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Semi-Tropics Research
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PROJECT EVALUATION - ICRISAT/MALI
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This report was prepared by O. Webster, University of Arizona. The basic objectives of ICRISAT as outlined in the Doggett/Sauger/Cummings report - October, 1971 are:

'(1) To assist the various nations within the zones described (most countries in the drier regions of Africa; and West Pakistan and India in South Asia) to increase their agricultural production and real income of their farmers;

'(2) To provide the bases whereby the increasing populations may not only be able to provide the minimum food requirements for survival but, at the same time, improve the nutritional quality and balance in their diets, and thus be able to be more productive members of the society.'

A center was to be established similar to the other institutes, such as IRRI, IITA, and CIMMYT, and the site selected must conform to numerous specific requirements (these are discussed in the report). No location in Africa met the specifications and only two in India. A location near Hyderabad was chosen.

This Center in India was to serve as '(a) a world center for the improvement of sorghum, millet, pigeon peas, and chickpeas; and (b) a center to promote the development and demonstration of improved cropping patterns and systems of farming which optimize the use of human and natural resources in the low rain-fall unirrigated, semi-arid tropic'. Other pulses are important in these areas and, since the Institute was established, groundnuts (peanuts) has been added.

The planners for the Institute recognized that although some research findings at the Center may be transferrable to other areas in the semi-arid tropics that much of the effective research must be conducted in the ecological zone where it is to be applied. The report referred to above suggested four centers of work in Africa to strengthen the center in India, namely '(1) Alemaya in Ethiopia for the highland areas, (2) Serere in Uganda for East Africa Area, mainly between 3,000 and 5,000 feet above sea level, (3) Samaru in Nigeria for the Guinea Savanna Zone, and (4) Bambey in Senegal for the Sudan Savanna Zone.'

The Committee of Vallaeys/Webster/Doggett visited these locations and made their report in August 1972. At each location there is a major experiment station serving a large ecological zone. The committee envisioned that the ICRISAT personnel would be a complement to the local staff, but with regional responsibilities. This proposed arrangement was patterned after the arrangement made to locate personnel from the ARS/USAID Major Cereals Project for West Africa at Samaru, Nigeria (1963-1973). These personnel became an integral part of the Institute for Agriculture Research /Samaru and were directly responsible to the Director. This research was

fully cooperative, with the station providing office space, laboratories, labor, land, etc. At the same time, the ARS/USAID personnel had regional responsibilities in coordinating research activities in cereal improvement throughout West Africa, by organizing workshops, an exchange of visits by the scientists, research information and germ plasm. In turn, this arrangement was patterened after the arrangement between the USDA and the State Experiment Stations which over the years has proven to be a very effective and efficient method of conducting research. The Federal personnel are placed on a particular station to take care of specific needs which are not being met. And as soon as the station is able to take care of this need, the Federal support is with-drawn. The same arrangement might be considered for the sorghum-millet program in Mali. As soon as the National Government is able to train and finance its own program, then at least some of ICRISAT's support can be withdrawn. There will, however, always be a place for some outside agency to serve as a research coordinator between countries. This has been a function of IRAT in French West Africa.

The ICRISAT program for Africa has not developed excatly as planned. The centers in Ethiopia and Uganada have not been established for obvious reasons. Personnel are located at Samaru/Nigeria and Bambey/Senegal. In addition, it has been a wise move to place personnel in Mali, Niger, Sudan and Tanzania to strengthen national programs. Requests have been made for ICRISAT support in other countries.

The main functions of the ICRISAT scientists in west Africa are to conduct research to develop improved cultivars and farming systems which can be recommended as a package deal to the respective extension services in the

region. In some countries, these recommendations are passed on to the field services of SAFGRAD (Semi-Arid Food, Grain Research and Development). This agency is an off-shoot of our Major Cereal Project, organized under the auspices of OAU-CCTA. This is a congenial arrangement for Mali, as will be mentioned later.

