CIAT

CASSAVA PROGRAM REVIEW CONFERENCE

CIAT Staff

Notes and Observations

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These notes and observations were contributed by the following

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The Future Role of Cassava

W O Jones made the introductory remarks The remarks were based on his paper "Some views of a program of research on Manihot esculenta" He stressed the fact that the demand for livestock products is increasing rapidly, hence the derived demand for cassava may be expected to increase rapidly as well, provided that its price is sufficiently low to compete with other available feeds One advantage of this crop is that it is largely "not time specific" Cassava fits well in labor-intensive, small-scale agriculture it would be desirable to continue and improve this status The greatest single virtue of this crop is that it can return extreme high yields of calories under a variety of conditions

- Cassava should not be considered a protein source

- Dr Jones stated his confidence that fresh cassava as a delicacy will further be consumed in the future to add to the continuingly increasing demand for the crop

- An examination of cassava should, however he accompanied by consideration of other root crops and also plantain as alternate food sources

Franklin Martin pointed out that the role of cassava is to produce cheap calories, for food and feed more effectively than any other crop He added that cassava could be utilized in a number of ways, among others as a raw material for the processing industry He felt that more research was needed on the utilization of cassava as a raw material

Patrick Haynes pointed out that competition exists among the various root crops and other crops He felt that cassava was likely to become a very important component of processed foods because of its potential for high productivity and low cost He agreed that cassava should be considered primarily as a source of calories

G Bolhuis explained that not only the roots, but also the young green leaves of the cassava plant, were eaten in large parts of the world and these play a role as protein sources

A Pradilla stressed the importance of cassava in the diets of low income families in Colombia Hence, in spite of its low protein content cassava is an important source of protein for these families as "yuca" has been found to provide around 4 percent of the total protein intake in urban areas and 5-6 percent in rural areas He would favor research emphasis on improving the protein quantity

W O Jones pointed out that the quality of cassava protein tends to be low and he thought that cassava would be a very inefficient source of protein He would favor the legumes as a protein source

A Pradilla agreed with Jones but pointed out that cassava formed an important part of present consumption and that consumption patterns were difficult to change in the short run Furthermore, lack of purchasing power would prohibit the consumption of new,relatively expensive foods

D Coursey suggested that it would be important to get away from the idea that root crops are inferior to other crops and that research and researchers on these crops are inferior to other research and researchers It is necessary to get away from typical European thinking and to try to understand the views and habits regarding cassava of those cultures that grow and consume this crop

Coursey further suggested that we place major emphasis on promoting the production of cassava for direct human consumption although we should not forget its potential as a raw product

H Steppler pointed out that the primary issue with which we are faced is where do we go in the next 5 to 10 years? He suggested that we look forward The problem of today may be quite different from that found five years from now Today it appears that the most important cassava utilization is for direct human consumption Maybe in five years it will be for animal consumption and industrial uses

Jones thought that cassava would maintain its importance as a human food for a long time to come, particularly for low income peoples However its importance for industrial uses would increase

Haynes suggested that cassava be used in the future for products such as bread and other products consumed by high income families

D J Rogers commented that cassava would always be fitting the ecology of some population groups as well as their taste The possible long term cumulative effects of HCN contained in roots and leaves and human health should be considered it may become a serious problem in the future

Godfrey-Sam-Aggrey informed that large quantities of cassava leaves are eaten in West Africa

Silvestre cited some statistics of cassava production in Africa (see Rafael Diaz's study) He stated that, in West Africa production of cassava increases in relation to population where cassava is not a basic food, and decreases in countries where it is a basic food

- In the future we may see a stabilization of direct consumption and an increase of non-direct food uses

M Magoon asked why cassava had not received the same research attention as other crops if it had so many virtues He thought that cassava would continue to be a basic carbohydrate source for the Indian population for a long time to come, but its yield and quality should be improved

E Normanha mentioned that Brazil is the world's largest grower and consumer of cassava roots Only a small quantity is exported

- The consumption of this crop is mostly as a source of energy although some protein is supplied by "Mandioca"

- The vitamin B group is also present in substantial amounts as evidenced by bio-assays with rats beta-carotene has also been identified in yellow cassava in southern Brazil

- The leaves of the Mandioca plant are also consumed in that country as a vegetable after boiling

- Cassava flour "farinha de mandioca", is another form of consumption of cassava, particularly in the south where it is largely produced and in the north east to where it is brought from the south in dry years when local availability of fresh roots is low

- The average consumption of Mandioca in Brazil is 250 kg per year per capita

- The most important work on cassava presently under way at the Institute of Campinas deals with disease resistance

Wilson asked What would happen if cassava could be produced in four months instead of twelve and could be harvested mechanically?

