

AID/TA/AGR
43

DEVELOPMENT OF AN ACTION PROGRAM TO SYSTEMATICALLY
ACHIEVE AN EXPANDED PRODUCTION OF BASIC CEREAL AND
LEGUMINOUS GRAIN IN THE REPUBLIC OF PANAMA.

Charles Breitenbach, Agriculture Program
Analyst, TA/AGR., AID/Washington

I. Introduction

The present report was prepared as a contribution to the USAID/Panama Agriculture Sector Study of the Republic of Panama under Project 525-11-190-070. Its objective as defined in an October airgram to AID/W "TDY Assistance Agricultural Studies" was "To review and analyze present production practices for basic grains and to recommend a priority list of recommended diffusion and research action, by individual crop, to adequately support future expansion of basic grains production by small and medium size producers."

The author had the opportunity to visit Panama for a similar purpose from June 22 to July 7, 1972. At that time he assisted the "Facultad de Agronomía" of the "Universidad de Panamá" to prepare a proposal titled "Papel de la Universidad de Panama en Préstamos a Pequeños Agricultores para los Cultivos de Maíz, Arroz, Frijoles y Sorgo." It was presented as the University's recommended contribution to a program of small farm crop development under the second phase of a Capital Assistance Loan to the Government of Panama. At that time the author visited the provinces of Coclé, Herrera, Los Santos and Veraguas in a trip arranged by the Facultad de Agronomía. He was accompanied by Drs. Reinmar Tejeira and Alfredo Bernal of the Facultad. Both large mechanized rice farms were observed and small farms on which rice was grown under un-improved culture.

It was possible to see maize in production in various stages of development under mechanized, semi-mechanized and non-mechanized practices. Neither cowpeas "frijoles" (*Vigna sinensis*) nor dry beans "porotos" (*Phaseolus vulgaris*) were in production at that time.

The authors' second visit to Panama, on which the present report is based, took place from January 10 to January 30, 1973. During the second trip the author was accompanied by this colleague in the Agriculture Division of the Technical Assistance Bureau of AID/Washington (TA/AGR/AID/W) Dr. John Malcolm. They formed a two man team in which Dr. Malcolm reviewed the situation in Horticultural Crops while the writer did so in basic grains.

During the author's second visit the two AID/W technicians' program was arranged by Ing. Agr. Rolando Armuelles of the Ministry of Agriculture. They were escorted through the provinces of Cocolé, Herrera, Veraguas and Chiriquí by officials of the Ministry. Ing. Agr. Felix Estrada accompanied the technicians in the provinces of Cocolé, Herrera and Veraguas. Ing. Agr. Ramon Cascante, Director of the regional office of the Ministry of Agriculture in Chiriquí provided the consultants with the services of Sr. Miguel Angel Gomez to escort them through Chiriquí. They were shown the agricultural area of El Progreso, Concepcion and Alanje by Ing. Agronomo Enrique. At Volcan they were met by Ing. Agr. Roberto Rodríguez, head of horticultural crop production in the "Zona Alta", and at Boquete by Perito Agr. Juan Ayarza. During this trip it was possible to see only small quantities of rice as the late season crop had been almost entirely harvested.

Corn was observed in production, both on two large mechanized farms and under non-mechanized condition both in the tropical conditions of Azueros and on the highlands of Chiriquí. Several large fields of Grain Sorghum were observed at Azueros and in Chiriquí. This was also true of cowpeas. Only a few small plots of dry beans were seen and they were in the highlands at Volcan and Boquete.

Dr. Malcolm's interest was to observe the production of horticultural crops. The consultants were able to observe onions, tomatoes, melons and watermelons in production in Azueros. At Volcan the production was principally potatoes while at Boquete a number of plantings of onions and potatoes were seen as well as some production of cabbage and head lettuce. It was the intent of the two AID/W technicians to write their reports on basic grains and horticultural crops independently. Dr. John Malcolm has dealt with the sector on Horticultural Crops and the author Dr. Charles Breintenbach was responsible for this section on Cereal Crops and Grain legumes.

Both authors wish to express their gratitude for the excellent cooperation they were extended by the Ministry of Agriculture and for the fine travel arrangements that were made during their trip to the field. The consultants were met and cordially received at each scheduled stop on their itinerary and as a consequence they were able to obtain a good idea of both the basic grain and the horticultural crop production in the country.

The author is particularly fortunate in that during his first visit to Panama his counterparts were members of the "Facultad de Agronomía." During the second trip his local associates were primarily officials of the

Ministry of Agriculture. Thus he has been able to obtain a prospective into the roles of these two primary GOP agencies responsible for the development of agriculture in this nation.

The writer's first visit to Panama, during June and July of 1972, took place during the rainy season. His second visit January 10-30, 1973, occurred during the dry season. Both his opportunity to work with these two different institutions and his chance to observe crop production in different seasons have been of great assistance in the preparation of the present report.

II. The Problem of Planning Agricultural Development in Panama

Agricultural development in the Republic of Panama should be conceived in the author's opinion, in terms of three separate stages, these are:

1) The immediate problem: This is to increase agricultural production and income on the small farms of three of the nation's most densely populated provinces, Herrera, Los Santos and Veraguas. It will be argued that because the Azueros Peninsula has a short rainy season and because most of the soils except those of the bottom lands along the rivers tend to be poor and at times somewhat eroded, the area will be a difficult one in which to increase the nation's crop production. That argument can not be denied. Certainly with Panama's rapidly growing population now about 1,430,000 and expected to reach about 2,000,000 persons by 1980, it will be difficult there to reduce the nation's enormous over-all imports of agricultural products which continue to increase each year. This need not be the major objective of the immediate program. If the nation is to prevent serious political turmoil, the potential result of too rapid a migration from the

rural areas to its urban centers, it will be necessary to improve the earnings and thereby the conditions of the nation 52.4% of the population who live in rural areas. This can be accomplished effectively only if improved agricultural production and correspondingly increased earnings can be achieved by the nation's high percentage of small farmers who cultivate the more than 80% of Panama's farms each of which are less than 20 hectares in size. The program for the solution of this immediate problem may be called one of social reform through agricultural development. It should not be justified on the false hope of eliminating the nation's crop production deficit. This program's goals need to be, first to pay for itself after a period of five years and second to help alleviate the nation's food deficiencies if only in part.

