scope of Proposal:

An International Plant Nutrition Institute (later referred to as the Institute) is proposed to focus and sustain attention on the means of supply of plant nutrients and ways of using them more efficiently. By combining a number of disciplines within a single center, neglected areas of research which have lacked a sponsoring organization can be identified and studied.

Such a center will provide a critical mass of highly motivated scientists and teachers not only to concentrate on basic research but to reduce to practice fundamental discoveries as they are reported at laboratories throughout the world. In providing essential functions such as definition of problems, analyzing, storing and dissemination of information, as well as serving as a training center for advanced scientists, it will increase the pool of skilled experts and hasten the utilization of knowledge throughout the world.

The proposed Institute would attack problems of nutrient supply by considering the overall system: interactions of plant, soil, water, fertilizers and weather. Particular attention would be given to three priority areas: 1) investigation and development of means to control and increase the biological fixation of nitrogen and microbial solubilization of soil nutrients; (both fields have received too little attention for too long, although these mechanisms provide the basic nutrient supply on which the world depends for most of its food);

2) conservation and reuse of the plant nutrients in farm and other wastes and in animal and human manure; and 3) improvement of chemical fertilizers, especially for the tropics and subtropics, and the technology to produce them.

Biological Fixation of Nitrogen and Microbial Solubilization of Soil Nutrients:

As fundamentally important as these biological processes are to agriculture, particularly in the developing countries, there is a dearth of data that can be readily utilized to improve their impact on a broad basis. While a number of valuable collections of Rhizobiaceae have been made, very little work has been done to screen them for efficiency under tropical conditions. Correspondingly, work is limited on the exploration of other symbiotic and non-symbiotic nitrogen-fixers in relation to more productive agriculture for the tropics and sub-tropics. In both cases, more attention is needed in some of the more basic aspects of biological fixation of nitrogen. As envisaged, the Institute would also be concerned with microbial solubilization of other nutrients in the soil -- phosphorous is one example. All of these microbiological approaches have the potential of developing a technology that would be "low-capital-input" in nature and thus more readily adaptable by the small farmer.

Re-utilization:

One group within the Institute will lead the work on re-utilization research. Re-utilization of nutrients in crop residues, farm and urban wastes (including manures and sewage) is an inherent part of all farming systems but like all recycling systems, it is subject to losses. Control of these losses on the farm, in the forest, factory, and from the urban community will go a long way toward meeting the nutrient needs of our crops. Conservation systems must be studied as thoroughly as systems for bringing new nutrients into plant cycles but have received much less attention to date.

Means of saving the nutrients in the leaves and stems of plants will be assessed, especially in tropical environments. An attempt will be made to maximize the role of root systems and assure efficient utilization of available nutrients. Manure and urine from the house as well as the barn contain most of the plant nutrients of the food and feed consumed. Sanitary, efficient and acceptable means will be identified or devised to return these nutrients to the fields. Towns and cities are extremely wasteful. Better means of recovering the valuable components of garbage and sewage will be sought. Similar waste and disposal problems created by the factories processing fruits, vegetables and some industrial crops may be solved in a similar way. Various means of saving plant nutrients will be studied.

Farm management schemes, minimum tillage, incorporation, multiple cropping and rotation may all conserve plant nutrients in the field. Manures can be saved and returned to the fields directly or following composting. Composting can also be utilized to concentrate and sanitize urban wastes. Anaerobic fermentation can produce useful gas from plant residues, manures and sewage. The sludge from such fermentation still contains all of the nitrogen, phosphorus, potassium and secondary and micro nutrients in the fermented organic material. Industrial processes, based on partial oxidation, perhaps coupled with steam reforming can be used to recover both nutrients and energy. Finally, although wasteful of both nitrogen and sulfur, simple burning of plant and animal wastes does not destroy phosphorus and the basic elements. The mineral nutrients can be carried back to field and reused by crops.

