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# Beans and Maize: important examples of multiple cropping

Beans and maize are two basic constituents in the diets of the Latin American people. This is especially true in rural areas and in the economically marginal sections of the large cities. Not so well known is the fact that about 80 percent of the beans produced in Latin America come from small farms; in addition, the majority of these beans are grown together with maize. And, 60 percent of the maize produced is seeded in association with other crops, most frequently with beans. Clearly, associated cropping of beans and maize account for a large part of the total production of these two basic constituents of the Latin American diet.

These facts plainly justify the efforts several national and international institutions — among them CIAT — are directing to problems related to multiple cropping, especially maize grown together with beans. This production system is a reality on countless small farms in Latin America. The farmer produces the two crops first to feed his own family and then to sell the surplus in the marketplace.

CIAT researchers are studying both climbing and bush types of beans for the bean-maize association. The bean agronomy group is attempting to stabilize yields of beans grown alone at about four tons per hectare and yields of beans grown with maize at about two tons. The scientists have already attained these levels under optimum conditions. The efforts are focused on stabilizing yields under various ecological conditions and reducing, as much as possible, the need for applying inputs to help the farmer cut costs.

Much of the research deals primarily with the production aspects, actually growing the two crops together. The agronomy group, however, coordinates its priorities and activities with those of other disciplines in the CIAT Bean Program, namely plant breeding, plant


**Yields of more than 4,000 kilograms per hectare are possible when climbing beans are grown in monoculture.**

pathology, entomology, soils, microbiology, physiology and economics. Present work in evaluating and distributing germplasm to client groups such as national programs and other entities has been built on activities that go back six years. Some of these major activities, and the year of their initiation, are:

* Collection of germplasm (1970)
* Preliminary evaluation of accessions in the germplasm bank (1975)
* Selection of outstanding progenitors to include in the breeding program (1976)
* Replicated trials (1975)
* Increase of availability of seed (1976)

* International trials to verify ranges of adaptability (1977)

* Extensive trials in various national programs (1977)

Two other efforts of the overall research program complement the evaluation and development of new germplasm. These are:

* Agronomic studies of bean-maize associations including density and methods of planting and weed control; and,

* Studies of genotype-environmental interactions—factors that are important in germplasm evaluations.

Several other factors are also important in forming a total package of technology. These are, however, best studied within each country or at the micro-environment level. They include: times for seeding, management of moisture (irrigation), fertilization, evaluation of location-specific technology, soil management and economic evaluation.

Several preliminary results are available from the early experiments in bean-maize intercropping.

* Optimum densities in locations like the Cauca Valley of Colombia (where CIAT is located and where conditions are favorable for bean production) are: 200,000 plants per hectare for bush beans (planted alone or with maize); and, about 150,000 plants per hectare for climbing beans (alone or with maize).

* If no environmental or growth factors are known to limit production, intercropped beans and maize can be seeded at the optimum densities for planting either crop alone.

**High seeding densities must be used if climbing beans in monoculture are to yield heavily.**

* Combinations of various herbicides applied at low levels are more efficient and economical than high levels of a single herbicide in controlling weeds in intercropped beans and maize.

* Yields of maize planted with either bush or climbing beans are not apparently decreased by the association planting but remain about the same as yields of maize planted alone.

* Very early results show no interaction between the system of seeding and the variety of beans planted, but this must be confirmed.

Only limited genetic variability has been identified in the climbing beans collected in Latin America. Additional explorations must be made in every possible ecological niche of the continent and the world. It is estimated that only 20 percent of the available genetic material of climbing beans and 50 percent of the material of bush beans have been collected up to now.

A rapid evaluation system must be developed and evaluated for existing germplasm and that to be collected in the future.

Definitions are needed of the magnitude of the genotypic-environmental interactions under different environmental conditions.

It is necessary to initiate a program of genetic improvement to combine various high-yielding sources with sources having resistance to the principal insects and diseases.

A series of optimal alternatives for bean-maize associations must be established that are strictly related to planting systems in Latin America. It would be desirable to especially consider the socio-economic conditions of the small farmer in developing these alternatives.

An active training program for technical personnel is needed to take advantage of research in bean-maize intercropping. Principles can be applied to other crop production systems; well-trained personnel can apply this knowledge and field experience to the systems and crops common in their own localities. Thus, a multiplier effect of these CIAT research efforts can be extended into other crops and ecological zones.