2) The intermediate problem: This phase of the nation's agricultural development should be to increase the nation's agricultural production with the two goals: to eliminate agricultural imports wherever possible and to expand the nation's agricultural exports at least to that point where they earn sufficient foreign exchange to off-set the costs of necessary food imports which can not be produced domestically. This can not be accomplished on Panama's small farms; it will require the concerted effort of a nation-wide, all inclusive agricultural program. In this second phase new crops and agricultural products other than the three major agricultural exports of Panama today, i.e.: bananas, sugar and shrimp will have to be developed for sale to new markets abroad. There may be a good opportunity for Panama to revitalize the nations poorly maintained stands of beverage

crops: coffee and cacao, to export fresh and processed horticultural products, and to develop an export animal husbandry industry on the large percentage of the nation's land not adequately suited for crop production.

3) Long Range Development: Finally a long range program is required to expand the nation's agricultural production as the population expands into those large territories of Panama where roads do not yet penetrate. The unexploited provinces of Bocas del Toro and Darien may well prove to be the nation's richest agricultural reserves, but unless the lands there are developed according to pre-determined land use patterns they may quickly erode as is already the case in large areas of the central provinces and the chance to exploit their potential may not long continue to be realized.

The present report will attempt primarily to consider the potential of improving agricultural production for an increased agricultural rate of earning in the central provinces of Herrera, Los Santos and Veraguas where most farm holdings are under 10 hectares. This is in accord with the objectives of phase 2 of the proposed capital assistance loan. Reference will however be made to what might be achieved by the use of similar improved practices on larger mechanized farms.

It is not likely that any of the cereal or legume grains produced under either the immediate or the intermediate phases of a program for agricultural development in Panama will ever compete for the export market. There is, however, a possibility that the new cereal crop, sorghum, which has only recently been introduced may replace corn as the nation's feed grain and that it could so satisfy any presently existing or future needs

for grain in local animal production, as to greatly increase the availability of poultry, swine and possibly fattened beef. Likewise a new grain legume, soybeans, now first being tested in Panama, could also fill an important role in the nation's agriculture as a vegetable oil for human consumption and as a protein concentrate in animal feed.

Grain sorghum and soybeans were scarcely known in North America some thirty years ago, but since that time they have become two of the United States most important crops. Recent advances in the breeding of both these crops are making them equally adaptable for production under tropical conditions.

Local imports of feed grains have increased from 1,808 metric tons in 1968 to 19,900 tons in 1972 and these imports are likely to increase geometrically unless more feed is produced domestically.

Vegetable oil imports have increased from 9,000 tons in 1968 to 15,600 tons in 1972 and neither the production of coconut oil nor African palm oil offer a solution.

III. The Situation in Rice

Between the 10 years which comprise the 1960-61 cropping season and the 1969-70 season rice production increased from a country total of 2,114.8 thousand quintals of rough rice to 3,643 thousand quintals. Though it is true that the total production has fallen off during the last two growing seasons 22.9% and 17.6% respectively, this is probably largely due to the poor distribution of rains during 1971 and 1972. Some reduction in total national production however, may also be due to the fact that in recent years many large rice producers entered the field with little preparation

since they could readily receive credit. The incentives for rice production have continued to be good because the Instituto de Fomento Económico (I.F.E.) maintained the value of No. 1 rough rice at \$6.00 per hundred weight, a price well above the world market.

It must be pointed out that all rice production in Panama on both small subsistence farms as well as on large mechanized farms is carried out under upland conditions and must depend entirely on rainfall for its irrigation. The good incentive price has caused some business minded venturers to try their luck in marginal areas of Veraguas where the rainfall patterns is lower than normally desired. These are the men who have suffered worst in the last two years.

Plantings of first crop rice expanded 73.7 thousand hectares in the 1960-61 growing season to a high of 118.1 thousand hectares in 1966-67 and then began to decline to 111.2 thousand hectares in 1969-70, probably as a result of the realization of the large risks involved in large farm rice production. However, yield per hectare of rough rice continued to increase on a national average from 21.5 hundred weight per hectare in the first rice crop of 1960-61 to 25.1 hundred weight in the first rice crop of 1969-70 or about .36 hundred weight per year as a result of improved technology in rice production. The average yield of the second crop increased from 19.4 hundred weight to 23.2 hundred weight per hectare during the same ten year time span or an average of .38 hundred weight per year. As a consequence of these increases in yields rice production has about kept up with demand and only small amounts of rice have had to be imported. Milled rice imports averaged 457,600 lbs. a year over the last five years.

The largest area of rice production is in Chiriqui where the soils tend to be quite fertile and the rainfall higher than in Azueros. Next in production is the area of Veraguas east of the Azuero peninsula, and close to the Pan American highway. It is the part of the province where the precipitation is the highest although the soil is marginal for rice.

Although quite a good deal of rice is also grown in the Azuero Peninsula, this is for the most part produced on small subsistence farms. The large bulk of it is consumed in the area of production and does not enter on the domestic rice market.

There is considerable question in the author's mind whether rice should be a major crop emphasized for assistance on small farms under the second phase of the Capital Assistance loan program. The precipitation in much of Herrera, Los Santos and Veraguas is low for upland rice. Under the upland conditions in which rice is now planted, yields tend to be very poor. The national average per hectare is so low, less than 25 hundred weight, that it hardly pays to plant rice except for home consumption on plots of less than 50 hectares. The greatest earnings under the existing conditions result from economics which can be achieved only through the mechanization of the crop. Even when a tractor is rented for the preparation of the seed bed on small farms the cost of such a rental is always very high as compared to the cost of similar work on large fields. The amount of labor required to plant rice in rows by hand is also higher than in the case of most alternative crops. For that reason most rice is broadcast on small farms and, as a consequence of an unequal distribution of the seedlings, yields tend to be considerably below the national average.

Other disadvantages of this crop for the small farmer are that to obtain good production large amounts of expensive seed are required. Two to three quintals of seed at \$12.00 per quintal are recommended per hectare, when Nilo 1 or Nilo 2 are used. It does not pay to grow the local unimproved varieties as they are highly susceptible to Pericularia, a serious disease in all parts of the Republic. In both mechanized and hand cultivated rice the use of herbicides is recommended. Where hand weeding is practiced on small farms the cost in labor is high but even more important is the fact that the damage done to the development of the seedlings is often serious. Good fertilization requires the use of at least 5 or 6 quintals of a complete 12-24-12 formula and 2 to 3 quintals of urea before the crop flowers. This rate is in fact low but until dwarf strawed types have been developed for local use, higher rates of fertilizer use run the risk of causing the tall rice types to lodge excessively. When fertilizing rice by hand it is also difficult to get a good equal coverage over the entire field.