The ICRISAT/MALI program was inaugurated in 1976.. At present, the two staff are P. G. Serafini, Agronomist (1977), and John F. Scheuring (1978), breeder. These young men are former Peace Corps Volunteers, speak fluent French, love the people and are completely dedicated to their work. If the job outlined for them in Mali can be accomplished, they will do it. I am pleased that this team will continue their good work. They meet regularly with the various members of the Malian Government and there is a completely harmonious relationship. A question I always raised as we met with Malian staff was, "Are you pleased with the operation to date of the ICRISAT program and what changes would you suggest?". In all cases, I received an affirmative reply as to the first part and there seemed to be a general consensus that the general scope of the work should remain the same for the present. When special problems arise for additional technical assistance, the Malian staff can draw on the resources available from the larger center in Upper Volta or from the Center in India.

An important function of the ICRISAT is in the field of training. I visited five stations located at Sotuba, Cinzana, Baramandougou, Barbe and Kopora. At all locations, there is a young staff being trained to take responsibilities of conducting the research as directed by the ICRISAT staff. Some have been trained at the Center in India and others on the

job'. At each station, the senior staff member was asked to explain the work being conducted on the station. This gave me an insight of how they have been integrated into the program. The boys are able to take their instructions and conduct the experiments from seedbed-preparation through the analysis of the data. At one station I saw the work sheets and the statistical analysis of an experiment all neatly and accurately done. The objective of the ICRISAT staff is to have competent personnel at each station to eliminate much of the travel now required for supervision. The station personnel are being given greater responsibility for the conduct of the work. In my opinion, this is essential and if mistakes are made, this is a part of the learning process and can be excused as long as the same mistake is not made twice. In our discussions with station staff, we emphasized the importance of gaining the confidence of the local farmers, learn of their problems, and work with the ICRISAT staff in planning experiments to get solutions. I was told that farmers visit the station and observe the experiments. I raised the question, "What if a farmer wishes to have a particular cultivar or cultural practice tried on his farm?". I was told that the director of the station was not permitted to work off a station, but the request could be handled by SAFGRAD in their field trials service. I further pointed out that the function of the station was being accomplished if visiting farmers were impressed by some of the trials, but the situation would be serious if nothing is being done to attract their attention.

Agricultural research has been conducted throughout West Africa for a number of years, but still there has been little change in the farming

operations of the peasant farmer, especially in the production of cereals. There are numerous reasons for this. One, generally until recently the farmer has been able to provide for his own needs using his traditional methods of farming and secondly, he is slow to change if there is any chance of risk in not providing for his food requirement. More important, in my opinion, research has not provided a "package" which, if adopted, will increase his return per unit of input. There are numerous constraints placed on the plant breeder working in the tropics. After working ten years in Nigeria (1963-73) we were not able to come up with an improved sorghum or millet cultivar, but we were able to demonstrate the potential of maize as a cereal crop for the Northern Guinae Savanna region of Africa. Why had not farmers been growing the crop before? The answer is two-fold: (1) lack of suitable varieties, and (2) fertilizer. Sorghum and millet are crops when if grown on poor soils produce a panciel or head will produce some grain. Maize, under similar conditions, will produce nothing. Chemical fertilizer, when available at a reasonable price, wil give a more profitable return when placed on maize than sorghum or millet in the 600-1500 mm rainfall region.

John Scheuring is very knowledgeable about the constraints in breeding improved sorghums and millet varieties, these took us ten years to learn in Nigeria.

Sorghum - An improved variety must have the same cycle as the locals. Planting must be done with the first good rains and the crop must mature after the rains have stopped at the end of the season. Grain maturing during the rain molds quickly and becomes unfit for human food. The varieties in

in the longer rain-fall areas must be photo-period sensitive, that is, the planting period can vary as much as a month, depending upon when the rains begin, but the maturation period must be the same time, regardless of the time of planting. A delay in planting is a problem during the rains, because the seedlings are subject to heavy attacks from shoot fly. Some progress has been made in finding sources of germ plasm with some tolerance to seed molds and shoot fly. The varieties must be resistant to the diseases and insect pests in the area. Fortunately, good resistance is present in local varieties, due to centuries of natural selection. We have tried producing shorter plants of local types, which could be planted in higher plant densities with fertilizer. Such material will give improved yields, provided the rains are normal. If the rains stop early, the heavy vegetative growth uses the available moisture and the crop soon goes into drought stress and fails. The peasant farmer avoids this catastrophe by planting in hills three or four feet apart, so that each plant has a large surface area to draw on for moisture. Witch weed (striga) is a parasitic plant found throughout Africa and India. Many varieties fail when grown in fields infested with this weed. ICRISAT personnel have been able to identify sources of resistance. In the past, breeders have developed good varieties only to find upon release that the grain quality did not meet the consumer requirements. Dr. Scheuring and his staff have been working with D. L. Rooney, College Station, Texas on quality studies. A micro-technique has been developed for quality determination for making tō (local food) requiring only 20 grams of grain, thus making it possible to sample grain from single heads. The ICRISAT staff have made a survey of the sorghums of

