IFDC

Volume 19, No. 3
September 1994

ISSN 0149-3434

Report

an update on the work & progress at the International Fertilizer Development Center

Crop Rotation Improves Crop Yield and Soil Productivity in the Sahel

Ongoing research being conducted by IFDC-Africa in the Sahelian zone of West Africa has produced some interesting results. The main objective of this research is to investigate the effects of continuous monoculture, crop rotations involving legumes, and different levels of nitrogen fertilizer on yields of cereals and legumes and the soil characteristics.

Dr. André Bationo, IFDC Senior Soil Fertility Scientist, stationed at the Sahelian Center of the International Crops Research Institute for the Semi-Arid Tropics, was the principal investigator for this research project.

"The intensity of land use in West African semiarid tropics, resulting from increasing human population pressure, puts high demand on maintenance and improvement of soil fertility," Bationo says. "The fallow period of the traditional bush-fallow system of restoring soil productivity has been reduced and in many areas the practice has disappeared, leading to continuous cultivation. This practice makes farming more dependent on fertilizer for sustaining high yields. Long-term fertilizer experiments in West Africa have shown that fertilizer application is an effective means to increase yields."

In spite of the recognized need to apply chemical fertilizers for high yields, the use of fertilizers in West Africa is limited by lack of capital, an inefficient distribution system, poor communication, and other socioeconomic factors. A more cost-effective means of improving soil fertility and productivity is necessary.

"One possibility is rotation of cereals and legumes," Bationo says. "Legumes are known to increase soil fertility through their nitrogen-fixing capacity. Groundnut and cowpea are the most widely grown grain legumes in the West African semiarid tropics. These legumes are also often intercropped with pearl millet in the Sahelian zone and sorghum in the Sudanian zone."

"The crops included in our research were pearl millet, sorghum, cowpea, and groundnut," he says. "Four nitrogen levels were used in the four experiments including the rotations of continuous fallow, fallow-millet, groundnut-millet, cowpea-millet, and continuous millet. Soil samples were collected from these trials and measured for organic carbon, available phosphorus,

(Continued on page 6)

(Photo by Dr. André Bationo)

A Nigerien farmer pictured in front of his granary views his crop after the use of fertilizers. His granary will be full this year and his family's food requirement will be met.

IFDC Report

Publisher:
International Fertilizer Development Center

Editor
Marie K. Thompson

IFDC Report is a quarterly publication of the International Fertilizer Development Center (IFDC), Muscle Shoals, Alabama, U.S.A. Telephone: 205-381-6600, Telex: 810-731-3970 IFDEC MCHL, Telefax: 205-381-7408. Unless otherwise noted, printed material published in the *IFDC Report* is in the public domain and may be freely reproduced. Source acknowledgment and a copy of any reproduction are requested. Subscriptions are free. French- and Spanish-language editions of the *IFDC Report* are available from IFDC.

IFDC is a public, international, nonprofit organization, governed by an international board of directors with representation from developed and developing countries. The Center is supported by various bilateral and multilateral aid agencies, private foundations, and national governments. IFDC focuses on increasing and sustaining food and agricultural productivity in developing countries through the development and transfer of effective and environmentally sound plant nutrient technology and agribusiness expertise.

Change of Address:
To avoid missing copies, allow six weeks for change of address. Send details to: *IFDC Report*, P.O. Box 2040, Muscle Shoals, Alabama 35662, U.S.A.

President's Report

(Photo by Charles E. Butler)

Dr. Amit H. Roy
IFDC President and Chief Executive Officer

During this quarter I visited Dhaka, Bangladesh, where the Fertilizer Distribution Improvement (FDI-II) Project, funded by the United States Agency for International Development (USAID), came to a close. Since this has been a major policy reform project that is having a significant impact on fertilizer marketing, availability, and prices in Bangladesh, I intend to focus my comments in this issue of the *IFDC Report* on this project. Since becoming involved in the initial project (FDI-I) in 1979, IFDC has been a prime mover behind the privatization of fertilizer distribution in Bangladesh. Since that date fertilizer use has increased substantially while during the current decade, the country has become self-sufficient in rice production, two vital elements in an agricultural success story that, according to the Government of Bangladesh, was in part due to IFDC's efforts.

Between 1978 and 1983, FDI-I was one of the pioneer projects that contributed to the development of a new marketing system to increase agricultural production by increasing fertilizer use. Technical assistance through FDI-I brought major policy changes including the implementation of the new marketing system by the Bangladesh Agricultural Development Corporation (BADC), whereby fertilizers were sold at primary distribution points (PDPs); the transfer of fertilizer transportation below PDPs to private wholesalers; the removal of restrictions on fertilizer trading; and decontrolling retail prices. These FDI-I reforms created a competitive group of private wholesalers and dealers and resulted in a marked improvement in fertilizer availability at competitive retail prices to farmers.