There are possibly three systems which might be investigated to make rice production on small farms competitive with that on large mechanized rice farms. The first is the use of small hand operated tractors such as the "Kabuta." The second is the possibility of joining small consecutive farms into cooperatives the members of which might jointly mechanize their holdings by the use of a cooperatively owned or rented tractor. Of greatest potential, it would seem to the writer, is the possibility of growing inundated rice on such small farms. The best hoped for yields with the best seed and best available technology now worked out for upland rice in Panama

is estimated to be 80 to 90 quintals per hectare. This is well below one half the yield which might be expected from inundated rice. Though the rainfall pattern is low for rice in most of Azuero there are numerous flat areas there which could be diked and into which running streams might be diverted during the rainy season.

Perhaps an intensive extension program to teach inundated rice production to small farmers in two or three areas of Herrera, Los Santos and Veraguas might prove to be good testing grounds in which to determine whether inundated rice production can be successful under local conditions. If it worked on small farms the new technology could more easily be transferred to large mechanized rice producing areas in other parts of the Republic. Of course the technology for inundated rice production has still not been worked out in Panama. Only the Taiwanese Mission in Santiago is successfully producing rice under inundated conditions. This would mean that it would be necessary to bring in experts trained abroad. Possibly the Taiwanese field party or a group of experts trained at the CIAT in Colombia would be able to work out and teach inundated rice practices.

Information on improved rice production technology is seriously lacking. Panama should make greater use of the plant breeding work at the IRRI in the Philippines and the CIAT in Colombia to develop an improved technology for this crop under local conditions. The best yielding rice varieties found in introduction trials of varieties obtained from such international centers as IRRI, CIAT and the PCCMCA program should be quickly crossed with the best Nilo lines now in production. By a backcross breeding

program the long grain disease resistant qualities of the Nilo types should be crossed onto the short strawed more highly productive IRRI type rices. The latter's superior yield potential should be used to bring up local yields by permitting increased fertilizer usage without suffering the present consequence of excessive grain loss through lodging.

The current widely-accepted belief that rice should not be planted on poorly drained soil nor in areas of rainfall in excess of 1,000 millimeters is no doubt a consequence of the plant type of the Nilo varieties now recommended. If it proved possible to introduce inundated rice culture and to grow the dwarf statured IRRI type rice varieties, then Panama's heavier soils in the high rain belt areas might prove to be the best land for the crop.

IV. The Situation in Corn

Corn production increased from a country total of 1,295.5 thousand quintals of shelled corn in 1960-61 to 1,929.3 thousand quintals in 1969-70. Yields have fallen considerably during the last two years about 36.2% in 1970-71 and 37.9% in 1971-72. Unlike the situation in rice this is probably more a result of an adjustment due to the relative pricing between rice and corn, than it is the result of poor rain distribution, or faulty management. Corn producers may well have been discouraged from producing maize for the market because the average yield of shelled corn per hectare is below 17.5 quintals per hectare and it is fixed by IFE at \$4.25 per quintal. In contrast the nation's average yields of rough rice tend to be above 21 quintals per hectare and the support price of No. 1 rough rice is \$6.00 per

quintal. Many commercial producers of corn claim that they can not make a profit at the guaranteed rate. It needs to be pointed out, however, that except for a relatively small number of large mechanized farmers who have decreased in number, most corn is produced on farms of less than 20 hectares and that both its cost and risk of production are considerably less than for rice.

Planting of first crop corn increased from 48.2 thousand hectares in 1960-61 to 6810 thousand hectares in 1967-68 and then continued at a lower rate of around 60.8 thousand and 61.4 thousand hectares in the two successive years that followed. Plantings of the second corn crop increased from 29.1 thousand hectares in 1960-61 to 44.8 thousand hectares in 1967-68 and then also began to decrease.

Although the total area planted to corn has continued to be below the 1969-68 high, the average yields of shelled grain has continued to increase per hectare in both the first and the second planting. In the first planting this average increased from 16.1 quintals per hectare in 1960-61 to 18.0 quintals per hectare in 1969-70. During the same 10 year period the average yield of the second planting increased from 14.2 to 18.4 quintals per hectare. This has to some measure compensated for the losses in national production caused by the reduced area planted to corn.

The average annual increase of .20 quintals per hectare in the first crop and .42 quintals per hectare in the second crop is largely due to the substitution of the indigenous varieties with "Tocumen 70" and to the greater ability of this new variety to respond favorably to higher rates of fertilizer application.

Because corn is a widely adaptable crop and can be grown on much of the soil in Panama it is quite equally distributed in all provinces. However, within the extent of its potential yield capacity it is highly responsive to fertilization. It should never be planted on poor soils nor in areas where the precipitation tends to be low.

Corn to a much larger extent than rice tends to be consumed on the farm. This is because a greater percent of the nation's corn crop than rice, about 95% is grown on small farms. About 25% of production is used for the producer and his family for food and about 40% of production is used by the farmer for his poultry and livestock feed as well as for his next years seed. Because of the rapidly developing commercial poultry industry there is a need to import corn and sorghum for feed each year. Unless national feed grain production is raised this deficit is likely to increase.

The author believes that corn is one of the best crops for emphasis on small farms under the second phase of the Capital Assistance Loan program. Except on the drier areas in the Azuero Peninsula, a condition found in parts of Herrera, the average yields in Azuero tend to be above those in all other parts of Panama other than on the fertile soils of Chiriqui. The national average yields for corn production are 20 quintals per hectare. This is because the native varieties are grown largely without fertilizer and so have lost their ability to respond to the addition of mineral nutrients.

Work at the Facultad de Agronomía has demonstrated that average corn yields can be brought up 50% in most areas just by using the improved variety "Tocumen 70" and improving seed bed and cultivation practices.

With the use of proper fertilization these yields can be doubled. It is quite possible to get yields of 60 to 70 quintals of corn per hectare under most farm conditions with the technology already on hand and this is more than three times the national average.