Mali and know the characteristics required by the farmer. At present, the plan is to test a number of local and introduced varieties and identify the ones which give the most stable yields in different environments.

In addition to developing adapted varieties, Dr. Scheuring is investigating the potential of hybrids. Many people have suggested that hybrids have no place in peasant agriculture. Dr. Scheuring and I do not share this view. Hybrid acceptance by peasant farmers has been demonstrated in Kenya, where as many acres of maize are planted by the peasant farmer as the large farmer. For hybrid acceptance it must really be superior - a new model in which the yield advantage can be seen, and not require a sophisticated analysis to demonstrate improved yield. Scheuring has made a good start at developing hybrids using locally adapted germ plasm. The yield advantage of hybrids has been demonstrated in the USA, when the hybrids are grown under a range of environmental conditions.

One criterion for the success of hybrids is for seed production to be in the hands of commercial seed producers. Scheuring believes that this is a possibility in Mali. The development of the disease, ergot on the sterile female plants in Nigeria, would limit seed production in Nigeria. I was assured that this disease was not present in Mali. If this disease should become a problem, then seed production would have to be confined to irrigated areas during the dry season, when ergot does not develop.

Millet - Pearl millet is the predominant cereal crop in the region of less than 600 mm of precipitation. Our tour of Mali took us through this area and in general the crop looked good. Based on my experience working with millet in Nigeria, I believe more rapid progress can be made in millet

than sorghum. This crop is as vulnerable to striga as is sorghum, but there is apparently some resistance in some Malian populations. A major factor which reduces millet yields is the disease, downy mildew. Resistance to this disease is also present in the local millet. Smut doesn't appear to be the problem as it is in Nigeria.

There are two types of pearl millet being grown in West Africa. A day neutral type, which when planted in May will mature in August, and a photosensitive type, which when planted in May will mature in September-October. Seed weathering is not a factor in millet as in sorghum and since the seed has a post-harvest dormancy it will not germinate in the "head" when exposed to a rainy period when mature. Millet investigations by ICRISAT have shown that elite germ plasm is generally not transferable from country to country, but that all the germ plasm required for a given area can be found by inbreeding in local populations. After developing elite inbreds, these can be easily recombined to produce synthetics. Good synthetics have already been developed in Senegal, Niger and Nigeria, and it should be possible to do the same for Mali in four or five years.

Hybrid millets are a possibility and as elite inbreds are developed they should be preserved as potential parents.

Finger millet (Eleusine Coracana). This is a new crop for Mali and yields of 1700 kg/ha were harvested from some trials. It appears to be best adapted to heavier soils in low areas where there is a good moisture supply. Scheuring writes, 'Although it is unacceptable in the major food systems it makes suitable gruel. Eleusine could be successfully introduced as an 'emergency crop since gruel is a common food during hungry seasons and years'.

Plans are being made for further testing and possible release.

Other millets have been tried, but show no potential.

Grain legumes. Cow peas are generally intercropped with sorghum and millet. The plants are wide spaced and yields per unit area are low. The crop does provide an excellent protein supplement to the cereal grain used for human food and the forage is carefully preserved for feed for the live stock (cattle, sheep). Seed set on cowpeas is reduced by insects (thrips). The more dense the stand, the greater the loss. Therefore, one seldom sees the crop planted in pure stands. It has been demonstrated in Nigeria that yields are great enough in pure stands to merit a spray schedule to control the insects.

Pigeon peas is a crop sponsored by ICRISAT. This is a major crop in India, but has never "caught on" in west Africa. The crop is grown on the experiment station, Mokwa, Nigeria and the only market for the seed is to the people from India. Perhaps this is due to the fact that peanuts provide much of the vegetable protein requirements of the people. We saw good plots of pigeon peas on the experiment stations and the crop has been introduced and accepted by the station staff as a food. I would suggest that a group of varieties be tried to find one more adapted than the one variety in the trials.