Continued technical assistance was necessary to fulfill the development objectives of the Bangladesh Government to establish an efficient fertilizer program based on the full participation of a competitive private sector. The availability of fertilizers at reasonable prices, technical knowledge regarding fertilizer use, and the availability of working capital were identified as factors that constrained fertilizer use in Bangladesh. The FDI-II project was designed to mitigate these constraints and increase fertilizer use.

The FDI-II project included four major components: policy reform, a commercial credit program, dealer development and technology transfer, and a management information system.

A review of the project activities of the past 15 years reveals a number of outstanding achievements. First, fertilizer policies formed an integral part of FDI-II in establishing a free market where the private sector could flourish. The reforms designed under FDI-II were comprehensive and complementary and focused on fertilizer market development, subsidy removal, and the reorganization of BADC. A major step in the process of privatization was completed in December 1993 when all subsidies on fertilizers were withdrawn. As of June 1994, 238 domestic training programs and workshops for 11,022 participants were completed during the FDI-II project.

The principal benefits of the project include: (1) fertilizer is available to farmers in all locations of Bangladesh at reasonable prices, (2) the number of farmers using fertilizer increased, (3) improved fertilizer use efficiency resulted in increased yields and returns to farmers, (4) new employment opportunities

were generated, (5) fertilizer imports were handled more efficiently and at substantially lower costs than under BADC, and (6) the Bangladesh Government was able to reallocate funds from fertilizer subsidies to other areas of the economy.

The project had the following important impacts: (1) fertilizer use increased considerably, (2) fertilizer use became widespread among small and marginal farmers in Bangladesh, (3) increased input use led to higher yields, (4) higher yields resulted in increased farm income, (5) dealers began providing fertilizer credit to enhance the ability of farmers to purchase fertilizer, and (6) improvements in fertilizer distribution yielded savings and benefits for Bangladeshi farmers.

The total employment generated in fertilizer marketing, including the self-employed retail network, is estimated to be about 170,000 persons. As a result of the project, the Bangladesh Government saved funds due to subsidy withdrawal and privatization of fertilizer importation and the domestic fertilizer business. Savings from 1988/89 to 1993/94 are estimated at TK 4,758 million (US $119 million).

Building upon the success achieved during the FDI-II project, the Government of Bangladesh and USAID have initiated a new project that will focus on agrobased industries and technology development. The project will focus on achieving increased productive employment in agriculture and related enterprises, which is the key to achieving the poverty reduction goal of Bangladesh and the donor community.

IFDC, as the prime contractor, in cooperation with Mississippi State University, Ronco International, and Winrock International Research Institute, has been selected to implement the project. The contract is being negotiated. The new project will focus on five key subsectors: fertilizer, seed, poultry and livestock, agricultural machinery, and agricultural processing. Clearly the progress made in the fertilizer sector has provided the impetus for major progress in other agricultural sectors.

Amit H. Roy

IFDC Research Assesses Environmental Impact of Cadmium in Phosphate Fertilizers on Soil, Plant, and Human Health

According to results of research being conducted by IFDC, the possibility of cadmium accumulating in the soil from the application of fertilizers and entering the food chain through crop uptake at unacceptable levels appears to be based more on hypothetical considerations than real-life scenarios. Most phosphate fertilizers contain only small amounts of cadmium and moderate rates of application do not appear to pose serious problems.

For the past few years Dr. Raman G. Menon, IFDC Senior Soil Fertility Scientist, and Dr. S. H. Chien, IFDC Senior Soil Chemist, have been conducting research on cadmium in phosphate fertilizers. The main activities of IFDC's cadmium research include surveying and documenting the accumulation of cadmium in soils and its availability to crops that may occur as a result of long-term use of phosphate rocks and soluble phosphate fertilizers in the tropics and conducting greenhouse and field trials to investigate various factors influencing cadmium uptake by crops.

"Increase in total cadmium levels has been observed in soils collected from long-term experimental sites fertilized with phosphates; this increase, however, was not reflected on cadmium content of plant tissues," Menon says.

Furthermore, an IFDC survey of sites with recorded history of fertilizer use in selected countries in Asia, Africa, and Latin America indicate that the amount of cadmium in the soil and plant tissues was well below maximum permissible levels adopted by most countries.