Small farm production of corn is not likely to have to compete with mechanized corn production at least in the near future. The mechanized farmer can earn a considerably larger margin of profit growing rice. In addition corn is more adaptable to the semi-mechanized or hand-operated farm than is rice. Both seeding by hand and harvesting by hand are easier than in rice and the control of weeds is less of a problem. The risk of losing ones crop as the result of disease is much less than in rice too.

Since the practices for obtaining improved corn production are well known a campaign to achieve this on small farms should not be difficult.

Because of corn's response to good agronomic practices it generally pays to rent a tractor for the seed bed preparation. A good variety should be used. The locally selected "Tocumen 70" is always preferred because it is more hardy than the best introduced hybrids and because under most small farm conditions it has not been out-yielded by the latter. However, if the supply of "Tocumen 70" is short either of the hybrids Pioneer 306 or Poey 66 may be substituted. About 50 lbs. of seed per acre are required.

About 8 quintals of 10-30-10 are recommended on the fertilizer responsive varieties at the time of seeding. For best results one to two quintals of urea should be side-dressed next to the corn rows when the stands are about 40 days old.

A better variety than "Tocumen 70" can no doubt be bred. The author believes a program of corn breeding in Panama is more urgent than in any other of the Republic's crops. It is recommended that high priority be given to bringing in a foreign corn-breeder for this purpose.

With improved varieties which may be achieved it should be possible to increase present optimum corn yields of between 60 and 75 quintals per hectare to as high as 120 quintals in Panama.

V. The Situation in Sorghum

Sorghum is a new crop for Panama. It is first being grown on commercial scale in Panama this year. Production of this crop will no doubt be encouraged by the fact that the IFE has placed a fixed price on it of \$4.25 per quintal which is the same as that for corn.

Sorghum has considerable advantage over corn in marginal areas where the soil tends to be poor for corn or where the precipitation may tend to be somewhat short for corn. As many of the small farms in Azuero meet one or the other of these conditions it could have very good acceptance there. In particular it should be tried in the drier areas of Herrera and Veraguas. Unlike corn, sorghum can withstand long periods of drought by reducing its transpiration and slowing its metabolism. It stops growing and then when it starts to rain the plant starts growth again where it left off.

A number of superior introductions of grain sorghum have been tested by the "Facultad de Agronomía" in Tocumen. Among the best of these are an ICA variety from Colombia named "Nativia" which has the advantage of being true-breeding. Also of promise are the Pioneer hybrids P814 and P846 and the Northup King hybrid NK133A. All of these have been found to exceed a

production of 70 quihals per hectare when fertilized with the fertilizer application recommended for corn. Results obtained in other tropical countries have consistently demonstrated that sorghum can equal or out-yield corn production in grain except under optimum land-use conditions.

The author believes that the grain sorghums should play a major role in the Capital Assistance Loan program intended for the development of Herrera and Los Santos and Veraguas. It could be used to replace corn for poultry and swine feed on the small farms and thereby release additional corn for the market.

Until adequate research has been done to specifically determine the best agronomic practices for grain sorghum production the standard practices recommended for corn may best be applied.

It is very possible that the greatest potential for this crop in Panama may be as a rotation crop with rice in large mechanized plantations. It would be well suited to follow rice in those areas where they are attempting to get a ratoon crop of rice with residual moisture.

In a number of tropical countries grain sorghum is already being grown as a perennial crop for two or more harvests. After the panicles are harvested the stalks are cut down to ground level. The stover is raked off and the field is fertilized as was the original seed bed. If adequate moisture is available, the second crop often yields more grain than the first and in a much reduced growing period.

There is a very good chance that grain sorghum yields can surpass the grain yields of corn in Panama.

VI. The Situation in Dry Grain Legumes

There is considerable confusion as to what is the dry grain legume of Panama. The fact is that there is not one, but two. They are the dry bean Phaseolus Vulgaris locally called "poroto" and the cowpea Vigna Sinensis known in Panama as "frijol." The confusion arises because the two are not distinguished. Both are reported together in production statistics as "frijol" and the term is used for dry grain legume food imports as well.

In truth the Cowpea is a relatively new introduction. Though it now largely has replaced the dry bean in local production, it is still not the dry legume of import. The problem is that the dry bean "Phaseolus vulgaris" has become so susceptible to virus diseases that healthy dry beans can no longer be grown in Panama except at a few areas in high altitude such as Volcan and Boquete. As a result cowpeas Vigna sinensis, a species of African origin, is replacing the dry bean, and now appears on many local markets.

A third legume the pigeon pea Cajanus Cajan known locally as "guandu" is also produced in Panama, but as it is generally eaten green it must be considered a vegetable and therefore is not discussed here.

Between the 10 years which comprise the 1960-61 cropping season and the 1969-70 season dry grain legume production generally continued to decline. Production fluctuated between a high of 158.80 thousand quintals in 1962-63 and a low of 91.30 thousand quintals in 1964-65. Yields of these crops fluctuated between 3 and 7 quintals per hectare. At this low rate of production there is little incentive to grow dry grain legumes.

The dry grain legumes are rarely grown under mechanized conditions except in a few instances where cowpeas are now being produced as a commercial crop on large farms following rice.

The small farmer generally keeps his seed from year to year. It is usually of mixed origin diseased and genetically degenerated. In most cases, no fertilizers, pesticides nor herbicides are employed and frequently the stands are not even weeded with a machete. The crop is planted after corn or rice at the end of the rainy season in order to take advantage of any residual fertilizer not utilized by the previous cereal crop. As no investment and little time is expended the farmer is satisfied to harvest whatever he can get.

About five years ago a cowpea variety from Venezuela was first introduced. Known by the variety name "Arauca" it has proved highly superior to other dry grain legumes in the Republic and yields more than twice as much as did the best previous dry grain legumes. Yields of thirty quintals per hectare can be obtained if adequate fertilizer quantities are applied and good agronomic practices are used.

The Facultad de Agronomía is now working with a collection of cowpeas varieties from the PCCMCA and among them they have selected and are multiplying varieties which have consistently outyielded "Arauca" in yield trials. The great advantage of Vigna sinensis over Phaseolus vulgaris is the high degree of resistance to the bean mosaics.

To obtain good yields of cowpeas they should be planted at the end of the rainy season after a rainy season crop. Because they mature in 75 to 90 days they are able to make use of small amounts of residual moisture which remain in the soil.

