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PREFACE

This Cassava Studies Report follows the outline provided by Dr. H. A. Rodenhiser. It attempts to be frank in the assessment of problems related to improvement of this crop. I have attempted to give a broad picture rather than detailed information.

Statistics of production of this crop are particularly weak. There simply are no reliable figures dealing with the quantities actually produced.

In most of the factors considered the frequency of "unknowns" is high. There is no doubt of the great significance of this crop in the underdeveloped nations. There is a crying need for scientific investigation of these plants, and I trust that there will be an opportunity to forge a significant program of studies using modern agricultural techniques to improve the use of these plants among those whose lives depend on them, and to fill the gaps in our knowledge.

CASSAVA STUDY REPORT

Introduction

Since much confusion exists in the literature and in the minds of many workers concerning the names, properties, and uses of this root crop, it seems useful to given an explanatory statement about these items.

The scientific name is Manihot esculenta. In the past, separate species names have been applied to subspecific variations; for example, M. utilissima (those races of the species that contain a very high concentration of the toxic principle, a cyanogenic glucoside, which releases HCN by enzymic action), M. aipi, M. dulcis, and/or M. palmata (used for those races purported to be free of the toxic principle). I have demonstrated (Rogers, 1963) the futility of attempting to apply these names to the species, and for scientific purposes, we must call all of the races, whether toxic or not, by the one species name, M. esculenta.

The same crop is called by various common names in various parts of the world. All apply to the one species, Manihot esculenta. The names most frequently encountered are: cassava in English-speaking tropical areas, yuca in Spanish-speaking areas, mandioca or macacheira in Brazil, manioc among French-speaking peoples, and by other less well-known epithets in the Far East. Tapioca, one of the products manufactured from the roots, is sometimes used as a common name.

The plants are woody-stemmed shrubs, with an average height of about ten feet, maturing in 6, 10, 12, 18 or 24 months, depending on the variety, climate, locality and local preference.* The enlarged tuberous roots contain about 20-35% dry-matter, consisting largely of starchy carbohydrates, and with relatively small content of proteins (some varieties reported to have

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* Footnote follows.

Footnote for page 1. Maturity

Maturity is a poorly defined concept for roots of Manihot esculenta. No actual basis has been established, except by observation and this varies from place to place. These plants, which are short-term (4 or 5 years) perennials, do not exhibit the same definite points of maturity exhibited by grain crops. Apparently when one harvests these plants is a matter of choice, depending on need, climate and local custom. The following factors probably enter into the decisions concerning "maturity:" (1) Starch accumulation, (2) length of dry and wet seasons, (3) desire for certain qualities, such as softness or hardness of the root, or amount of accumulated sucrose as contrasted with accumulated starch, (4) necessity to harvest plants before rivers inundate the growing area.

With respect to (1) above, Cours (1951) has indicated that for cultivars growing in Madagascar, there is a gradual and steady rise in starch content for the first eleven months, then a slow decline for three months, then a reversal towards a gradual, steadily increasing starch yield during the last seven or eight months of the test. Genetic variations also play a role in various times of maturation, but these are sufficiently well masked by environmental influence as to be difficult to assess.

up to 2%, but usually 0.5-1.5%, depending on the age at which harvested); fats, vitamins and minerals are produced in fractional percentages. No average figure for production per acre can be relied upon, but workers in various countries and institutions have reported yields of as much as 30-35 tons per acre.

Cassava is used either in a fresh or dried state. Some of the varieties may be eaten fresh by peeling and boiling, as a starchy vegetable, much as Irish potatoes are used. In the dried state a variety of different products are used. The chipped and dried roots are used largely for animal food. A considerable market has developed in various European Countries for the chips. Most use is made of the roots in a grated and dried state. Several interesting native techniques have developed among various South American Indian tribes to process the bitter (or poisonous) varieties. (See Rogers, 1963). In general, the grated, dried material is made either into a large "cake" (called cassabe), as much as 3 feet in diameter and an inch thick, and used by breaking off chunks and moistening them with various types of sauces or liquid preparations; or as "farinha" - a loose crumbled material - in Brazil. Tapioca, a product which requires considerable processing, is seldom used in native food preparation. Most of this product is exported to the temperate zone countries, Table I. Many variations are found in the preparation of the dried products. One interesting variation is that where natural fermentation of the starchy roots is encouraged, and afterwards the root is ground and dried. The advantage apparently is in the conversion of some of the starch to sugar, and probably also to increase the content of protein.

Several interesting products are derived from the roots. For example, small cocktail wafers are frequently made in the West Indies. The juice

squeezed from the grated, poisonous roots is boiled down to a thick brown sauce, to which is added a number of flavoring and spicy substances. The sauce is called "pepper-pot" in some Latin American areas, and is reminiscent of Worchestershire Sauce.

ECONOMIC IMPORTANCE

Geographical distribution: Present

Cassava is a world-wide crop, grown in regions loosely defined as "lowland tropics," generally between latitudes 30° N. and S. and almost always below 6,000 feet altitude within these regions. The plants are quite frost sensitive, though some are grown in regions of southern Brazil where occasional frosts occur. Varieties have very broad adaptations to moist and dry regions, and for this reason, are useful in those regions where monsoonal rains frequently fail. There are varieties adapted to nearly every soil type found in the tropics, to the extent that the general opinion is that this crop has no particular preference.

Manihot esculenta is most often described as a door-yard crop. Seldom are large acreages grown in one farm, but each family has a planting sufficiently large to support its needs. There are some areas exceptional to these statements, largely in Brazil and in Thailand, where the plants are grown to provide for both local requirements and as a cash-crop export to the temperate zones.

Geographical distribution: Origins

There is little doubt that cassava is an American crop, probably first raised in the lowland areas of Meso-America (present-day southern Mexico, Guatemala, and Honduras). From Meso-America, the crop was carried throughout

the American tropics by Indians, long before the advent of the white man. Consensus for the American origin comes from the fact that no species of the genus Manihot, with some 150 to 200 species, are found as natives outside of the Western Hemisphere tropics. The only species now found in other tropical regions of the Old World are the cultivated species (M. esculenta and several rubber-bearing species of minor economic significance), and these have been shown to have been distributed from the Americas after European contact, by European explorers, traders, etc. From studies made over most of the range of the crop, it can be said that the largest amount of variation is to be found in the American tropics, and the variations presently exhibited in Africa, Asia, the Pacific and Indian Ocean islands, are reflections of variations already existing in New World Tropics. The germ plasm of interest and significance to crop is found largely in the Americas.

Production Status

1. Food Products. As stated above, the largest production of this crop is small-farm, not in large acreages. Only in the markets of the larger cities are there appreciable numbers sold as cash crops. Therefore, production statistics are not reliable on a country-wide basis. The methods of reporting lump together many variations in production techniques, and again provide poor yardsticks for comparisons. A general rule-of-thumb can be applied to this New World crop (also applicable to other crops transported beyond their native range): the plantings in the Old World tropics generally outproduce the New World plants, for there are fewer attacking pests and diseases in the Old World tropics. Different varieties are capable of differing production in differing time spans. To make comparisons of production on a country-wide basis with other countries would be similar to comparing all the wheat raised in Italy (preponderantly macaroni type) with the wheat

raised in Germany (preponderantly bread type). There is little value to be gained in such comparisons. Eye-ball type statistics give some indication of the value of the crop, however. Using admittedly crude techniques, we discover that the major source of carbohydrate for the lowland tropics in the Western Hemisphere is cassava in one form or another. Perhaps the most consistent large-producing area is Brazil, where "farinha" is almost a national dish. The farinha is a standard item on the table of rich and poor alike.

One area in which a tremendous increase in the crop is noted is Africa, where phenomenal quantities are reported by Jones (1959). One major reason for this increase is the fact that the crop can withstand, or is immune to, attack of locusts. Another factor is the crop's capacity for withstanding considerable periods of drought. Still another reason for the rapid acceptance in Africa is that cassava can produce on extremely poor soils.

Another problem in reporting the production status of this crop is the fact that it has a dual nature; one, as a staple crop, producing dried, storable carbohydrate in a number of forms; and two, as a fresh vegetable crop, where no storage (or long storage) is possible. Statistics most often deal with the dried products, not the fresh roots. The figures of the various FAO yearbooks represent the dried products alone. FAO has not gathered general data on the fresh root production or consumption. Holleman (1964) reports that 2 or 3,000 tons of fresh roots are shipped from the Dominican Republic to the United States.

The statistics reported as Appendix One give the latest information from the FAO yearbooks., and from Walker (1966).

2. Commercial Products. The largest use of cassava starch for commercial enterprise is in paper sizing. The potential for growth of this use is good, provided a steady production schedule and high yielding varieties can be established. The greatest difficulty encountered by the paper companies at

present is the frequent failure of the local agricultural facilities to provide a continuing supply of the raw materials. Part of the difficulty is due to the "normal" production techniques, that is, production in small fields with a multitude of different varieties with differing starch quality. Unless the agricultural economic and social problems of large-scale, high-yielding varieties is solved, the paper companies will not have the needed supplies on a continuing basis.

Cassava starch is used to a considerable extent in local economies as a laundry starch. The figures for such use are not given in most statistical summaries, and the amount thus used is not known. Potentialities also exist for conversion of the starch to various special-purpose adhesives, for example as an adhesive for stamps. Alcohol can also be produced from cassava starch, but whether there is a potential for competitive production of alcohol from cassava, contrasted to synthetic production, is a moot question.

The woody stems of the cassava plant have been used in paper-making, but it is doubtful that this will become a commercially feasible product.

Nutritional Value

The figures given in Table 2, while representing analyses made on samples fromthe Far East, may also be taken as an average for the entire crop. Table 3 gives a set of figures compiled by the author from two identical sets of cultivars grown at two separate experiment stations in Jamaica in 1955. These figures indicate that the nutritional value of the crop is certainly greatly influenced by the environmental conditions. The crop does respond to improved soil nutrition. The plot at Bodles Experiment Station was on an area that had been under continuous cultivation for some years, whereas the plot at Grove Place had been under grass, and received cattle manure for some years. The significance of this statement may seem an

obvious, and perfectly reasonable, outcome until one compares it with statements made by several workers that cassava does not benefit from additional fertilizer.

As can be seen from these data, the roots of cassava contribute very little else than carbohydrates to the diet. However, when one considers the caloric content and production per unit of cultivation, this is a tremendous productivity, perhaps more so than any other crop. Table 4 compares productivity, in terms of calories/acre with corn and rice. If one considers the possibility of cassava as an animal food, one may consider the potential value of cassava in terms of protein production.* In areas of the lowland tropics, where the usual animal food concentrates (alfalfa and various grain mixtures) are unusually expensive, an inexpensive cattle and hog feed becomes imperative.

I should like to introduce another potential value of the high caloric production of cassava. Recent investigations by Gray (1966) indicate that cassava provides an excellent substrate for growth of certain fungi imperfecti with a production of fungal protein at the rate of one pound of protein from 7 pounds of cassava carbohydrate. This experimental result indicates a potential value in either human or animal feeding which should be investigated in depth.†

It is well-known that the foliage of cassava is a high protein-yielder (Rogers 1959) and has been successfully employed in chicken and cattle feed supplements. Furthermore, the amino acid balance of the leaf protein for human nutrition is relatively good (Rogers and Milner 1963) Certain people (largely West African) use the foliage regularly in their diets and among some of these tribes, the cassava plant is known as the "bread-from-the-roots, meat-from-the-leaves" plant. Clearly, much research will be required to assess the value of the plant as a foliage-protein source. If properly managed,

* Maner (1967) has indicated the high value of cassava root for swine feed, provided care is given to proper balance of the diet.

† See addendum for further discussion on potential protein production.

Addendum to Page 7, Cassava Study Report - Protein Production

The literature on this subject is quite limited, as it refers specifically to the use of cassava as a medium for growing microorganisms. Much has been written, however, on various microorganic production of proteins, from a variety of substances including various plant and animal materials including refuse, and even from petroleum. Most of the studies employ yeasts of the genus Candida (torula), but numbers of microporganisms have been employed, including bacteria (Escherichia coli), a variety of fungi, Ascomycetes, Basidiomycetes and Fungi Imperfecti. No one of these organisms has come to the front as the best organism for edible (or balanced) protein production. In each case, problems have arisen concerning the necessary nutrient medium to give a more desirable product. These problems most frequently arise when turning from laboratory scale production to full, economic mass production. In this connection, it seems that the technology necessary to produce the protein is beyond the capacity or capability of developing nations. Furthermore, the costs of production have not yet been brought down to a point where the developing nations could afford to go into full-scale production. Acceptability of the product by those most in need of the increased protein food is a critical element in judging the suitability of microorganic protein. In many cases, it is claimed that an odorless, tasteless substance is produced, and that when this is added to normally used foods it is accepted. A case in point is the tapioca macaroni produced by the Central Food Research Institute of Mysore, India. This product, made of wheat flour mixed with peanut and tapioca flour, is used by many Indians. While no microorganic protein was incorporated in this product, it seems to point the way to acceptability by conservative groups.

The protein produced by any of a number of procedures requires special or careful handling, storing and processing. Apparently the protein molecules are susceptible to degradation after production. These factors must be taken into

account as a part of the overall feasability studies.

There seems to be little doubt in the minds of the workers who are most closely associated with food protein production by microorganisms that the difficulties above cannot be overcome. In all cases, it is felt that the problems are technological ones, requiring more intensive investigation, and that none of the difficulties are insurmountable. With specific relation to cassava, it is known that a crude form of fermentation process is employed by primitive people in a very uncontrolled manner. It is doubtful that the fermentation is induced with the specific idea of increasing the protein content, but it is certainly true that the protein content is raised by this process. More likely, the fermentation is employed to break the starches into simpler carbohydrates, and perhaps to produce some more desirable flavor.

several cuttings of foliage could be produced per year. It is not probable, however, that the same plantings would equally produce a large root supply. Since alfalfa does not produce well in the lowland tropics, this aspect should be studied intensively.

Prospects for Improvement and Development of Specific Varieties in the Western Hemisphere? Africa?

The fact that by its nature the crop is normally reproduced from stem cuttings rather than by seed gives the opportunity for maintenance of pure lines, once developed, indefinitely. This is an obvious advantage to the plant breeder. Furthermore, the sexual reproductive mechanisms in cassava are such that the plants are obligatedly outcrossed, thus making the process of crossing for new varieties and strains a much simpler task. With the two above attributes, it should prove relatively simple to develop a plant almost tailored to any of a set of required conditions. The main difficulty which will be encountered in the breeding is the fact that pollen sterility is found in many of the varieties and may cause difficulty if we must transfer genetic material from these.

Another important feature is that there are a number of wild species in the genus Manihot, and from experiences with a few of these, there seems to be little difficulty in interspecific crossing, thus opening up the opportunity for introducing genetic material from the wild into the cultivated species with relative ease.

The last factor of importance to breeding for better varieties is the fact that I am in the finishing stages of producing a very thorough classification of the interrelationships amongst the cultivars and the wild species, thus providing plant breeders with the best possible information with which to begin a genetic program.

The largest difficulty with respect to improvement of varieties is our

gross ignorance of the inheritance patterns of the cultivated varieties and the almost total absence of genetic information about the wild species. Clearly, much work will have to be done to overcome these blank spots in our knowledge before any sort of meaningful breeding program can commence. I cannot estimate the time necessary for this work at this state of development. It may be that I am overpessimistic with regard to genetic problems, but with the present knowledge available, we can predict nothing accurately.

We must make a clear and unambiguous statement of our objectives before commencing a plant-breeding program. For example, should there be an effort made to breed varieties with higher protein content? The problem of breeding for higher protein content in the root may be more complex and time-consuming than will be profitable. Perhaps the investment of time in research to produce fungal protein, mentioned earlier, will pay off more rapidly, and with higher output than would the eventual higher protein produced primarily by new varieties. Are there any other qualities which we should aim for in breeding programs? One area for investigation is the real or fancied resistance to virus diseases. On several occasions, reports of virus disease attack has been found to be nothing more than a nutritional deficiency - the lack of some critical nutrient element. Before real progress can be made in the breeding for virus resistance, one must be absolutely certain that the symptoms are indeed caused by a virus agent, and not by some other set of factors.

Before any improvement program through plant breeding begins, an intensive survey of existing varieties and their present qualities should be made. In other words, a germ plasm collection should be made. Since the American tropics are the place of origin of the crop, the obvious place to do experimental work is in the Americas, not Africa. Some germ plasm may exist

already which will contain various desirable qualities. Furthermore, there must be agronomic studies, determining the most suitable cultural methods for high yield. Many such studies have been conducted at various places in the lowland tropics of the world, and these must be evaluated to determine the validity of the work, and how much significance may be attached to the work already done.

Improvement can certainly be anticipated from a thorough investigation of the types of harvesting equipment. In addition, some of the lowland areas in Latin America, such as the llanos of eastern Colombia may be made substantially more productive by following very ancient patterns of land preparation done by prehistoric Indians. In these areas subject to alternating periods of inundation and drought, much effort was made by the Indians to mound up the earth, plant manioc on the ridges and water-tolerant crops in the intervening ditches. Agricultural engineers could probably devise relatively inexpensive techniques to serve the same purposes.

Clearly, alongwith the potential improvement in yields through the above types of endeavors, the study of tropical soils for cultivation of cassava is needed. With root crops in general, and also with cassava, light, friable soils allow much more facility in harvesting than do heavy, plastic-type soils. The difficulty, however, is that the former types of soils are frequently much less fertile than are the latter. But the general problem of soil fertility in the tropics needs intensive study because, by nature, the tropical soils are very different from those found in the temperate zone. They require new concepts to be developed to maintain high fertility levels and to conserve them for long periods of time. Soil experts of several types, including microbiologists, chemists, and ecologists must work together to provide the necessary new concepts. Soil fertility with relation to cassava yields is a relatively untouched area.

RESEARCH

a. What is being done, by whom, and what needs to be done to improve cassava for the lowland tropical areas?

b. Where are the centers of excellence throughout the world?

There are very few large, concerted efforts being made anywhere in the lowland tropics. Certainly nothing similar to the International Rice Institute exists for cassava. The problem has been that since the products of cassava are of so little importance to temperate zone commerce, there has been little need felt in the capitals of the world where impetus for doing research is usually initiated. Almost none of the tropical countries where the crop is significant have the necessary ability to mount and maintain a program of satisfactory scope and duration to have produced meaningful results.

The existing efforts to improve cassava are found largely in Brazil. In this former country, until recently, an active group for the study of cassava and other root crops was working at the state-supported agricultural experiment station at Campinas, state of São Paulo, Brazil. To my knowledge, this group is not active at the moment. Some efforts (unfortunately rather feeble) were being made at the equivalent of the USDA's Beltsville Station for Brazil, at Kilometer 17, near Rio de Janeiro. Some agronomic and plant-breeding work has been done at federally-supported Brazilian experiment stations in the states of Minas Gerais (near Sete Lagoas) in Pernambuco, and in Para, at the Instituto Agronomico do Norte, in Belem. At this last-mentioned station, a very large collection (over 200) of varieties from the Amazon basin have been brought together, and a number of studies of these varieties made to select the most productive types for that region. Most of this work was carried out by one individual, Sr. Milton de Alburquerque, and whether there will be a continuing effort after

his retirement (which is imminent) is a moot question.

In India, in the southern state of Kerala, an experiment station devoted to the improvement of tropical root crops has been established, and is now under the direction of Dr. Magoon, a cyto-geneticist with a Ph.D. from Wisconsin. A complement of workers, including plant breeders, physiologist and soil experts are carrying out what seems to be a well-conceived program. Over a thousand cultivars of cassava from India are maintained in a collection, and from these, certain hybrids have been developed which are promising as high-yielding types. A student from this station, Mr. S. G. Appan, is now a Ph.D. candidate under my supervision. If one may use this candidate as a measure of the competence of the personnel of the Kerala station, then there is a good group working there. Mr. Appan was farm manager of the station, and has had considerable experience with the plant-breeding and agronomic work on cassava. Since cassava cultivation is expanding at a very rapid rate in southern India, this station has considerable importance, and should be supported.

Until quite recently, the French were responsible for some very good work on the agronomic aspects of cassava on the island of Madagascar. Under the direction of Cours, most of the varieties which have developed on that island were collected, and various aspects studied. Cours (1951) documented the various types of morphological variation which were found, studied growth patterns, production capacities, harvesting, etc. Unfortunately this work is no longer maintained, particularly since that island's independence from France.

Before World War II, when the Dutch were in control of the Indonesian islands, the most productive centers for tapioca were in various parts of the islands of Java and Sumatra. However, the facilities there are no

longer active, and Indonesia is no longer an exporting country.

In addition to the above-mentioned centers, nearly every agricultural experiment station in Latin America, in Africa and in the Indo-Malaysian areas have had intermittent experiments with cassava. None of the programs has had a long history, and most are planned with a low-income, low priority background. As a result, very little objective, scientific work has been accomplished. One may almost anticipate the type of work before arriving at a station; first, a collection of varieties will be established, usually including varieties sent from Brazil, and a few locally-occurring varieties used as a standard/check. After establishing a collection, a variety trial will be established, and then, after measuring the results, one, two or perhaps even three varieties will be chosen as "best" for the region, and the remaining collections are allowed to die out. Positive results from such efforts are barely measurable. But there has been another effect, which is not at all measurable, and which may have had some unexpected long-range effects; namely, the introduction to the region of germ plasm which may "escape" from the experiment station and into the local farmers' plots either by intention or by accident. From a strictly biological, scientific point of view, the effects of such mixing would offer a very interesting and challenging problem. From a practical standpoint, however, this type of problem must await solution to some of the more pressing needs.

The United States" efforts through foreign agricultural aid has been rather sporadic. This author knows of three Latin American countries where some work has been done. In Bolivia, near the city of Santa Cruz, a large processing plant for starch was erected but never completed. In Brazil, at Araripina, state of Pernambuco, another large facility for starch production was erected, but again never operated. Similarly, at Gloria da Goita, Per-

Pernambuco, another factory was built with U.S. funds, and again never operated. It must be emphasized that the above facilities failed because of poor planning, not because of the crop. In two of the factories, the lack of water or the presence of iron in the water supply caused failure. In the case of third the plant, in Bolivia, no thought had been given to the ability of the local farmers, using their own cultivation techniques, to produce a sufficiently large quantity of roots to make the operation of the plant practical. Clearly, there should have been better planning before the starch factories were erected, and not afterwards. In Bahia (through cooperative work with Colorado State University) efforts are under way to develop a factory to prepare dried chips from the roots to be sold in Europe as cattle food. This last endeavor may have more chance of success than the earlier ones, but at none of these facilities is there, or was there, an integrated effort between agricultural scientists, engineers, local farmers and business interests. There are very likely other efforts to aid Latin American studies, but these are not known to me.

I have carried on a program for the systematic study of cassava since 1953. This work has never been done as my major income-producing effort, but it has been a major research interest. The total amount of money spent on the work has amounted to less than $15,000, and this is a generous estimate. Indirectly, however, much larger sums have been spent in attempting to find adequate methods to use computers in the study of crop plants. This effort has been successful, and I now have a number of very useful working computer programs which will aid immeasurably in the analyses of multivariate data which must be applied to any modern agricultural study.

While the major thrust of my research has been in the strictly biological classification of this crop (Rogers, 1965, 1967), I have consistently tried to keep abreast of the problems of a more practical and immediate

nature; namely, the improvement of the crop for human needs. Towards these objectives, I have gathered perhaps the largest collection of herbarium samples and published works on cassava assembled in any one place. These collections, however, are far from complete. I have also attempted to stimulate work on cassava by many workers. My estimate of the present-day standard of knowledge of this crop is that we are at a level comparable to the knowledge of corn (maize) about seventy years ago. We have a long way to go.

c. Production hazards (diseases, insects, fertility levels, water requirements, and sensitivity to day length).

While I have touched lightly on some of these aspects earlier, it is well to mention them individually.

1. Diseases. Perhaps the most serious problem for M. esculenta, a mosaic disease, is caused by insect-transmitted virus. Two viruses have been identified as being involved, each transmitted by a different insect vector. Another potential disease thought to be virus-initiated is called "superbrotamento" in Brazil, the effect of which is a stunting of the plants and excessive branching. The virus-caused abnormalities apparently are more serious (or are better recognized?) in Africa than in the Americas. A survey of the occurrence in the Americas is hampered by a factor mentioned earlier, that physiological problems are frequently identified as "virus," and the true nature of the diseases is not clearly established.

Various bacterial or fungal diseases have been reported, such as root-rot, leaf ring-spot, and other probably secondary effects on leaves. No assessment of the seriousness of these diseases has been attempted.

2. Insects. Insects are clearly involved in the transmission of the virus diseases. At various times and places, I have observed the caterpillar of a sphingid moth attacking the foliage of cassava, but seldom have the

symptoms been sufficiently severe to cause reduced production. Holleman's FAO report (1964) however, indicates that this caterpillar caused serious and extensive damage in the Dominican Republic. Wasp-caused galls have been observed on the leaves in nearly all the growing areas of cassava; but again without any apparent reduction in normal functioning of the plants. On one or two occasions, I have seen severe bud-attacking insects causing considerable damage to a field of cassava, but the insect is not known. Aphids of various types attack the young foliage, causing chlorotic symptoms on the leaves. The severity and difficulty of control has not been assessed. It is probably true that when more intensive, modern investigations have been carried out, more definitive knowledge of insect and disease damage to the crops will be discovered.

3. Fertility-Levels. This area, previously mentioned in other contexts has not produced a very meaningful literature. Many fertilizer trials are reported with varying recommendations, but one of the most surprising is that cassava does not respond to increased fertilizers.* This may be true, inasmuch as cassava like rice, has been long grown by primitives who have unconsciously selected varieties to be grown under very poor fertility conditions, and the varieties tested in the fertilizer trials are incapable of responding to increased quantities of inorganic materials. Before response to fertilizers can be achieved, new varieties will have to be developed.