G Trant commented that mechanization would be needed for large scale operations

Jones stated his belief that given the present rate of increase of human population it is extremely difficult to visualize mechanization without displacement of human labor and consequently adding to human distress if mechanization is used on a large scale

Productivity Factors

Physiology

Cock made the opening remarks concerning potential productivity, comparing root crops with cereal crops He suggested attainable yields of 80-90 tons roots per hectare within 9 months, and threw open discussion with the question, "Why are we not getting this level of yield?"

Magoon noted that cassava lagged some 150 years behind other crops in terms of research input In India, breeding started in 1965 using heterozygous material with a wide range of variability, but severe breeding depression occurred Yields from commercial varieties were in the region of 5 tons/ha but newly bred varieties have yielded well, and responded to fertilizers 84 tons/ha with 100 100 100 NPK no irrigation after 10 months High yield is associated with plant type tall branched type with leaf area duration after five months and medium - narrow leaves being important considerations

Jennings stated that the best yields obtained in East Africa were associated with species crosses with good leaf retention, e g , M esculenta x melanobasis Yield of 67 tons per hectare over 20 months has been attained He suggested that vertically oriented narrow leaves may be important although he had no experimental back-up Also yields will be greater if plant does not lose leaves between 6th month and harvest The CH_2O translocation from above ground parts to roots varies and is considered important

Cock, "Does anyone care to comment on high radiation areas suiting narrow leaf types?" No takers

Normanha explained that an interrelationship existed between branching and hand weeding with single stems facilitating weeding Rapid canopy cover reduces weed establishment and reduces number of weedings and production costs

Arraudeau said single stems are not popular in Madagascar Large leaves however, are important Yields range from 80-150 tons/ha over 22-36 months (in experimental plots)

Bolhuis came in to say that on fertile soils in Java, large roots were produced which yielded 60 tons/ha Cassava is not grown there any more

Cock, "Does anyone have any ideas regarding dry matter partition and root initiation?"

Haynes "Has anyone any knowledge of leaf area index values for unbranched and branched types?" It is unfair to compare these contrasting types at the same spacing

Arraudeau, No data on this in Madagascar, but Rogers knew of two reports in Nigeria and Kuala Lumpur

Wilson pointed out the rate of tuber growth was initially slow, and suggested the possible key to increased production was by reducing the length of crop cycle by increasing root growth, stimulating earlier vegetative growth and achieving a better CH_2O distribution

Jennings stated that tuber initiation occurs after the first six months and stressed the importance of results by Beck showing yield related to total leaf area Production per acre (D W unit area) is a more important criterion than single plant yields

Thompson went further and talked in terms of production of dry weight per unit area per unit time

Hernandez made it input/out put/area/time Also, it is 'roots' which cassava produces not tubers What is meant by branching type?