Good yields require heavy seeding rates, about 1 quintal of seed per hectare. Though it is not the common practice to fertilize edible legume crops in Panama it does pay to do so when quality seed cowpeas are used. Until now an all purpose fertilizer such as 12-24-12 has been recommended at the rate of 4 to 6 quintals per hectare. Further research is required on cowpea fertilization. If good root nodulation exists it is doubtful that Nitrogen would be needed after the seedlings are established. The elimination of nitrogen from the fertilizer would result in a considerable saving to the producer.

The planting of cowpeas is recommended on the small farms of Azuero only if good seed of tested varieties can be made available. Cowpeas are a good source of protein when eaten on the farm. They are produced at a time of year when few other crops may be used in rotation. The crop has a good potential and is replacing the dry bean which is no longer economic to plant due to its susceptibility to disease. The use of dry beans *Phaseolus vulgaris* should be discouraged.

VII. The Situation in Soybeans

Soybeans are only recently being tested in Panama but at the "Facultad de Agronomía" Experiment Station in Tocumen several fields were observed which were producing heavy crops of beans. Soybeans are already being produced in commercial scale in a number of tropical countries under conditions not unsimilar to those of Panama. Brazil is a big producer and considerable quantities are grown in the Cauca Valley of Colombia.

Until recently the soybean was considered to be a temperate crop because the original germplasm introduced to the U.S. from mainland China and Korea were photoperiod responsive. They grew vegetatively as the days lengthened and flowered as soon as the days started to shorten. Under the short day, tropical conditions these temperate varieties hardly had time to leaf before they flowered, matured a seed crop, and died. The development of photo-insensitive soybean varieties changed that situation. Today there are varieties which grow as normal vegetative plants in the tropics and do not start to flower until the seedlings have attained sufficient stature to produce a good crop of beans.

The University of Illinois has a centrally funded contract with AID/W for the purpose of developing improved soybean varieties for tropical conditions. The Facultad de Agronomía could well benefit and possibly hasten soybean production in Panama by cooperating with Illinois in this program.

Soybeans are not now recommended for production in Azuero under the Capital Assistance Loan program. Too little is still known about how to grow them under local conditions. The author has mentioned them here because this could be a crop of considerable promise at a later date under both mechanized and small farm conditions.

VIII. A Program of Agricultural Development Assistance

Before a basic strategy for the development of improved crop production is ever initiated a program of action needs to be carefully evaluated. To be successful the small farmers within the program must achieve significant increases in their earnings without an excessive additional input of the farm family's labor. Only too frequently large extension programs have failed because the advances they attempted to achieve were not sufficiently remunerative to dynamically move the farm families they were intended to assist. It must never be forgotten that the "status quo" also has a price valve; the farmer must be convinced that it will be well worth his while before he will willingly change his present practices.

Most farmers already know how they might increase their earnings by at least 20% through improved changes in their farm practices they already understand. That they do not do so has often been attributed to laziness. The fact is that in many instances this is an excuse for failure used by bad agricultural planning advisors who have not been able to get agriculture moving.

The AID experience in the Philippines in extending new IRRI rice varieties and improved practices for their production demonstrated that traditional farming practices can quickly be changed. What it took was a package of technology simple to use, but so dramatic

in result as to be able to convince the farm family that their way of life could be materially improved.

The lesson is simple. In Panama, too, the USAID Mission might better not invest in any program of small farm development assistance other than for political expediency, unless the program can materially change the lives of the farm families it is intended to affect.

Basically, there are three factors which need to be evaluated before it can be decided whether a program of this nature should be undertaken. They are:

1. What is the status of the art today?

The available information acquired both through research and practical experience needs to be evaluated in order that the program planners may be advised of all the promising possibilities of improving farm incomes.

Where information is lacking, what that lack is needs to be determined so the void may be filled.

2. What are the packages of technology which could be made available to small farmers?

Obviously it is not possible to try to teach too much that is new at once. The program must establish priorities with high potential pay-offs. It should be decided how the available information may be assembled into small but integral programs,

"packages", which are complete in themselves and can be made available to cooperating farmers as integral units. Their use must be easy to demonstrate if the new technology is to take effect on many farms.

The different "packages" which might be assembled need to be ranked in accordance with the estimated value they could have in affecting the farmer's immediate and long range well being.

Where potential packages of special priority are found but gaps still exist in the information needed to make them pay off, provision must be made to complete the necessary research.

3. What are the facilities available with which to undertake the projected program?

The program has to be limited by a number of outside factors which must decide its size and scope. Most important is the amount of capital which can be invested in it. Next are the commodities that will be required and the services which must be provided within the available program budget. Finally when and how the program is to begin must to a great extent be determined by when needed commodities can be obtained and by the trained manpower available to it.

Only when these three factors have been carefully evaluated should a basic strategy be defined as a plan of work.

1. What is the status of the art today?

In general the farmers on small farms in Panama are better off than in most Latin American countries to the North and South. This can no doubt be attributed to the high standard of living in the Republic as a whole. A daily laborer earns \$2.50 per day and no doubt a great many small farmers receive some of their income other than from their farms. The price support system maintained by IFE for basic grains and the assured basic price at which certain horticultural crops such as onions and potatoes are maintained to help all farmers to obtain a fair price for their produce.

It is rare to see a farmer plowing with oxen; even on small farms the land is prepared for seeding by rented tractors. The use of fertilizer is higher on most small farms than in many Latin American countries and the use of insecticides and weed-icides is common. Still Panama is seriously deficient in the development of new technologies for the 95% of her farmers who work farms under twenty hectares in size.

There is some good information available with which to improve the agronomic practices in rice, maize and to some extent the grain legumes. This research has made it possible to recommend superior fertilizer applications for the principal crops on each of the different soil types in the Central Provinces.

The information includes methods and density of seeding for each crop and the best herbicides to control weeds. To some extent, spraying and control methods have been worked out to reduce insect pests. The Ministry of Agriculture has prepared a quite acceptable guide which tells how best to cultivate rice, corn and cowpeas and tomatoes on mechanized, semi-mechanized and subsistence farms. The Facultad de Agronomía sums up the best defined practices for growing Panama's principal food crops in its "Progreso de Labores de Investigaciones Agropecuarias" published in 1970. With the information available, it is estimated that yields of the cereal and grain crops may be brought up on well managed farms from the national averages now obtained, as follows:

<u>Crops</u>	<u>Present National Av.</u>	<u>Optimum Yield with Existing Varieties</u>
Rice	30 Quintals/ha.	80-90 Quintals/ha.
Maize	18 Quintals/ha.	60-75 Quintals/ha.
Sorghum*	----	60-75 Quintals/ha.
Dry Grain Legumes	7 Quintals/ha.	25-30 Quintals/ha.