While these investigations are concentrated at CIAT, trials are being initiated at other locations in Latin America with support from national institutions. Trials are often done on private farms, to study the application of these systems in stabilizing yields of beans and maize. Attainment of this yield stability will signify a great step forward in increasing the production and agricultural productivity in the rural zones of Latin America.

The close association between bean and maize plants implies that both compete critically for water, light and nutrients necessary for growth.

# New system insures clean cassava seed

It is often difficult to obtain sufficient material to assess a new cross or line of an asexually reproduced plant. In addition to initial needs, if early evaluations are promising, the material must be further multiplied as rapidly as possible for advanced trials and regional testing at the farm level.

Cassava is an important example of a crop reproduced asexually at the commercial level. It has, however, a low propagation rate. A mature cassava plant furnishes sufficient vegetative material for 10-30 commercial cuttings (25-cm long) annually. Consequently, the propagation rate is considered to be only 1:10-30 annually. If shorter, two-node cuttings are used, the rate will be somewhat higher, perhaps as high as 1:150 a year. The shorter cuttings require, however, special moisture conditions and cleanliness in the field so a reproduction system utilizing short cuttings is not practical for use under farm conditions.

In view of these limitations in cassava propagation rates, CIAT researchers have developed a simple system for rapidly multiplying vegetative materials. The system will have a wide range of applications because it requires no expensive equipment, little space and the entire process is simple. Perhaps, most importantly, the planting materials produced are free of diseases.

With this system it is possible to obtain, under optimum conditions, as many as 36,000 commercial cuttings within a year from one mature plant. Figure 1 illustrates how cuttings from the single plant are multiplied to produce many commercial-size stakes.

The first step consists of building a propagation chamber for sprouting the stem cuttings. Ordinary hollow concrete blocks with wide holes are laid on edge as shown in Figure 2 to form a bed 2.4 x 1.2 meters. The holes in the blocks are sealed at the bottom so they will hold water for humidity maintenance during the sprouting period.

To insure proper drainage, the area inside the bed is filled with about 10 centimeters of crushed stone. Over this is spread sterilized, lateritic soil (adjusted to pH 6) for the rooting medium. The soil can be sterilized with either 20 liters of 10 percent formaldehyde or with methyl bromide at the recommended rate. (Methyl bromide is very poisonous; application instructions should be followed carefully). If needed, fertilizer can be added to provide medium fertility.

A simple wooden frame covered with transparent plastic or polyethylene is built to cover the chamber. Dimensions of the base of the cover should be large enough that the edges of the frame rest over the centers of the holes in the concrete blocks.

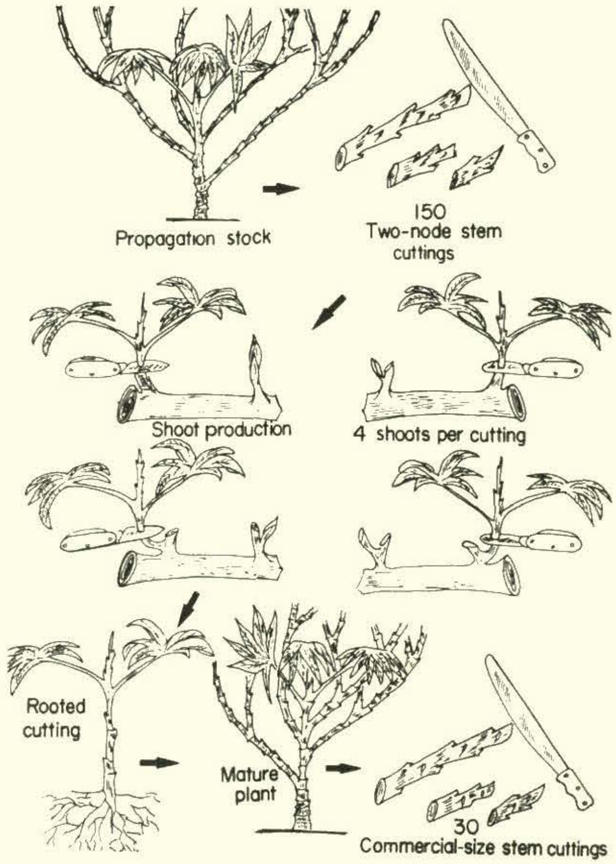


Fig. 1. Diagram illustrating CIAT's cassava propagation system utilizing small stem cuttings.