"Phosphorus is a major limiting factor for crop production, especially in the tropical soils," Chien says. "For example, approximately 1 billion hectares of acid, infertile soils in tropical America are deficient in phosphorus. For sustainable crop production on these soils, it is essential to apply adequate amounts of phosphate fertilizers. At present, the only way of making phosphate fertilizers with low cadmium content is to use phosphate rocks with low cadmium content. However, this would exclude some major phosphate resources, which are needed."

IFDC is collaborating with the Asian Vegetable Research and Development Centre (AVRDC), Taiwan, and Ruakura Agricultural Research Centre, New Zealand, in conducting greenhouse and field trials to study the impact of application of phosphate fertilizers with high cadmium contents on the accumulation of cadmium in soils and possible uptake by plants.

It will probably take hundreds of years for the concentration of cadmium in the soil to exceed the maximum permissible level of 3 mg of cadmium per kilogram (as established by the European Commission) through fertilizer use. However, fertilizer is not the only source of cadmium in soils. Inputs from acid rains and aerial depositions are equally important sources of cadmium in plants, especially in industrialized countries.

IFDC Project Comes to Fruition in Albania

(Photo by Charles E. Butler)

Thoma Tola, Agricultural Journalist and Commentator, National Television of Albania (left) and Shpetim Bimo, Interpreter with IFDC-Albania (right), discuss the accomplishments of the IFDC Albania project with James J. Schultz, Director of IFDC's Outreach Division.

"IFDC is making a difference in Albania," says Thoma Tola, Agricultural Journalist and Commentator, National Television of Albania.

Tola recently came to IFDC Headquarters to participate in a Training Program on Fertilizer Marketing Challenges. He says that his attendance in the month-long training program will increase his understanding of fertilizer marketing and allow him to more clearly explain the new concepts to Albanian farmers through his television programs as the system has changed from communism to democracy.

Having worked in the government-operated media for the past 10 years, Tola is experiencing the same transition from communism to democracy as the Albanian farmers that compose the primary target audience of many of his public service programs as the system has changed from communism to democracy.

"Yesterday we were the voice of the party—what the party said, the television said, but today it is quite different," Tola says. "Now we create opportunities for the people to express opinions and share their views with their fellow Albanians."

As a television reporter/anchor, Tola says that he has been on the front line of the changes that have taken place since 1991. He said IFDC has played a major role in those changes where farmers are concerned.

Tola recalled covering the first IFDC-assisted fertilizer auction in Albania, which he labeled as "historic." He said the auction received a lot of resistance from the budding entrepreneurs initially until they realized that the process could actually help save them money and obtain the right kinds of fertilizer for the farmers' crops.

"By participating in the auction the future dealers were getting involved in the free market economy without actually realizing it," Tola says.

Shpetim Bimo, an interpreter with IFDC-Albania and also a participant in the training program, realizes the crucial role that Tola and television played in the successes of the IFDC project in Albania. "It was difficult to get in touch with all of the potential dealers," says Bimo. "We recruited Tola's help to get the word out to entrepreneurs about the advantages of the free market system and how it works."

Bimo appreciates the value of IFDC's contribution to establishing the free market systems in the Albanian agricultural sector. "It is easy to bring in food to a country like Albania, but to bring in knowledge and skills is a very different and difficult thing. This is where IFDC came in."

Both Albanians view the establishment of the Albanian Fertilizer and Agricultural Inputs Dealers Association (AFADA), with the support of IFDC, as a very big step in the right direction. They emphasized the recent success of AFADA in negotiating with the Government of Albania to lower the tax on the first privately imported fertilizer into Albania from 30% to 10%.

A Conversation With The Honorable Hasan Halili, Minister of Agriculture and Food, Government of Albania

(Recently the Editors of *Biznesi Bujqesor* (BB), the official publication of the Albanian Fertilizer and Agricultural Inputs Dealers Association (AFADA), interviewed the Honorable Hasan Halili, Minister of Agriculture and Food of Albania. The text of that interview is published here.)

BB: Various international organizations have stated that Albania has the highest ratio of progress in Eastern Europe. Do you agree with this?

HH: I agree with the results of the survey performed by IFDC, the International Bank for Reconstruction and Development (IBRD), the International Monetary Fund (IMF), and the Directorate of Statistics in the Ministry of Agriculture of the growth of agricultural production items, livestock, and trade of agri-inputs. In my opinion, the reasons for the more rapid growth of Albania compared with other East European countries is as follows:

First is the support that the Albanian people gave to the Land Law. Second is the pragmatist level of our Albanian farmers to secure their food and their willingness to make a better living. The generation of Albanians living in the year 1951—a year that left tracks in the lives and health of the people whose families died for lack of bread—is still living now. It was they who energetically supported the application of the Law on Privatization of Land and also oriented the youth who put in motion the democratic forces of Albania for the victory of democracy and made possible the rapid growth presented in this survey.