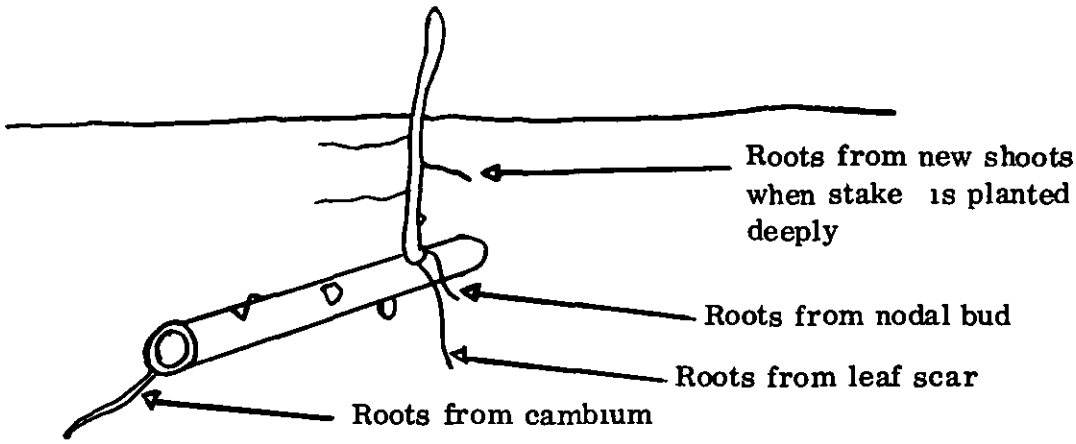
Rodgers discussed rooting, contrasting adventitious roots and primary roots Also,branching pattern was determined by the number of buds developing on the planting material

Magoon stated that roots from the nodal region were not important, as the largest roots rose from the cambial area of the cut end of the planting material

Wholey conflicted with Magoon's statement and suggested method of placement of planting piece can effect root distribution

Rodgers said in shoot development each bud develops a shoot which, on flowering from the terminal bud, stimulates branching

Normanha said horizontal planting pieces give rise to four root types



Cock "Have all these root types the ability to accumulate starch?" -

Wholey this is a line of approach for research work

Normanha, some starch can also be accumulated in old planting pieces Also grafting "wild" manihot with M esculenta produced the following results wild scion on esculenta stock produced tubers esculenta scion on wild stock produced no tubers

Bolhuis said that planting the stakes upside causes strange things to happen but Wilson commented that this grafting phenomenon indicates that a specific tuberisation 'factor' is operating

Arraudeau felt that planting stakes upside down was shown experimentally to depress yield by 30 percent Three methods of planting—vertical inclined and horizontal— can effect branching In Madagascar vertical placement is favored because it produces a single shoot

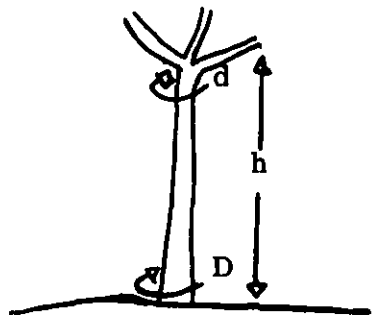
Magoon linked planting method with root development and stated that growth substances can stimulate prolific rooting but they may not bulk Events from 2-5 months after planting are very important in relation to final yield The time at which tuber bulking begins depends on variety

Cock, "Could we have comments on cultural practices? Specifically planting methods "

Bolhuis said that there were no appreciable differences between methods in Java but Arraudeau said method of planting depends on climate In the mountains of Madagascar vertical or angle planting of 10-30° is usual Horizontal planting is very rare

Correa said in Brazil it has been shown that vertical placement is better but the mechanical planters only plant horizontally

Da Silva explained that there is a correlation between botanical characters and yield



also n = number of stems
v = volume of stems
α = leaf angle

200 plants sampled and above paramenters were correlated with yield Increase in h showed decreased yield, and both stem diameters were positively correlated with yield Leaf angle, stem number and volume also correlated with yield

Cock, "Can we turn this discussion to planting density?"

Estrada said new results from a student project show

90 tons/ha from 1 00 x 40 m against
30 tons/ha from 1 00 x 1 00 m, using
Llanera as the test variety

All the roots were marketable and plants grew much taller at close spacings

Bolhuis said 1 00 x 30 m can be attained at very high levels of soil fertility

Steppler response to spacing will also depend on time to maturity

Jennings pointed out the density interaction with rainfall and nutrients In East Africa high ridges 1 50 m apart and 1 00 m deep are required to conserve moisture in the freer draining soils in dry areas Grant asked if ridging automatically increased yield No takers

Correa commented that in Brazil the optimum is not known but root size decreases and stem production increases with increased population per unit area

Fertilizers

Haynes said root crops generally have been over the centuries unconsciously selected for high yielding ability in low nutrient soils and that there is a need to identify a plant habit which will respond to nitrogen fertilizer

Cock, "What about timing of nitrogen fertilizer?"