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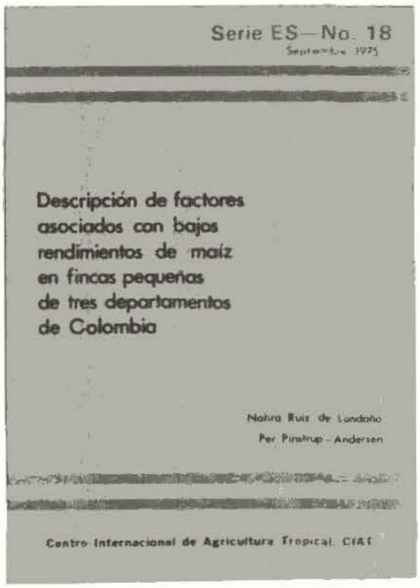


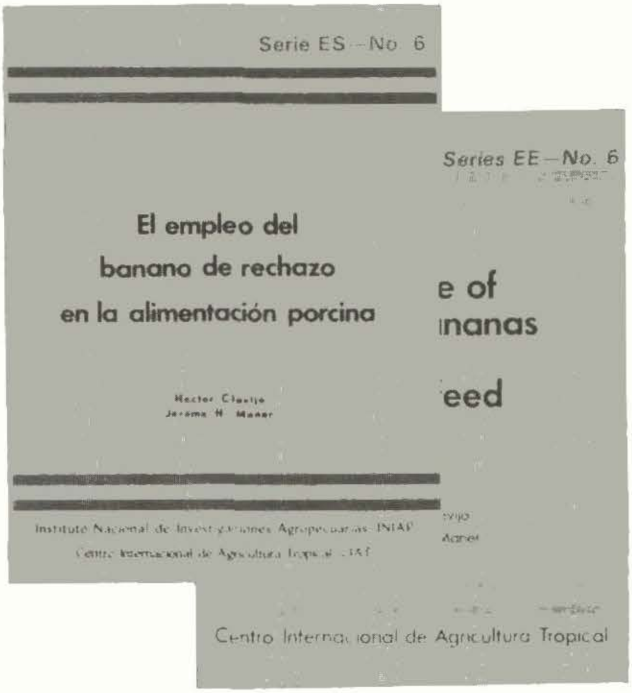


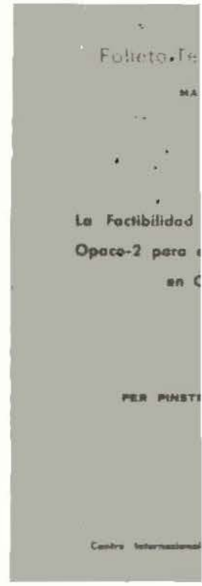


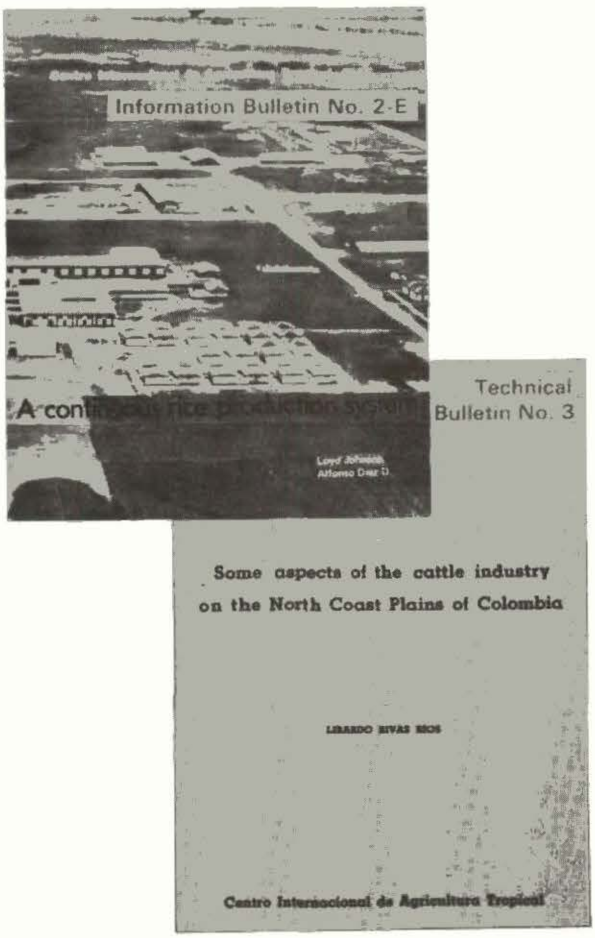


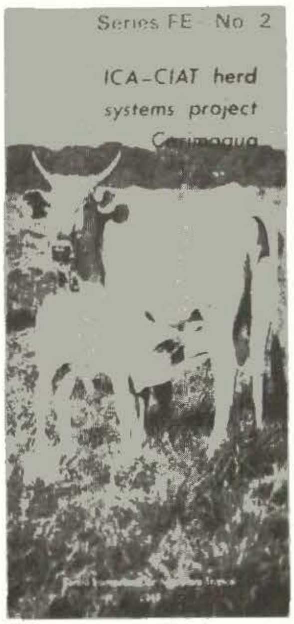



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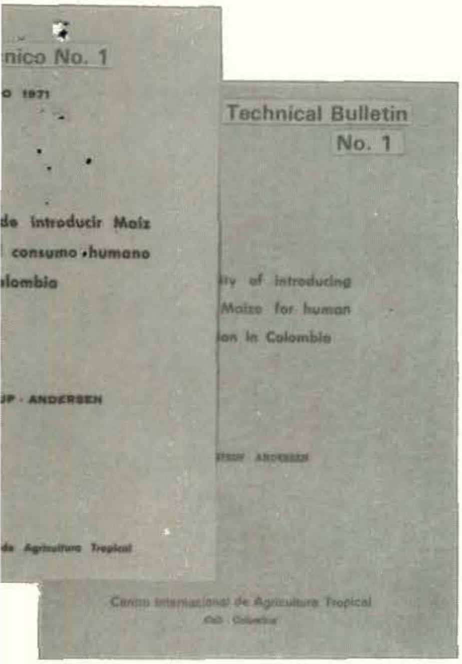


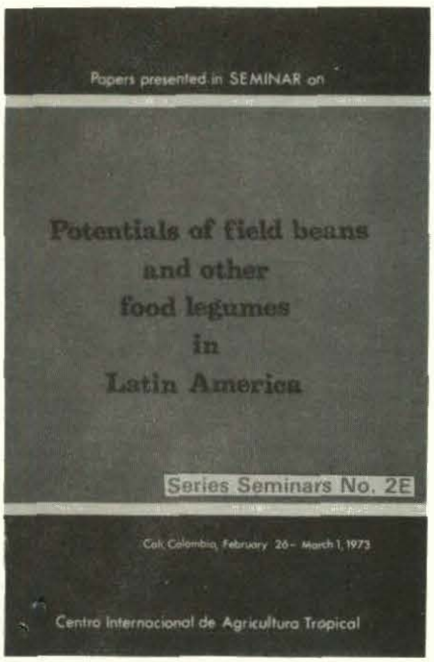


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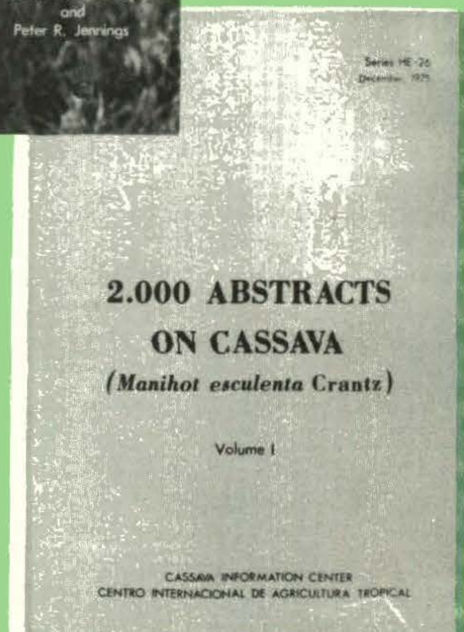

Fig. 2. Seeding of two-noded stakes in the propagation chamber to obtain sprouts for rooting.

Fig. 3. The propagation chamber showing abundant sprouts ready for cutting and rooting.

When the chamber is ready, stems of mature cassava plants at least eight months of age are sawn into two-node lengths (a hacksaw is ideal). After immersion for five minutes in a 5 percent solution of Arasan, the cuttings are planted horizontally, one centimeter deep, in the chamber (Fig. 2). The soil should be watered to maintain adequate but not excessive moisture. Holes in the blocks must be kept full of water to maintain high humidity in the chamber.