The Honorable Hasan Halili
Minister of Agriculture and Food
Government of Albania

BB: What is your opinion on AFADA?

HH: I appreciate the efforts of AFADA for securing fertilizer and for realizing the Presidential decree regarding the import duty. Decreasing the custom duty from 35% to 10% required some time; therefore, the association needed more time to import nitrogen fertilizers. By importing about 15,000 mt of fertilizer in 3 months, Albania solved its emergency fertilizer needs, but it could not meet all of the farmers' demands. AFADA will attempt to import more fertilizer to meet Albania's needs; it is estimated that Albania needs 200,000 mt of nitrogen fertilizer per year. I would suggest that AFADA dealers consider not only their profit on fertilizer sales but also the farmers' difficulties in affording the fertilizer.

BB: You have helped directly in reducing the tax on custom duty; what about the turn-over tax?

HH: In reality, the parliament and the specialists of the Ministries of Agriculture and Finance understood the necessity of reducing this tax, and they presented it to the parliament. I believe that for those fertilizers that cannot be produced in the country the turn-over tax should be removed. This is the responsibility of others, but we have the right to make proposals.

BB: Success has been achieved in the fertilizer sector for the privatization of the market. How do you see development in the seed industry and the animal feed market?

HH: I would say that most imminent is the marketing of pesticides, and in the talks I have had with the representatives of IFDC and AFADA I have proposed that they should work to open shops for selling pesticides, for which a big market exists in Albania. A concrete example is the pesticide shop near the Institute for Crop Protection in Durres, opened by an Albanian crop protection specialist. There is a great market potential for this type of business in Albania, and it is a duty of the Ministry of Agriculture and the banks to organize and open credit lines for this activity. As for seeds, the Seed Enterprise continues as a state-owned enterprise (SOE)

(Continued on page 6)

IFDC Conducts Agronomic Evaluation of Colombian Indigenous Phosphate Rocks

In the acidic soils of the humid tropical regions of Latin America, phosphorus deficiency is a major factor in reduced crop production. In these regions, the direct application of indigenous phosphate rock may be an economically attractive alternative to the use of the more expensive, imported soluble phosphate fertilizers such as triple superphosphate (TSP) for certain soils and crops. Some Latin American countries have phosphate rock deposits which, if used to supplement soluble phosphate fertilizers, would allow a saving of much needed foreign exchange.

In 1992 IFDC began a 2-year study to investigate the use of two Colombian phosphate rocks, Huila and Pesca, for aluminum-tolerant soybean cultivars grown on acid soils (Oxisols and Ultisols) in Colombia's east plain. The study has been carried out by Dr. S. H. Chien, IFDC Senior Soil Chemist, in collaboration with the researchers of Alabama A&M University and the Instituto Colombiano Agropecuario (ICA) of Colombia. This project has been funded by the U.S. Agency for International Development (USAID) under the Historically Black Colleges and Universities program.

Three local soybean varieties varying in their resistance to aluminum toxicity were tested for their capabilities to use phosphate rock as compared with TSP. The agronomic results showed that the variety having the most aluminum tolerance has the potential to use phosphate rock. For example, Huila phosphate rock was found to be as effective as TSP in producing grain yield obtained with a more aluminum-tolerant soybean variety (*Soyica Ariari*) grown on an Inceptisol without liming. The relative agronomic effectiveness of Huila phosphate rock was reduced to 53% as effective as TSP when the soil was limed. The residual value of the relative agronomic effectiveness of phosphate rocks with respect to TSP was greater than the initial value. The reactivity of phosphate rock was also found to be less important in the residual effect than in the initial effect.

The effect of soybean variety on the soybean grain yield varied with (1) actual yield or net increase yield over the control, (2) sources of phosphate fertilizers, (3) rates of phosphate applied, (4) liming of soil, and (5) types of soil. All of these factors need to be considered when we try to optimize the benefits of using indigenous phosphate rock for soybean production on humic tropical acid soils.

(Continued from page 1)

total nitrogen, and exchangeable bases."

Fertilizer nitrogen significantly increased the yield of millet, sorghum, cowpea, and groundnut. Continuous monocropping of millet and sorghum resulted in lower yields across nitrogen levels compared to cereals following legumes. Legume yields were also consistently lower in monoculture than when rotated with a cereal.