4. Water Requirements. Varieties of cassava are grown under an extremely diverse set of water relationships, from the almost completely saturated conditions of mud flats along the Amazon River to places where the annual rainfall is lower than twenty inches per year. But aside from these generalities, little precise information on actual requirements is available. I am not aware of any experimental work in this respect. In-

* Footnote -

Fn 16

Footnote for page 16.

Perhaps the most impressive statement of the failure of fertilizers to improve the production of yuca is given by A. Machado in Boletin Tecnico, Centro Nacional de Investigationes de Cafe (Colombia), Vol. I, no. 5, 1-16, 1951. Other than this one citation, a number of other, informal, comments have been made by workers to the author of this paper which gave the same general impression. Perhaps what is intended by these reports is that the value of fertilizers is not great when factors relating to economic considerations are involved, but it is still not certain that the varieties chosen for various fertilizer trials indeed could respond because of their selection by farmers for growth in poor soil conditions.

frequently, cassava is grown in irrigated areas, but for the most part, other crops have priority on irrigated land; and cassava received irrigation only after all other requirements have been met.

5. Sensitivity to Day-length. The only information available with respect to the day-length for optimum growth is observational, not experimental. Since the crop is grown almost exclusively in tropical countries, no apparent reaction to differing amounts of day light is noticeable. Only a small number of plants have been raised in greenhouses available to me, but those that have have usually been quite sensitive to day-lengths in the latitudes of New York and Colorado. In connection with light (not length, but intensity), cassava has a crown of leaves disposed in a very impressive manner to capture the maximum amount of sunlight, and thus convert a maximum amount of energy to stored carbohydrate.

GENERAL

a. Available world germ plasm banks, and where located.

The data available at any one time may be obsolete. As pointed out previously, little long-range experimental work has been carried out with these plants, and as a result, very good collections have not been maintained. Since many efforts to bring plants together have been made, it is likely that the major germ plasm of the species has been widely spread, and found incorporated in what appear to be locally-occurring varieties. But no assessment of this situation has been carried out.

The largest collections apparently exist in various parts of Brazil. The experiment station at Campinas (São Paulo State in Brazil) probably

still maintains collections made in southern Brazil. In northeastern Brazil, in the state of Pernambuco, the largest collection is to be found at the També Experiment Station. Other collections in Pernambuco are located in Araripina (far western part of state) and at Lagoa dos Gatos. In the Amazonian region, the best maintained and most extensive collection is found at the Instituto Agronomico do Norte, in Belem.

To my knowledge, no major collections are maintained in Peru, Bolivia, Equador, Colombia or Venezuela, although in the past there have been collections at stations on the eastern slopes of the Andes.

Between 1954 and 1960, I had a collection of locally-occurring cultivars on the island of Jamaica. After an intensive search, we found over 100 differently-named (though certainly with some synonymy) cultivars. These were grown in museum plots at the Bodles Experiment Station and at the Grove Place Experiment Station. Unfortunately, these plots have not been maintained, and the conditions presently extant are unknown. The fact that so much variation was found in one small island is probably due to various efforts in the past, where importations of varieties from other countries were made, kept on the experiment station grounds for some time, and then allowed to "diffuse" into various farmers's plots. I suspect that similar activity has occurred in most of the growing areas, with an effect which will come to light as more long-range activities are developed.

There are probably several African collections, but the status of these is unknown. The island of Madagascar may still maintain "museum plots."

In Asia, a very large collection of locally-occurring cultivars is kept at the Central Tuber Crops Research Institute, Trivandrum, Kerala, India, under the direction of Dr. M. L. Magoon. Over 1,000 cultivars are in the

collection, although it is recognized that much duplication occurs.

There is no present assessment available of the status of collections in Indonesia. This former Dutch colony was the center of cassava cultivation in all of the Indo-Malaysian Archipelago before World War II.

From the above, it is clear that an assessment of the situation in various important growing areas must be made and new collections made.

b. Identification of locations and institutions for cooperative work.

In Latin America, the most promising areas where work should be centered are as follows:

Brazil:

State of São Paulo, the State Agricultural Experiment Station, Campinas.

State of Minas Gerais, the Federal Agricultural Experiment Station, Sete Lagoas.

State of Pernambuco, the State Agricultural Experiment Station at Tempé and at Araripina.

State of Para, Instituto do Agronomico do Norte, Belem.

State of Amazonas, at Manaus.

Bolivia:

North of Santa Cruz at the Experiment Station General Savedra

The State Experiment Station at Riberalta.

Peru:

The Federal Experiment Station at La Molina, near Lima, and at Tingo Maria.

Equador:

Pichilingue

Colombia:

Experiment stations in Palmira, Villavicencia and Monteria.

Venezuela:

Maracay.

Dutch Guiana:

Paramaribo.

Costa Rica:

Interamerican Institute of Agricultural Sciences, Turrialba.

Honduras:

Escuela Agricola Panamericana, Tegucigalpa (and Zamoruno).

Mexico:

Chiapas.

Vera Cruz, Cotaxtla Experiment Station

Jamaica:

Department of Agriculture, Hope Gardens.

Puerto Rico:

Mayaguez, Federal Agricultural Experiment Station.

Trinidad:

College of Agriculture (University College of W. I.), St. Augustine

c. Recommendations as to varieties and selections that should be studied initially at Palmira and other locations.

Since a number of collections have been brought together at Palmira, and at Manizales, there are sufficient variants extant to begin a number of agronomic, disease, and agricultural engineering studies. Since the soils of the Cauca Valley are excellent, their qualities need not be so intensively studied. There are probably a number of additional variants existing in Colombia which would provide a useful "bank" of germ plasm to begin breeding and other studies. Likewise, there are several wild species in Colombia

which would serve to begin cross-breeding studies, to determine compatabilities and problems in genetic transfer.

The llanos of eastern Colombia and the coastal areas near Monteria also have a number of locally-occurring varieties with which to begin comparative studies of adaptability with those from the Cauca Valley. A number of "switch-back" studies between the three areas would develop information concerning specificity of requirements for soils, pH, moisture, maturation, etc.

Amongst the locally-occurring varieties, studies should be initiated towards selections which would be useful in mechanical methods of planting, cultivating, and harvesting. Useful attributes in these directions would be close-set buds on the stems, varieties with unbranched stems (late-flowering), and with roots clustered close to the point of attachment, and those whose roots have more bulbous shapes (rather than long and slender). With these attributes should also be considered variations in starch and HCN content, maturation dates, etc. Simultaneous studies on methods of use of the roots and leaves could be initiated. These include methods of production of various types of products: chipped, dried roots; extracted starch; utilization of the peel (or root epidermis); foliage productivity, both fresh and dried; etc.

d. Facilities needed.

The requirements are not unusual for the majority of the efforts in studies of cassava. Field cultivation and land preparation machinery, fertilizer applicators, spray equipment, large-scale balances, etc., all of which, at the start, should be of standard types. For the plant breeder, the same sorts of tools as would be required for any large plant work. Probably insect-free houses for the observation of insect-pollinators, greenhouses and growth chambers with careful control of light, temperature

and moisture supply, microscopes for chromosome studies, camera attachments, staining equipment and allied types of equipment would be essential. For physiological and chemical studies, a standard well-equipped laboratory will be required. Perhaps the only specialized equipment in the laboratory would be for the studies of the physical and chemical properties of starch. Botanical studies whould have a well-equipped herbarium for documentation of the work. This should be air-conditioned to maintain bug-free and dirt-free environments. Soils laboratory work would require the usual types of equipment for microbiology, chemistry and physics. The agricultural engineering facility would be equipped with various machines needed for developmentment of specialized equipment, such as diggers (similar to those for potatoes, with sufficient modification to accomodate the larger roots), choppers and chippers, root-peeling devices, drying ovens, etc. The disease and insect pest studies will require specially-constructed greenhouses, growth chambers, provisions for housing insect collections, microscopes; both light and electron (for the study of viruses), ultracentrifuges and special slide preparation equipment, incubators, autoclaves, etc.

An important adjunct to the primary studies is a complete library and information retrieval system. These should employ the latest techniques available in computer-aided cataloguing and indexing. Reproduction facilities, including Xerox machines, card and tape punches, readers, printers, microfilm and microfiche readers should be a part of the combined library and computer facility.

The facilities mentioned above are for the primary investigations. In addition, computing facilities are an essential if the work of the investigators is to be correlated and put to maximum use. Without such facilities, data correlation and retrieval becomes a very time-consuming task, and delays the application of the gathered data beyond a reasonable time. For an

organization such as the one envisioned, one of the second-generation type of computers (IBM 7000 series or Control Data Corporation 1600 series) would be adequate. Since many of these computers are now available at much-reduced costs, as second-hand equipment, the initial investment would not be prohibitive, and the work that can be accomplished with these machines far exceeds the capacity of hand-operated desk calculators. Such a facility would serve the purposes of the whole institute, including scientific, educational and management endeavors.

Clearly, much of the equipment mentioned above could be used in common with other parts of the endeavor, and for various crops. Over-all control of the equipment must be under some sort of supervisory group.

e. Staffing requirements.

This discussion must assume that the staff will have other duties than the study of cassava alone. For example, all root crops could be under the direction of one staff, and each staff member could carry out simultaneous work with those crops chosen, provided he has adequate assistance. However, assuming the ideal situation of one man, one crop, the following recommendations are given:

1. Plant-breeding, genetics: 2 senior, 2 junior scientists, 4 technicians, 3-6 laborers, tractor drivers, etc.
2. Agronomy: 2 senior, 2 junior scientists, 5 technicians, 10 laborers.
3. Physiology, chemistry: 2 senior, 2 junior scientists, 6 technicians, 3-4 laborers.
4. Botany: 1 senior, 2 junior scientists, 4 technicians, 2 laborers.
5. Soils: 1 senior, 2 junior scientists, 4 technicians, 4 laborers.
6. Agricultural engineering: 1 senior, 2 junior engineers, 5 technicians, 10 laborers.

7. Entomology: 1 senior, 2 junior scientists, 4 technicians, 4 laborers.
8. Pathology: 1 senior, 2 junior scientists, 4 technicians, 2 laborers.
9. Computing facility: 1 statistician, 1 systems analyst, 2 programmers, 4 operators, 1 maintenance engineer, 5 technicians.
10. Library: 1 senior, 2 assistant librarians, 4 assistants.
11. Management: 1 senior scientist, 1 business manager, 5 clerks, 10 typists.
12. Assorted mechanics, truck and tractor drivers, shop and maintenance men.

f. Recommendations of candidates.

The only students known to me who have worked towards graduate degrees with training specifically on cassava are Mr. Seymour H. Sohmer and Mr. S. G. Appan. Both have been (or are) investigating systematic and cytological botanical studies of the cultivars and related wild species of Manihot. Mr. Sohmer completed his master's thesis on cytological and systematic investigations of the cultivars grown in the collection at Turrialba, Costa Rica. He is now teaching in the Department of Biology, Wisconsin State University, La Crosse, Wisconsin 54601. While I directed his research work, he actually completed the master's at the University of Tennessee. I would recommend him for one of the junior scientist posts. Mr. S. G. Appan, mentioned earlier in this report, is an extremely promising Ph.D. candidate under my direction at this time. He will complete the requirements for the Ph.D. in June, 1969, with a dissertation on the classification of the genus Manihot, using computer techniques in the process. He has already had eight years of practical experience with cassava, working on agronomic and cytological problems in southern India, with several publications of a practical nature. With his background (and hopefully completion of his degree) I would recommend him for the botanical senior post.

Before any further recommendations can be made, a canvass of available

people would have to be conducted. For example, I know that there are workers trained in the Dutch Agricultural School at Wageningen who might be better qualified than most. Other workers are being trained in tropical agriculture at the University College of the West Indies in Trinidad whose experience might be useful. Some English workers, formerly occupied in the eastern tropics might be available, but I have no specific knowledge of these people. Probably the best-trained people would come from Universities in the States, given special training with root crops in general, and then perhaps an "acquaintanceship" course with cassava.

I would be pleased to help provide the "acquaintanceship" efforts on a part-time basis, if arrangements could be made during the summer months. This would be part-time theoretical, part-time practical. I would also be pleased to advise on setting up of the computer-library facilities, since I have spent much time recently in these types of endeavors, with the purpose of developing programs useful in agriculture.

RECOMMENDATIONS FOR PROCEEDING

Given the establishment of the Institute, the personnel, and the facilities, the work could proceed with short and long-term goals simultaneously.

The short-term goals should be largely efforts to increase production from existing varieties. The main efforts would be agronomic, to discover how production can be increased without great emphasis on new germ plasm developments. Allied efforts would be to cut down on insect damage (using general purpose insecticides), selection of existing high-yielding variants, determination of maturation times, water requirements, and cultivation procedures. Most of the short-term goals could be accomplished in a period of 2 to 5 years.

The long-term goals would be those in which the plant breeder could be the most effective individual, though other efforts would probablybbe profitable. From the beginning, the plant-breeder would wish to establish the nature of the inheritance patterns in cassava, determine effective breeding procedures, become familiar with available germ plasm in existing variations, and discover the problems of transferring genetic materials from one inbred type to another. The first efforts would be toward developing some knowledge of "standards" in the crop. By standards, I mean intimate knowledge of a few selected varieties concerning their productive capacity, their gene constitution, their disease-resistance, their soil and moisture requirements, their suitability for producing one or more desired end products, etc. Having developed these standards, and a set of achievable goals, then the development of new and profitable variations could be measured against the standards.

Also under long-term operations would be a survey of the types of varieties which exist, where they exist, and the collection of these into a few well-selected museum plots. Before establishment of central museum plots, some knowledge of the disease problems would have to be established. It would certainly not be wise to begin indiscriminate shipping of variations from one part of the world to another until the effects of various insect and disease infestations are known. Perhaps the most suitable arrangements would be establishment of locally-occurring varieties in various of the allied experiment stations. There, with suitable control, a preliminary screening of the disease and insect problems could be made, Perhaps an intermediate station in the tropics, but outside the growing areas should be the initial point for introduction. About the only area known to me where such could be accomplished is in either northwest or northeastern Mexico. There are no present uses of cassava in these parts (States of Tamaulipas or Sinaloa).

Implications from the above paragraph are that the study of pests and diseases, soil, water and temperature requirements must be started immediately. These areas are clearly necessary for a successful program.

Botanical studies of the varieties should include classificatory work, the physiology of HCN production, photosynthetic rates, starch production, fiber characteristics, etc. The botanical group should aid in the information retrieval of the primary data.

Longer-term experimental efforts must consider the possible use of cassava as a substrate material to produce protein by fungi, as a source of cattle food from the leaves, and in various industrial processes. In these areas, there would likely be requirements for personnel and laboratories which have not been mentioned earlier.

No mention has been made of the concomitant studies of importance; namely, the application of the findings of the above experimental group. Economists, sociologists and agricultural extension agents play a very important role in these types of endeavor. I am not sufficiently familiar with the exact nature of such operations and would have to depend on others for advice.

LITERATURE CITED

1. Cours, G. 1951, Le Manioc a Madascar, Mém. Inst. Sci. Madagascar, Serie B, Tome III, Fasc. 2, pp. 203-400

2. Gray, W. D. and M. O. Abou-el-Seoud. 1966. Fungal Protein for Food and Feeds, III. Manioc as a Potential Crude Raw Material for Tropical Areas. Econ. Botany, Vol. 20, #3, July-Sept. 1966, pp. 251-255.

3. Holleman, L. W. J., 1964. Report to the Government of the Dominican Republic on a Survey on Cassava Production and Processing. FAO of the U.N., Rome.

4. Jones, W. O., 1959. Manioc in Africa, (Food Research Institute) Stanford Univ. Press, Stanford, Calif.

5. Rogers, David J., 1959. Cassava Leaf Protein, Economic Botany, Vol. 13, #3, July-Sept. 1959, pp. 261-3.

6. Rogers, D. J., 1963. Studies of M. esculenta Crantz and related species, Bull. Torrey Bot. Club, Vol. 90, #1, pp. 43-54.

7. Rogers, D. J. and Max Milliner, 1963. Amino Acid Profile of Manioc Leaf Protein in Relation to Nutritive Value, Econ. Botany, Vol. 17, #3, July-Sept. 1963, pp. 211-6.

8. Rogers, D. J. 1965. Some Botanical and Ethnological Considerations of M. esculenta , Econ. Botany, Vol. 19, #4, Oct.-Dec. 1965, pp. 369-77.

9. Rogers, D. J. 1967. A Computer-aided Morphological Classification of Cassava, International Symp. on Tropical Root Crops, Univ. West Indies, St. Augustine, Trinidad, April 1967. (mimeographed) and in press)

10. Walker, H., 1966. The Market for Cassava., Tropical Products Institute, Ministry of Overseas Development, T.P.I. Report No. G 21, April 1966.

Maner, Jerome H., 1967. Utilisation of Yuca in Swine Feeding, paper presented at the International Symposium on Tropical Root Crops, St. Augustine, Trinidad, April 2-8, 1967.

TABLE I

TAPIOCA AND CASSAVA, STARCH AND FLOUR, IMPORTS TO U.S.A.*
FISCAL YEAR 1965-66

Country	Quantity 100 lbs.	1,000 dollars
Brazil	76,658	2,395
Thailand	251,495	8,577
Malaysia	3,323	143
Other countries	963	42
Totals	332,439	11,157

* Imports, for consumption,, Table 5, p. 77. U. S. Foreign Agricultural Trade by Countries, (A supplement to the Monthly Foreign Agricultural Trade of the U.S.)

TABLE 2

Composition of Cassava (per 100 grams)

Manihot esculenta

	Refuse	Water	Food Energy	Protein	Fat	Carbohydrate		Ash
						Total	Fiber	
	%	%	Cal	g	g	g	g	g
Edible Portion	0	64.7	131	1.1	.3	32.7	1.3	1.2
As purchased; refuse, brown skin, and thin inner layer	26	47.9	97	.8	.2	24.2	1.0	.9

	Calcium	Phosphorus	Iron	Vit. A	Thiamin	Riboflav.	Niacin	Ascorbic Acid
	mg	mg	mg	I.U.	mg	mg	mg	mg
Edible Portion	33	53	.9	trace	.07	.03	.6	40
As purchased	24	39	.6	trace	.05	.02	.4	30

From Table 3, p. 20, #121 - Composition of Foods used in Far Eastern Countries, Agriculture Handbook, No. 34

Bureau of Human Nutrition and Home Economics, U.S.D.A.

TABLE 3

ANALYSIS OF CASSAVA ROOTS

Jamaica, 1955

	Bodles Agricultural Station	Grove Place
WHOLE TUBER		
	% Glucose	
Range	.26 - 2.40	.44 - 3.1
Average	.98	1.17
	% Sucrose	
Range	.13 - 1.70	.20 - 2.6
Average	.98	1.67
	% Starch	
Range	3.5 - 34.9	21.5 - 57.1
Average	20.75	31.0
SKIN (epidermal and subepidermal material)	p.p.m. HCN	
Range	130.7 - 1097.8	238 - 2208.6
Average	432.9	1019.2
CORTEX	p.p.m. HCN	
Range	36.7 - 306.7	27 - 345
Average	102.3	144.0

TABLE 4

Crop	Latin America		Africa		Far East	
	Yield per Hectare (tons)	Calory production per Hectare (millions)	Yield per Hectare (tons)	Calory production per Hectare (millions)	Yield per Hectare (tons)	Calory Production per Hectare (millions)
Cassava	128.0	13.95	67.0	7.30	81.0	8.82
Rice	17.5	4.3.	13.?	3.30	17.1	4.27
Maize	12.6	4.48	9.6	3.41	10.6	3.77

Source: FAO Production Yearbook, 1966. Vol. 20.

APPENDIX ONE

Products from cassava roots are used in most lowland tropical regions. Only a few countries produce sufficient excess to permit export. These are: Thailand, Brazil, Indonesia, Taiwan, Hong Kong, Malaysia, Madagascar and Togo. Below are recorded production figures for these countries, in thousand long tons.

	1948-52 (a)	1955-56-1959-60 (a)	1960-61	1961-62	1962-63	1963-64
Brazil	12,269	15,270	17,335	17,773	19,530	21,898
India	. . .	1,746	1,920	1,938	1,866	1,771
Indonesia	6,710	10,342	11,196	11,013	10,803	. . .
Madagascar	. . .	728(b)	814	790	837	837
Dominican Rep.	. . .	141	151	138	146	. . .
Taiwan	99	135	157	222	221	214
Thailand	265	581(c)	1,203	1,699	2,044	1,968
Togo	229	490(b)	555	. . .	971	1,071
Other Former French West African Territories	1,065	. . .	. . .	. . .	. . .	. . .

(a) Average for period

(b) " " 1957-58 - 1959-60

(c) " " 1956-57 - 1959-60

Source: FAO Monthly Bulletins of Agricultural Economics and Statistics as organized by Walker, 1966.

The amount of export from these countries is given below, along with the type of product exported.

Exports of Cassava and Tapioca Products from the Major Sources

(long tons)

	Average 1955-59	1960	1961	1962	1963	1964
BRAZIL						
Tapioca Starch	21,512	34,701	16,295	8,372	2,769	. . .
Cassava Flour	1,888	30,353	16,545	2,184	7,233	. . .
Pearls, Seeds, Flakes	791	833	1,198	1,178	899	. . .
THAILAND						
Cassava Flour and Tapioca Starch	85,035	237,611	409,450	372,266	306,388	. . .
Cassava Root	812	2,910	8,272	12,470	91,946	. . .
Waste Cassava for Cattlefood	27,999	24,594	18,274	9,435	22, 037	. . .
INDONESIA						
Cassava	47,333	102,314	85, 317	7,469	. . .	. . .
Cassava Flour	1,474	3,615	256	2,971	. . .	. . .
Pearls and Seeds	510	253	178	10		
MALAYSIA (Malaya and Singapore)						
Tapioca Starch and Cassava Flour	1,184	1,727	1,942	2,470	7,285	3,503
Edible Tapioca	5,105	12,800	13,749	12,543	14,942	14,765
MADAGASCAR						
Tapioca and Cassava	8,968	6,515	6,597	8,347	7,234	. . .
TOGOLAND						
Edible Tapioca	566	982	1,221	435	732	661
Tapioca and Cassava (a)	3,449	8,314	8,310	3,414	4,882	5,748
ANGOLA						
Casava Flour	174	1,831	1,301	. . .	. . .	. . .
Cassava Roots and Meal	30,683	57,777	57,800	. . .	. . .	. . .

Exports of Cassava, etc. (continued)

(a) Includes some semolina.

. . . not available

Sources: Commercio Exteriodo Brazil

Foreigh Trade of Thailand

Biro Pusat Statistic - Indonesia

External Trade Statistics, Department of Statistics Singapore - Malaysia

Statistique D'Outre Mer Imprimerie Nationale and Bulletin de Statistique, Service de Statististique Generale, Togo.

Commercio Externo Repartico Tecnica de Estadistica General - Angola

as organized by Walker, 1966.

The statistics given above do not indicate the destination of the exported products, and no trends can be detected. Walker (1966) states that the principle market for dried cassava roots (chips) is in Europe. Almost 600,000 long tons are imported anually for animal feed. The German Federal Republic alone accounts for 80% of this product.

Walker includes a number of more detailed tabulations, by variations in products, but these are of such a nature as to add little to this report.

Footnote for page 1. Maturity

Maturity is a poorly defined concept for roots of Manihot esculenta. No actual basis has been established, except by observation and this varies from place to place. These plants, which are short-term (4 or 5 years) perennials, do not exhibit the same definite points of maturity exhibited by grain crops. Apparently when one harvests these plants is a matter of choice, depending on need, climate and local custom. The following factors probably enter into the decisions concerning "maturity:" (1) Starch accumulation, (2) length of dry and wet seasons, (3) desire for certain qualities, such as softness or hardness of the root, or amount of accumulated sucrose as contrasted with accumulated starch, (4) necessity to harvest plants before rivers inundate the growing area.

With respect to (1) above, Cours (1951) has indicated that for cultivars growing in Madagascar, there is a gradual and steady rise in starch content for the first eleven months, then a slow decline for three months, then a reversal towards a gradual, steadily increasing starch yield during the last seven or eight months of the test. Genetic variations also play a role in various times of maturation, but these are sufficiently well masked by environmental influence as to be difficult to assess.

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Addendum to Page 7, Cassava Study Report - Protein Production

The literature on this subject is quite limited, as it refers specifically to the use of cassava as a medium for growing microorganisms. Much has been written, however, on various microorganic production of proteins, from a variety of substances including various plant and animal materials including refuse, and even from petroleum. Most of the studies employ yeasts of the genus Candida (torula), but numbers of microorganisms have been employed, including bacteria (Escherichia coli), a variety of fungi, Ascomycetes, Basidiomycetes and Fungi Imperfecti. No one of these organisms has come to the front as the best organism for edible (or balanced) protein production. In each case, problems have arisen concerning the necessary nutrient medium to give a more desirable product. These problems most frequently arise when turning from laboratory scale production to full, economic mass production. In this connection, it seems that the technology necessary to produce the protein is beyond the capacity or capability of developing nations. Furthermore, the costs of production have not yet been brought down to a point where the developing nations could afford to go into full-scale production. Acceptability of the product by those most in need of the increased protein food is a critical element in judging the suitability of microorganic protein. In many cases, it is claimed that an odorless, tasteless substance is produced, and that when this is added to normally used foods it is accepted. A case in point is the tapioca macaroni produced by the Central Food Research Institute of Mysore, India. This product, made of wheat flour mixed with peanut and tapioca flour, is used by many Indians. While no microorganic protein was incorporated in this product, it seems to point the way to acceptability by conservative groups.

The protein produced by any of a number of procedures requires special or careful handling, storing and processing. Apparently the protein molecules are susceptible to degradation after production. These factors must be taken into

account as a part of the overall feasability studies.