Farming systems. An improved cultivar will not respond to its fullest unless grown under a favorable environmental condition. The phase of work described as farming systems is designed to define those conditions.

I was pleased to learn that about 30 percent of the farmers in Mali depend upon animal traction. If this is a measure of agricultural

advancement, I would guess that farmers of Mali excel those in other west African countries. Such equipment does make it possible for a farmer to till more land than if the work is done by hand. I was told that only a part of the arable land in Mali is being farmed. Based on my observation, however, on a four-day-tour I concluded that the best of the arable land is being farmed and the remainder is marginal. A farmer with animals must provide for their care and feed. The feed consists of pasturing on grass in waste land, and of sorghum and millet stover. I was told that cotton seed sells at a premium to condition cattle before field work begins.

Mali has an agency, Mechanism Agricole with Drumani Zerbu as director, which develop ox drawn farm equipment. We met Jean Marie Togo, an ICRISAT trainee who had just returned from India and was to develop prototype equipment. This work will be under the guidance of Phil Serafini.

ICRISAT operates under the mandate that intercropping be a part, perhaps the major part, of its farming systems project.

Sorghums and millet in Mali are generally intercropped with cowpeas. The cowpea seed provides an important protein supplement to the people's diet, the forage is used for animal feed and the nitrogen left in the soil is beneficial to the succeeding crop. I was told that one method of planting cowpeas was to collect the weeds when hoeing the field and place them over the hill of newly planted seed to serve as a mulch. The following year sorghum or millet is planted on this spot. The farmer probably does not appreciate why he follows this practice, but he knows he gets a favorable response from both crops. Pigeon peas are being tried as a legume in the intercrop system. Some work should be done on plant populations as well as varieties in this sytem.

Toposequence trials were included in Cinzana, Barbe and Baramendougou in 1980. This involves a series of uniform treatments down the slope of a field. Usually the top of the slope is a laterite cap and the soil becomes deeper down the slope. Rain on these caps causes an erosion problem on the surface soil or may run underneath and create a water logging problem. Farming systems develop the best cropping practice for these soils.

As the work progresses, simple rotations should be devised which include dates of planting, cropping sequences, plant populations, and the use of chemical fertilizer. Sorghums are more responsive to fertilizer than millet, but trials should be planned for each. For years the rotations used at IAR/Samaru/Nigeria were designed to study production using grass fallow and some barn yard manure. Yields were generally relatively low, with grass fallows and better when manure was applied. After years of work with barn yard manure, its merits were established, but the peasant farmer had no way of getting such fertilizer. In the mid-1960's, the research emphasis was changed to one of designing experiments to determine the most economic response from continuous cropping. As population increases, land becomes more of a premium.

Station Development. The development of the Malian Semi-Arid Zone Research Center near Cinzana is a major undertaking. This is a joint venture between the government of Mali, USAID, and Ciba-Geigy Foundation. The station has three basic ecologic types representing vast areas of Mali. Two labs, a storage building and several out buildings have been completed. Houses will be built soon. The station director will be D. Nyangodo, who

is completing his Ph.D. degree in France. The development of this station should be carefully planned, with particular attention given to cropping sequences and breeding. The first plantings will be made in 1981 and it will take time to develop a complete program.

Outreach. The SAFGARD project of field trials is a congenial arrangement for extending the research findings of ICRISAT. I understand that over 60 field trials were planted in 1980. These two agencies work with the Malian extension service. It seems to me that with the agriculture research and extension serivce and responsive farmers operating in Mali, that we should see a significant advancement in crop production in Mali. Some countries worry about what to do with the surplus. I was told that the Malian peasant farmer plans to store up a seven-year food supply. There is a problem in some west African countries of absorbing a surplus of grain at a price profitable to the farmer.

Further recommendations. The ICRISAT program is going forward as outlined in the Project Paper, June, 1979. The two senior ICRISAT staff are performing in accordance with their job descriptions (pages 10-11). I have visions that the Malian program could become a model for other developing countries. I don't forsee any great "Green Revolution", but with the team approach, another five years should see 'package deals' available for the farmer.

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