* No information has been established on average sorghum yields.

These ceilings are in no way limits beyond which the individual crop may never be expected to yield. They are however, the rates of maximum production that the author estimates to be possible with the varieties now available to farmers. The reason for these ceilings is that production can in no crop be increased

beyond the genetic potential of its germplasm make-up to respond to the improved farming practices employed.

To date insufficient work has been done to select superior cereal and grain crops for use in the nation. Though large numbers of introduced varieties are now being brought in from the international centers, i.e. CIMMYT, IRRI, CIAT, and PCCMCA, there have been too few trained agronomists and too little time for these men to satisfactorily evaluate field trials. Neither the personnel nor the facilities have existed to breed superior crops specifically adapted to special needs within different parts of the country.

Particular needs within each of the specific crops have already been cited, but it may be well to recapitulate them. Most important in Rice is research to determine how inundated rice production may be effectively undertaken in Panama. Dwarf statured types are needed.

New and better corn varieties must be bred for the Nation. The fact that it was possible to markedly increase maize production by the introduction and local selection of "Tocumen 70" indicates that it should be possible to get even better production through a controlled corn breeding program.

The start of commercial sorghum production is a commendable development. The author is convinced that in many areas of Panama, particularly those with poor soils and those with

marginal precipitation sorghum will produce more grain than corn. Research is required on where these areas are, what varieties will do best there and the best agronomic practices to grow the crop.

Panama's agronomists are to be commended on having recognized the futility of trying to continue to grow dry beans in the Republic and on their work to convert to the production of cowpeas. Additional research is now needed on the choice of cowpea varieties for specific areas and on the control of disease in leguminous crops.

Research has been initiated and needs to be continued on the possibility of growing soybeans as a new grain legume in Panama.

2. What are the packages of technology which could be made available to small farmers?

The author will not attempt to place together the various elements of seed fertilizer and agronomic practices which would be required to tie up each of the packages mentioned below. It is believed that this should be assigned to the Facultad de Agronomía. An attempt will be made, however, to place these programs in that order of priority which may bring most significant increases of earning to the small farmer at minimum risk. Each package program will be briefly discussed.

- a. Corn production. Because of the nation's increasing demand for corn, both for human food and for animal feed, and

because the national hectareage in corn has gone down while annual imports of feed grain have gone up this program appears to be highly promising. As long as the large farmers are able to make greater profits from planting rice than they can from corn few of them are likely to compete with small farm corn production. The use of the variety "Tocumen 70" is able to improve production considerably over the national average and the agronomic practices for its best production have been worked out. The only serious problem to the development of this package may be the availability of large quantities of quality seed.

b. Sorghum production - The choice of sorghum as the second most promising package may be a little premature in view of the fact that it is such a new crop. The author recognizes this fact, but even in this there are certain advantages. It is easier to teach improved practices to a farmer on a crop that he knows nothing about than if it is on a traditional crop which he has always grown. Sorghum has been assigned the same fixed price by IFE, \$4.25 per quintal, which is given for corn, but with a serious shortage of animal feed likely to develop in the country both grains are likely to sell for more. According to preliminary information acquired both through yield trials in different parts of the country and from large plantings in Chiriquí, sorghum will yield at least as much grain as corn and on either marginal soils or where precipitation is limited it will

surpass corn yields. There are many such areas in Azuero.

It is true that not all the research which is needed has been done on this crop. This is particularly true of the best methods and densities of seeding. Provisional information will have to be used until conclusive seeding rate data is obtained from comparative field trials. Though the best varieties for Panama's needs are still likely to be introduced, satisfactory varieties such as "Nativia" from Colombia and the American hybrids NK133A and P814 and P846 will have to be depended on in the interim. Because of its priority needs, the AID loan should be encouraged to assist in financing this research. Tests needs also to be run on whether it pays to ratoon sorghum under small farm conditions.

c. Grain Legume Production - The production of grain legumes should be considered secondary to that of cereal grains in the national interest. Still a major aim of any agricultural development program ought to be to keep productive land in food production for the maximum number of days it can profitably carry crops throughout the calendar year. Cowpeas grow at the end of the rainy season when only vegetable crops are also grown and these generally require irrigation while cowpeas do not. If a farmer can get 20 to 30 quintals of grain by growing cowpeas, a range well within the limits obtained with the variety "Arauca", this no doubt would augment his income. Many small farmers will

consider that the labor involved is not worth the amount they can earn from the crop, but the author believes that the Nation's switch from dry beans to cowpeas has been a wise one and feels that the production of this alternative crop provides good promise. Better varieties than the standard variety "Arauca" have already been identified. Assistance is needed in the rapid multiplication of the improved seed. Research is needed in an adequate fertilizer formula for the crop and in improved strains of rhizohium bacteria for better introgen fixation.

d. Horticultural Crops. - The author has intentionally not dealt with crops other than the cereals and the dry grains legumes. It would be a mistake however, to eliminate the vegetables from the present section. They can be produced well in the dry season in Azuero in those areas where small amounts of water are available for irrigation and can bring a good price on the Panama City Market.

e. Rice Production. - The author considers rice production to be very low on a priority list of packages for the small farmer in Azuero. The precipitation there tends to be inadequate and the soil type generally marginal for upland rice. This is also a crop which cannot compete with large mechanized production on the plains. Farmers who wish to grow rice for their home consumption should not be dissuaded from doing so, but the risk is great and loan capital should probably not be used for this purpose.

The author does have one reservation in this recommendation. He feels there are a number of areas in Herrera and Los Santos where small farmers might grow rice under inundated conditions. At the present time only the Taiwanese mission has any experience in such rice production in Panama. Perhaps they could be encouraged to put in several demonstrations in the Azuero area. If this proved successful, the present low priority for a rice package possibly would not hold.