Small glass flasks are used to root the sprouts when they are ready for cutting in about three weeks. Discarded injection vials with capacities of about 25 cubic centimeters and with two-centimeter diameters are very effective and cheap and easy to obtain. Before using, the rooting flasks are sterilized for 30 minutes in boiling water. The water in which the sprouts are rooted is also boiled for 30 minutes and allowed to cool before filling the flasks. Flasks should be placed on a white painted table in a simple frame so they remain upright. A transparent, plastic covered frame similar to the one over the propagation chamber is used to protect the flasks with their sprouts from rain water contamination.

When sprouts in the propagation chamber are eight centimeters long (Fig. 3), they are cut one centimeter from

Fig. 4. Rooted cutting ready for field transplanting.

the base with a sterilized razor blade or very sharp knife The original two-node cuttings are left in the bed to resprout. Each cut sprout is placed in its own rooting flask in only sterile water. During the first week, the sprouts may look as if they are dying when many of their leaves wilt and fall. However, after two weeks, new leaves develop and the first roots will appear. When the sprouts attain some vigor, but before roots get very long, the new plant is transplanted into the field (Figs. 4 and 5). The young plant should be buried up to the base of the first leaf, taking care to protect roots from damage. The transplants should be watered for the first two weeks.

In the propagation chamber, new sprouts can be cut for rooting when they are eight centimeters long. Each two-node cutting should produce eight sprouts within four months after planting in the bed (Fig. 6). If this production rate is maintained and all transplants live in the field, at the end of a year there should be 1250 plants between eight and 12 months of age. If each one yields an average of 30 larger, commercial cuttings or stakes, then the original parent plant has produced 36,000 planting stakes.

This new system of vegetative material propagation should have wide application because it doesn't require

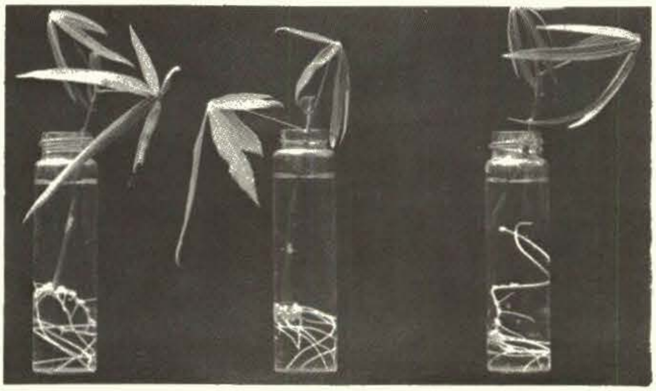

Fig. 5. These rooted cuttings in water have already passed the ideal stage for transplanting in the field.

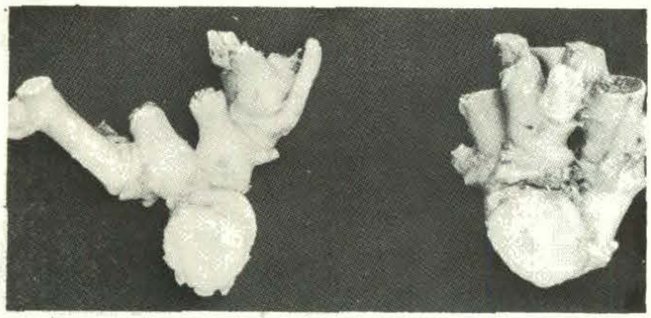

**Fig. 6. Two cassava stakes of two nodes each that have had sprouts cut from them. The stakes may produce up to nine sprouts per node.**

expensive installations or equipment. The method is simple; an agricultural technician can care for the propagation chambers and rooting units. Thus, national programs can multiply promising vegetative material to fill the needs of farmers who require disease-free plants produced in a short time.

With this propagation method, planting material free of cassava bacterial blight (CBB) is easily obtained. CBB reduces early growth of new plants in the field and increases the incidence of root rot. This disease can cause yield losses of up to 50 percent. It spreads rapidly by means of contaminated propagation material. This propagation method provides CBB-free material which should be used as basic planting seed. Consequently, the system ought to provide a rapid increase of material always free of this severe disease.

# In-country training provides capable livestock leaders

Since 1968 CIAT has conducted an extensive program to train production specialists, both in crops and livestock production. The specialists are qualified to solve problems at the farm level in several disciplines and to identify production limiting factors.