There seems to be little doubt in the minds of the workers who are most closely associated with food protein production by microorganisms that the difficulties above cannot be overcome. In all cases, it is felt that the problems are technological ones, requiring more intensive investigation, and that none of the difficulties are insurmountable. With specific relation to cassava, it is known that a crude form of fermentation process is employed by primitive people in a very uncontrolled manner. It is doubtful that the fermentation is induced with the specific idea of increasing the protein content, but it is certainly true that the protein content is raised by this process. More likely, the fermentation is employed to break the starches into simpler carbohydrates, and perhaps to produce some more desirable flavor.

Proposed areas to be covered in the Cassava study report.

1. Economic importance.

   a. Geographical distribution. — Historical evidence of Am. origin -

   b. Production status (representative yields in different parts of the world).

   c. Nutritional value - (for human consumption and for animal feeds). analyses of roots -

   d. What are the prospects for improvement and development of specific varieties in the low tropics of the western hemisphere? Africa?

2. Research

   a. What is being done, by whom, and what needs to be done to improve cassava for the low tropical areas?

   b. Where are the centers of excellence throughout the world?

   c. What are the production hazards (diseases, insects, fertility levels and water requirements, sensitivity to day length)?

3. General

   a. What is available in the world germ plasm banks and where are they located?

   b. Identification of locations and institutions for cooperative work.

   c. Recommendations as to varieties and selections that should be studied initially at Palmira and other locations.

   d. Facility needs.

   e. Staffing requirements.

   f. Recommendations of candidates who might qualify to become staff members of CIAT.

Report - graphs - comparison of yields - Nutritional

4. Recommendations for proceeding

Crop	Latin America		Africa		Far east	
	yield per hectare (tons)	Calory production per hectare (millions)	yield per hectare (tons)	Calory production per hectare (millions)	yield per hectare (tons)	Calorie production per hectare (millions)
Cassava	128·0	13·95	67·0	7·30	91·0	8·82
Rice	17·5	4·37	13·2	3·30	17·1	4·27
Maize	12·6	4·48	9·6	3·41	10·6	3·77

Source — FAO Production year book 1966 vol 20

	yield - calories per hectare (millions)							
	Europe	N. America	Latin America	Near East	Far East	Africa	Oceania	World ave.
Cassava	–	–	13.95	7.95	8.82	7.30	12.42	9.48
Sweet potato	13.16	9.68	7.23	8.36	9.02	6.48	8.92	7.80
Rice	10.15	11.9	4.37	7.32	4.27	3.30	12.22	5.07
Maize	8.43	16.51	4.48	7.22	3.77	3.41	5.87	8.08

Table 3, p. 20 #121 - Composition of Foods used in Far Eastern Countries, Agriculture Handbook, No. 34
Bureau of Human Nutrition and Home Economics, USDA

Composition of foods, 100 grams, edible portion, and as purchased

Cassava, common, bitter (Manihot esculenta):	Refuse	Water	Food Energy	Protein	Fat	Carbohydrate		Ash	Calcium	Phosphorus	Iron	Vit. A	Thiamin	Riboflav.	Niacin	Ascorbic Acid
						Total	Fiber									
	%	%	Cal	g	g	g	g	g	mg	mg	mg	I.U.	mg	mg	mg	mg
a. Edible portion	0	64.7	131	1.1	.3	32.7	1.3	1.2	33	53	.9	Trace	.07	.03	.6	40
b. As purchased; refuse, brown skin, and thin inner layer	26	47.9	97	.8	.2	24.2	1.0	.9	24	39	.6	Trace	.05	.02	.4	30

RESULTS OF ANALYSIS OF CASSAVA TUBERS

	Samples from Bodles Agricultural Station	Grove Place
WHOLE TUBER		
	% Glucose	
Range (total)	.26 - 2.40	.44 - 3.1
(first 1/3)		.44 - 1.9
Average	.98	1.17 *
	% Sucrose	
Range (total)	.13 - 1.70	.20 - 2.6
(first 1/3)		.9 - 2.4
Average	.98	1.67 *
	% Starch	
Range (total)	3.5 - 34.9	21.5 - 57.1
(first 1/3)		22.2 - 39.0
Average	20.75	31.0 *
SKIN (epidermal and subepidermal material)	p.p.m. HCN	
Range (total)	130.7 - 1097.8	238 - 2208.6
(first 1/3)		576 - 1399
Average	432.9	1019.2 *
CORTEX	p.p.m. HCN	
Range (total)	36.7 - 306.7	27 - 345
(first 1/3)		64 - 238
Average	102.3	144.0 *

* Grove Place averages computed on first 1/3 of data.

CASSAVA STUDY REPORT

Introduction

Since much confusion exists in the literature and in the minds of many workers concerning the names, properties, and uses of this root crop it seems useful to give an explanatory statement about these items.

The scientific name is Manihot esculenta. In the past, separate species names have been applied to subspecific variations; for example, M. utilissima (those races of the species that contain a very high concentration of the toxic principle, a cyanogenic glucoside, which releases HCN by enzymic action), M.alpi, M.dulcis, and/or M.palmata (used for those races purported to be free of the toxic principle). I have demonstrated (Rogers, 1963) the futility of attempting to apply these names to the species, and for scientific purposes, we must call all of the races, whether toxic or not, by the one species name, M. esculenta.

The same crop is called by various common names in various parts of the world. All apply to the one species, Manihot esculenta. The names most frequently encountered are: cassava in English-speaking tropical areas, yuca in Spanish-speaking areas, mandioca or macacheira in Brazil, manioc among French-speaking peoples, and by other less well-known epithets in the Far East. Tapioca, one of the products manufactured from the roots, is sometimes used as a common name.

The plants are woody-stemmed shrubs, with an average height of about 10 feet, maturing in 6, 10, 12, 18 or 24 months, depending on the variety, climate, locality and local preference.* The enlarged tuberous roots contain about 20-35% dry-matter, consisting largely of starchy carbohydrates, and with relatively small content of proteins (some varieties reported to have

* footnote attached

A PROPOSAL FOR CREATING AN INTERNATIONAL INSTITUTE FOR AGRICULTURAL RESEARCH AND TRAINING TO SERVE THE LOWLAND TROPICAL REGIONS OF THE AMERICAS

Dr. Lewis M. Roberts

Dr. Lowell S. Hardin

October, 1966

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SUMMARY OF THE PROPOSAL

Increased productivity in agriculture is an important element in advancing the economic growth of largely agrarian, developing countries. In aggregate, world food production is barely keeping pace with population growth, even at the present levels of inadequate consumption, so there already is a deficit to supply. Increased food production is therefore an important need. Production alone, it is recognized, does not assure distribution and consumption by the world's needy. Production, however, must be the primary focus. The two principal ways to increase food production are by: 1) obtaining higher yields from land already in use, and 2) bringing new lands into use.

Lands presently contributing little to food production exist in the hot tropics of Latin America, Africa, and Asia. While modern scientific crop and livestock production knowledge of these tropical regions is scant, these areas are believed to have a substantial agricultural potential. In relatively close juxtaposition to the largely untapped lowland areas between the Tropics of Cancer and Capricorn live an estimated more than half of the world's people whose diets are usually deficient in both quantity and quality.

The hot tropics have been slow to develop because of many interrelated political, economic, social, climatic, and biological factors. Much of the knowledge which might permit rational utilization of the lowland tropics for food production remains to be developed. The hot tropical regions, except for export crop technology developed by colonial powers, have been largely bypassed by

modern agricultural science. Under increasing population pressure people are moving into lowland tropical areas that until now have been sparsely populated. The question therefore is this: Given the world's present and prospective food needs, can man through modern science develop the production, marketing, distribution knowledge, institutions, and techniques whereby more intensive agricultural use of lowland tropical areas becomes economically feasible?

To help answer the above question in Latin America, the creation of an International Institute for Research and Training in Tropical Agriculture is proposed. A possible location is Palmira, Colombia. The institute could be operated in a manner similar to the management of the International Rice Research Institute in the Philippines and the International Maize and Wheat Improvement Center in Chapingo, Mexico. A number of indigenous experiment stations have already been established in the tropical lowlands of Latin America. Thus a potential network of stations with which a strong, autonomous international institute could productively cooperate now exists.

To allocate funds for research and training in the hot tropics is to invest in an area of undefined potential. Short-run returns on scarce funds would probably be greater in the more favorable, temperate areas. The objective here, therefore, is not to make major diversions of funds from needed programs in the temperate zones of the hemisphere, but to make a strong start toward solving the problems peculiar to the tropics. If present rates of population growth continue,

both areas must develop their capacity and contribute to rising food requirements. If rising expectations of people in these areas are to be realized, productivity of the agricultural sector must rise.

The Latin American tropics comprise a variety of ecological zones, each of which will require specific adaptive research to capitalize upon its inherent productive capacity. The areas concerned may be roughly divided, based upon present knowledge, into land areas which are favorable, unfavorable, and unclassified as to potential. The first are known to have unexploited potential for greatly increased returns from relatively small inputs. These include the northern coastal plains of Colombia, the Caribbean and Pacific littorals of Mexico and Central America, the Pacific coast of Ecuador, and the eastern Andean slopes between 500 and 1,000 meters elevation extending from Venezuela through Colombia, Ecuador, Peru, and Bolivia.

The second category includes much of the hot humid jungles of the Amazon and Orinoco basins and the Colombian Pacific coast, where greater efforts and investment will be necessary to pave the way for agricultural advance. Little is known about the third category of lands. Their potential for both crop and animal production may be good. Included are the central plateau of Brazil and the flat plains or llanos of Venezuela and Colombia.

The areas described vary with respect to rainfall patterns, soils, topography, ease of access, communications, and stage of social and economic development. They have, however, two factors in common which are important for crop adaptation: temperature and photoperiod. Experience with rice, corn, and other crops has shown that these two

conditions make it relatively easy to move plant materials throughout the tropical zone and have them adapt reasonably well.

The proposed institute would follow in many respects the successful International Rice Research Institute model. It would emphasize an interdisciplinary approach by highly qualified career scientists employing advanced research facilities. It would help develop trained people at locations within the region in which the scientists expect to work. The institute would have as a major goal the training of scientists and the development of technology to serve in building strong national programs and institutions. Cooperative arrangements with other centers for research, training, and extension would be developed throughout a large region. International exchanges and communications among scientists from the several related fields and nations would be encouraged. Were such a center located in Colombia, it would add an important link to the chain of international institutes concentrating on tropical and semitropical agriculture, which now includes the International Rice Research Institute in the Philippines and the International Maize and Wheat Improvement Center in Mexico. An international institute of this type in Latin America is greatly needed to train Latin American scientists and to provide the mechanism to promote cooperative work in the Latin American area on common problems.

The Latin American institute would not be concerned with a single crop or enterprise. It would concentrate on the identification and solution of tropical crop and livestock production and distribution problems and on the training of people in a problem-solving research and educational environment.

It is recognized that the institute should focus its major efforts in crop improvement on only a few crops that are vitally important from the standpoint of nutrition rather than dilute its forces on a large number of crops. It is proposed that top priority be given to one or more of the potentially most important grain legume crops for direct human consumption such as soybeans, beans, cowpeas, and pigeon peas. These are rich sources of protein, the nutritive element that is so important for normal growth and health and the one that is the most deficient on a world-wide scale, especially in the tropical regions. A portion of the present protein deficit and greatly increased future needs for this vital component in man's diet must be supplied from animal sources. It is therefore proposed that forage legumes and grasses for livestock be given a high priority rating along with the grain legumes for direct human use.

Corn and rice are of primary importance in the tropical regions of Latin America. Fortunately the proposed institute will not need to make a primary thrust in its research and training programs to improve these two crops, since the basic work being done by the International Maize and Wheat Improvement Center in Mexico and the IRRI in the Philippines makes this unnecessary. In order fully to capitalize regionally on the valuable results emanating from the IMWIC and the IRRI, it would, however, be highly desirable for the institute in Latin America to serve as the headquarters for a small group of corn and rice specialists, probably only one or two for each crop, who would work in close connection with the IMWIC and the IRRI in extending these results and doing the necessary adaptive research throughout Latin America.

The crop improvement program activities previously mentioned are those recommended for the institute to concentrate on at the beginning. The development of proper cropping patterns or systems of rotation to overcome problems of soil management and fertility, diseases, insects, and weeds might make it highly desirable for the institute to give attention to a few other crops important to the tropics in the future. Needs, opportunities, and results should dictate the decisions in this connection. Crops, or categories of crops that are important, or potentially so, for the tropics are root crops such as cassava, yams, and sweet potatoes; vegetables; and tropical fruits such as plantains and citrus fruits.

The crop program would be conducted by an interdisciplinary team including geneticists - plant breeders, soil scientists, plant physiologists, plant protection and weed control specialists, agricultural economists, and engineers.

Livestock work would concentrate on ruminant animals, with emphasis on the study and prevention of diseases; nutrition; forage production, utilization, and range management; genetics and reproduction; and the economics of various systems of husbandry under tropical conditions. This, too, would be an interdisciplinary effort.

Library and documentation services will, of course, be necessary.

Much of the institute's work, particularly in adaptive research for the various ecological zones, would be carried on at cooperating indigenous institutions located throughout the Latin American tropics. Potentially these include two Mexican stations, one in the state of Veracruz and one in Chiapas; three stations in

the Caribbean, two in Puerto Rico and one in Trinidad; the National Agricultural Research Center at Maracay in Venezuela; the INIAP stations of Pichilingue and Santo Domingo in the Pacific littoral of Ecuador; two stations in Peru, one at Iquitos and the other at Tingo Maria; the Santa Cruz station of the University of San Simon in Cochabamba, Bolivia. In Brazil, the institute would expect to cooperate with the IPEAN station in Belem, the University of the Amazon in Manaus, the Rural University of the State of Minas Gerais especially at its Triangle station, and the University of Minas Gerais in Belo Horizonte. In Colombia, in addition to the institutions mentioned above, two ICA stations would collaborate in the work of the institute: La Libertad station in Villavicencio, and Turipana station in Cerete. The Inter-American Institute of Agricultural Sciences (IICA) at Turrialba, Costa Rica, is another potential collaborating organization. This is a tentative listing. Direct contacts with potential cooperators have not yet been made.

In addition to its own research program, the institute would cooperate with national institutions in the region on problems of mutual interest. It would conduct part of its experimental work in collaboration with these, and would maintain a bank of genetic materials for the major crops and perhaps breeding stock in animals which would be available to the cooperating stations. Ties with the other two major international institutes mentioned above, in the Philippines and Mexico, would assure the program an international scope, permit exchange of information and of scientists, and avoid duplication of work.

The training program would be an essential component of the work of the institute. In collaboration with other North American and Latin centers and through direct cooperation with the National University and the University of Valle, both formal academic and interne-type training would be provided. In-service training as well as opportunities for study at the predoctoral and postdoctoral levels are proposed.

The institute is expected to be an autonomous institution, directed by an international board of trustees, on which the Ford and Rockefeller Foundations would be represented. The technical staff would be international in character, with emphasis on highly-trained permanent personnel who would be, in the main, from Latin America.

Costs of the institute are estimated as follows: 1) At the outset, $1 million per year to cover staff salaries, perquisites, and transportation, with an increase to approximately $1,600,000 annually when the institute is fully operative; 2) $1 million annually for operating expenses during the initial stages, increasing to $1,600,000; 3) capital costs for buildings and equipment of between $4 and $5 million. If Colombia should be selected as the site for the institute, it is expected from informal statements by Colombian officials that the amount of land needed would be provided by the Colombian government.

It is proposed that the Rockefeller and Ford Foundations share equally the capital and operating costs. The institute would be organized and established in a manner that would enable it to attract and accept financial support from other sources, such as governments, private individuals and institutions, international agencies, etc., as time goes on.

Considerations favoring locating the proposed institute in Palmira, Colombia, include: 1) Location within the ecological zone in which the work would be focused, with a climate which favors the maintenance of germplasm collections; 2) existence of distinct microclimates within short distances; 3) geographically central location at Palmira; 4) site adjacent to the National University Faculty of Agriculture at Palmira which adjoins an experiment station maintained by the Colombian Agricultural Institute (ICA). The University of Valle in Cali is also nearby; 5) attractive living conditions are available in Cali; 6) promised Colombian governmental support of the institute including the land for the institute buildings and experimental fields and plots; 7) apparent generally favorable attitude toward the proposed institute by the host country. All factors considered, no alternate location has been identified which has as many advantages as are believed to exist in the Colombia site.

A PROPOSAL FOR CREATING AN
INTERNATIONAL INSTITUTE FOR AGRICULTURAL RESEARCH AND TRAINING
TO SERVE THE LOWLAND TROPICAL REGIONS OF THE AMERICAS

Outside of Communist Asia and west Asia, most of the world's diet-deficit subregions are in the tropical belt between the Tropics of Cancer and Capricorn. Two-thirds of the world's peoples live in countries with nutritionally inadequate national average diets. The diet-deficit areas include all of Asia except Japan, all of Africa except the southern tip, almost all of Central America, the Caribbean and tropical South America except Brazil.[1] The less developed, diet-deficit countries have average per capita incomes only one-tenth that of diet-adequate countries. Food deficiencies reflect the low level of living standards in general.

Modest improvement in quantity of food per person and in food quality in diet-deficit countries is being scored in the decade of the 1960's. On a 1957-59 base equal to 100, the index of per capita food available in Latin America stood at 102 to 103 during the period 1960-1964; it rose to 105 in 1965. But much of the slow dietary improvement is due to increased imports. Prior to World War II, the less-developed countries of the world were net exporters of 11 million tons of grain. This year they will likely import 25 million tons.

To hold their own with burgeoning population growth, developing countries, including those in tropical Latin America, need to increase available food supplies three to five percent per year. To advance living standards and accelerate economic development, most of this increase should come from increased productivity of the

1. The World Food Budget, 1970, FAER19, ERS, USDA.

agricultural sector of the countries themselves. Importation, even if the foodstuffs could be acquired, transported and paid for, is but a partial solution.

Economic development is a complex, inadequately understood process. We do know, however, that the less developed countries are predominantly agrarian; that the productivity of resources employed in agriculture is low compared to levels of developed countries; that properly designed and sustained research into the technical, economic and institutional aspects of agriculture can point the way to increased efficiency and higher output. Advances in agriculture are essential, integral components of the total economic development package.

To help resolve food-population balance problems, advances are needed on three fronts:

1) Production will need to increase in those areas capable of producing surpluses (the United States, Canada, Western Europe, Oceania, Argentina, Uruguay). The surplus productive capacity of these areas will be needed in the next decade or more to help meet minimal food requirements and overcome the threat of famines in Asia, Africa, and Latin America. Problems of increased output in these areas, with the possible exception of Argentina and Uruguay, are less technical than economic. (Deficit countries have limited purchasing power with which to buy from surplus producers.)
2) Production of food in food-deficit, economically underdeveloped countries throughout the world, especially in the tropical belt, should increase rapidly. Because technical production knowledge of the tropics is scant, the problem here has technical, economic and institutional components.

3) Reduction of population growth rates in most of the world, especially in those areas, mainly in the tropics, where there are already food deficits.

Technically, the output increases sought from surplus-producing countries should be forthcoming. As analysts have pointed out, however, "it is impossible to assume that maximum effort on the part of the surplus-producing nations will effectively resolve the growing world food deficit or that they can stand permanently between the hungry nations and the threat of famine. At best, this solution would be a temporary and unsatisfactory expedient, and in the long run would be self-defeating."[2]

The concern of this discussion is with increasing the capabilities of the underdeveloped countries in the tropics to improve the productivity of their agriculture. Increases in food output, where economically feasible, are sought. The overall objective is to help the total economies to grow more rapidly. The focus is on the hot or lowland tropics of Latin America.

The hot or lowland tropics as used here are arbitrarily defined as those regions of the tropics at elevations between sea level and 1,000 meters (approximately 3,000 feet). These areas, which range from dry to very wet, represent the greatest remaining potential for adding to present agricultural production. They are shown on the attached map, page 4.

The aggregate of hot tropics represents by far the greatest portion of land surface. Approximately 89 percent of all Latin America is lowland; yet only a small percentage of the population lives in this

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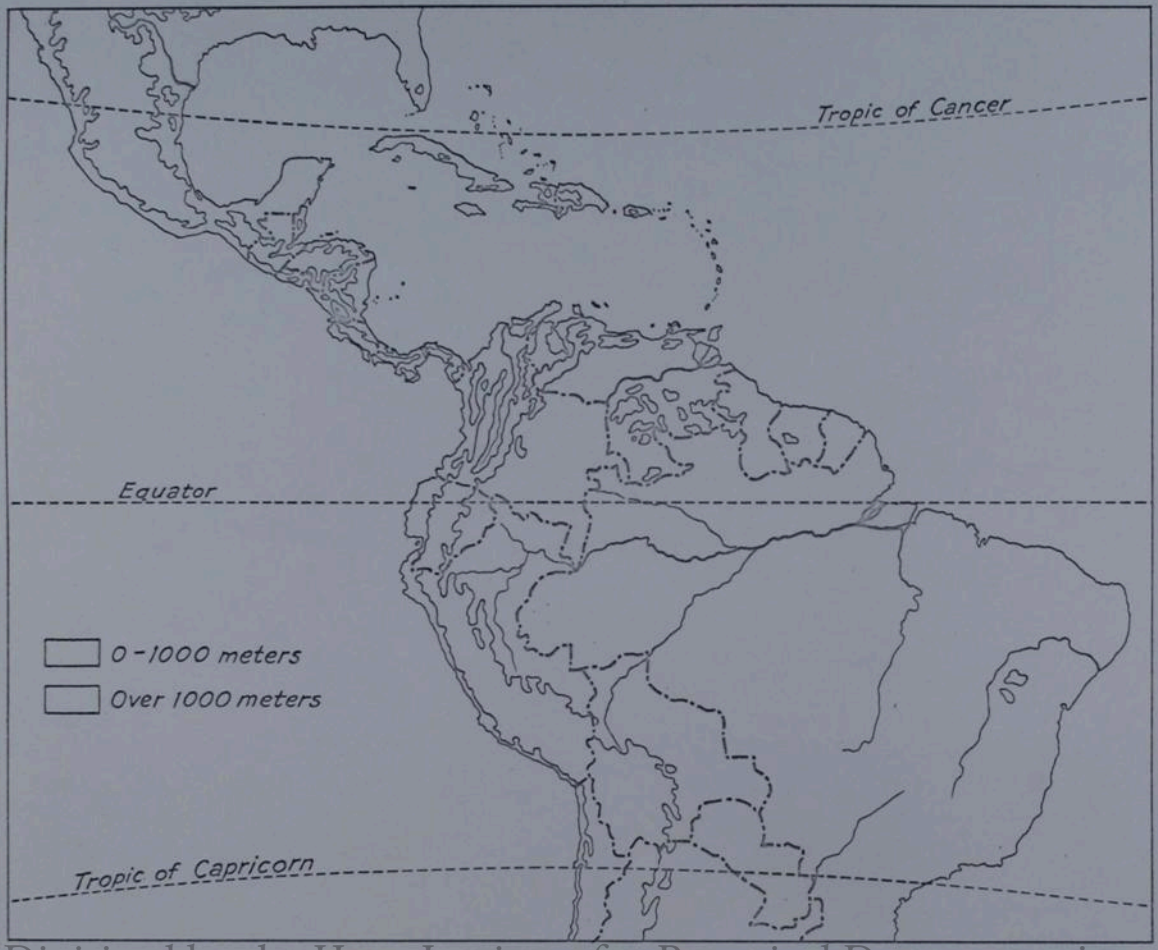
2. Report of the Ad Hoc Panel on the Proposal for the Creation of a Tropical Research Foundation - Harrar et al. Dec. 1965.



vast area. Only about 30 percent of the people of Venezuela, Colombia, Ecuador, Peru, and Bolivia live in the hot tropics; Brazil's interior has a population density of less than two persons per square mile. This situation is changing, however. Since the time of the conquest, people in tropical Latin America have naturally chosen to settle in the areas most attractive for living, where the climate was pleasant, health problems were minimized, communications were possible, and the essentials for life could be had. As a result, the population is largely concentrated in the higher elevations of the mountain chains running through Mexico, Central America, and the Andean region of western South America, and along the relatively narrow coastal strip of eastern Brazil. These desirable areas are now saturated; and as population pressures continue to build up, the people are forced to migrate to the less attractive regions if they are to be involved in agricultural pursuits. As might be expected, the migrants seek out and settle first the most favorable parts of these undeveloped areas. A brief review of some of the hot tropical areas under consideration illustrates their diversity:

Undeveloped Hot Tropics

1) Northern Coastal Plains of Colombia - The rather large coastal plain area in the north of Colombia has fertile soil, about 40 inches of rainfall annually with alternating wet and dry seasons, adapted to annual crops; its flat topography is susceptible to mechanization; it has communications, and is quite accessible geographically. Problems, such as poor drainage, remain to be resolved, but this is a hot tropical area which should prove relatively easy to develop.

2) Coastal Plains of Mexico and Central America - Parts of the coastal plains extending the length of both the Caribbean and Pacific sides of Mexico and Central America fall into the same general category as the northern coastal plain of Colombia from the standpoint of potential for food-crop and animal production and the relative ease of developing this potential.

3) Coast of Ecuador - The Pacific littoral of Ecuador is another quite favorable hot tropical area. It has basically good soils which could be converted into very productive ones if the proper management practices were known and applied. The average rainfall in this flat area ranges between 50 and 70 inches annually, falling in the months of December to May with an alternating dry season of about six months' duration.

4) Eastern Foothills of the Andes - the Oriente - This is another zone that deserves careful consideration. It is of potential importance in the immediate future. The term "zone" in this instance is used advisedly because the reference is to an aggregate of land in the eastern foothills of the Andean range extending from Venezuela through Ecuador and Peru to Bolivia, in these countries called simply the Oriente. This zone does not represent an area that can be neatly defined from the ecological or agricultural standpoint. It is a strip along the eastern slope of the Andes, beginning at an elevation of about 400 to 500 meters, where the Amazon headwaters start to rise more abruptly, and extending upward into the foothills to an elevation of approximately 1,000 meters.