3. What are the facilities available with which to undertake the projected program?

A project of assistance to small farmers based on the introduction of packages of technology such as outlined in the priority projects listed above is at very best risky. To enter into such a venture with a multi-million dollar loan all at once would appear to be fool hardy. Especially is this true since there has been no experience in these type activities in Panama upon which to base a wide-spread extension operation.

It makes sense to start out with two or three pilot ventures in different parts of Azuero first. At each perhaps 250 farms might be assisted. From these first operations initial experience can be gained. Within the pilot project additional apprentice extension agents could be trained. Where to obtain adequately trained extension agents will be a major obstacle that will have to be overcome.

The Facultad de Agronomía had only graduated seventy-three Ingenieros Agrónomos as of 1970. Its capacity for graduating new students is less than twenty-five students a year and these are generally hired well in advance of graduation.

The practical school of agriculture at Divisa which graduates students at the level of "Perito Agrónomo" has only three hundred students in all its three years of classes and because of the high attrition rate, it graduates less than fifty students a year. This means that it will probably be necessary to take untrained extension agents and to give them a practical background in extension if a program of the scope anticipated under the Capital Assistance Loan is ever to take place.

A further consideration is the fact that the rainy season starts in April or May in Azuero. Preliminary plans would have to be drawn up to start with the first planting before then. The cooperating farmers will have to be contacted before that time and arrangements made to provide them with necessary credit to undertake one or more of the package programs. The initial group of extension agents will have to be organized into teams and the program made known to them. The procurement of a vehicle for each extension agent and for the backstopping superior who heads each team will be a major concern.

It is estimated from experience in the Philippines that each extension agent can handle twenty-five to thirty cooperating

farmers effectively but that he probably should not be assigned more than twenty-five cooperators the first year.

If we attempt to reach 750 farm cooperators the first year in three pilot projects, 250 farmers in each of three pilot areas, this would appear to be an ambitious program for the 1973-74 growing season. It would require thirty extension agents divided into three teams of ten each. Three team supervisors would be required and a total of thirty three jeeps. The author believes this is the maximum that could be attempted on such short notice.

IX. Other Considerations

In the report that this technician prepared with the University of Panama's Faculty of Agronomy in July of 1972 it was recommended that the College of Agriculture should be responsible for the small farm development program. They should be assigned loan funds to undertake the necessary research required to support the packages of technology which have been outlined in the present paper. They would also be made responsible for training the extension agents under the program and for the continued supervision of these extension agents after they took up their function of working with cooperating farmers.

At the time of the July report the Ministry of Agriculture was not included as part of the proposed program. The Instituto de Fomento Económico was assigned the responsibility both of credit management and of extension supervision.

Since the July paper was written these intentions have been modified. The Ministry of Agriculture is now to be given a major role in the program. After having had the opportunity to observe the Ministry's programs during his January 1973 visit to Panama, the writer believes this to be a wise decision he has been impressed with the work he was shown and the enthusiasm of the Ministry employees.

The effort to improve farming practices on small farms under the Capital Assistance Loan program is intended to reach several millions of dollars. In a program of that size it would be well to involve all three agencies, the University, the Institute and the Ministry.

It is the author's opinion that the Faculty of Agronomy should continue to be assigned the responsibility for the research and for the training and technical supervision of the extension agents under the program. This is specified in the July paper.

The Instituto de Fomento Económico should be the loaning agency. However, during his July 1972 visit to Panama the author was not impressed with the IFE extension program. It seemed to him, that in their role of loaning agents, the IFE personnel generally considered themselves to be of superior position and that because of this they were unable to communicate with the small farmer on his plain.

It is strongly recommended now that the extension (production) program under the Capital Assistance Loan be assigned to the Ministry and that whenever possible the extension agents under the program be Ministry personnel supervised by the Ministry of Agriculture.

X. List of Recommendations

1. It is recommended that the nation's agricultural development be planned in three separate time-phased programs scheduled successively. These are:

- a) The Immediate Problem, to increase agricultural production and income on the small farms of three of the Nation's most densely populated provinces, Herrera, Los Santos and Veraguas.
- b) The Intermediate Problem, to eliminate agricultural imports through domestic production where possible and to expand Panama's exports to that point where they off-set the cost of food imports which cannot be produced domestically.
- c) Long Range Development, to expand the nation's agricultural production to those large territories of Panama where roads do not yet penetrate.

2. It is considered that immediate assistance to the provinces of Herrera, Los Santos and Veraguas is a political need, to prevent excessive rural migration to the urban centers where there are inadequate employment opportunities. The program's goals should be

first to raise farm incomes and second to help alleviate the Nation's food deficiencies to any extent this is possible.

3. It is recommended that two new grain crops be given special attention in the Nation's agricultural planning. The first is grain sorghum which has already been initially tested and has excellent prospect of off-setting the Nation's rapidly increasing feed grain imports. The second is soybean which after present tests may prove to have the potential of reducing Panama's enormous vegetable oil imports.

4. It is recommended that upland rice, as grown in Panama, not be considered for production on less than 50 hectare plantations except where it is grown for home consumption. This is the minimum area in which it can be economically mechanized.

5. Rice is not recommended for the small farms of Azuero both because it cannot be economically mechanized on small farms and because of the ecology. There is insufficient precipitation and the soils are marginal for the crop.

6. It is considered that research on the possibility of growing rice under inundated conditions might be experimented on some better suited small farms in Azuero. If the practice resulted there, it could more easily be transferred to the large mechanized areas of production.

7. It is recommended that persons experienced in the production of inundated rice undertake this research in Panama.

Expertise might be obtained from the Taiwanese Mission in Santiago or from the CIAT in Colombia.

8. A breeding program is urgently needed to transfer the dwarf straw characteristic of the IRRI rice varieties ^{to} the long grain Pericularia disease resistant "Nilo" types preferred in Panama. By this method it should be possible to make the upland varieties now grown more fertilizer responsive and less lodging prone.

9. Corn is highly recommended for production on the small farms of Panama. It is widely adapted for production over large regions of the country and does particularly well in many areas of Azuero. Because the variety Tocumen 70 greatly outyields the local varieties that have been used and because new technologies have been developed for its increased production it is practicable to bring yields up from the national level of 18 quintals a hectare to between 60 and 75 quintals on well tended small farms. Unlike rice, corn can be grown economically on small farms. It does not have to compete with mechanized production at this time.

10. It is considered that a variety better than Tocumen 70 can be bred. A high priority should be given to bringing in a foreign corn breeder for this purpose.