Crop rotation sequences significantly improved the soil chemical characteristics. There was a decline in organic matter under the continuous millet, cowpea-millet, and groundnut-millet crop sequences. The fallow-millet sequence supplied more mineral nitrogen than the legume-cereal rotation. Nitrogen availability was greater with a cowpea-millet rotation than with continuous millet. The rotation systems were more productive than monoculture, but there was no difference in maintaining organic matter.

"Previous research in this zone has emphasized the positive effects of rotation in terms of improved crop yield; addition of nitrogen from legumes; improved soil physical, chemical, and biological properties; increased organic matter content; and better pest and disease control," Bationo says. "However, data thus far generated point to the fact that the effect of various crop rotation sequences on soil organic matter is negative. This has important implications on the sustainability of these cropping systems particularly in the fragile Sahelian environment. More information is undoubtedly needed on the effects of rotations on the physical, chemical, and biological properties of the soil and hence on overall soil productivity."

(Continued from page 5)

because the mechanism has not been found to organize, gather, multiply, and market seeds in the private sector.

Recently a study conducted by the Food and Agriculture Organization of the United Nations (FAO), the Ministry of Agriculture, and other international organizations tried to determine the proper way to make the transition from a state system of gathering and multiplying seeds and marketing them in the private sector. It is clear that this cannot be achieved during 1994, but I believe that the legislation will be prepared during 1995.

IFDC Scientist Evaluates Sources of Phosphate Fertilizers for Rice Production in Vietnam

Rice is the single most important crop in Vietnam. It is planted on 82% of the total farm area, and it accounts for more than 85% of food grain output. Though total rice production increased from 11.8 million tonnes in 1979 to 21.5 million tonnes in 1992, further increases in rice production on the currently cultivated soils appear to be reaching a limit for meeting the national demands. Further increase can only be achieved by increasing agricultural inputs, which is often hampered due to financial constraints (lack of foreign exchange), and by expansion of rice production into areas with so-called problem soils, mainly acid sulfate soils.

Vietnam has the largest area of acid sulfate soils of any country in the world. Acid sulfate soils are characterized by the occurrence of pyritic materials in the subsoil. Upon drainage and aeration, oxidation of pyrites results in very acid soils containing some toxic elements such as aluminum, iron/manganese, and hydrogen sulfide. The soil is rich in humus and nitrogen but low in phosphorus.

Phosphorus is the most important nutrient for rice growth on acid sulfate soils. Beginning in December 1992 Dr. Upendra Singh, IFDC Senior Systems Modeling Scientist, who is currently stationed at the International Rice Research Institute (IRRI), conducted a series of field experiments to evaluate sources of phosphate fertilizers for rice production on acid sulfate soils of the Mekong Delta. The work has been funded by the Australian National Development Assistance Bureau (AIDAB). The research was jointly carried out by IFDC, IRRI, and the Vietnamese cooperators, Dr. Cong Doan Sat and Ms. Phan Thi Cong from the Institute of Agricultural Sciences, Ho Chi Minh City. The sources of phosphate fertilizer that were evaluated include single superphosphate (SSP) and thermophosphate (TP), both locally produced, and imported diammonium phosphate (DAP).

"Our results show that without application of phosphate fertilizer in the dry season, grain yield was very low, only 1.7 tonnes/ha," Singh says. "Application of phosphate fertilizers not only resulted in improved phosphorus status of the soil but also gave higher grain yields. Grain yields significantly increased to 4.1 tonnes/ha with SSP, 4.3 tonnes/ha with DAP, and 4.8 tonnes/ha with TP. Higher grain yield with TP fertilizer may be due to its high composition of bases and, therefore, reduced iron and aluminum toxicities to rice plants. We also observed the superiority of TP over SSP and DAP in the wet season. However, grain yield increased only from 0.8 tonnes/ha to 1.6 tonnes/ha. Our results also suggest that dosage of phosphorus should not be based entirely on optimum economic rate but must also consider positive effects of toxicity amelioration and high residual effect."

The development and refinement of existing methodologies to extrapolate results to other acid sulfate soils will be the focus of future research.

(IRRI photo)

The President of the Asian Development Bank, Mitsuo Sato (center) visited the International Rice Research Institute recently to observe rice research, being explained here by Dr. Upendra Singh (right), IFDC Senior Systems Modeling Scientist, stationed at IRRI.

IFDC Report

International Fertilizer Development Center
P.O. Box 2040
Muscle Shoals, Alabama, U.S.A. 35662