The Oriente undoubtedly offers one of the best prospects in all of South America for opening new and potentially rich agricultural

lands during the next two to three decades. Colonization of this sparsely inhabited zone has begun on a significant scale in Peru and Bolivia and is getting under way in Colombia, Venezuela, and Ecuador.[3] In general, the soils are fertile and the natural drainage is good. It is quite tropical at the lower limit of its elevation range, and gradually becomes semi-tropical as the altitude approaches the upper limit of approximately 1,000 meters. The annual rainfall varies from averages of 70 to 90 inches to as high as 103 inches in Iquitos, Peru. The rainy season north of the equator, on the Venezuelan and Colombian slopes, is from April or May to November, and below the equator from October or November to April.

5) Tropical Jungles - In addition to these benign hot tropical areas just described, there are others that are much more difficult to settle and to make productive. Three areas in northern South America are in this category, and they have much in common. These are the vast Amazon basin that lies mainly in Brazil, and extends into the eastern portions of Peru, Ecuador, and Colombia; the Orinoco basin in eastern Venezuela; and the narrow Pacific littoral of Colombia. These are tropical jungle areas - very hot and humid. They comprise by far the largest aggregate of undeveloped land in the tropics of this hemisphere; the Amazon drainage system alone covers two-fifths of the South American continent. They also present some of the greatest obstacles to development. Up to the present time, they have so successfully resisted the encroachment of man that the population is approximately five million people in

3. See Crist, Raymond E., "Andean America: Some Aspects of Human Migration and Settlement," the Graduate Center for Latin American Studies, Vanderbilt University, Occasional Paper No. 3, May 1964.

the more than 2.7 million square miles of the Amazon basin; most of the Orinoco basin and the Pacific coastal strip of Colombia are only slightly more densely populated, with averages of less than 10 persons per square mile.

Typical rainforest climates prevail. Temperatures in the Amazon basin near the equator are close to 80°F with little seasonal variation; an estimated average of 70 to 80 inches of rain falls annually, becoming heavier near the eastern slopes of the Andes. Flooding is frequent; in the rainy season, whose peak is reached in March-April, the river rises as much as 40 feet, and its tributaries flood most of the area. South of the equator, a short dry season occurs in August-September.

Along the Colombian littoral, the average yearly rainfall is 100 inches, and in places reaches record heights of over 350 inches. Inhospitable in themselves, these conditions foster others even more hostile: plant diseases, pests, and weeds which prosper better than food crops; poor soils; lack of drainage; absence of land transportation; and diseases which attack both man and animals.

6) The Campo Cerrado - There are two other major hot tropical areas whose potential agricultural resources and development possibilities for the immediate future are an enigma at the present time. These are the expansive campo cerrado area of north central Brazil and the llanos of eastern Colombia and southern Venezuela.

The central plateau of Brazil, covering an area of 750,000 square kilometers, (about 290,000 square miles) has a rural population of 2,128,028. Lying in the southern half of the tropical zone,

with elevations ranging from 300 to 1,200 meters, it is characterized by moderate temperatures (an average of 70° to 73°F, dropping to 43° in winter and rising to 79° in summer). Rainfall averages 50 to 60 inches annually for most of the area, concentrated in the summer months of October to April, with an alternate dry season lasting four to six months. Low soil fertility accounts for the prevalence of campo or savannah vegetation; the area has some good soil, however, and much soil that could be made productive with modern techniques. Roads exist and more are being built; rail and air transport are also available to a lesser degree. Large areas of nearly level or gently rolling land are suitable for mechanized farming, and broad areas of rolling and hilly topography could support grazing.[4]

7) The Llanos - This area comprises over 130,000 square miles of low-lying flat plains extending from the Orinoco River basin inland to the Amazon basin, occupying one-third of the total area of Venezuela and almost one-third of Colombia. It is sparsely settled - 10 to 25 persons per square mile near the Andean slopes and less than 10 in the lands skirting the Amazon basin. The climate is hot and dry from December to April, with parching winds; the rains start in May and continue to November, interrupted by a drought in June and July. During the rainy season flooding occurs, with rivers rising 12 to 15 feet.

4. Survey of the Agricultural Potential of the Central Plateau of Brazil, American International Association for Economic and Social Development (AIA), Rio de Janeiro, March 1963.

* * *

From these brief descriptions of the principal areas in the lowland tropics of Latin America, it is readily apparent that there are wide variations in amounts of rainfall and precipitation patterns, soil qualities, topography, vegetation, and other ecological factors in the hot tropics of the western hemisphere. They all have two very important ecological factors in common, however. These are high and rather uniform temperatures and uniform photoperiod. The low latitude regions throughout the world also possess an important attribute which is economically important when combined with other production factors: this is the amount of solar energy at earth's surface, which in the low latitudes is at its maximum for the photosynthetic process.

Within the tropical belt, temperatures are largely a function of elevation. Near the equator itself, the annual mean temperature at sea level will vary slightly between 78° and 82°F and at 1,000 meters it is usually rather constant, ranging between 65° and 70°. As the Tropics of Cancer and Capricorn are approached, these ranges of temperature tend to lower a bit; but within the elevation range of sea level to 1,000 meters, they still maintain a strong direct relationship to altitude. Also, within the tropical belt, the variations in length of day (number of hours of daylight, technically referred to as photoperiod) are moderate.

Temperature and photoperiod are two of the most fundamentally important factors in determining the adaptation of plant species and varieties, as well as the range of adaptation of their disease and

insect enemies. The relative uniformity of temperature and photoperiod in the lowland tropics permits great flexibility in moving plant materials throughout the latitudinal range of the tropical zone and having them adapted reasonably well. This is the basic explanation for the fact that the outstanding race of maize, Tuxpeno, originally from the Caribbean coastal plain of Mexico, can be grown successfully in the hot tropics of Central America, Venezuela, Colombia, Ecuador, Peru, and Brazil, and in many countries of Africa and Asia. The soils are quite different in these countries, and the rainfall patterns are also extremely varied, yet Tuxpeno has proved to be quite well adapted in the lowland tropics in all three continents. Similarly, the tropical maize germplasm of Colombia and the Caribbean region is well adapted in many parts of India and Africa. In fact, the first nine corn hybrids released in India were made up, on the whole, of approximately 50 percent of inbred lines imported from the corn improvement program in Colombia. The improved varieties and lines of wheat produced in Mexico and Colombia do well in Pakistan, India, Kenya, and other tropical countries around the globe.

Superior rice varieties bred at the International Rice Research Institute in the Philippines are sent to tropical and subtropical countries with widely varying growing conditions; for example, in 1965 research was conducted at over 40 different locations in Southeast Asia, and over 5,000 samples of seed were sent to other experiment stations throughout the world. Water and soil management, disease and pest control, and other improved techniques developed by the institute are being introduced by rice scientists in the different areas.

These are just a few selected examples from among many that could be cited to illustrate the relative ease of transferring the research results derived in one location of the tropics to many other areas throughout the tropical belt, provided proper precautions are taken to assure their applicability to different regional conditions through adaptive research.

Role of Agricultural Research and Training in Developing the Hot Tropics

Several books and papers have been published[5] dealing with the lowland tropics in general, and especially with the western hemisphere. Some trace the slow pace of development and advance possible explanations for low levels of agricultural utilization and performance. Complex inter-relationships among historical, political, economic, social, climatic, and biological factors contribute to the conditions that prevail today.

Scientific knowledge that is needed to permit rational and economic use of the lowland tropics for crop and livestock production is clearly inadequate. Except for specialized work on traditional export crops, the hot tropical regions in Latin America, and also in Africa and Asia, have been largely bypassed by modern agricultural science and technology.

Certain crops important for industrial purposes and world trade such as rubber, sugar cane, bananas, cacao, tea, cotton, and spices, have received considerable attention, and have been the subjects of good research work, especially in some of the former European colonies. The Dutch had their network of very fine experiment stations

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5. See Appendix, page 61, for a partial listing.

on the island of Java in Indonesia, the Belgians their huge center in Gandajika in the Belgian Congo, and the British their rather small but well-run tropical center in Trinidad, along with centers in Africa and India. Most of these research stations had no real concern with the problems of increasing basic food production in the regions where they were located. With the decline of colonialism, the work of these centers diminished or ceased altogether.

The creation of the International Rice Research Institute in 1961 represents the first step taken in recent years to develop an international agricultural research and training institute concerned with increasing man's basic food supply. The philosophy underlying the institute and the techniques employed by the Ford and Rockefeller Foundations in its development have already demonstrated their worth. In its five-year life IRRI has contributed to the architecture of superior rice varieties, has evolved superior production practices, and has implemented widespread application of findings through training and information programs. In presenting the reasons favoring the establishment of an International Institute of Tropical Agriculture located in Africa, Dr. F. F. Hill of the Ford Foundation[6] made the following comments:

"Although the International Rice Research Institute established by the Ford and Rockefeller Foundations is still quite young, experience to date indicates that an organization of this kind can perform the following important functions:

(1) By bringing together a highly-qualified staff on indefinite tenure, well-balanced as between the relevant disciplines, and

6. Proposal for an International Institute of Tropical Agriculture located in Africa, Overseas Development, Discussion Paper.

by providing them with the facilities required for high-quality research and experimentation, it is possible to increase materially the speed with which higher-yielding varieties of crops and improved management practices adapted to varying conditions within a major region are developed.

(2) An important contribution can be made toward training professional personnel within the region in which they expect to serve -- the high-level manpower required to staff agricultural colleges, experiment stations, and administrative posts in ministries of agriculture and extension services.

(3) An institution such as the Rice Research Institute can serve as catalyst and pace-setter -- an instrument for helping to improve the efficiency and effectiveness of other research, training, and extension organizations throughout a large region. It can demonstrate to visiting administrators and scientists in a way that is not otherwise possible the kind of balanced, sustained attack that is necessary if the foundations are to be laid for steady and reasonably rapid progress in increasing agricultural production.

"A series of well-staffed regional institutes with adequate facilities, located at strategic points in the major underdeveloped regions of the world, could materially speed the process of agricultural development in these regions. Like the Rice Research Institute,

they could put teams of highly-trained, experienced specialists to work on major problems requiring basic or applied research; they could help train the high-level professional manpower needed in the region; and through regional conferences and seminars, provision of good library facilities and exchange of plant materials, they could make it possible for scientists at other institutions in the region greatly to increase their effectiveness. They would, in effect, provide the kind of function that was performed by a half dozen major land-grant institutions in the United States during the latter part of the last century and the first part of this one. Every state had an agricultural college and a system of experiment stations. But a half dozen leading institutions set the pace.

"It is not suggested that private foundations could or should undertake to establish all of the high-level regional research and educational centers that are needed. In an earlier OD discussion paper, the development currently under way in Mexico looking toward the establishment of a strong education-research-extension center at Chapingo was described. If this center develops as anticipated, it can serve as a regional resource for Latin America although more than one such center is needed to serve this large region."

Adding an Important Link to the Chain

The International Rice Research Institute is continuing to develop well. The International Maize and Wheat Improvement Center in Mexico is being restructured to help it do a more effective job in assisting nations to improve their production of these two vitally important food crops.

For reasons outlined above, it is proposed that an international agricultural institute for research and training be created in South America to serve the lowland tropical regions of this hemisphere.

Basic Objectives of an International Agricultural Research and Training Institute Located in South America

The basic goals of the proposed institute would be similar to those of the other two links in the chain. These are clearly stated in the excerpt of Dr. Hill's comments quoted on pages 13-15. Such an institute would represent the addition of a new component of international cooperation. It would complement indigenous national programs of research and training in the hot tropics. Its creation would be based on the premise, and the understanding on the part of the collaborating nations and international organizations which may be involved, that giving more attention now to the hot zone would not be achieved by lessening the present emphasis on the higher-elevation, temperate-climate areas in the Latin American tropics, or for that matter, on the other temperate regions of the hemisphere. Increasing the productivity of the lands in these temperate areas where most of the people now live is tremendously important, and undoubtedly deserves top priority in the allocation of national and international funds and efforts. Further, sustained growth of indigenous institutions is essential. Creation of the institute, therefore, is intended to complement, not to divert resources from indigenous research and training establishments. The institute is seen as one means of positively focusing additional attention and investment on tropical agriculture.

Scope of the Institute's Research and Training Activities

The institute would concern itself with research problems in any area of the lowland tropics where the rainfall amount and distribution is adequate for the economic production of basic food crops and of forages and feeds to support animal industries. This may be as little as 20 inches of annual precipitation, if it is distributed in such a way as to provide sufficient moisture for good plant growth over a period of normal crop season under the high-temperature conditions of the tropics - four to five months is ordinarily enough.

In other words, the institute would not limit itself to working only in the humid or very wet tropics (60 inches or more of rainfall annually). However, at least at the beginning, it would not concern itself with areas that are so arid (about 15 inches of rainfall or less) that they must depend basically on irrigation for successful crop production.

Clearly, this gives the institute a broad latitude of ecological conditions within which to work. It would focus its efforts and resources within this wide range of conditions to make significant progress on well-defined, important problems. As the institute grows, such focusing would be left largely to the judgment of the director, the staff, and the board of trustees, with the general criteria always in mind that resources and efforts should be so directed as to have the broadest possible impact for increasing basic food production in the shortest possible time.

The institute should have two main avenues of research activities, directed toward increasing the efficiency of production of

1) food crops, and 2) livestock. Work in these two general fields should be launched simultaneously. As the undeveloped hot tropics begin to be opened up for settlement, many areas will prove to be best suited, and indeed in certain instances only suited, for animal production. Food crop production may be too costly because of moisture, soil, climate, drainage, location, or market problems. Ruminants, especially the bovine species, can convert coarse forages into high quality human food rich in protein. These highly-prized, high-value animal products have expanding international markets; they may be a source of much-needed foreign exchange so essential to the development of the nations involved. Animal products can also make important nutritional contributions to the diets of local people if priced within their reach. Hence the need for a balanced crop and livestock program.

Suggested Priorities and Staff* for Crop Research

It is proposed that the institute concentrate its major efforts in crop improvement on a few carefully selected crops rather than diffuse its efforts by working on a wide variety of crops. The crops selected should have potentially very broad utility in the lowland tropics of the world and should be especially important from the standpoint of human nutrition.

With these concepts as major guidelines, it is suggested that the areas of program activities briefly described below be seriously considered for high-priority attention. It is recognized that additional careful analysis and planning are needed to develop precise program and staffing patterns. Operationally, it would be wise to name an institute director as soon as the institute's creation

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* See Table, page 39.

is assured. It would be his responsibility, with the assistance of his management board, to evolve detailed research and staffing plans.

Grain Legumes (soybeans, beans, cowpeas, pigeon peas) - It is proposed that top priority be given to the potentially most important grain legume crops for direct human consumption such as those mentioned above. These are rich sources of protein, the nutritive element that is so important for normal growth and health and the one that is most deficient on a world-wide scale, especially throughout the tropical regions. Well-adapted grain legume crops need to be identified to fit into the cropping systems of the tropics. Two senior and one junior staff members would be needed at the beginning to initiate the program. As research develops in this general field of grain legumes, two additional staff members, one senior and one junior, will probably be needed.

Forage Legumes and Grasses - A portion of the present protein deficit and greatly increased future needs for this vital component in man's diet will have to be supplied from animal sources. It is therefore proposed that forage legumes and grasses for livestock be given a high-priority rating along with the grain legumes for direct human use. Work to improve the forage legumes and grasses would dovetail very closely with another major thrust of the institute, the program to increase livestock production with concentration on bovine species, which will be described later on. There would be very close cooperation and coordination between these two program efforts, especially in the areas of forage evaluation and utilization and range management.

The staff requirements for this research would include two forage specialists at the outset with two range-management specialists to be added as the program develops.

Corn and Rice - Corn and rice are of primary importance in the tropical regions of Latin America. Fortunately the proposed institute will not need to make a primary thrust in its research and training programs to improve these two crops, since the basic work being done by the International Maize and Wheat Improvement Center in Mexico and the IRRI in the Philippines makes this unnecessary. In order fully to capitalize regionally on the valuable results emanating from the IMWIC and the IRRI, it would, however, be highly desirable for the institute in Latin America to serve as the headquarters for a small group of corn and rice specialists, probably only one or two for each crop, who would work in close connection with the IMWIC and the IRRI in extending these results, and doing the necessary adaptive research throughout Latin America.

Corn - The base of the Northern Andean Maize Improvement Program is already established in Colombia. Even closer coordination of efforts between this regional base and the overall International Maize and Wheat Improvement Center is now possible with the recent reorganization of the center in Mexico. Dr. D. D. Harpstead, present head of the corn improvement work in the Andean region, is a candidate for leadership of the corn work in the proposed new institute. Two junior staff members would be needed. These should be Latin Americans trained to at least the M.S. degree level.

Rice - As in the case of corn, the institute would serve as a regional base for a rice specialist who would work as a member of the team effort of the International Rice Research Institute, concentrating on rice problems of tropical Latin America. One senior staff member would be required, plus one, possibly two, junior staff members as the program develops.

how to stimulate and improve their defensive mechanisms, and how to treat them during the course of disease. To accomplish this, we need to study the physiological response of animals to tropical conditions, to investigate the nature of disease-producing agents, and to learn more about the vectors that may be involved, since these are the factors that will indicate which diseases are the most important economically.

Certain broad areas of research will include:

1) Study of means to reduce the devastating effect of disease on growth and reproduction.
2) Development of means for improving the effectiveness of prophylactic and therapeutic measures in the control of viral, bacterial, and protozoan diseases.
3) Assessment of the role which internal and external parasites play in bovine health in the tropics.

An excellent veterinary research laboratory is already in existence on the campus of the National University in Bogota, Colombia. Although this laboratory is associated with the Veterinary Faculty of the University, it is a part of the Colombian Agricultural Institute - ICA, and, as such, has responsibility for developing a country-wide program on animal diseases. Close collaboration between this laboratory and the animal improvement program of the tropical institute can be easily achieved on the basis of mutual interests.

Staff requirements for this program at the start would include one senior and two junior microbiologists, and one senior and two junior pathologists; as the programs progress, one senior and two junior epidemiologists should be added.

provide the delicate balance of amino acids normally required by monogastric animals. Because of their unique physiology, these polygastric animals are able to utilize enormous nutritive resources which man cannot consume directly. This is not true of poultry and swine, whose rations include ingredients that may be consumed directly by man, and are needed as sources of energy and proteins.

Secondly, our knowledge and know-how concerning poultry and swine production can be transferred to developing nations with greater ease than is the case with dairy and beef cattle production. In the case of swine and poultry, and to some extent with dairy cattle, it is more feasible than with beef cattle to modify certain environmental influences and thus reduce the stress which these have on productive efficiency. Furthermore, our knowledge of disease problems, nutrition, physiology, and management permits the establishment of poultry operations almost anywhere in the world - limited, of course, by economic considerations. In addition, advances through genetic selection have been more rapid in poultry and swine than in other domestic species, and tremendous progress toward high reproductive efficiency (egg laying, farrowing rates, and rates of growth), has been achieved in these two species which, at the same time, have a rather broad range of adaptability.

Diseases - Enormous livestock losses, both perceptible and imperceptible, are caused by disease - perhaps up to 50 percent of potential productivity. The reduction or elimination of these losses would result in more economic and significantly increased livestock production. To achieve a condition of health in animals requires that we learn how to protect them from exposure to disease-causing organisms or situations,

exposure to innumerable disease hazards, semistarvation - it is little wonder that those which survive require five to six years, and often more, to reach a size acceptable for market. We know that even the indigenous cattle will respond to better feeding and improved health measures to such an extent that they can be marketed in less than half the period normally observed. Whether the necessary practices, as now understood, are economical under tropical conditions remains to be determined.

Large areas of many countries are devoted to pasture and range lands for cattle, sheep, and goats, for several reasons: These regions may be inaccessible, or unsuitable for agricultural purposes; too great an investment may be required to adapt them to cultivation; they may be public lands as yet awaiting distribution and settlement. Undoubtedly some of these areas will ultimately be utilized for the production of food crops to be consumed directly by man; others can be improved for forage and pasture use, while still other portions will remain partially or totally unproductive.

Suggested Priorities and Staff:*
Concentration on Bovine Species
with Major Emphasis on Beef Cattle

In considering research priorities and staff requirements, the animal program of the institute should concentrate on ruminant animal production, for two important reasons: firstly, ruminant animals possess the unique ability to utilize the fibrous substances of which forage and fodder plants are composed. The bacterial fermentation processes which take place in the digestive tract of polygastric animals have the additional advantage of making it unnecessary to

* See Table, page 39.

diseases which result in unthriftiness, poor growth, abortion, etc., although less apparent to the casual observer, cause incalculable losses in potential productivity. In addition, the erratic nutrient intake of cattle, sheep, pigs, goats, and chickens lessens their resistance to disease organisms.

Death losses, often reaching 20-40 percent of herd population, are common. Low fertility, abortion, and death of newborn result in extraordinarily poor reproductive rates. In some cattle-producing areas, calving percentages are as low as 30 percent, whereas they should be well above 70 percent of cows of breeding age.

In some tropical areas substantial quantities of milk are obtained as a by-product of the beef operation. The extent to which beef cattle can be made more productive in milk yields should be explored. Milk production is affected by feeding, disease, management, genetic factors, and climate. To date, no one has satisfactorily solved the problem of increasing the milk-producing potential of cattle in the tropical areas of the world. There are data which indicate that higher milk yields can be realized in the tropics, but more intensive study of the factors involved is needed. Whereas criollo cattle in the tropics will produce barely enough milk to feed a calf, production records from a few experimental cattle indicate that with proper care improved cattle will produce 5,000 lbs. and more of milk a year.

Considering the fact that these animals are raised under extremely adverse conditions - precarious health of the mother,

production for a long time to come. The animal improvement program should concentrate on ruminant animal production. It is believed that it is entirely feasible and highly desirable to increase meat production in many of the tropical regions previously described, and that the institute should have an important role in helping to bring this about. In this way, the institute could make one of its most valuable and far-reaching contributions, since more meat, and other animal products as well, are required in the solution of the number one problem of human nutrition, protein deficiency.

Animal production plays an important role in the agricultural economy of most Latin American countries. It is a principal source of income from export sales in Argentina, Brazil, Uruguay, and Mexico. On the other hand, some Latin American nations such as Chile, Venezuela, Peru, and Bolivia rely upon imports to meet their deficit, even though their potential for livestock production has not been realized. The use of milk, eggs, and meat in the family diet is largely determined by economic considerations; consequently, given the importance of the nutritive value of animal products, the need is urgent to lower production costs through the application of improved technology.

Livestock production in the tropics has suffered from a lack of sound information which can be deliberately applied toward resolution of the problems. For example, losses caused by diseases are routinely accepted by livestockmen as a cost of doing business over which they have little or no control. Direct losses from death due to diseases such as anaplasmosis, rabies, enteric infections, and anthrax, are excessively high. However, the occurrence of many

in Colombia, might be available for transfer to the institute by the time it is operational. A senior specialist in entomology would also be needed, and as these programs develop, four junior staff members may be added, two in pathology and two in entomology.

Weed Control - Crop agriculture will be possible in the hot tropics only as we learn how to control weed competition economically. Some of the new chemical herbicides are quite effective and will be very useful in helping to control weeds in the lowland tropics. One senior specialist and two junior specialists will be needed to work on this aspect of the problem. These specialists will need to work in close collaboration with the crops specialists, the agricultural engineers, the physiologists, and the agricultural economists in order to mount the kind of attack that is called for to solve the weed problem. Herbicides will have to be combined with proper rotations and with sound practices of land preparation and tillage by mechanical means to devise effective methods of control that will be economically feasible and advantageous.

Animal Improvement Program: Livestock Production Needs in the Tropics

The diet of people who live in the tropics is very often deficient in the quality, as well as quantity, of the protein component. By incorporating even small amounts of animal products, dietary imbalances of amino acids can be corrected, leading to substantial improvement in the total worth of the diet. In addition, large parts of the tropical areas offer enormous potential to add to the world supply of food resources because these will remain in grass and forage

staff in Colombia, might be available for the position in soil fertility and management. It is anticipated that workshops organized periodically at the institute, bringing together selected groups of experienced soil scientists for limited periods of intensive consultation, will form an important feature of program development for this group.

Plant Physiology - There is a general lack of sound knowledge of most of the basic physiological processes that govern the adaptation and healthy growth of a population of crop plants under field conditions, even in the temperate zones of the world where science and technology are far advanced. The scarcity of such knowledge under tropical conditions is many times greater. A much better understanding of plant-soil-water-light-temperature relations under hot tropical conditions is required. Plant physiologists at the institute would work closely with the soil and crop management specialists, and also with the plant breeders and geneticists. This phase of the program would require one senior specialist at the start, and probably an additional senior or junior scientist as the program develops.

Plant Protection: Diseases and Insects - In the hot tropics, plant growth is rapid because of the high temperatures, high incidence of solar radiation, and usually quite adequate moisture. But the plants' enemies - diseases, pests, and weeds - also prosper under such conditions. Research programs to control the economically important diseases and insects in the main crops which are selected for the institute to concentrate on will be required. Dr. David Thurston, plant pathologist with The Rockefeller Foundation program

The crop program would be conducted by an interdisciplinary team including geneticists-plant breeders, soil scientists, plant physiologists, plant protection and weed control specialists and agricultural economists. The scientists from all of these disciplines would focus their joint efforts on the identification and solution of problems that restrain the increase in yields of those crops with which the institute will be concerned. They would be expected to march in lock step to achieve these goals, and would work together in the same geographical and agricultural regions agreed on as having top priorities for attention.