Bolhuis said small farmers cannot afford fertilizer, while Rogers felt that every species of Manihot he had seen had shown a response to nitrogen

Magoon explained the need to change the genotype to get away from the lack of fertilizer response Results from India show that half the nitrogen at planting and half after one month is better than all applied at planting When half of the nitrogen is soil-applied and half foliar-applied, yield was not affected but HCN was reduced

Jennings said stem dry matter is produced at the expense of roots in African soils which are high in nitrogen

Normanha suggested that applications of nitrogen made tissues softer and increased damage from shoot fly (Silba pendula) Wilson said nitrogen in root crops often delays onset of tuberisation leading to a longer time to harvest Also, there is a metabolic tie-up between carbohydrates and nitrogen which could cause inefficient energy use

Cock, "We understand that potassium is important in root crop nutrition Has anyone any information on this?"

Arraudeau presented tables showing uptakes of major nutrients (to be circulated separately when we have copies)

Crop Protection

Galvez said in South America the following diseases are important

Viruses Common mosaic virus - different to African and Indian

Vein virus

Latent virus - no symptoms

Mycoplasma - "witches' broom"

Virus resistance varies with climatic conditions and is most severe in the high temperature coastal areas inland there is less No improvement will be made until resistance is found

Jennings said strains of virus are known to exist even in the same field, therefore breeding for total resistance will be difficult

Magoon virus can be transmitted by grafts and white fly Leaf loss can be as much as 30-40 percent and chromosome number is increased in all parts of the plant No control method is known

Normanha said "witches' broom" causes 90 percent yield losses during severe attacks in Brazil Some areas have a 100 percent incidence Electron microscopy shows mycoplasma responsible Thrips also attack in areas with "witches' broom" and due to increase in disease when thrip populations increase, it is suspected that they may be transmitting agents

Bacterial diseases

Galvez Pseudomonas and Xanthomonas are both reported to cause bacteriosis in cassava Now known to be Pseudomonas

Product Characteristics

Composition of the root

1 35 percent dry matter
2 Dry matter is 80 percent starch
3 Crude protein is very variable, up to 7 25 percent on a wet weight basis
4 Fibre content is very low (less than 1 1/2 percent of fresh weight)
5 Fat is very low

Starch Quality

Little variation the viscosity is low for paper making

Yield

It was suggested that yield be measured in calories or starch The consensus of the more pragmatic members of the conference was that dry matter or density (hence dry matter) are the easiest methods of measuring yield

Conversion factors for starch were given as

Dry matter % - 6 8% = % starch (Bolhuis)
Dry matter % - 4 5% = % starch (Da Silva)

The starch (NFE) is 98 5 percent digestible

Nitrogenous Compounds

The nitrogen content and composition do not change with time

The nitrogen is 40-50 percent protein, the non-protein N is 50 percent free amino acids the remainder is glucosides and HCN This composition is independent of the N content of the roots

The crude protein is 40-50 percent digestible by the monogastric animal but is highly digestible by the nonruminant

The protein is lacking in the S amino acids methionine and cystine and possibly lysine and threonine

Cyanide

Chronic HCN poisoning is becoming well recognized it causes goiter and

nerve damage Boiling for 30 minutes removes all HCN however, there was some question on whether HCN built up again after standing

It was suggested that sweet varieties are more dangerous than bitter ones because people think they are safe In fact sweetness and HCN content are not directly related

Cyanide may interfere with the metabolism of sulfur amino acids It is excreted in the form of thiocyanate, which is detectable on a zero cyanide diet

Human Nutrition

The feeling that only inferior people on inferior diets eat cassava must be eliminated Some people prefer cassava to other feeds The question of leaf protein was raised, as was fermentation, etc

General

Cassava should be regarded primarily as an energy source releasing other resources for protein production

Agricultural Engineering

Normanha (1) A mechanical planter has been developed to plant two rows This fertilizes and plants
(2) Hand weeded and tractors
(3) Mechanical Harvester - must cut stems and leaves to 20 cm and then you pull through the field 90 percent of the cassava is obtained If heavy rooting varieties are harvested you have some problems
Chopper cuts stems and shreds them for harvesting of the root

Johnson What is the cost of the planter? $600 in 1964

Number of men required 1 tractor 3 men on planter

What is minimum size mechanized? No good answer

Hernandez What do you want to use machinery for?
-Research should be done on land preparation methods

Steppler Don't question the importance of size of farm, etc , but what are the characteristics of plant to achieve maximum mechanization?