11. Sorghum is recommended to replace corn in Panama in those areas where the soil is poor for corn and the precipitation marginal or deficient for its production as is the case in the drier

zones of Herrera and Veraguas.

12. If adequate seed of a pure-breeding variety such as the Colombian variety "Nativia" can be obtained, its use is recommended in preference to U.S. hybrids which must be purchased new each year. The latter have not been found to greatly outyield good pure-breed sorghum varieties under most tropical conditions.

13. Adequate information is still lacking on the best density and method of seeding grain sorghum in the nation's different provinces. Research on such cultural practices should be assigned a high priority.

14. Grain sorghum should prove highly adapted to planting on mechanized large farms following rice at the end of the rainy season. The practice needs to be researched.

15. The practice of ratooning sorghum for successive harvests has proved successful and in other tropical countries and has produced very high yields of grain as long as adequate moisture is available. The practice required that the stalks be cut back to ground level after each harvest and that the stooling plants be heavily fertilized with urea at the start of each new cycle. The ratooning of sorghum should be investigated under local conditions.

16. It is considered that the Ministry of Agriculture has made a wise decision to discourage the planting of dry beans, Phaseolus vulgaris, "porotos" in Panama as the result of poor yields due to the diseases of the crop. Present substitutes of dry legume grain production with cowpeas, Vigna sinensis, "frjoles" has proven

promising and should be extended.

17. Work should be continued on the introduction and testing of new cowpea varieties introduced under the PCCMCA program for the selection of new varieties which will yield more than the standard Venezuelan variety "Arauca" now employed.

18. Research is required on improved agronomic practices and better fertilizer formulas by means of which present cowpea yields may be increased.

19. Research is required on how to increase root nodulation for better nitrogen fixation which continues to be poor in many stands of cowpeas.

20. Small farmers should be discouraged from saving their own cowpea seed. As in dry beans, the virus count of cowpeas can rapidly build up. Planting should be recommended only if good seed can be made available.

21. Research is needed on the control of disease in leguminous crops. Methods of growing virus free cowpeas for seed should be studied.

22. Research should be extended on the possibility of introducing commercial soybean culture for future production in Panama.

23. The introduction and testing of improved soybeans varieties for the tropics needs to be expanded. It is primarily the photo insensitive types which have a good yield potential in the tropics.

24. Contact should be made with the AID centrally funded contract on tropical soybean production at the University of Illinois for improved varieties and for assistance in local soybean development.

25. A pilot extension project is recommended in two or three areas of Azuero before a large extension program is started there on small farms under the proposed second phase of the Capital Assistance Loan. Unless it can be shown that such a program can materially increase crop harvests and farm incomes a large program has little chance of success.

26. It is recommended that the extension program under the pilot project be based on those packages of technology which will have a high priority of success.

27. It is considered that the different packages of technology which can be introduced may rank in the following order in accord with their probability of success in raising small farm incomes in the Azuero Peninsula.

- a) Corn production
- b) Sorghum production
- c) Cowpea production
- d) Horticultural crops

28. Rice is not recommended for assistance under the pilot project both because Azuero is generally poorly suited to its production and because its production on small farms does not

compete with mechanized production on tracts over fifty hectares. A possible exception could be inundated rice.

29. It is recommended that the pilot projects not exceed work on 750 farms in 1973-74. This is because of the limited time remaining in which to make available all the necessary pre-requisites to be able to start when the rainy season commences next April or May. Such a program in three areas would require 30 trained extension agents each of whom could work with 25 farmers. Three extension agent supervisors would be required and a total of 33 vehicles for transport.

30. Because adequate trained agricultural personnel is very limited, it is considered that additional untrained agents for a more extensive program could be trained through participation in the pilot project.

31. It is recommended that the Facultad de Agronomía should be assigned the following functions in the pilot project and that provision should be made to provide for these as part of the Capital Assistance Loan at such time as the Phase 2 part of the loan be approved.

- a) Training of the extension agents and their continued technical guidance after assignment in the field.
- b) The establishment of demonstration plots which will serve as base lines to determine what each technical package is capable of producing and the relative success of individual farmers in attaining these goals.

- c) The performance of specific research considered to be necessary in order to fill in specific gaps of technology noted to be deficient in the individual crop production packages.

32. It is recommended that the Instituto de Fomento Económico be the finance agency responsible for extending small farm credit loans, but that its work be restricted to these functions.

33. It is recommended that the agricultural extension program of assistance to small farmers should be under the Ministry of Agriculture. Provision should be made to provide funds to the Ministry so that it may be able to continue the functions listed below, on a permanent basis under the Capital Assistance Loan program, at such time as Phase 2 of the loan may be approved.

- a) Operation of the extension program with agents who shall be either Ministry employees, or else given Ministry tenure as soon as that is possible.
- b) Day to day supervision both of the individual extension agents and of the overall agricultural extension program under the loan program to small farmers.

which will range from zero for some public sector projects, to very high levels for certain investments in the private sector, simply because we are not yet sophisticated enough in national income accounting to make the appropriate imputations for the contribution of public sector investments to the welfare of the society. Thus an assumed rate of return of 12.5 percent again does not exceed the bounds of plausibility.

Let us now turn to the contribution of raw labor to growth. By raw labor we have in mind totally unskilled and untrained laborers. In the case of Panama, for purposes of illustration, it is not unreasonable to assume that an unskilled worker receives an income of approximately half the wage of the average member of the labor force. Let us further assume that labor's share of total output (the functional share) is 60 percent, hence the share of raw labor, assuming that each member of the labor force possesses the same amount thereof, is 30 percent. With a growth in the labor force of 5 percent per annum, as was the case during the 1960's, raw labor will contribute 1.5 percentage points to the annual growth rate (5 percent of 30 percent). If the composition of the labor force were to remain constant and if wage rates for people of given ages, skills, education, etc., were to remain unchanged, the growth in the labor force would contribute another 1.5 percentage points for a total 3.0 percentage points (60 percent times the 5 percent growth rate). It is important to point out, however, that the second 1.5 percentage points is a return to human capital, as it represents the amount of growth that is achieved by equipping the new members of the labor force with the same amount of education, skill, etc., as is initially possessed by the average labor force participant. The nature of this human capital is, however, essentially that of maintenance--it represents the rate of accumulation of human capital.