Soils - A solid, well-rounded research program on the important problems of the soils of the hot tropics is basic to all other efforts to increase food crop and animal production. These areas can become major contributors to the increased food resources of the world only if a fuller understanding is attained of the soils therein and of the physical, chemical, and biological interactions of the soil environment, and if practical systems of management of such soils for sustained productivity are developed. The bush fallow system practiced in certain areas has served a useful purpose but cannot provide the level of productivity needed for increasing population intensities. This and other management systems must be studied thoroughly to develop basic principles that can be translated into practices which will give sustained high levels of productivity. A uniquely competent and imaginative group of soil scientists will be required for this program, which must serve as a major focus of the work of the institute. It is proposed that the soils research program be launched initially with two senior specialists - one in soil fertility and management and one in soil physics, water movement, and drainage. It is possible that Dr. J. M. Spain, a soil scientist on The Rockefeller Foundation

Nutrition - The full productive potential of animals in some areas is rarely achieved or, if it is, the time required is too long. Total productivity can often be substantially improved by reducing the period required to grow animals to an economically marketable age. We have found that even criollo or indigenous cattle can be made ready for market faster by an improved or more adequate nutritional level. In addition to determining ways of providing a continuous adequate supply of nutrients so that gains are rapid and efficient, it is necessary to focus on the land, plant, and animal relationships, to study ways of using otherwise wasted nutrient sources, and to study the role of micro-nutrients, particularly of range cattle, in different ecological situations. Normally, animals which are adequately fed, by whatever means, survive and reproduce better than similar animals which are inadequately nourished.

Research projects designed to permit economic analyses in this section would include:

1) Study of techniques and methods for obtaining maximum sustained utilization of the grasses and forages of tropical pasture and range lands and for improvement in the productivity of these areas as measured by total meat yield.
2) Investigation of growth patterns of bovines kept on pasture grasses as affected by seasonal changes.
3) Evaluation of feed additives (supplements, complements) in increasing growth and conversion efficiency.
4) Interrelation of nutritional regimen and reproductive efficiency.
5) Study of the use of agricultural by-products in bovine feeding.
6) Study of the nutritional requirements and feeding methods for improved milk production.

Two senior and two junior staff members would be needed to initiate these projects. As the institute develops, one senior and two junior specialists would be added. As with other investigations, cooperation with institute agricultural economists would be a part of the research design.

Physiology: Genetics and Reproduction - For the most part, the kinds of livestock encountered in the hot tropics are derivatives of early introductions of mixed breeds. Many indigenous types have developed, mostly by a process of natural selection. Their productive and survival value has been poorly evaluated. Their potential contribution to crossbreeding programs, to the formation of new breeds, and to selection pressure is unknown.

Recommendations to livestockmen concerning the improvement of their cattle should be based on knowledge and experience of the performance of these animals under the environmental stress of the tropics. Although at some future time large-scale breeding programs will need to be established, the research in the area of genetics, breeding, and reproduction should initially include:

1) Study of genetic compatibility of beef and dairy characteristics of cattle under tropical conditions.
2) Study of environmental stresses affecting the performance of dairy cattle in the tropics.
3) Improvement of calf crop production through fertility studies of beef and dairy cattle in a tropical environment.
4) Compilation and evaluation of growth, reproduction, and survival data relative to indigenous stocks.

One senior physiologist and one junior staff member in physiology would be needed to initiate the programs, and one senior geneticist would be added at a later date.

Agricultural Economics

The economics component of the institute should be production-oriented. The principal thrust of economics involvement here is not, for example, the derivation of new methodology or of a more adequate theory of economic development per se. It is hoped, however, that the institute's economics work can contribute to these important objectives both directly and indirectly.

The institute should recognize the critical role that indigenous institutions may perform in effecting structural and institutional changes within their countries - and in contributing significantly to conceptual, methodological and theory-of-growth problems. To such institutions, institute economists, like other institute scientists, should have meaningful, working, voluntary research and training linkages.

Functions - Within the institute there are important, full-partnership functions for the agricultural economists to perform as a part of the institute team. These functions include assistance in:

1) Defining or identifying high priority, researchable problems. It is recognized that relatively few technological breakthroughs are fully predictable. But through economic analysis, one can at least partially predict the consequence of one as compared to another production research success - both in the short and longer run. Such planning is presumably involved in rational research program development.

The process of resource allocation for the institute asks: Is the investment (in breeding, selection, testing, cultural practices) to obtain the capability of one more pound or bushel of output per production unit worth the input? This applies to the decisions of the researcher and indirectly to the practical operation at the producer level.

The above functions may in part be compared to market testing, drawing specifications for a product prior to its design and manufacture. It asks, what specifications must my research product meet to be successful? What will be the necessary price (cost of practice), the needed yield (performance), the required monetary product (physical quantity output x market price at farm level)?

To approximate answers to questions of the types raised above requires intimate knowledge of farm management, diffusion rates, incentives - the economics of production in the farming area the institute serves. It also requires that the institute's production research be so designed that economic analysis of findings is possible. Hence, additional functions are also relevant.

2) The statistical and economic design and interpretation of technical research of the institute. Here the economist's contribution can be major. As soon as possible, however, the institute should have a statistician on its staff.

3) The economic organization and operation of farm production units - existing and potential - size of unit, cropping and/or livestock systems, equipment, labor. Identify and understand

types of farming, understand the complementary and competing relationships among crop enterprises in each type of farming. Knowledge of this character is essential to the architecture of new technology, to furtherance of new practice adoption and estimation of production responses.

4) The identification of alternative means whereby purchased farm production inputs may be made available to farmer producers - seeds, fertilizers, insecticides, power, machinery, breeding stock, water - at what prices and with what degree of certainty.

5) The projection of market demand for the area's agricultural products - domestic, export market outlook and development, short and long run - prices, incentives, alternatives. What are the implications of food self-sufficiency to the capability, and the growth potential of the total economy, for example?

Obviously, performance of these functions will involve use of development theory; consideration of public policy matters. These should not be ignored by the institute staff. A suggested approach, however, might be to assist and encourage growing indigenous institutions to develop their capabilities in this as well as in the above outlined areas. At the same time, a portion of the institute economist's time should be available for working through theoretical constructs, improving measurement and analytical capability. He is located in a live laboratory in development. He is presumably constantly examining his own concepts concerning growth theory, for he must have a framework to guide his day-to-day work. An analyst

can and must contribute to the work of the planner. Thus in his own live laboratory and in his linkage to indigenous institutions, he should directly and indirectly make contributions to development theory and practice.

Staffing - Based upon the above, the following guidelines are suggested with respect to the organization and operation of agricultural economics within the institute.

1) There should be a minimum of two agricultural economists on the institute staff.

2) Like other scientists, these men should be working professionals involved in research and teaching. Their function is that of doers.

3) While the personal and intellectual attributes of the men come first, their specialty orientation should be toward production economics and farm management, broadly defined. One of them, at least, should be grounded in statistical design and analysis. If a third person were added, a specialty in marketing structure and institutions, broadly conceived, is suggested.

4) At least one of the economists should hold full membership on the institute's research committee (or policy committee or management committee) so that economics is represented from the onset in the decision-making process with respect to the distribution of the institute's resources.

5) The economists should have the same type of staff, career appointments that prevail in the institute. Their supporting infrastructure - graduate assistants, computational facilities, technicians, travel, enumerators - is also assumed.

6) Development, modification, expansion of the economics component of the institute should be based upon developing needs and demonstrated performance - in the community of fellow scientists. This may be the appropriate route for considering the need for other social scientists - sociologists, anthropologists, or for moving into public planning, policy, and related investigations directed to structural change.

7) Consideration should be given to the appointment of two or three "new" Ph.D's on staggered three-year terms. These men might be considered as postdoctoral staff. These men would complement the specialized talents of the senior economist, and would provide a reservoir for recruitment of experienced permanent staff people.

Agricultural Engineering: Experiment Station Planning and Development

One of the most frequent requests for assistance from research institutions in Latin America at present is for consultation and advice on the planning and development of experiment stations. There will be a need for such services for several years to come, as these institutions continue to expand. The institute itself will also need agricultural engineering services for the first four or five years, to plan and develop the experiment station at its headquarters location and to assist with production and storage problems.

It is proposed that, at the beginning, the institute have a small section in agricultural engineering concerned mainly with experiment station development. Mr. Roland Harwood, a specialist in this

field who has worked for the past 10 years in the Rockefeller Foundation Colombian Agricultural Program, could be considered for this assignment.

As time goes on, it is quite likely that the institute would wish to expand this section to include research work on farm machinery, water, and drainage problems. Practically no research work is being done to determine the appropriate machines and tools to use in the tropical lowlands, how to use them correctly for proper land preparation and correct tillage, especially for effective weed control, or how to modify them to adapt them better to specific conditions. The decision to expand in this direction could be taken two or three years after the institute is in operation; it would hinge largely on the calculated payoff on investment of resources required balanced against other attractive opportunities that the institute might have at that time.

Library and Documentation Services

All modern research is dependent upon a library and documentation service to keep the research staff and trainees informed of the vast body of printed matter published all over the world. No longer is it possible for a scientist to be well informed of the advances being made in more than a limited field of science. In technology alone it is believed that anyone whose training was completed more than five years ago is now technically obsolescent. Access to literature and help by trained librarians, documentalists, and language and subject specialists are needed to guide scientists and technologists to the information essential to the solution of special problems, for current awareness of

the state of investigations of their specialty, for a complete review of the history of investigations of a particular problem, and an awareness of the major developments in related fields. In the absence of such guidance, the scientist could spend all of his time reading without covering all of the literature he should read and without engaging in any research work.

The institute should have a carefully selected library collection containing the most-often-consulted bibliographies, abstract and review journals, monographs, and references covering the fields of interest to the institute. Little-used or rare materials should be collected in the form of photocopies, which are less expensive and occupy 90 percent less space.

In addition to the internal operational functions of selection, acquisition and processing of library materials, and of maintenance and binding, the library would furnish the readers services of reference and circulation; it should offer bibliographic service to the resident members of the staff, and develop the publication of some informative device such as an index, annotated bibliography or other tool both for the staff and/or other libraries engaged in tropical agricultural research. This latter service should be developed in cooperation with the International Rice Research Institute and the International Maize and Wheat Improvement Center, in order to provide an integrated and more complete approach than might be possible if each attempted to provide the service alone.

The staff needed for the library and documentation service should include a librarian-in-charge; a head of acquisitions and

technical processes (classification, cataloguing), and assistants; a person in charge of circulation and readers services, and assistants; a head of bibliography and documentation, and assistants; a head of the photoduplication department, and one assistant (this could be a part of the general photographic department.)

Information Service

To assist in the dissemination of institute findings and to handle visitors, the institute should employ one senior and one junior information specialists from the onset.

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The institute may wish to consider in the future adding sections of human nutrition and of food technology. Decisions to take such action or not, however, should rest on careful studies to determine if involvement of the institute in these two very important areas is highly desirable in comparison with other possible ways of achieving the desired results.

ESTIMATED STAFF REQUIREMENTS

	Initial		Future [1]	
	Senior Specialist	Junior Specialist	Senior Specialist	Junior Specialist
Crops Program				
Grain Legumes	2	1	1	1
Forage Legumes and Grasses (pasture and range management)	1	1	1	1
Corn	1*	1	-	1
Rice	1	-	-	1
Soils	2 (1*)	-	-	2
Physiology	1	-	-	1
Plant Protection				
Plant Pathology	1*	-	-	2
Entomology	1	-	-	2
Weed Control	1	1	-	1
Animal Program				
Animal Health				
Microbiology	1*	2	-	-
Pathology	1*	2	-	-
Epidemiology	-	-	1	2
Nutrition	2*	2	1	2
Physiology	1	1	-	-
Genetics	-	-	1	-
Agricultural Economics				
Production Economist (statistical design, analysis)	1	1	-	1
Production Economist (farm management analysis, planning)	1	1	-	1
Marketing Economist	-	-	1	1
Agricultural Engineer	1*	-	1	-
Library and Documentation Services	1	4	-	-
Information Specialist	1	1	-	-
Director	1*	-	-	-
Asst. Director	1*	-	-	-
	23	18	7	19

1 During the next 2 to 5 years while the institute is growing to the level of full operation.

* Individuals who may be considered for transfer from the present RF program in Colombia to the institute.

Training Program

Any long-range development effort in the agricultural sciences must make provision for a strong training program. Latin American scientists and technicians will be needed in large numbers to carry research results into frontier areas of the various countries as they are opened up, to apply and interpret new findings as development proceeds, and ultimately to staff the institute. The underlying goal of the institute - to help increase the efficiency and economic contribution of agriculture in the hot tropics - can probably be best achieved in the long run by accelerating the training of Latin American scientists and technicians.

The shortage of both professional and subprofessional personnel in all branches of the agricultural sciences in Latin America is critical. A few good schools of agriculture exist, but no university in the American tropics gives a Ph.D. in the agricultural sciences, and only a very few offer the M.S. degree. In some countries, such as Peru, where several new universities have been created in a short space of time there is an acute shortage of qualified personnel to staff them. Furthermore, much of the training in Latin American universities is not done in conjunction with field work, because of tradition and lack of facilities. A training program in tropical agriculture staffed by top-ranking scientists and planned along the lines laid down by the Rockefeller Foundation Mexican Program and the International Rice Research Institute could provide an important stimulus for education in the agricultural sciences.

The location of the institute in Palmira, Colombia, would permit in-service training at the experiment station to be combined

with formal instruction at the adjacent Faculty of Agronomy of the Colombian Agricultural Institute (ICA); candidates for advanced degrees at the University of Valle in nearby Cali could undertake individual research projects at the institute under the supervision of specialists. A system of scholarships would be worked out to enable outstanding young scientists from all over the Latin American tropics to study at the institute; advanced training for junior personnel would be bolstered by fellowships for study abroad and grants for travel and observation of experiment stations in other countries, and for attendance at international conferences and seminars.

There is also a need to build up competence in tropical agriculture among United States scientists. Young agricultural specialists from the United States would be offered training at the institute at the pre-doctoral and postdoctoral level, in an effort to generate more interest in this important field in the U.S. A program of exchanges could be worked out with the cooperating institutions to give the widest possible impact to the training program. The institute itself, however, would not become a degree-granting institution. Degree-granting functions are considered to be within the province of existing institutions, both Latin and North American. It is expected, however, that the institute would become the locus for in-service, dissertation, and postdoctoral research experience for young scientists and technicians.

The information and documentation service would keep alumni and other collaborators in touch with research results and educational projects of the institute.

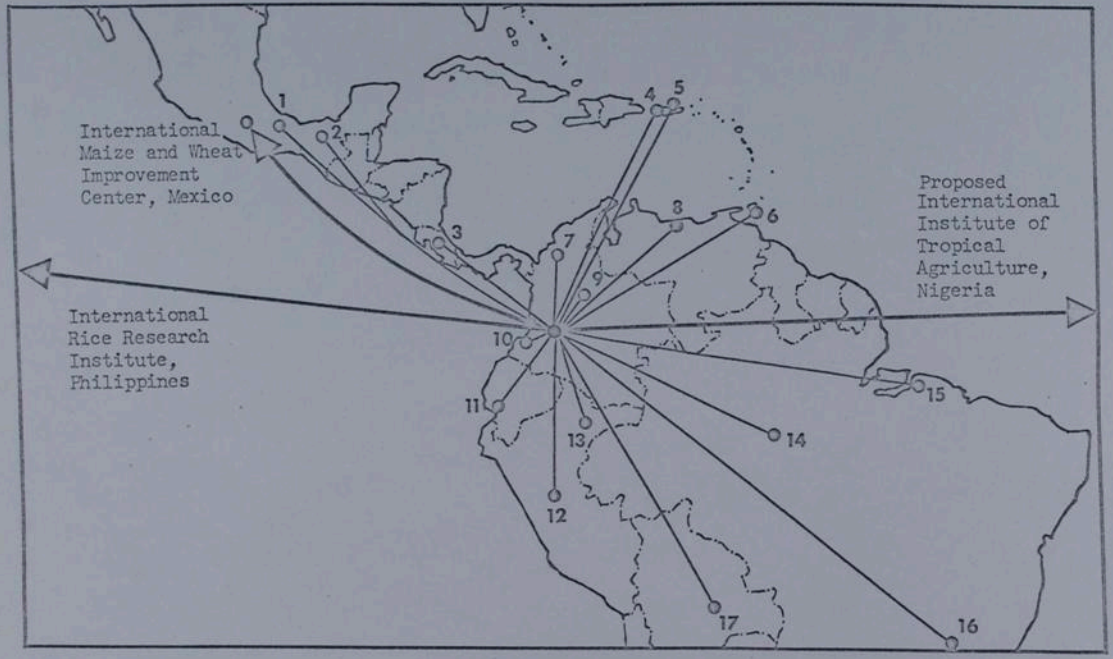
Cooperation with National and Other Latin American Institutes

Most of the Latin American countries in the hot tropics have established national agricultural research institutions to help meet the food and nutrition needs of their populations, to develop products for export, and to furnish raw materials for national industry. These organizations maintain experiment stations with research facilities for crop and animal production, forestry, veterinary science, nutrition, and related disciplines, some to a greater extent than others. Several of these national programs show promise of making important contributions to our knowledge of crop and livestock production. In some cases, The Rockefeller Foundation, USAID, the Ford Foundation and other assistance agencies have provided scholarships, capital, and technical assistance to help create a nucleus of research workers. These would be encouraged to establish a cooperative working relationship with the proposed institute.

By working closely with selected tropical stations, the institute could provide an important stimulus to research, and serve as a hub from which to help coordinate the efforts toward improving tropical agriculture throughout Latin America. A central clearing-house for information would facilitate rapid dissemination of experimental findings and eliminate duplication of work; a central bank for genetic materials could help speed up plant breeding programs throughout the area; meetings and seminars sponsored by the institute would help Latin American scientists keep abreast of developments in tropical agriculture throughout the world.

Centers with which the tropical institute might cooperate are located in ten different countries and represent a wide range of

ecological conditions. The map on page 44 shows the location of these institutes and their relation to Palmira, Colombia, the suggested headquarters site (see page 52 ff.) They span the entire tropical belt of Latin America, reaching from the state of Veracruz, Mexico, to central Bolivia, and from the mouth of the Amazon to the Pacific coastal jungles of Colombia. All the main hot tropical regions with which the institute will be concerned (see pages 5 to 9) are represented:



RELATION OF COOPERATING INSTITUTES TO PALMIRA, COLOMBIA

1. Cotaxtla, Mexico
2. Chiapas, Mexico
3. Turrialba, Costa Rica
4. Mayaguez, Puerto Rico
5. Rio Piedras, Puerto Rico
6. Trinidad
7. Cerete, Colombia
8. Maracay, Venezuela
9. Villavicencio, Colombia
10. Colombian Pacific littoral
11. Pichilingue, Guayaquil, Ecuador
12. Tingo Maria, Peru
13. Iquitos, Peru
14. Manaus, Brazil
15. Belem, Brazil
16. Belo Horizonte, Brazil
17. Santa Cruz, Bolivia

1) In the northern coastal plains of Colombia, the collaborating institution would be the Turipana Experiment Station of the Colombian Agricultural Institute (ICA) located in Cerete in the province of Cordoba.

2) Cooperating stations in Mexico and Central America would include the Campo Cotaxtla (Centro de Investigacion Agricola y de Industria Animal para Zonas Tropicales) in the state of Veracruz, Mexico, which is well advanced in its experimental program in tropical agriculture; and a government station that is just being started in the state of Chiapas. The well-equipped Inter-American Institute of Agricultural Sciences (IICA) maintained by the Organization of American States at Turrialba, Costa Rica, offers a third possibility for collaboration in this region.

3) Two stations located on the Pacific littoral of Ecuador would offer their facilities for collaborative work with the institute. These are the Pichilingue and Santo Domingo stations operated by the National Institute of Agricultural Research (INIAP). The Pichilingue station in particular is well launched on various research programs: it has 800 hectares with plantations of bananas, coffee, and cacao, and experimental work is in progress on corn, beans, forages, and beef cattle. Santo Domingo is a substation of INIAP, in the same general region.

4) Three stations in the Caribbean region would be potential collaborators: two are in Puerto Rico - one at Rio Piedras, just south of San Juan, and the other at Mayaguez on the western coast of the island. The third Caribbean station would be that of the University of the West Indies School of Agriculture in Trinidad.

5) Several national institutes maintain stations in different parts of the Oriente, or eastern Andean foothills: The institute would cooperate with the national agricultural research center run by the Ministerio de Agricultura y Cria (MAC) at Maracay in Venezuela, which has a broad crop and animal program. In Peru, a branch of the Servicio de Investigacion y Promocion Agraria, located at Tingo Maria, offers possibilities for collaboration, as does the Universidad Nacional de la Amazonia Peruana in Iquitos, created six years ago by the government to serve this region.

Santa Cruz, Bolivia, is a center of developmental activity which holds several possibilities for cooperative efforts: the veterinary faculty of the University of San Simon is located here. (The other faculties, including the Faculty of Agronomy, are at Cochabamba.) The Servicio Agricola Interamericano (SAI) operates a crop improvement program and a livestock center at Santa Cruz. The Bolivian government is sponsoring immigration and development in this area as part of its agrarian reform.

6) In the hot humid tropics, two Brazilian institutions would be potential cooperating stations. One is the Instituto de Pesquisas e Experimentacao Agropecuarias do Norte (IPEAN) in Belem, which the Brazilian government has operated for 25 years. It has 3,000 hectares, 200 of which are used by the Escola de Agronomia da Amazonia, for their research and training program. The other institution in this region would be the University of the Amazon located in Manaus.

7) The campo cerrado, or central plateau of Brazil, is at the present time the object of research and development plans being drawn up

by a consortium of Brazilian institutions with which a group of American universities known as the Midwest Universities Consortium for International Activities (MUCIA) is cooperating. The Brazilian institutions involved include the University of Minas Gerais, the Rural University of Minas Gerais, the University of Sao Paulo, the Agricultural University and Research Institute at Km 47, and the University of Brazilia (CEPETEC). They are supported by the Brazilian National Research Council and other private and public organizations. The American members of MUCIA are the University of Illinois, Indiana University, the University of Wisconsin, and Michigan State University. This important undertaking, once it gains momentum, would offer the proposed tropical institute opportunities to collaborate in developing agriculture for this area as well as for other regions of Brazil where cerrado conditions prevail. Already under development with Ford Foundation and USAID assistance is a new station in the Triangle area of western Minas Gerais. A part of the station network of the Rural University of Minas Gerais, this institution should be linked cooperatively to the proposed tropical institute.

8) For collaborative research in the llanos, the institute would work with the Colombian Agricultural Institute substation of La Libertad, located at Villavicencio. Here ICA has field and laboratory facilities which it would be pleased to share with the institute on a cooperative basis.

Cooperation with International Institutes

Close contact would be maintained with the two major international institutes which deal with tropical agriculture: the

International Rice Research Institute in the Philippines and the International Maize and Wheat Improvement Center in Mexico. Since the proposed tropical institute will be patterned basically along the same lines as these institutions, since it will serve the same goals, and possibly involve some of the same people, cooperation among the three organizations would be a logical development. Such contacts would be important for pooling research results on an international level, as well as for sharing new techniques of management and communication, and coordinating collections of breeding materials for the major tropical crops. To maintain ties with the world scientific community, exchanges of students and specialists might be worked out as research priorities are established and programs begin to take shape. The special character of the Latin American tropics, both their similarities to Africa and tropical Asia and their differences, will contribute to deepening and diversifying knowledge of how agriculture in all these areas can be developed to contribute more significantly to world food needs.

Organization of the Institute

It is proposed that in general the basic pattern of organization be adopted for this institute as is used by the International Rice Research Institute and the International Maize and Wheat Improvement Center. Modifications of this basic structural pattern will be made as needed, and as indicated by previous experience in the IRRI and IMWIC, to adapt this proposed institute to the Latin American setting.

From the onset the institute would be an autonomous organization under the general direction of an international board of trustees.

The board would consist of up to 12 members carefully selected for their capabilities, interest, and the contributions they could make to the institute's development and management. The Ford Foundation and The Rockefeller Foundation would be represented on the board.

The director of the institute would be selected initially by the two Foundations jointly, subject to the approval of the board of trustees.

The technical staff would be international in character. Care would be taken not to "overload" the staff with U.S. scientists. It is planned that highly qualified agronomists, animal scientists and economists from Latin America will be attracted to help staff the institute in such numbers that these countries will be well represented. It is clearly recognized, however, that the national institutions and programs in Latin America are short of well-trained scientists at present and will continue to be so for several years to come. Consequently, the institute must be very careful not to toll the key personnel away from the local organizations and thus in a sense compete with the very institutions it is designed to help. The institute will help provide advanced training and in-service experience for a large number of young or junior agricultural scientists from Latin America, and from among these select the best for permanent appointments, so that after a few years it will have developed its own good staff with well-balanced representation from the Latin American region.

There are many highly qualified Europeans and Japanese with experience in tropical agriculture in Africa and Asia. These should

definitely be taken into account, as should individuals of other nationalities, as the institute recruits its staff.

Estimated Cost

Technical Staff - The table on page 39 summarizes the estimated professional staff requirements for programs, 1) at the time of the initiation of the institute, and 2) at the stage when it is in full operation (perhaps five years after its creation).

Approximately 23 senior specialists and 18 junior scientists would be needed at the beginning. About $30,000 annually would be required to pay the salary, perquisites, and transportation of each senior staff member, and $20,000 for each junior scientist. On the basis of these calculations, approximately $1 million per year would be needed to pay staff salaries, perquisites, and transportation.

It is, of course, somewhat presumptuous to attempt to project staff needs for the future with a high degree of accuracy. These will depend on many factors, such as the success and results of different research programs, and on needs and opportunities which arise as the institute moves forward. To give a general idea of possible additional staff requirements as the institute develops to the point of full operation, estimates of approximately seven senior and 19 junior specialists have been arrived at. This would represent about $600,000 annual increase in budget for technical staff costs.

Operating Expenses - A fairly sound rule of thumb is that approximately the same amount is required in operating funds to support adequately

the work of a technical staff member with field and laboratory workers, supplies, equipment, etc., as is needed to pay his salary and perquisites. On this basis, it is estimated that the operating expenses for the institute would be approximately $1 million annually during the initial stage, and that this sum might step up to about $1.6 million per year when the institute is fully developed.