What are engineering characteristics of crop itself?

Johnson The tropics are best not prepared Cassava approaches this The more earth you must move the greater power required Deep roots or widespread roots require much power and effort You must get out of ground during wet weather you have a real problem of harvesting and rotting of the roots Mechanization can change cost structure 50 men replaced by tractor If machine is effective and displaces men at this cost it changes drastically the cost of production People here work hard On world market, machines made a big difference in wheat, rice, corn etc Use present labor available (less than $0 10 US per hour) machinery needs to help men to make more money We need to aid the small farmers

Chippers moved by hand can be made and used by the small producer This is good for surplus cassava Industrial products require a different approach

Wilson Expand Steppler's question - Try to reduce man's labor time in sun May not be same for small farmer as for large farmer What sort of plant type is best for this type of harvesting?

Bolhuis Some varieties are lifted much easier than others

Thompson We need a close compact type of medium sized roots

Rogers Might use inter-cropping system in relation to land preparation Long term productivity with minimum fertilizer input Keep total aspect of production

Johnson Interplanting is attractive, and is being used on small holdings Could be exploited and should be studied It is what people do, but has not been investigated

Haynes Mechanization Level of meal is related to human resources Degree of mechanization is important Nigeria has light soils that will not stand mechanization Under-industralized countries have to use machines manufactured somewhere else at high cost to the user A more thorough look should be given to situation as related to environment We require a knowledge of actual practices Find out what is going on before we move

Grant Is it not true that development is related to type of work people do? One should use own resources but I wonder if we should expect people to do this type of manual labor

Haynes Method of mechanization is related to resources one has In the shallow soils of Africa, it is impossible to mechanize In Central America one could mechanize the deep soils

Jones Degree of mechanization is related to resources long run solution to agriculture is mechanization Poor soils will stay as before Short term problem is that the advantages are great, especially as related to labor Long run solution only possible when industry can absorb displaced people When land becomes scarce then mechanization to remove yuca at specific time may be of interest

Summary Ecology and system has influence on how you grow Mechanization is attractive to some and not to others Engineering related to preservation and post harvest handling

In area of 2 4 ha, 18-20 months, use 130 man days of labor

50 man days - weeding
50 man days - harvesting
More important

One man can harvest from 500 to 1000 kg of roots per day

Relative value of chips to cassava Thailand 1970 - $61 000,000

Varietal Improvement

Purpose of Varietal Improvement

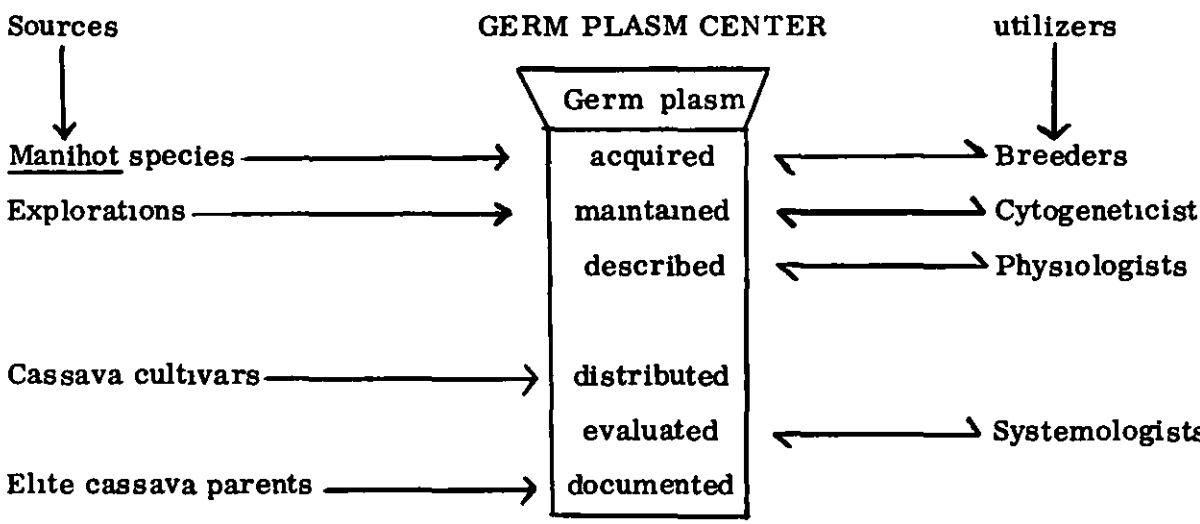
1 To extend cassava production into new areas because of the adaptability of Manihot