In the case of animal production specialists, CIAT trains animal scientists, veterinarians and even agronomists specializing in work related to animal production. In reality, many specialities — ranging from animal health to pasture weed control — are covered by livestock production. The livestock production specialist working in the lowland tropics must often be familiar with a range of disciplines.

CIAT's livestock production trainees come from institutions promoting animal production. Trainees are selected on their aptitudes, on their professional positions and on their abilities to assume leadership roles in livestock production. Until 1974, trainees first studied at CIAT, in Palmira, to acquire the necessary theory, then were sent to the North Coast of Colombia where they were assigned to previously selected livestock ranches for work on more practical aspects of livestock production.

After following that program for four years, CIAT training specialists decided to change the locational focus of livestock training courses. The non-Colombian trainees had experienced some problems during the practical phase on North Coast ranches. First, they encountered different names for drugs, forage species, weeds and insects that were unlike the names in their home countries. Secondly, economic factors were different, including the values of steers, cows, labor costs for hand labor compared with the use of agricultural machinery, and prices of agricultural inputs. These differences seriously affected the decision-making process on the ranches. The trainee is expected to advise the rancher from time to time on methods of improving operations. Because of the lack of understanding, trainees were frequently not effective in working closely with the ranchers. Thus, an important part of the overall training program did not operate efficiently.

Because of these limiting factors, in 1975 a new format was developed to train livestock production specialists. The new format featured placing the trainee back in his home country for the practical phase of the course. This would serve three purposes: (1) Professionals would be able to use their knowledge of conditions in their own countries; (2) after finishing the course, the benefits of the trainee's work in the course would remain in the home country; and, (3) the technology transfer process would be stregthened as national institutions assumed the responsibility of continuing assistance programs to the ranchers who participated in the training program.

**Two students in a CIAT animal production course empty mineral supplement into a trough in a ranch corral in Paraguay.**

**A trainee (left) and a technician prepare a herbicide solution to apply on pastures.**

As the first test of these ideas, a training program was established in Paraguay in collaboration with the national government and several national institutions active in the livestock sector. Among these institutions are the Faculty of Veterinary Medicine at the University of Asunción and SENALFA, an organization working on eradicating foot and mouth disease and which has received grants from the Inter-American Development Bank (BID). After establishing the cooperative agreement, the field program was set up in the Departamento (state) of Misiones, in a cattle producing area near the town of San Juan Bautista.

The course was established following the same teaching method developed on the North Coast of Colombia. The 11 Paraguayan trainees worked at the ranches for six months with supervision by an instructor of the CIAT training office. The course ended successfully in December 1975, after receiving enthusiastic support from the Paraguayan government and the cooperating institutions.

Much interest exists for repeating the course in Paraguay in 1977 but in some other part of the country, which has a large ranching economy. Other Latin American countries have asked for similar courses. For such training to be successful and of lasting value to a country, several conditions must be present. These will determine whether future courses will be conducted in other countries. Support and cooperation must be present in terms of human resources, cooperative ranches, transportation within the country and government or other institutional interest in continuing assistance programs to ranchers after the formal course has ended. When these conditions are present, this new training method for livestock production specialists offers many possibilities and advantages for developing the beef production sector in the tropical areas of Latin America.

The Paraguayan training experience received much favorable comment in local newspapers and on television. The following is extracted from an article which appeared in the 19 December 1975 issue of *La Tribuna*, published in Asunción.

"A postgraduate course for training livestock production specialists, sponsored by the Veterinary Faculty and CIAT, which is located in Colombia, ended with great success. The course lasted for 10 months and was the first testing of that course outside of Colombia. In this (training) module, specialists identify the problems in the location in which they work, including those of animal, ecological, economic and social natures.

"As Dr. Eduardo Ruiz Almada, dean of the Veterinary Faculty of Paraguay expressed it, this type of training permits putting adequate solutions into action. The course, at the postgraduate level, was part of the second semester of the sixth course of the Veterinary Faculty, in the new course plan, which is based on a new concept of the veterinary medicine profession. It gives major emphasis to the aspects of nutrition, pasture improvement, and utilization of feeds produced on the farm and replaces the old concept of giving major importance to preventive medicine, clinical veterinary practice and inspection of agricultural inputs.

"Dr. Patrick Moore, coordinator of the animal sciences training program at CIAT, expressed the opinion that this international center would offer courses similar to the one which ended in December 1975, in order to obtain a multiplier effect within Latin American countries of those efforts CIAT is making to train specialists in the animal sciences."

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