Capital Costs

Land - There are good reasons to believe, if Colombia is selected as the site, that the Colombian government will provide the necessary amount of land as part of its contribution to the institute. There is a very good block of land of some 500-600 hectares immediately adjacent to the Colombian Agricultural Institute experiment station and within a quarter of a mile of the Faculty of Agronomy at Palmira of the National University. It is held by one owner, and apparently a part or all of it can be purchased according to the need. It would appear almost certain that the Colombian government would be willing to buy whatever portion of this farm is needed, and lease it to the institute for a long term (25 to 50 years) on a peso-per-year basis.

At the moment, it is difficult to estimate the amount of land that would be desirable to fulfill the needs of the institute. Careful studies of the requirements of each research program will have to be made to reach a sound conclusion on this question. It would seem advisable that the institute not become saddled with the responsibility of developing and maintaining any more land at its headquarters site than is reasonably needed for the activities to be

based there. From the very start, the staff should establish a pattern of conducting as much of their research as is feasible in collaboration with, and on the premises of the different national research institutions with which the institute will be cooperating. It would be undesirable for the staff to form a habit of sticking too close to home base, which they might tend to do if there were an excess of land over the essential needs at the headquarters station. In the light of these general considerations, we venture to make a rough estimate that around 200 to 250 hectares will be needed at the headquarters of the institute.

Buildings and Equipment - The capital costs of the International Rice Research Institute have been approximately $7.5 million, including land. The costs of buildings and equipment for the proposed institute should be only about three-fourths those of the IRRI; i.e., between $4 and $5 million. The main reason for this is the fact that the Latin American institute will not need as large a headquarters set-up: it can and should accomplish a great deal of its research work through collaboration with research institutions in the various tropical regions as previously described. (Pages 45 to 47).

Financing

Land - This should present no problem since, as mentioned above, the site will almost certainly be provided by the Colombian government, if the institute is located in that country.

Capital and Operating Costs - It is proposed that initially The Rockefeller and Ford Foundations share equally the capital and operating costs. The operating expenses of the proposed new institute

in Colombia, including staff costs, would represent an expenditure of about $1 million annually for each Foundation if these costs are shared equally.

The institute would be organized and established in a manner that would enable it to attract and accept financial support from other sources, such as governments, private individuals and institutions, international agencies, etc., as time goes on. It is hoped that soon after the institute begins operations it would be successful in seeking additional funds from other sources to assist with operating costs, and especially with operating and other expenses connected with possible future expansion.

Recommendation of Palmira, Colombia, as Headquarters Site for the International Institute

For a number of reasons, which are reviewed here, it is suggested that the tropical institute's headquarters be located at Palmira, Colombia. In selecting the site for an institution of the type and quality envisioned in the present proposal, criteria must be taken into account which may be decisive factors in the effective functioning of the institute. Some of the considerations which determined the choice of Palmira follow:

1) The institute should be located within the ecological zone on which its work will be focused. The institute must be in the tropics; however, common sense and experience dictate choosing a spot located toward the more favorable end of the spectrum of tropical conditions, from which to spearhead a gradual and rational conquest of the harsher and less tractable regions. Palmira is located at an altitude of 1,000 meters, has a mean annual temperature of 75°F,

and an average annual rainfall of 40 inches. It is subtropical rather than torrid, but any crop, including forages, that is adapted to tropical and sea-level conditions can easily be grown with normal development in this region. And, most important, it will be easier in most instances to propagate and maintain germplasm collections at Palmira than at lower elevations under very high temperatures and heavy rainfall conditions.

Obviously, no one site will be representative of the wide range of ecological conditions previously described for the major hot tropical areas of Latin America. To do its job properly, the institute will have to conduct a large part of its work away from the headquarters site, in collaboration with national research institutions located in these different areas. Research activities at the institute's headquarters should be restricted to the work that best lends itself to the immediate environmental conditions.

2) The location of the institute should be geographically convenient.

Colombia is at the crossroads of the Americas. Map 2 (page 44) graphically illustrates this point. Palmira is located in the position of the hub of a wheel whose spokes extend to the several research stations with which the institute would collaborate.

Within Colombia itself, Palmira is likewise very favorably situated geographically with respect to ease of access to and communication with areas that represent the total gamut of ecological conditions found in the hot tropics anywhere in Latin America. From Palmira, it takes only about an hour and a half by car to reach the heartland of the tropical jungle area of the Pacific littoral where the average annual rainfall is about 350 inches and the mean annual

temperature is 80°F. This area is just as tough as the heart of the Amazon or Orinoco River basins and is in fact quite similar to them in many ways. By plane, one can arrive in Cerete, Colombia, in less than two hours. Here ICA has one of its five major regional experiment stations (Turipana) with 1,800 hectares (4,400 acres) of land typical of the benign hot tropical areas as described on page 5 under the section "Northern Coastal Plains of Colombia." Similarly, a flight of less than two hours' duration will take one from Palmira to Villavicencio, where ICA has another of its principal regional stations (La Libertad), which is representative of the vast llanos region of eastern Colombia and southern Venezuela. ICA would welcome collaborative assistance from the institute in the research efforts to solve the principal agricultural problems of this vast and potentially important hot tropical area. La Libertad has approximately 1,300 hectares (3,300 acres) of land, and ICA would be glad to share this and other facilities of the station with the institute.

3) The institute should be located near an existing college of agriculture, a strong agricultural experiment station, and a dynamic university. Many advantages would be derived from locating the institute immediately adjacent to the existing Faculty of Agronomy at Palmira of the National University, and to the neighboring agricultural experiment station of ICA. The college and the experiment station figure in cooperative plans made by ICA and the National University to launch postgraduate training in agriculture. Although the headquarters for the postgraduate college will be in Bogota, most of the training pertaining to tropical

agriculture under this program will be done at Palmira. While the proposed tropical institute would be autonomous and independent, it would want to establish close cooperative links with the Faculty of Agronomy and the experiment station of ICA at Palmira both in research and graduate training.

Another important advantage in locating the institute at Palmira would be the fact that it would be near (only 40 minutes by car on an excellent highway) to one of the most dynamic and progressive universities in Latin America. Distinct benefits would ensue from proximity to this viable academic community. The University of Valle in Cali could contribute a great deal to the institute, and vice versa, over time. The Faculty of Medicine of the University of Valle is deeply concerned with problems of health, nutrition, and general welfare of the people in the region. Its main pilot project in public health is at Candelaria, only 15 minutes by car from Palmira. The personnel of several sections of the proposed institute could work in close cooperation with the public health division of the Faculty of Medicine, to their mutual benefit. The University of Valle also has made a good start in developing a group of trained agricultural economists in its Faculty of Economic Sciences. Seven have advanced degrees from United States universities, including five in agricultural economics and two in rural sociology. Arrangements have already been initiated whereby this group is working with the Faculty of Agronomy at Palmira, and it should be a simple matter to expand these cooperative relationships to include the tropical

agricultural institute located nearby. As formal course work in the sciences as well as in the social sciences improves at Valle, students involved in institute training programs may draw directly upon the University's faculty.

Although the existing training potential is not ideal (e.g., the Veterinary faculty is at Bogota not Palmira, the sciences at the University of Valle are reported to be weak, graduate programs in agriculture are only now being developed and they are centered in Bogota, not in Palmira) with careful planning much can be accomplished within these limitations.

4) The institute must consider suitability of location from the standpoint of living conditions for staff. The success of the institute will hinge largely upon the quality of international staff it is able to attract and hold over a relatively long period of time. The Cali-Palmira area is attractive as a place to live from the standpoint of comfort, health (hospital facilities and doctors), schools, and cultural attractions. As a matter of fact, no other location within the hot tropics of Latin America can equal Cali in this regard.

5) The host country must have a real interest in the institute; it must sincerely want it and be willing to contribute to it. While several countries would like to have the institute located within their boundaries, Colombia probably has as strong an interest and desire as any to have it established there - perhaps even stronger. In informal conversations about this, the present Colombian Minister of Agriculture has essentially stated that the Colombian government wants the institute very much and would be willing to make substantial

contributions to it if it were located there. The leading officials of ICA have expressed the same viewpoint. In fact, the executive committee of ICA has informally stated that the Colombian government would provide the necessary amount of land as part of its contribution. They have repeated on various occasions their willingness to have ICA's facilities used cooperatively by the institute, whether it be located in Colombia or in some other country.

Discussion

It is recognized that the proposed Cauca Valley location for the institute has limitations. If an institute is located there, these shortcomings will need to be researched and management plans evolved to minimize their influence on the institute's effectiveness.

The institute may, by its location, tend to slight the large campo cerrado area of the Planalto in Brazil. But linkage to and support for the new UREMG (Rural University, Minas Gerais) experiment station in the Minas triangle near Uberlandia may help overcome this problem. Additionally, the U.S. and Brazilian consortia reports on the campo cerrado are not yet in. It is likely that additional research activities will evolve from this effort.

Theoretically, a larger country such as Brazil, were the institute to be located within its boundaries, might in time be better able to take over an institute than Colombia. However, search in Brazil identified no site judged to be equivalent to Palmira.

This location and plan of operation emphasizes the hot to hot-humid tropics to the exclusion of the temperate-like areas of Latin America. Thus the institute itself ignores the "quick" production increase potential believed by many to exist in Argentina, Chile and similar

temperate-like areas. However, the International Maize and Wheat Improvement Center and careful work with indigenous institutions provide alternate routes to temperate-zone assistance.

This proposal is for the creation of a new autonomous institution under North American direction; it does not develop an existing Latin American institution into a pacesetter for later national or regional take-over. Thus the institute's complementary role in assisting indigenous institutions must be constantly stressed. The long-run need is for quality Latin institutions under Latin management and support.

The institute proposes to work alongside ICA, the National University at Palmira, and the University of Valle. Concurrently, the Foundations sponsoring the proposed institute are attempting to help these Colombian institutions grow. The institute would be autonomous, but would expect to call on these Colombian institutions for collaboration. Care would therefore be exercised that too many outside programs are not centered in Colombia with too great an outside-assistance infusion. There is danger that well-intended assistance, if provided in excess, could hinder rather than help Colombian institutional development. Preliminary investigations would also have to be made into the extent to which these institutions can realistically be expected to assume financial responsibility for programs initiated by the institute.

General Comments

The proposed institute as conceived stresses the low tropics where knowledge is scant, where presumably the greatest gap exists in

man's theoretical and practical scientific capability in the agricultural production sciences. Much of the geographic area to be served has in it few people and tremendous shortages in the necessary infrastructure.

Emphasis is not on a single crop or enterprise as in the successful IRRI model. Several food and feed crops plus ruminant animals are to receive attention. However, the intent is to concentrate on those that are clearly most important in tropical regions. While social science as well as technological investigations and training are involved, a direct frontal attack on national structural problems of resource ownership and income distribution is not planned. Because of the many faces of the economic development problem in the Latin American tropics and the multifaceted approach of the institute, spectacular short-run achievements are improbable. Essentially, the institute takes a long look ahead and says: the hot tropics in South America will in time need to be used much more intensively. If agricultural productivity can be increased, this should help accelerate economic growth. Hungry, diet-deficient people can be better fed, clothed, housed and educated. Let's try systematically to learn how.

A –

Books

Alexander, Robert J., Today's Latin America, New York, Doubleday, 1962.

Bates, Marston, Where Winter Never Comes, London, Collancz, 1953.

Gourou, Pierre, The Tropical World, London, Longmans, 1958.

Paddock, William and Paul, Hungry Nations, Boston, Little, Brown, 1964.

Papers and articles

Alers-Montalvo, Manuel, "Cultural Barriers and Facilitators for Rural Development in Latin America," Cornell Latin American Year, Conference, The Potentials of the Wet-Humid Tropics in Latin American Rural Development, 1965.

Caicedo, Hernando, Aragonia Peruana, Cali, Colombia, 1958. (42 pp.)

Camargo, F.C., Report on the Amazon Region. Problems of Humid Tropical Regions, UNESCO, 1948.

Castillo, C.M., "Social Significance of Land Tenure Systems," Cornell Latin American Year.

Crist, R.E., "Some Aspects of Tropical Subsistence Agriculture and of Settlement in Latin America," Cornell Latin American Year.

Deutschmann, Paul and Fals-Borda, Orlando, "Communication and Adoption Patterns in an Andean Village," San Jose, Costa Rica, 1962 (Programa Interamericano de informacion popular)

Hanson, E.P., The Amazon, a New Frontier? New York, Foreign Policy Association, 1944. (Headlines Series No. 45, 96 pp.)

Neva, F.A., "Ecology of Certain Health Problems in the Tropics, with Particular Reference to Agricultural Practices," Cornell Latin American Year.

Paddock, W.C., "Natural and Humid Resources and Their Potentials in the Latin American Lowland Tropics," Cornell Latin American Year.

Samper, Armando, "The Role of the Tropics in the Economic Development of Latin America," Cornell Latin American Year.

Thome, Joseph R., "Title Problems in Rural Areas of Colombia: A Colonization Example," Centro Interamericano de Reforma Agraria, Mimeographed No. 3, Bogota, Colombia, 1965.

Taximetrics Laboratory
Department of Biology
Armory 101A
University of Colorado
Boulder, Colorado 80302
11 January 1968

Dr. H. A. Rodenhiser
Apartado Aereo 58-13
Bogota, Colombia

Dear Rody

I am embarrassed about this but I am being pressed to pay the airfare for the trip to Colombia. On 12 December I sent Dr. Grant a summary of my expenses with my receipts. That letter may have gone astray. I would appreciate it if you would call it to his attention. (Below is a copy of the expenses)

I am in the process now of writing up the report and it should take only a week or so to finish.

So far I have not heard from the lady in Washington who was supposed to be the librarian in charge of looking up information for various Rockefeller programs. Will you give me her name and address so I might call her?

My dental surgery went well on the 28th of December and I am now the possessor of a new set of temporary choppers; the permanent set to be installed probably within six months.

Best regards to you and your wife.

Sincerely,

David J. Rogers
Professor of Biology

DJR:gm

Expenses for trip to Bogota and return:

Car rental: Boulder-Denver	18.72
Plane,fare, round trip	492.30
Telephone, Miami-Boulder	5.00
Cablegram, Boulder to Bogota	3.75
9 1/2 days at $25 per diem	237.50
8 days consulting at $75/day	600.00
	$1378.77

DONALD G. BROTZMAN
2ND DISTRICT, COLORADO

COMMITTEES:
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TELEPHONE: 202-225-2161

DISTRICT OFFICE:
BUILDING 40, ROOM 202
DENVER FEDERAL CENTER
DENVER, COLORADO
TELEPHONE: 303-233-3611

January 29, 1968

Mr. David J. Rogers
Professor of Biology
Department of Biology
Armory 101
University of Colorado
Boulder, Colorado 80302

Dear Mr. Rogers:

As you requested, I am enclosing some material on the world production and trade in cassava and tapioca plants. I am sorry to be so late with a reply to your letter but I have just received this material from the Library of Congress. I hope you will find this information useful.

If I can be of further service to you, as your Congressman, please do not hesitate to contact me.

Very truly yours,

Donald G. Brotzman
Member of Congress

DGB:jhh
Enc.

FEB 2 1968

THE ROCKEFELLER FOUNDATION

AGRICULTURAL SCIENCES

COLOMBIA OFFICE
APARTADO AEREO 58-13
APARTADO NACIONAL 12-79
BOGOTA, COLOMBIA
CABLE ADDRESS: ROCKFEL

69 (CIAT)

January 29, 1968

Dr. David J. Rogers
Professor of Biology
University of Colorado
Boulder, Colorado 80302

Dear Dave:

Please accept my apologies for the delay in reply to your letter of January 11. I have been out with Drs. Zaumeyer and Howell on the pulse team hence the regretable delay.

Dr. Grant submitted your expense account to Dr. Hardin of the Ford Foundation sometime ago, and Dr. Hardin replied that they were processing your expense statement as rapidly as possible. I hope you have received the check by now.

I am glad to know your dental surgery went well. It is something I have to have done in the near future.

Warmest regards.

Sincerely,

Rody

H. A. Rodenhiser
Special Consultant

HAR/caa

THE ROCKEFELLER FOUNDATION

AGRICULTURAL SCIENCES

COLOMBIA OFFICE
APARTADO AEREO 58-11
APARTADO NACIONAL 12-79
BOGOTA, COLOMBIA
CABLE ADDRESS: ROCKFEL

013 (CIAT)

January 8, 1968

Dr. David J. Rogers
Professor of Biology
University of Colorado
Boulder, Colorado 80302

Dear Dave:

You will recall from our discussions we indicated that plans are being made to hire Miss Frances Tersillo to supply, among other things, bibliographic services for the study teams. There will be many requests for her services and Dr. Dorothy Parker has suggested that all requests for bibliographies etc., be made directly through her office in New York and she will in turn forward them to Miss Tersillo in Washington. It is believed that unnecessary confusion will result if several people approach Miss Tersillo for the individual requests. This procedure seems to us to have a lot of merit so please send your requests directly to Dr. Parker, Associate Director for Agriculture, R.F., New York.

Another item - when your report is completed please send it directly to us here in Bogota for review prior to submission to RF and FF.

You will recall our discussion on protein in yuca. I wrote to Pirie and enclosed is a copy of his reply. It appears that he is correct in his comment that information " got telescoped ".

Many thanks for the slides. They arrived a week ago and look good. You failed to send me a bill so suppose I'll have to wait until I see you to clear my debts.

Warmest regards.

Sincerely,

Rody

H. A. Rodenhiser
Special Consultant

HAR/caa
encl.

16 January 1968

Dr. Dorothy Parker
Rockefeller Foundation
111 West 50th Street
New York, N. Y. 10020

Dear Dr. Parker:

Dr. Rodenhiser advised that we should send requests for bibliographic services for Miss Frances Tersillo through your good offices. May I please request therefore that you ask Miss Tersillo to make for me a set of bibliographies on the appended topics.

For the study of the economic aspects of Manihot esculenta (cassava) I have a very good set of the scientific papers, but I do not have much in the way of books and journals describing the market value of the crop. About my only recourse has been through an old issue of the FAO Yearbook, and I would like to supplement this before writing my report.

Sincerely,

David J. Rogers
Professor of Biology

DJR:gm

BIBLIOGRAPHIC REQUEST

Specifically I am in need of the latest world production figures by major geographical units: for example. Latin America, tropical Africa, India and IndoMalaysia. I have no figures whatsoever to indicate the exports from any of these areas to the United States or to Europe. I would like to have a breakdown of the exports as to the nature of the exported substance; for example, I know that the dried chips of cassava are exported from the eastern tropics to western Europe for cattle feed - what quantities and what economic values in dollars and pounds does this amount to?

One of the products, tapioca, enters the market in Europe and the United States but I am not certain how much. I also know that the fresh roots are now imported into the United States for the Puerto Rican population and probably for the recent Cuban immigrants. It would be nice to have some idea how much fresh root is imported.

One of the great difficulties we have with reporting the significance of this crop economically is the variable nature of the reporting schemes - that is, all the figures, so far, seem lumped together of the various products mentioned and we have no notion from the statistics of the value of these products, not only abroad but in the producing areas.

If any report along the line of these problems can be uncovered I should be pleased to have it.

CLASS OF SERVICE
This is a fast message unless its deferred character is indicated by the proper symbol.

WESTERN UNION TELEGRAM

W. P. MARSHALL, CHAIRMAN OF THE BOARD
R. W. McFALL, PRESIDENT

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DL = Day Letter
NL = Night Letter
LT = International Letter Telegram

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BOGOTACOL 32 17 1845 =
DAVID ROGERS BIOLOGY DEPARTMENT ARMORY 101
COLORADO UNIVERSITY =BOULDERCOLORADO =

=CALL LOWELL HARDIN CALL FOUNDATION NEW YORK CONCERNING
TRAVELL =REIMBURSEMENT STOP UNDERSTAND FORD FOUNDATION
IS PROCESSING REIM=BURSEMENT BUT MAY REQUIRE ADDITIONAL
INFORMATION =
GRANT =

Miss Coiy (?) took the call on 1/19/68

COLL 101 ==NNNN= =

WU1201 (R2-65) THE COMPANY WILL APPRECIATE SUGGESTIONS FROM ITS PATRONS CONCERNING ITS SERVICE

The Rockefeller Foundation
111 WEST 50th STREET, NEW YORK, N. Y. 10020

AGRICULTURAL SCIENCES

CABLE: ROCKFOUND, NEW YORK
TELEPHONE: COLUMBUS 5-8100

November 21, 1968

Dear Dave:

Thank you for your recent letter with the enclosed copies of working papers provided at the demonstration of TAXIR. I am sorry that we were not able to be represented from this office at those meetings.

I am reading this with interest and will circulate it to my colleagues here for their information and comments. I presume that this same material was made available to Drs. E. J. Wellhausen and U. J. Grant who will, I am sure, have great interest in the potentialities of the TAXIR system.

With best regards,

Sincerely yours,

Ralph

R. W. Richardson, Jr.
Associate Director

Dr. David J. Rogers
Professor of Biology
Taximetrics Laboratory
Department of Biology
Armory 101
University of Colorado
Boulder, Colorado 80302

RWR:emw

The Rockefeller Foundation
111 WEST 50th STREET, NEW YORK, N.Y. 10020

AGRICULTURAL SCIENCES

CABLE: ROCKFOUND, NEW YORK
TELEPHONE: COLUMBUS 5-8100

July 17, 1968

Dear Dave:

Thank you for your letter of July 15 informing us that you plan a demonstration of the computerized information retrieval system this Fall.

I did bring to Ed Wellhausen's attention all of the material you left with me and we discussed this at some length late last winter. Ed expressed great interest and, as I recall, hoped to have the opportunity one of these days of visiting with you and certainly will appreciate being continually informed of your program.

I am not sure that I or any of my New York colleagues would be free to accept your very kind invitation. However, I am forwarding copies of this correspondence to Ed knowing of his continuing interest. It may be possible for one of our field staff members more directly concerned with programs which could effectively utilize your system to attend your demonstration if they are in the U.S. at that time.

In any event, we will be pleased to receive your questionnaire and certainly will give it wide circulation among our indicated field staff members.

With best regards,

Sincerely yours,

Ralph

R. W. Richardson, Jr.
Associate Director

Dr. David J. Rogers
Professor of Biology
Taximetrics Laboratory
Armory 101
University of Colorado
Boulder, Colorado 80302

RWR:emw
cc: Dr. E. J. Wellhausen

JUL 23 1968

APARTADO AEREO 58-13
BOGOTA, COLOMBIA
CABLE: CIAT

CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL

040

July 19, 1968

Dr. David Rogers
Professor of Biology
University of Colorado
Boulder, Colorado

Dear Dave:

I am sure that you must have received my letter of a few days ago concerning the payment of your consulting fee. Rody turned this over to me as soon as he received it, and unfortunately I did not act on it until after the Board meeting of CIAT which is now out of the way.

I have asked the New York office to reimburse you, and I hope that they now have done so. However, by copy of this letter I am reminding them to please pay your bill if they have not already done so.

Sincerely yours,

U. J. Grant
Director

UJG/caa

cc. Dr. L. M. Roberts

check received CA 24 July

15 July 1968

DR. Ralph W. Richardson, Jr.
The Rockefeller Foundation
111 West 50th Street
New York, N. Y. 10020

Dear Ralph:

You will recall back in February that we were developing an information retrieval system which would be directly applicable to some of the activities of the agricultural work done by Rockefeller. As I recall it was your intention to get together with Dr. Wellhausen in March sometime, and if there were an opportunity Dr. Wellhausen would try to correspond with me to show if he was particularly interested in the work. Since we haven't heard anything we are assuming that interest still exists.

The reason I am writing now is to discover whether or not you, as well as Dr. Wellhausen, would be interested to come here for a demonstration of the computerized information retrieval system sometime in the fall. At the moment we are planning to put on a demonstration for a number of people who would be potential users of our system. We expect that we will invite about 15 or 20 people around the country to come for about two days, or perhaps one day if they can't make it any longer, for a deomnstration and explanation of the system and its use. We think that this is perhaps the most powerful tool that can be developed for the storage of information and its retrieval in the biological sciences. We think that to really understand the system, it is necessary to spend at least one day, and preferably two, getting the system explained so that it can be incorporated onto your own kinds of activity.

The system we have developed was designed primarily to be an aid to the working biologist, and has a number of different ways in which it can be used as an aid.

I hope you will be thinking about this. We will send out shortly a questionnaire to find out if you are interested and what times are available to you. After we have heard from several other poeple we will then try to find a date which will be agreeable to all, but I would like to have a preliminary response from you to know if this kind of effort

has significance and interest to you.

Looking forward to hearing from you,

Sincerely,

David J. Rogers
Professor of Biology

DJR:gm

Taximetrics Laboratory

Armory 101

15 July 1968

Dr. U. J. Grant
The Rockefeller Foundation
Apartado Aereo 58-13
Bogota, Colombia

Dear Jerry:

On June 11 I submitted a bill for the write-up on cassava to Dr. Rodenhiser. Perhaps Dr. Rodenhiser has not had an opportunity to look after this matter.

Just by chance over the weekend I ran into Dr. Stonaker while he was visiting here in Colorado. He told me that Dr. Rodenhiser is now in Kenya. He also gave me the good news that you folks had had a big meeting there in Bogota about CIAT, and from what he knew it looked as though everything was progressing very nicely toward the development of that center. I certainly hope that everything is going well.

Sorry to trouble you about the consulting fee, but I do hope that it can be taken care of. Looking forward to hearing from you.

Sincerely,

David J. Rogers
Professor of Biology

DJR:gm

THE ROCKEFELLER FOUNDATION

AGRICULTURAL SCIENCES

COLOMBIA OFFICE
APARTADO AEREO 58-11
APARTADO NACIONAL 32-79
BOGOTA, COLOMBIA
CABLE ADDRESS: ROCKFEL

772 (CIAT)

July 10, 1968

Dr. David Rogers
Professor of Biology
University of Colorado
Boulder, Colorado

Dear Dave:

I regret the delay in answering your letter in which you presented your final bill for your services in preparing the report on yuca. I do appreciate having this information and I am asking the New York office to forward this amount to you.