The problems of reuse (with present knowledge) which need to be solved are mostly related to the cost in money and energy in gathering, processing and redistributing nutrients contained in the waste. Therefore, good economic analysis must accompany technical developments to provide a basis for selection of systems suitable for use in various locations and according to the amount of material to be handled.

Fertilizer Development:

No center for plant nutrient research would be complete without active research on fertilizers. Both new products and new production technology are needed. New and old raw materials must be evaluated and better or less expensive means of converting to plant use will be sought. By their nature and cost of production, fertilizers are items of trade and understanding markets, supply and demand are critical. Law, relating to prospecting, extraction of raw materials, production controls, and process patents and licenses all either limit or control the fertilizer supply and fertilizer cost. Too often lack of information about the law discourages efforts to develop new sources of fertilizers, excludes investment, especially off-shore investment, or may lead to unwise and disastrously costly mistakes.

An International Fertilizer Development Center is an essential unit of the Institute. The cost of basic production facilities to provide the range of raw materials needed for new product development would cost approximately $100,000,000 -- six to eight times as much as the rest of the Institute. Most of this capital overhead can be avoided through establishment of a branch of the Institute at the National Fertilizer Development Center, TVA, located at Muscle Shoals, Alabama. The Board of Directors of TVA has indicated willingness to cooperate in an international effort by allotting land for offices, laboratories and other facilities. The International Center would be supported by supplying utilities, services and materials at the same costs used within TVA. As space and facilities permitted, the international scientist will also be allowed to work in the laboratories, production and pilot plants owned by TVA. The details of their offer will be presented separately.

Fertilizers will be designed to overcome soil reactions which sequester nutrients from crops, which control leaching and which can overcome difficult management problems such as precise timing or applications in dense standing crops. Cost will not be neglected. More concentrated fertilizers which minimize shipping costs will be developed. Others will be found which have superior handling or storage properties, reducing both cost and the care necessary in handling. Economical production technology will be developed for the new products and improved technology developed for the "old" fertilizers.

Multidisciplinary Approach:

To be effective the Institute must combine a number of disciplines with focus on fundamental biology, chemistry and physics which can be applied to plants, micro-organisms, fertilizers and their integration into productive farming systems. Plant scientists will need to screen existing genetic collections and, if necessary, explore centers of origin to determine genetic limits of nutrient utilization. Studies in morphology, cell biology and plant physiology will replace simple empirical selection with guided search.

Soil research will be another key supporting discipline in the Institute, and will be closely integrated with other research on tropical soils now being conducted in many parts of the world. Soil chemistry will help to assay the nutrient supply and to assess the rates of availability of the nutrients. The presence and concentration or activity of toxic or detrimental elements within the soil can also be measured and used as a guide to plant selection, microbiological adaptation and soil management practice. The physical properties of the soil and the movement, retention, and release of water within it are critical for plant growth and for understanding nutrient uptake. For example, nitrogen utilization and loss are closely related to the percolation of rainwater and capillary flow of water into the active root zone or to the surface. Fertilizer solution rates, depth of placement and dispersion of the fertilizer through the soil are all inter-related and must be considered in product and system evaluation.

Soil microbiology is one of the prime fields in its own right but it is also the link between the soil and the plant which must be known and understood if many plant responses are to be predicted. The growth and survival of Rhizobia are dependent on soil conditions as well as on the species of plants in the field. The conversion and release of nutrients from crop residues, manures and other wastes is dependent on the microbial processes. Understanding the relationships is the key to controlling unnecessary loss. The natural soil flora have strong antibiotic output and can sanitize many wastes, including human excrement.

Plant and soil interactions, including nutrient uptake, are controlled to a large extent by the weather, therefore a meteorological/climatological section is needed both to define conditions under which various crops will be grown and to select appropriate areas for search, testing and recommending final adaptation trials and introduction of a variety, a fertilizer or particular strains of micro-organisms.