Sincerely yours,

U. J. Grant
Local Director

UJG/caa

P.S. We have been tied tight with our first board meeting!

Regards!

The Rockefeller Foundation
111 WEST 50th STREET, NEW YORK, N.Y. 10020

AGRICULTURAL SCIENCES

CABLE: ROCKFOUND, NEW YORK
TELEPHONE: COLUMBUS 5-8100

July 17, 1968

Dear Dr. Rogers:

Dr. Grant has forwarded to me your final bill in connection with the preparation of the study report on cassava for CIAT. This has been approved and forwarded to our Comptroller's Office for reimbursement. You should be receiving a check in the amount of $630 to cover these expenses within the next few days.

I wish to take this opportunity to express my warm appreciation for your assistance to CIAT. I have not yet seen a copy of your report, but I am confident that it is of great interest and will be of much help to CIAT in planning its research program on cassava.

Sincerely yours,

Lewis M. Roberts
Associate Director

Dr. David J. Rogers
Taximetrics Laboratory
Department of Biology
University of Colorado
Boulder, Colorado 80302

LMR:sd
cc: Dr. U. J. Grant

11 June 1968

Dr. H. A. Rodenhiser
Rockefeller Foundation
Apartado Aereo 58-13
Bogota, Colombia

Dear Rody:

Enclosed is my bill for preparation of the report on cassava.

Since I last wrote directly to you, I have added some few remarks to the report, and as you requested, sent them directly to Dr. Grant. Unfortunately, I could not amplify my remarks on the production of protein from cassava very much. I had Miss Tersillo make quite a thorough search, and while she did an excellent job, there really was very little that could be uncovered. As I suspected, very little work has been done on cassava in this direction, though many other substrate sources have been investigated. Certainly research from the ground up will have to be done, if this is to be made a part of the Center's work.

I will be very interested to hear the decisions concerning the Center's activities. I certainly hope that cassava, my main interest in botany, will be on the list of crops to be included. I intend to continue my own work with the classification of the species (and the whole genus), and hope that it will be contributory to any work Rockefeller does in Colombia.

In the event that cassava is not included in the research efforts of CIAT, I would like to go to FAO, and perhaps other international bodies, to see if they cannot support the work. I hope that that will never have to be done.

Sincerely,

David J. Rogers
Professor of Biology

DJR:gm
Encl.

To: The Rockefeller Foundation

From: David J. Rogers

For: Preparation of study report on Cassava for CIAT

Date: June 11, 1968

Following are costs for preparation of the study report on cassava submitted earlier to Dr. U. J. Grant.

1.	Typing expenses	$25.00
2.	Consulting fees . . . . 8 days, $75/day .	600.00
3.	Miscellaneous phone calls	5.00
	Total	$630.00

Original carbon sent to Dr U J Grant - 15 July 1968

Taximetrics Laboratory

Armory 101A

13 May 1968

Dr. U. J. Grant
The Rockefeller Foundation
Apartado Aereo 58-13
Bogota, Colombia

Dear Dr. Grant:

This belated addendum to my report on Manihot esculenta refers to the potentiality of using cassava as a substrate to cultivate microorganisms for protein production. This goes with page 7 of the report. Under any circumstances, I strongly recommend that thvestigations of this potential be made part of the cassava work.

Sincerely,

David J. Rogers
Professor of Biology

DJR:gm

Apl 68

Miss Frances Tersillo
Biological Sciences Communication Project
The George Washington University
2000 P Street, N.W.
Washington, D. C. 20036

Dear Miss Tersillo:

Your references and "reprints" have been arriving like spring showers. I appreciate all the time and effort you have spent. My sincere thanks. If what I am looking for is in print, I ought to be able to find it now.

Sincerely,

David J. Rogers
Professor of Biology

DJR:GM
CC: Dr. Dorothy Parker

APR 29 1968

THE ROCKEFELLER FOUNDATION

AGRICULTURAL SCIENCES

COLOMBIA OFFICE
APARTADO AEREO 58-11
APARTADO NACIONAL 32-79
BOGOTA, COLOMBIA
CABLE ADDRESS: ROCKFEL

435 (CIAT)

April 20, 1968

Dr. David J. Rogers
Professor of Biology
University of Colorado
Boulder, Colorado 80302

Dear Dave:

Thank you very much for your letter of April 17 concerning the report on the starches. I believe you have answered most of our questions which have been raised to date.

I hope that Miss Tersillo has now been able to furnish the data which you have requested. If not, I suggest you give her a call and find out when she will have it available. There may be some misunderstanding as to what you actually want.

Sincerely yours,

U. J. Grant
Local Director

UJG/caa

Rogers – Ford Foundation
Rockefeller Foundation
W 50th NYC
Time-Life

212 - CO 5 8100

Lowell Hardin
212-573-5000
Ford Foundation

THE GEORGE WASHINGTON UNIVERSITY
Biological Sciences Communication Project

April 19, 1968

Professor David J. Rogers
Taximetrics Laboratory
Department of Biology
Armory 101
University of Colorado
Boulder, Colorado 80302

Dear Professor Rogers:

This will, somewhat belatedly, acknowledge receipt of your request for information about the relationship of microorganisms to protein production from plant carbohydrate sources and storage of roots (especially Manihot roots) after harvest. Dr. Parker forwarded this to me with her letter of April 4. What with one thing and another stemming from Dr. King's assassination, I received it on April 10.

I'm afraid that work on a request for information received from Dr. Crowder at Cornell has prevented me from giving your request much attention. I did, however, want you to know that it has been received and that I shall try to at least get copies of the materials you specify off to you this next week. The literature search portion of your request may have to wait another week to 10 days until I finish with the precedent Crowder request.

If you are up against any deadlines for your report, I'd appreciate your advising me of this. It may help me to plan my work more effectively.

Yours sincerely,

Frances Tersillo

(Miss) Frances Tersillo
Bibliographer

cc: Dr. Dorothy Parker (RF/NY)

SUITE 700, 2000 P STREET, N.W. / WASHINGTON, D.C. 20036 / PHONE 462-5828

THE ROCKEFELLER FOUNDATION

AGRICULTURAL SCIENCES

COLOMBIA OFFICE
APARTADO AEREO 58-11
APARTADO NACIONAL 12-79
BOGOTA, COLOMBIA
CABLE ADDRESS: ROCKFEL

379 (CIAT)

April 8, 1968

Dr. David Rogers
Taximetrics Laboratory
Department of Biology
Armory 101A
University of Colorado
Boulder, Colorado 80302

Dear Dave:

How is suggested addition to your Cassava report progressing? I'm inquiring because just recently Jerry learned that he would be presenting the proposals for the Center to the Foundations in New York around the middle of May.

Dave - please send your addition and changes directly to Jerry as I will be in Turkey for a couple of weeks beginning the 17 of April.

Best personal regards.

Sincerely,

Rody

H. A. Rodenhiser
Special Consultant

HAR/caa

17 April 1968

Dr. Ulysses J. Grant
The Rockefeller Foundation
Apartado Aereo 58-13
Bogota, Colombia

Dear Jerry:

On March 15 Dr. Rodenhiser pointed out several places in my report on yuca that he would like to have amplified. One of these required considerable search of literature which is not directly available to me. I have asked Miss Tersillo in Washington to round up some material, but she is apparently at work on some high priority job and has not yet had an opportunity to round up the literature that I requested.

Some of the other questions about the report can be answered more easily and I enclose herewith some supplementary material to be incorporated in the report now in your hands. In order that you can quickly refer to the questions asked by Dr. Rodenhiser I am including a copy of his letter requesting the information.

Rody's first question dealt with maturity. I think that the footnote included herewith will answer this question. The footnote can be inserted behind page 1 with an asterisk placed on the word preference" in the third line from the bottom of page 1.

The second request for an expansion of information concerning protein production by microorganisms has to be searched by Miss Tersillo. I can say without much research that the starch from cassava has not been used in any significant, large, scientific efforts for protein production. About the only modern effort that I know of has been stated in the present report (Gray, 1966). To my knowledge, Gray worked on a laboratory scale, and not on a production basis. I am continuing to work on this particular question.

The third question dealt with fertility levels. Again I believe that the information is best stated in a footnote and I have included this footnote to be inserted just behind p. 16 with an asterisk on "fertilizers," in the fourth line of the paragraph labelled Fertility-Levels, page 16.

The next request from Rody was that I delete the paragraph on information retrieval and the personnel to man a computer system. I understand the reason for this request and would merely suggest that, if this is amenable to you, those portions be merely struck from the present report. Since nothing needs to be said about computers for information retrieval, I think that this can be excised from the report without doing damage to the continuity. If you decide that I should rework this area I will do so.

The Rockefeller Foundation
111 WEST 50th STREET, NEW YORK, N.Y. 10020

AGRICULTURAL SCIENCES

CABLE: ROCKFOUND, NEW YORK
TELEPHONE: COLUMBUS 5-8100

April 10, 1968

Dear Dr. Rogers:

This will acknowledge your request for information. It has been forwarded to Miss Tersillo. I hope that you are not in a great rush because she is working on another list of references needed urgently.

Sincerely yours,

Dorothy Parker

Dorothy Parker
Associate Director

Dr. David Rogers
Department of Biology
Armory 101
University of Colorado
Boulder, Colorado 80302

DP:msh

29 March 1968

Dr. Dorothy Parker
Rockefeller Foundation
110 West 50th Street
New York, New York 10020

Dear Dr. Parker:

Dr. Rodenhiser has asked that I amplify my report in a couple of directions for the new studies that they wish to develop in Colombia. If possible I would like to take advantage of the good offices of Miss Tersillo to make some more searches of the literature for me.

The search area of interest deals with the production of proteins by microorganisms using plant carbohydrates as the base for the cultivation of the microorganisms. Dr. Rodenhiser in his last letter sent along a list of possible references that might be interesting to examine in relation to this particular aspect of things. I am forwarding this list to you, and the list has marked intries on it which I think might be interesting. The purpose of sending the list is to give Miss Tersillo an idea about the kinds of references that might be useful as she goes through searching for this kind of information.

I would like to ask another favor of Miss Tersillo if this is at all possible. Since our library resources here in Colorado are relatively limited and do not contain some of the reference materials which are listed I wonder if it would be possible to ask for Xerox copies of each of the papers marked on this list; unless of course they turn out to be a whole book, which would then make it necessary for me to boorow it.

My major concern is as mentioned above - the relationship of microorganisms to protein production from plant carbohydrate sources. I would like to ask in addition if Miss Tersillo could discover if there are any references available to her which discuss the storage of roots after harvesting, particularly Manihot roots. I have the following references concerning this, but these publications are not available to me and they probably are available somewhere in the Washington area. These references are:

Subramanyam and Mathur, Bull. cent. Fd technol. Res. Inst., Mysore, 1955-56, 5, 110

Majumder, Ibid., 1954-55, 4, 164

Majumder et al., Ibid., 1955-56, 5, 108

Kirpal Singh and Mathur, Ibik., 1952-53, 2, 181.

There may be other references to the storage of Manihot roots, but I am not sure that I know what they are.

I trust that I am not overburdening Miss Tersillo for this work. Thank you for your assistance.

Sincerely yours,

On page 2 of Rody's letter he asks about storage requirements. I am a bit confused by the question as to whether it deals with the storage of the roots or the storage of germ plasm, but rather than to wait for clarification on this point I will assume that the interest lies in the storage of germ plasm. My reply is therefore directed to this point.

Germ Plasm Storage. Since the "germ plasm" for Manihot esculenta is a vegetative portion (stem cutting) there is little likelihood that we could maintain under the best of conditions viable material as cuttings for more than six months. Native farming practices indicate that if one places mature stems of Manihot under shade and under some light cover (leaves, for example) the stem will be viable for as long as 3 - 6 months.

In light of the paragraph above I would like to introduce a concept only recently being generated by Dr. Alfred Jones who has considered the problem of a "genetic bank" for sweet potatoes. It is Dr. Jones' opinion that the concept of a large living collection of sweet potato varieties is not a useful procedure (particularly because of loss to disease, confusion of labelling, and cost). It is possible in populations of sweet potatoes (whose methods of propagation are similar to that of yuca) to recover in a very short time any gene desired from a small sample of any group of cultivars. This possibility is based upon the fact that the sexual mechanisms involved in the production of seeds is of sufficient heterogeneity to contain any desirable properties. With this short discussion we can see that if we collect the actual seeds from Manihot populations there will be a high probability of having any recombination of genetic material needed for germ plasm banks. Sowing a random sample of these seeds will produce in the derived plant some particular useful gene combination. When the desired gene combination is found, it is cultured as long as is required by vegetative propagation.

Since this idea is probably one not entirely familiar to breeders of root crops such as Manihot esculenta it is likely that this concept will take some time to be accepted, but I am convinced from my knowledge of M. esculenta that it would not be profitable to maintain either living collections of all cultivars for breeding purposes nor to spend much time doing research and designing complex controlled environment chambers for the storage of the vegetative cuttings. We have no data on storage requirements for seeds of M. esculenta.

I trust that this satisfies the requirements, and that you can use the report to advantage.

Sincerely,

David J. Rogers
Professor of Biology

DJR:gm

THE ROCKEFELLER FOUNDATION

AGRICULTURAL SCIENCES

COLOMBIA OFFICE
APARTADO AEREO 58-15
APARTADO NACIONAL 12-79
BOGOTA, COLOMBIA
CABLE ADDRESS: ROCKFEL

276 (CIAT)

March 15, 1968

Dr. David Rogers
Taximetrics Laboratory
Department of Biology
Armory 101A
University of Colorado
Boulder, Colorado 80302

Dear Dave:

Jerry and I have again reviewed in detail your good report on Cassava. We are sure that many questions will be raised regarding the proposed program during the anticipated review session in New York, hence, some degree of amplification in the report would be most helpful.

On page 1 reference is made to maturity in 6-24 months. Just what constitutes maturity and is there any indication of "maturity" in lines prior to the six month growth period? Is there any information on the composition of the roots in the early stages of development?

Page 7 - In our opinion your reference to the use of some of the microorganisms in relation to protein production is exciting and believe it would be of real interest to expand your discussion on the subject in your report. Some work has been done particularly with the yeasts (Torula and others), bacteria and actinomycetes, and of course the work by Gray with the fungi. You probably have the background material in your files but if not, enclosed are some references that may be helpful. If you feel they are not complete possibly you would want to request Miss Tersillo via Dr. Parker in New York to complete the references.

See Machado

Page 16 - Fertility levels. It might be well to cite a few data supporting the statement regarding lack of response of yuca to increased fertility levels.

Pages 23 & 24. With regard to the two paragraphs on information retrieval, we would suggest that at this stage you confine the write up to the primary phases. Both Dr. Grant and I agree on the need eventually for the total system but we must keep in mind we are starting the program on a very modest scale in fact much smaller than we had originally envisioned at the time you were with us in Colombia. For the time being then we would suggest that item 9 under staffing

requirements would be deleted.

We are reasonably well assured that provision will be made for the development of facilities for an international germ plasm bank. What information do you have Dave regarding storage requirements for Cassava or the other starchy crops. Hopefully this is available as we will need the data on temperature and humidity requirements when the specifications for the facility are developed.

Enclosed is a copy of Roger Hoffer's paper on Remote Multispectral Imagery. I'm sure you will be interested in it. Did you get a copy of Bob McDonald's paper that came out about the same time.

Best personal regards.

Sincerely,

Rody

H. A. Rodenhiser
Special Consultant

HAR/caa
encl.

The Rockefeller Foundation
111 WEST 50th STREET, NEW YORK, N.Y. 10020

AGRICULTURAL SCIENCES

CABLE: ROCKFOUND, NEW YORK
TELEPHONE: COLUMBUS 5-8100

March 7, 1968

Dear Dave:

Thank you for your recent letter with the attached correspondence with Dr. Wellhausen. Dr. Wellhausen will be in New York next week and we will expect to review this project with him.

I am delighted that you were able to provide a concise outline of the characteristics for the proposed information retrieval system to him.

We are also very interested to learn that you expect to be able to demonstrate this system later this summer. I would hope that one of us would have an opportunity to observe this system in operation. We look forward to hearing further from you as your plans develop and will write further concerning Dr. Wellhausen's interest.

With best regards,

Sincerely yours,

Ralph

R. W. Richardson, Jr.
Associate Director

Dr. David J. Rogers
Professor of Biology
University of Colorado
Taximetrics Laboratory
Department of Biology
Armory 101
Boulder, Colorado 80302

RWR:emw

Taximetrics Laboratory
Department of Biology
Armory 101A
University of Colorado
Boulder, Colorado 80302
25 March 1968

Dr. H. A. Rodenhiser
Rockefeller Foundation
Apartado Aereo 58-13
Bogota, Colombia

Dear Rody,

I am wondering whether there is anything that you can report to me about the Manihot studies. Since I wrote the report I have had an opportunity to spend some time talking with Dr. Alfred Jones in the USDA at Tifton Georgia. Hells in charge of the sweet potato breeding project there. From him I have gotten a number of number of ideas which I think would be very fruitful in the breeding of cassava. I am not sure whether the report I sent needs to have an addendum concerning these ideas but I would be glad to provide them if you feel it would be useful.

I have not submitted a bill for the time I spend on the report preparation. Should I do so now?

Best regards to you and Mrs. Rodenhiser.

Sincerely,

David J. Rogers
Professor of Biology

DJR:gm

THE ROCKEFELLER FOUNDATION

AGRICULTURAL SCIENCES

COLOMBIA OFFICE
APARTADO AEREO 58-11
APARTADO NACIONAL 12-79
BOGOTA, COLOMBIA
CABLE ADDRESS: ROCKFEL

129 (CIAT)

February 13, 1968

Dr. David Rogers
Taximetrics Laboratory
Department of Biology
Armory 101A
University of Colorado
Boulder, Colorado 80302

Dear Dave:

We have just received the one copy of your cassava report. Many thanks for your time and effort and the speed with which you have carried out this assignment.

Dr. Grant and I will be reviewing the report right away and do appreciate your offer of further help as may be needed. You may recall that we indicated that in the near future we anticipate having a session in New York with the Rockefeller and Ford Foundation people to discuss the reports on the projected programs. I'm sure we will be asking you to help us on this one. I'll drop you a line again just as soon as we go over your report.

Warmest regards.

Sincerely,

Rody

H. A. Rodenhiser

HAR/caa

2 February 1968

Dr. Ralph Richardson
Rockefeller Foundation
110 West 50th Street
New York, New York 10020

Dear Ralph:

As you know, I've been working on a study report on yuca for Drs. Grant and Rodenhiser for consideration of the inclusion of this crop in the work of the new Institute to be established in Palmira. I have just completed the first draft of the report, and will send it off to Dr. Rodenhiser, hopefully on Monday.

One of my strong recommendations in the report was that a computer be installed in the Institute to allow rapid correlation and retrieval of the data derived from the primary studies, not only on yuca, but on all the various crops and activities to be included in the Institute's work. Having made that recommendation, I began to think that such a facility would be a valuable adjunct in all of the various Institutes around the world, as well as other projects as the germ-plasm banks for corn, wheat, etc. As a matter of fact, I met Dr. Mario Gutierrez G. in Mexico just before Christmas. He is anxious to use some sort of computer program for the retrieval of information about the Maize Germplasm Bank at Chapingo.

Many different groups and workers want to get going with computer programs, but most of them are at a loss when it comes to the problem of getting a computer to work for them. With this problem in mind, I thought it might be well to tell you (and others of the Foundation who might be interested) about the work we have already done in the field of data correlation and information retrieval. My group and I have worked for some years (as you know) on these problems, and I think that we have both useful programs and know-how which could be of tremendous assistance to people in the various agricultural endeavors. Our team is unique, I think, in that we have had experienced biologists, mathematicians, and programmers working together on problems of data processing fro biology and agriculture for a total of 23 man-years. We have not only worked from our own interests, but have had the collaboration of a number of different types of biologists whose problems have widened our scope to a point where we feel that we understand the needs of most endeavors in agriculture and biology. Our experience has paid off recently in the development of a very powerful computerized biological IR system. This system is nearing completion, and will be ready for demonstration by July of this year.

We would like to put our talents and the IR system to work, and would like to explore possibilities of collaborating with the many teams which you support. We could, for example, act in an advisoryccapacity for those who want to get a particular set of data into a data bank for retrieval. In other cases, we could actually enter into the operations for a sufficient length of time to train both biologists and computer experts in the proper procedures, and while during the training period, actually produce results meaningful to the work at hand.

I do not have any concrete proposals for such collaboration at the moment, but would like to explore the possibilities with you. Since I have to be on the east coast on February,19, I would be pleased if I could come talk to you on either the 20th or 21st. If possible, I would also like to talk to the people in the Ford Foundation who are working with you in the development of the various institutes and programs around the world, However, I would leave it to your discretion about inviting them in for talks.

Can you make it on either of the days mentioned above? If not, and you find the possibilities interesting, could you tell me when you do have some free time (is there any such?). Perhaps I could call you next week, say the 8th or 9th, to make arrangements.

Sincerely,

David J. Rogers
Professor of Biology

DJR;gbm

2 February 1968

The Hon. Donald T. Brotzman
1330 Longworth Building
Washington, D. C. 20015

Dear Mr. Brotzman:

Thank you very much for the extensive and very useful documents on cassava. They will prove very helpful and we are all grateful for your staff's efforts on our behalf.

Very sincerely,

David J. Rogers
Professor of Biology

DJR:gm

FEB 8 1968

The Rockefeller Foundation
111 WEST 50th STREET, NEW YORK, N.Y. 10020

AGRICULTURAL SCIENCES

CABLE: ROCKFOUND, NEW YORK
TELEPHONE: COLUMBUS 5-8100

February 6, 1968

Dear Dave:

In reply to your February 2 letter I am pleased to advise that I expect to be in the office on February 20 and 21.

I would enjoy discussing with you further thoughts concerning the possibility of collaborating with you and your colleagues concerning information retrieval systems which might improve effectiveness and efficiency of several of our plant breeding efforts. At this stage I think we would prefer to meet alone with you in these offices and would not anticipate inviting people from the Ford Foundation to this very preliminary discussion.

Looking forward to your visit later this month,

Sincerely yours,

R. W. Richardson, Jr.
Associate Director

Dr. David J. Rogers
Professor of Biology
University of Colorado
Taximetrics Laboratory
Department of Biology, Armory 101
Boulder, Colorado 80302

RWR:emw

Aerogramme

Taximetrics Laboratory
Department of Biology
Armory 101A
University of Colorado
Boulder, Colorado 80302

Dr. H. A. Rodenhiser
Rockefeller Foundation
Apartado Aereo 58-13
Bogota, Colombia

Dear Rody,

I am sending along two copies in two separate mailings of the cassava studies report. These things take longer than I anticipate and I am sorry that it was not in your hands sooner.

After having gathered information through the good offices of Mrs. Tersillo I did not feel the need to have a visit with Dr. Jones at Stanford. I do hope, however, his advice will be sought on the appropriate occasion because I think the man has some tremmendous contribution to make with respect to the root crops and cassava in particular.

Please feel free to dismember this report and reassemble it in any manner you see fit. If there are sections which you feel inadequate I would appreciate knowing of these so I may help out further. As you can see, I have followed your outline but there may be other sections or questions which have not been adequately covered.

Let me know when you have had the opportunity to present this information in New York. I do hope that we will be successful in getting the institute section on root crops going.

Best regards to Mrs. Rodenhiser and Dr. Grant.

Sincerely,

David J. Rogers
Professor of Biology

DJR:gm

12 February 1968

Dr. Ralph W. Richardson, Jr.
Rockefeller Foundation
111 West 50th Street
New York, N. Y. 10020

Dear Ralph,

I expect to arrive in New York on the morning of the 20th. If possible I would like to see you, day, about 11:00 A.M. that day. If this is not a convenient time, I will also have the afternoon available. I'll call ~~you~~ as soon as I get to a phone.

Sincerely,

Professor Rogers Biology

DJR:gm

February 6, 1968

Mrs. Frances Tersillo
Biological Sciences Communication Project
2000 P Street, N.W.
Washington, D.C. 20036

Dear Mrs. Tersillo:

Thank you very much for the listings on the economic aspects of cassava. Incidentally, "yuca" is an acceptable synonym in the Spanish-speaking areas of Latin America.

It was my suspicion, and is borne out by your conversations with the "commodities" people there in Washington, that cassava has not made sufficient impact on the export market to be given adequate statistical treatment. It is difficult, therefore, to indicate the fundamental importance of this crop in the lowland tropical areas of the world.

I am particularly pleased to have the full paper by Walker, of the Tropical Products Institute on the market for cassava. This gives as much information as I care to use in the study report.

I will be pleased to have any additional material which you may uncover since I make a feeble attempt to keep as complete a record of the crop as possible. In this connection, you might be interested to know that I, in collaboration with a Sr. Montaldo in Maracay, Venezuela, have put together a rather extensive listing of the bibliography of this crop. Our bibliography is probably full of citation errors (some of the citations are second- or third-hand) and it needs very careful checking before it can be considered useful. However, if you have interest in such things, I'll be glad to show you this.xxxxxx. You might have some suggestions on proper procedures to check it.

Thanks again for your considerable efforts.

Sincerely,

David J. Rogers
Professor of Biology

cc. Dr. D. Parker.

ROTHAMSTED EXPERIMENTAL STATION, HARPENDEN, HERTS., ENGLAND
Director: SIR FREDERICK BAWDEN, F.R.S.

REF

Telegrams:
HARPENDEN 4671

27th December 1967

Dear Dr Rodenhiser,

Thank you for your query about protein in cassava (18/12/67). I think two comments of mine, made in various articles and in conversation with members of the Rockefeller staff, have got telescoped. We are primarily interested in the extraction of leaf protein and I have mentioned cassava leaves as a possible source. The published figures on extraction from cassava leaves are not encouraging. My thesis was that this should not stop work because, in trials in Ghana, there were considerable differences between varieties so it seemed possible that there were varieties that extracted well. Furthermore, Dr Storey at Amani, has virus tolerant strains that are in much fuller leaf at the time of harvest than the normal strains. I suggested that these should be tried as leaf protein sources too.

The comment on tubers deals with yams (Dioscoria) not cassava. When in New Guinea, I was told that the variety with the local name "Wundunggul" had 2·5% N in the tuber. I have urged various people to find out how much of that N is protein - much of it may be useless or even toxic. So far as I know that observation has not been published (except by me) but it is in a PhD thesis on the nutritional position in New Guinea and the analyses were done by Mr D Murty of the NG Dept of Agriculture so I believe them.

The evidence that the N in cassava actually is protein is pretty sketchy. Much of it is NON. I know of no evidence that there is ever a significant amount of protein in the tuber - unlike theleaf. As you probably know, Mr D D Rogers (New York Botanical Garden) maintains a vast card index on the cassava varieties. He may have included the N content of the tubers in it. If you get any interesting information from him I would be grateful if you would pass it on. I would be especially interested if he had figures differentiating N soluble in hot water (which would be non-protein) from that in the residue (which could be protein).

In the hope that I can interest your institute in work on leaf protein as well, I am sending some papers about it by surface mail.

Yours sincerely

N W Pirie

Transcription of Tape recorded in Bogota, Colombia. 4 December 1967

This is Monday, December 4, in the evening. First of all a diary of the trip. Got off to a bad start from Denver; the plane did not leave the airpor to Dallas until about 1:00 PM; was grounded in Dallas from about 2:30 or 3:00 until about 8:15. I called up Don Smith in Denton, Texas, and he came down and we had supper together. By American Airlines went to Mexico City where I landed about 12:30 AM. After about an hour of messing around I got an in-transit visa to stay on the airport. I moved over to Varig, and discovered that the flight that was to leave at 2:15 AM had been rescheduled the day before to leave at 6:15 AM the next morning; so I spent the whole horrible night trying to find a comfortable spot on a bench in the Mexico City Airport. Never again!

Finally got on the Varig flight #811; went to the first class cabin; had an argument with the steward who said I had nothing but a tourist or economy class seat so was shoved back into the back end of the thing. (Must look into this and see if I don't get some recompense for that particular part of the journey. Finally landed in Bogota about 11:30 AM on Saturday; was met there by a fellow by the name of Jaime, whose last name I can't remember; he's the chauffeur (chofer) for CIAT, which stands for Centro Internacional Agricultura Tropical. Had a note that the two people I was to see immediately had gone down to the cabin about 80 miles away from Bogota at a much lower elevation. After calling around finally about 6 o'clock at night I contacted one of the assistant directors of the Rockefeller Foundation's activities here in Columbia, Dr. Robert Waugh. Dr. Waugh, who doesn't know anything about the CIAT program,told me that he was awfully busy, but that he would meet me for Sunday morning breakfast, which he did. We had breakfast at the Tequendama which is the only modern hotel in town. Incidentally I am staying at the Hotel Presidente which is not much as far as hotels go. if this is where the Presidents stay, God help Colombia.

Finally decided on Sunday morning to take a taxi and go down to where I would find Dr. Grant and Dr. Rodenhiser. The trip down was very spectacular and, as usual in the Andean country, lots of terrible roads with lots and lots of switchbacks. But the country was beautiful and that sort of made up for the whole trip. Met Dr. Rodenhiser, his wife; Dr. Gerald Grant, his wife; and the wife of Dr. Waugh who had gone down to the cabin. After spending about two hours there and having a light lunch we turned right around and came right back up the same road I had just gone down. This was better than staying in Bogota, however, which is an ordinary looking Spanish-American town with all the usual faults and all the usual types hanging around on the streets. Came back on Sunday night and arrived in town in time to go again for supper; and then home to bed early again.

This morning I met Dr. Rodenhiser alone. The other member of the development of CIAT, Dr. Grant, turned out to have a bad sore throat so he had been in bed all day long. Dr. Rodenhiser and I discussed in general the kinds of problems that were involved in the development of the Center for Tropical Root Crops, or as it turns out, for Tropical Agriculture. It also turns out that it has not yet been decided by the directorship of the Rockefeller Foundation (and also the Ford Foundation which is involved in this thing) that we are indeed to have a section on tripical root crops, and as much as anything else the job that I have to do is to sell the directors on the idea that manioc is well worth the studying. To that end Rody and I spent the morning talking about ways and means by which we might convince them that this is indeed a profitable and useful adventure. We talked of various aspects of the problem of research and development with the root crops in general and with yuca in particular, but didn't get very far with the whole show, as far as I can tell. It is left up to me pretty much to convince the higher ups that indeed we will have something to do for the crop which I consider to be, of course, one of the most fundamental parts of life in the tropics.

I have an outline prepared by Rody which he thinks may be the points that I will have to cover in making the report. One of the things that seems to be interesting to Rodenhiser was the fact that there had been a report on some varieties which purportedly contain a higher percentage of protein than otherwise. This is a crop from somewhere over in New Guinea, and of course, this kind of report is very obscure. What is meant by "more protein" is still an unknown item. I think perhaps what is going on is that somebody tested a fairly young root and found that in the developing root there was indeed a higher percentage of protein. It, of course, is conveniently not mentioned in the report as to what the age of the root was when the analysis was made. However, I suggested that young roots might have some benefit for use in this particular thing. What do we mean by young? This is the question - it is hard to answer.

In the afternoon after getting some travelers checks exchanged we went out to the experiment station which is supposedly the one run by the Colombian Department of Agriculture. It turns out that again Rockefeller Foundation is largely responsible for the development of the staff as well as the program that is involved at that particular station. One of the big things there is a potato program which has a young man trained in Wisconsin as it director. We visited the growing varieties and crops of potato, saw some of the experiments that are being done there. God knows, the Irish potato is getting plenry of attention in these parts. The potato breeder is Nelson Estrada.

a trip down to Cali and see the experiment station there. One of the things I promised is to send copies of our Manihot reprints to Dr. Luis Eduardo Batiño, Director, Centro Nacional de Investigacion Agropecuarias. Address is Apartado Aereo 233, Palmira, Valle, Colombia.

Taximetrics Laboratory

Armory 101A

12 December 1967

Dr. Ulysses J. Grant, Director
Rockefeller Foundation, Agricultural Sciences
Apartado Aereo 58-13
Bogota, Colombia

Dear Jerry,

My expenses for the trip to Bogota were:

Car rental, Boulder to Denver and return	18.72
Plane fare, round trip	492.30
Trip to Magdalena Valley	21.50
Telephone - Miami to Boulder	5.00
Cablegram - Boulder to Bogota	3.75
9 1/2 days at $25 per diem	237.50
8 days consulting @ $75 per day	600.00
	$1378.77

I trust that the report which I am working on at the moment will have the desired result. I am very pleased to have had the chance to spend some time there, because it clarified many points I needed.

Thanks for the opportunity of visiting you and give my thanks to Dr. Rodenhiser.

Best wishes for a merry Christmas and a happy new year.

Sincerely,

David J. Rogers
Professor of Biology

DJR:gm

KX 135 Kodachrome-X FILM

ASA 64

FOR COLOR SLIDES

Use in DAYLIGHT or with BLUE FLASH

DAYLIGHT PICTURES

FOR AUTOMATIC CAMERAS OR EXPOSURE METERS

The film speed is a measure of the film's sensitivity to light. Set the film speed dial on your camera or exposure meter at 64 to assure proper exposure of this film.

SETTING CAMERAS WITHOUT AN EXPOSURE METER

DAYLIGHT EXPOSURE TABLE FOR *KODACHROME-X* FILM

Set the *shutter speed* at 1/100 or 1/125 second and the lens at the f-number indicated under the lighting condition below that matches the lighting on your subject.

Bright or Hazy Sun (Distinct Shadows)	Cloudy Bright (No Shadows)	Heavy Overcast	Open Shade†
			
f11*	f5.6	f4	f4

*f16 for brilliant scenes, such as those containing much sand or snow—f5.6 for backlighted closeup subjects.

†Subject shaded from sun but lighted by a large area of sky.

For ready reference, tape this table to your camera case.

FLASH PICTURES

USE BLUE FLASHBULBS

Use blue flashbulbs and fresh batteries. Weak batteries cause flash failure. Choose a flash-exposure strip from the group below for your type of flash reflector and bulb. Set your shutter speed at **1/25, 1/30,** or **1/40** second. Estimate the distance in feet between *flash* and *subject*. Set your lens opening at the f-number in the block below this distance. You can cut out one of the strips below and tape it to your equipment. If your camera has flash guide numbers on the lens mount, set it at the guide number below for your flash reflector and bulb.

Guide Nos.	Reflector Types	Flash-bulbs	KODACHROME-X Film 1/25, 1/30, or 1/40 sec					
50		AG-1B	KODACHROME-X Film 1/25, 1/30, or 1/40 sec					
			Distance (feet)	4-5	6	8-10	12	15-20	25
			Lens Opening	11	8	5.6	4	2.8	2
65		AG-1B M2B	KODACHROME-X Film 1/25, 1/30, or 1/40 sec					
			Distance (feet)	4-5	6	8-10	12	15-20	25
			Lens Opening	16	11	8	5.6	4	2.8
100	 *	AG-1B M2B	KODACHROME-X Film 1/25, 1/30, or 1/40 sec						
			Distance (feet)	5	6	8-10	12-15	20	25
			Lens Opening	22	16	11	8	5.6	4
95		M3B M5B 5B 25B	KODACHROME-X Film 1/25, 1/30, or 1/40 sec						
			Distance (feet)	4-5	6	8-10	12	15-20	25
			Lens Opening	22	16	11	8	5.6	4
140	 *	M3B M5B 5B 25B	KODACHROME-X Film 1/25, 1/30, or 1/40 sec					
			Distance (feet)	6	8	10-12	15	20-25	
			Lens Opening	22	16	11	8	5.6	

*Polished bowl reflector.

10 November 1967

Dr. H. A. Rodenhiser
The Rockefeller Foundation
Apartado Aereo 58-13
Bogota, Colombia

Dear Rody,

Unless the air lines tell me I cannot come on the days proposed, the following is my projected time of arrival and departure:

Arrive Friday, December 1, at 9:22 P.M. via Braniff

Leave Saturday, December 9, at 10:30 A.M. via Avianca

I trust that I can ask your assistance for accomodations, etc.. upon arrival. Any instructions you care to give concerning activities during this period will be appreciated. I assume, of course, that we will be doing some beating around in the bush (or at least on farm grounds).

Do you suppose that while we are visiting Monteria that we can get up to see the old city of Cartagena? I have been wanting to see that place, but never have had the opportunity to do so.

I am making travel plans via a local travel agency, and a according to your letter have booked first class passage. Any other instructions about reimbursement, needed receipts, etc. will be appreciated.

Looking forward to seeing you.

Sincerely,

David J. Rogers
Professor of Biology

DJR:gm

HOTEL TEQUENDAMA
BOGOTA

ANTICIPO CONCESIONARIOS
ADVANCE PAYMENTS TO CONCESSIONARIES

DRUG STORE DEL
Hotel Tequendama
№ 28383

Bogotá, Dic 16 de 19 07.

Registro No. _____
Habitación No. _____

Nombre
Name

Explicación _____ $

1 Kaomycin 11 8 cc. $ 34.20

NO ESCRIBA ARRIBA DE ESTA LINEA

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Firma del Huésped - Guest Signature

CAJERO

AG-111

CLASS OF SERVICE
This is a fast message unless its deferred character is indicated by the proper symbol.

WESTERN UNION
TELEGRAM

W. P. MARSHALL, PRESIDENT

1201 (4-60)

SYMBOLS
DL = Day Letter
NL = Night Letter
LT = International Letter Telegram

The filing time shown in the date line on domestic telegrams is LOCAL TIME at point of origin. Time of receipt is LOCAL TIME at point of destination

1967 NOV 24 PM 6 38

KA128

K CDL921 VIA ITT ZCZC AWC908 VIA ITT BT B2166 EZ100 =

BOGOTACOL 17 24 1900 =

DAVID ROGERS BIOLOGY DEPARTMENT ARMORY 101 =

UNIVERSITY OF COLORADO BOULDERCOLUSA =

YOUR HOTEL RESERVATION CHANGED TO PRESIDENTE =

RODENHISER =

COL 101 =NNNN=

THE COMPANY WILL APPRECIATE SUGGESTIONS FROM ITS PATRONS CONCERNING ITS SERVICE

NOV 1 1967

THE ROCKEFELLER FOUNDATION

AGRICULTURAL SCIENCES

COLOMBIA OFFICE
APARTADO AEREO 53-13
APARTADO NACIONAL 12-79
BOGOTA, COLOMBIA
CABLE ADDRESS: ROCKFEL

381 (CIAT)

November 18, 1967

Dr. David J. Rogers
Department of Biology
Armory 101
University of Colorado
Boulder, Colorado 80302

Dear Dave:

Many thanks for your letter regarding your date and time of arrival in Bogota. However, if you have any change in schedule send me a cable. We have made a reservation for you at the Hotel Tequendama for late arrival on December 1.

There is one complication in that I have a committment of long standing for that Friday December 1 evening, but will have someone to meet you at the airport. With regard to the plane tickets Dave, there are several arrangements that can be made - the New York office can get them for you or you can buy them in Denver and when you arrive here this office will reimburse you. Be sure to keep receipts for the tickets and for hotel rooms to submit with your expense account. In view of the limited time before you leave if you have any questions beyond this I would suggest you call Dr. L. M. Roberts in the New York office.

Dr. Grant and I are looking forward to your visit.

Sincerely,

Rody

H. A. Rodenhiser
Special Consultant

HAR/caa

NOV 0 1967

THE ROCKEFELLER FOUNDATION

AGRICULTURAL SCIENCES

COLOMBIA OFFICE
APARTADO AEREO 58-11
APARTADO NACIONAL 12-79
BOGOTA, COLOMBIA
CABLE ADDRESS: ROCKFEL

f 338

November 3, 1967

Dr. David Rogers
Dept. of Biology
Armory 101
University of Colorado
Boulder, Colorado 80302

Dear Dave:

It was good to talk with you last week and to learn that you will be available for the proposed trip to Colombia.

Dr. Grant and I feel it will be most helpful if you had the opportunity to observe, first hand, the three primary locations for the work in Colombia - Palmira, Monteria and the Llanos, prior to preparing your report. There may be others you would like to visit but we can discuss this when you arrive in Bogota.

The dates are flexible but if convenient for you I might suggest the latter part of this month or earlier so as not to be here from December 15 until the first of the year. As you know work schedules are rather erratic at the stations during this period. Please drop me a line as to your time schedule.

I was in Washington last Sunday and Dr. Byerly mentioned that certain varieties of cassava grown in New Guinea were reported to have somewhat higher protein content than those grown in other parts of the world. Do you know anything about this? I have written him for more details.

Best regards.

Sincerely,

Rody

H. A. Rodenhiser

HAR/caa

THE ROCKEFELLER FOUNDATION

AGRICULTURAL SCIENCES

COLOMBIA OFFICE
APARTADO AEREO 58-11
APARTADO NACIONAL 32-79
BOGOTA, COLOMBIA
CABLE ADDRESS: ROCKFEL

319 (CIAT)

October 16, 1967

Dr. David J. Rogers
Department of Biology
University of Colorado
Boulder, Colorado

Dear Dave:

I am most happy to receive your letter indicating that you will take on the responsibility to prepare the report on cassava.

We have written to the New York office requesting them to prepare the necessary papers for your appointment. Dr. Grant and I will be in New York for some meetings from the 23rd to the 27th of this month and I will call you at that time. May we suggest, however, as a first step, that you plan to meet with us in Bogota to formulate the detailed plans for the survey and report preparation. This will afford opportunity to visit the proposed location for the Center at Palmira and if your time permits on this trip to possibly include visits to some of the Centers of excellence. We can discuss some of these details on the phone next week.

Sincerely,

Rody

H. A. Rodenhiser
Special Consultant

HAR/caa

19 October 1967

The Hon. Donald T. Brotzman
1330 Longworth Building
Washington, D. C. 20015

Dear Mr. Brotzman:

May I request your assistance in the following manner? I understand that through your facilities it is possible to use the Library of Congress Reference Service. Would you through this service find information concerning the world production and trade in cassava and tapioca plants and/or products. I know that the Foreign Agricultural Service, USDA, prints reports entitled "World Agricultural Production and Trade." Unfortunately this deals with different commodities in different issues and I do not have a cumulative index which tells me where to look for tapioca or cassava.

I will be pleased to have your assistance and thank you very much.

Sincerely yours,

David J. Rogers
Professor of Biology

DJR:gm

WASHINGTON STATE UNIVERSITY
PULLMAN, WASHINGTON 99163

DEPARTMENT OF AGRICULTURAL ECONOMICS

October 2, 1967

AIR MAIL

Dr. David J. Rogers
Department of Biology
University of Colorado
Boulder, Colorado 80302

Dear Dave:

Thanks for your note. No changes in the Information Storage and Retrieval project. With reference to those weeds, I have found this:

Two agencies of the USDA dabble in Manihot esculenta. The Economic Research Service (USDA) publishes a monthly "U.S. Foreign Agricultural Trade by Countries, Fiscal Year ---." On page 77 of the May, 1967 issue, Tapioca is mentioned. Quantity and value of exports on the series included. The Regional Analysis Division of the ERS-USDA puts out periodic publications such as "Agricultural Diversification and Economic Development in Thailand," Foreign Agricultural Economics Report #8.

The Foreign Agricultural Service, USDA, prints a monthly report called the "World Agricultural Production and Trade." Unfortunately, this deals with different commodities in different issues, and I was unable to find a cumulative index.

My suggestion would be to contact the Foreign Agricultural Service and/or one of the members of the Colorado Congressional Delegation. The latter can use the Library of Congress Legislative Reference Service to meet your request. My guess is that you will find answers to the production and value questions, and you likely will learn something about acreage. I would hold very little hope for meaningful answers to the cost of production question.

Peace.

Sincerely,

Paul

Paul W. Barkley
Associate Professor

PWB/sn

FOOD RESEARCH INSTITUTE
STANFORD UNIVERSITY
STANFORD, CALIFORNIA 94305

Telephone: 321-2300 Cable: FOODRES STANFORD

September 28, 1967

Professor David J. Rogers
Taximetrics Laboratory
Department of Biology
Armory 101
University of Colorado
Boulder, Colorado 80302

Dear Dave:

I found your letter of September 7 waiting for me when I returned to the office today. I am delighted that the Foundation is this serious about manioc and would like very much to do anything I can to help you in the study they have requested.

I shall be fully committed for the next few months to completing a study of marketing in staple food crops in Tropical Africa and shall not have much time to spare for anything else. On the other hand, I certainly could find a day or two for conversation about manioc and hope that it will be possible for us to get together. From my standpoint, I think it would be simpler if you were to come here, although the prospect of a visit to your shop is also tempting.

I expect to be away from Stanford for the week of October 15th to 21st but otherwise I am available. I shall be working most of the time at home where my telephone number is: 323-7917.

Best regards.

Sincerely,

Bill

William O. Jones
Director

WOJ:nn

29 September 1967

Dr. Dr. H. A. Rodenhiser
The Rockefeller Foundation
Apartado Aereo 56-13
Bogota, Colombia

Dear Rody,

I had just posted my letter of acceptance of the task to prepare a report along the lines you suggested on Manihot when your kind letter arrived. Not having your Colombia address I sent it to New York, but a carbon of the letter is enclosed for your reference.

Sincerely,

David J. Rogers
Professor of Biology

DJR:gm

27 September 1967

Dr. H. A. Rodenhiser
The Rockefeller Foundation
111 West 50th Street
New York, New York 10020

Dear Rody,

My delay in answering your kind invitation to prepare a survey of needs for Manihot esculenta has been dictated by my desire to consider the problem rather fully before jumping in. The time element is my major concern, but I think, now that classes have started and other research projects are in full swing, that I can produce a satisfactory and useful report.

I am pleased, therefore to do the job. Since the outline you gave me is rather comprehensive, and leaves much room for individuals to "move about in," I will welcome any further directives you care to give concerning any and all aspects of the report development.

Sincerely,

David J. Rogers
Professor of Biology

DJR:gm

7 September 1967

Dr. W. O. Jones
Food Research Institute
Stanford University
Stanford, California 94395

Dear Bill,

The Rockefeller Foundation has recently asked me to put together a report on the importance of and need for research on manioc. The purpose in asking this is to decide whether they should make such research studies one of their primary objectives for a new tropical lowland agricultural experiment station which they hope to put up in the Cauca Valley of Colombia. A rough outline of what they are asking about follows:

1. Economic importance
   - Nutritional value
   - Geographical distribution
   - Importance for both human and animal consumption
   - Production status (representative yields in different parts of the world)
   - Production hazards (diseases, insects, critical agronomic requirements)

2. Research
   - What is being done, by whom, and what needs to be done to improve these crops?
   - Where are the centers of excellence?

3. What are the prospects for world benefit?

4. What is available in world germ plasm banks and where are they located?

This is a whale of a job. I would certainly like to talk to you about it before going on and doing this piece of work. As you know I am a very optimistic-type botanist and feel I should be pulled back a bit by the ugly facts of life concerning these plants. Would you be willing to spend some day talking with me about the subjects above I listed? If so, I believe we can arrange for the Rockefeller people to pick up the tab for you to come here or me to go there, whichever is most convenient.

Sincerely,

David J. Rogers
Professor of Biology

DJR:gm
Signed in his absence

SEP 5 1967

The Rockefeller Foundation

111 WEST 50th STREET, NEW YORK, N. Y. 10020

AGRICULTURAL SCIENCES

CABLE: ROCKFOUND, NEW YORK
TELEPHONE: COLUMBUS 5-8100

August 29, 1967

In reply please quote: GA AGR 6701
Allocation No. 29

Dear Dr. Rogers:

I am pleased to advise you that the officers of The Rockefeller Foundation have allocated the sum of $234.70 in payment of expenses incurred in connection with your attendance at a meeting in the Rockefeller Foundation offices in New York on August 24, 1967, to help plan the root crop improvement program of the International Center of Tropical Agriculture in Colombia.

This sum is available immediately as an outright grant. I am requesting our Comptroller's Office to send you a check for $234.70, and you should be receiving this within the next few days.

Sincerely yours,

John J. McKelvey, Jr.
Deputy Director

Dr. David J. Rogers
Department of Biology
University of Colorado
Boulder, Colorado 80302

JJM:sd

SEP 2 6 1967

THE ROCKEFELLER FOUNDATION

AGRICULTURAL SCIENCES

COLOMBIA OFFICE
APARTADO AEREO 58-13
APARTADO NACIONAL 12-79
BOGOTA, COLOMBIA
CABLE ADDRESS: ROCKFEL

269 (CIAT)

September 18, 1967

Dr. David J. Rogers
Department of Biology
Armory 101
University of Colorado
Boulder, Colorado 80302

Dear Dave:

With reference to my letter to you regarding our request for your participation in the root crop study I now have the details as to financial arrangements for the mission. The Rockefeller Foundation will provide first class flight tickets, per diem at $25.oo and an honorarium of $75.oo per day for the actual number of days spent on the assignment.

Drs. Crowder and Blaser have accepted the assignments for the pasture grasses and forage legumes studies and it appears that Drs. Howell and Zaumeyer will be available for the soybean and pulse assignments. We do hope you can join in on the cassava mission.

Best personal regards.

Sincerely,

Rody

H. A. Rodenhiser

HAR/caa

cc: Dr. U. J. Grant

The Rockefeller Foundation
111 WEST 50th STREET, NEW YORK, N. Y. 10020

AGRICULTURAL SCIENCES

CABLE: ROCKFOUND, NEW YORK
TELEPHONE: COLUMBUS 5-8100

August 28, 1967

Dear Dave:

In our meeting on Thursday, we reviewed the primary objectives of the over-all programs and areas of research proposed for CIAT. You may recall that the general areas included research to solve livestock production problems in the hot tropics and in the crops field, pasture grasses and forage legumes, grain legumes and root crops. Eventually, consideration may be given to including vegetable and fruit crops.

We are now in the process of recruiting several specialists to help us in preparing reports which would provide basic information for the early planning and development of the research in each of the above areas. We are hopeful that, in line with our discussions on Thursday, you will take the assignment on cassava. We will try and interest another specialist for the sweet potato and yam crops.

You suggested that we send you a brief outline of the general topics to be covered. Here are some items which have not been reviewed by Dr. Roberts and Dr. Grant but will give you a general idea of what should be included in the root crop report.

1. Economic importance
   - Geographical distribution
   - Importance for both human and animal consumption
   - Nutritional value
   - Production status (representative yields in different parts of the world)
   - Production hazards (diseases, insects, critical agronomic requirements)

2. Research
   - What is being done, by whom, and what needs to be done to improve these crops?
   - Where are the centers of excellence?

3. What are the prospects for world benefit?

4. What is available in world germ plasm banks and where are they located?

I know you are busy, Dave, but do hope you can take on the preparation of this report. If you agree in principle, we can proceed with working out the details. The time factor is flexible as I'm sure you would need to do some traveling.

Again, we want to thank you for meeting with us and will appreciate hearing from you as soon as convenient.

Sincerely yours,

Rody

H. A. Rodenhiser
Consultant

Dr. David J. Rogers
Department of Biology
Armory 101
University of Colorado
Boulder, Colorado 80302

HAR:sd
cc: Dr. Lewis M. Roberts
Dr. U. J. Grant

Taximetrics Laboratory

Armory 101

25 August 1967

Dr. H. A. Rodenhiser
Rockefeller Foundation
Time-Life Building
New York, New York

Dear Dr. Rodenhiser:

It was a pleasure meeting with you. I shall gabsmith interest the development of the Institute for Applied Research.

My expenses for the trip were:

Air Transportation	$195.70
Ground Transportation	14.00
Per diem (one day)	25.00
	$234.70

Sincerely,

David J. Rogers
Professor of Biology

DJR:gm