Fertilizer technologists with a range of disciplinary background will be needed to develop fertilizer designed specifically for the unique requirements of tropical agriculture. All of the soil and crop and fertilizer technology disciplines must be combined in management systems to take fullest advantage of native supplies of nutrients, the potentially inexhaustible supply of nitrogen in the air and the effective use of fertilizers.

Training:

Training will be an essential element of the program of the Institute This will be coordinated by a professional staff but much, if not all, of the training will be conducted by or under the supervision of the working scientists. Training at the center will be for advanced acientists or extension leaders. There is no need foreseen to use the center for training technicians, extension agents or farmers.

Information:

The gathering and dissemination of information on plant nutrients will be a major function of the Institute. The library will be a cornerstone but there should be no attempt to duplicate the collection at TVA. Data collection, storage and retrieval is similar. TVA and FAO have already established an efficient and readily accessible system on fertilizer production, marketing and use. They are already the accepted source of such data and nothing is to be gained by duplicating the service. Publication of research at the center, satellite facilities or independent laboratories will extend the knowledge obtained, enhance the prestige of the center and its scientific staff and help to keep investigators in the field fully informed on the work of their colleagues. Production of displays and other visual media, perhaps including movies, can be undertaken directly by the information division or through a contractor.

Organization:

The organization of the Institute will reflect both the biological and technical environment around the world. The central laboratory of the Institute can be located in almost any part of the tropical world but should be close to a center of scientific activity. The central laboratory will be devoted to portions of the research and advanced training for the most part. Satellite centers will be advisable or necessary for two reasons. Since studies of the efficiency of nutrient use by plants is a study of the reaction of plants to their environment, materials, varieties and even concepts must be tried under various conditions. Not every soil or climate can be tested but sufficient

variety can be sought to permit generalizations in which both the scientist and the farmer have confidence. The advantage of developing a satellite adjacent to existing facilities has been discussed. TVA is the logical example because of the very high cost of the basic building blocks from which new fertilizers can be built. Other satellites might be developed in conjunction with international centers which maintain a major germ plasm bank or a university or research center with a major collection of bacterial or mycorrhizal species and strains.

Contract research is another means by which the center can minimize capital costs while controlling the direction of research and assuring that significant results will be reported in a timely manner and widely distributed. Contracts which support graduate students can relieve the shortage of qualified microbiologists. Contract research may also be effective in creating local facilities for training. A scientist with a good record in adaptive research can often relate to extension agents and to farmers as well or better than the professional teacher who has never had the opportunity to test the ideas he is passing along.

Contract research has many other advantages. The skills of active scientists can be tapped without luring the men from the institutions in which they are established. Thus the Institute will become a supporter and not a competitor of national and especially university programs. This will have the effect of maintaining a broad base of inquiry and avoiding the myopia which could develop if all the work were done at the Institute.

Field research must be done in various locations and in a range of climates. It is not desirable to create a whole system of branch stations. It is desirable to have wide geographical and climatic coverage by using a large number of cooperators. Again funding capability will be important. Many university scientists have the interest and ability to make significant contributions but have very limited budgets to support research. This budget support will be provided.

Linkages with other institutions is the critical element in almost any complex scientific undertaking. The international institutes will be the source of much of the biological material and hopefully will cooperate in breeding desirable cultivars; further, they should be anxious to test that which is identified by the International Plant Nutrition Institute. National research centers and universities will play both roles. FAO, UNIDO, and UNDP are all sources of information and potential program exchanges. Industry cannot be ignored. The commercial seed industry, especially in the developed countries, has a scientific capability which dwarfs many of the better universities. Fertilizer manufacturers and vendors offer possibilities in testing production ideas but more importantly, in testing farmer acceptance of new products.

Estimated Cost:

Preliminary estimates for the Institute indicate about $19 million for capital facilities, and about $8 - $10 million per year for operating expenses (including an envisaged fertilizer technology component -- possibly at TVA). This component at TVA would require around $4 million in capital costs, and $2 - $2.5 million in annual operating costs.