2 To improve the crop in areas where it presently is grown This will be possible through

a) removing present yield limits
b) removing such barriers to production as insect and disease susceptibility
c) developing plant characteristics as needed i e , mechanization and others
d) working on factors which promote yield by determining maximum yield for a given situation This is probably different than the optimum yield

To achieve these goals the germ plasm material is available

Germ plasm organization



This is a skeleton diagrammatic scheme of the germ plasm center There would be many features added to make it a flow chart scheme

Discussion notes

D L Jennings Elite cassava lines must be maintained in clonal plantings for easy vegetative propagation

Lines which are to be conserved for undefined reasons (preservation) should be maintained as seed Preventing the loss of valuable gene sources should be one of the main concerns for the germ plasm bank It is not possible to know what species will be valuable in the future

European workers are now trying to revive the old cereals to conserve old genetic material for future use The conservation of elite gene stock would warrant expensive procedures The preservation or conservation of other gene material must be evaluated carefully, which probably will require work on seed storage Descriptions of lines must be established and maintained for use by interested cooperators

Rogers Genus Manihot now consists of 95 species and innumerable cultivars which make the collection of all cultivars impossible Therefore the objectives of the germ plasm collection must be well defined before collecting everything

Cultivars do not exist in isolation so when a variant type is found there probably is a wild type in the area This wild type should be made available for breeding purposes

Because of widely varying environmental demands a single location for the germ plasm bank is not desirable or even possible Some of the species will only survive under ecological conditions where they are adapted, such as the Amazon or dry areas in other locations

E Hernandez Xolocotzin Practically all cassava programs start out with a collection of material but as enthusiasm wears off the maintenance of the collection appears to be excessive and the breeder in charge only maintains the elite material

Discarding of material or maintaining gene sources through composites often appears to be a simple way of reducing the need to keep everything In corn, the breeders found it necessary to go back to the old lines maintained in the area of collection when they could not recover genes fast enough from the composite lines maintained in the central bank

The following are some points for consideration in the germ plasm program

1 Budget needed
2 Problems of vegetative propagated crop
3 Seed research to preserve gene sources more easily
4 Establishment of a long time center for plasm

Hernandez stated that genetic erosion is a function of cultural erosion The Indian culture is maintained in many areas, which means that there has been a maintenance of maize variability and possibly even an increase rather than genetic erosion The same may be true of yuca

H Steppler F A O does not include root crops in their plan for germ plasm maintenance so some other organization should

There are two types of germ plasm banks somewhat analogous to banking systems i e

1 Savings bank put in the collection and simply maintain for future use
2 Checking account or the working collection for more or less regular use by the breeder, agronomist-physiologist or others This "bank" should have sufficient material available to avoid long delay in the utilization of it

CIAT's interest is in a working collection and the material should be described in working groups as soon as possible so the real work can proceed

In sunflower, lines susceptible to rust were identified through electrophloresis The possibility of similar work exists in cassava

M L Magoon Referred to the potato germ plasm bank as an example of the feasibility of vegetatively reproduced crops maintained in that way

S G Appan Made a presentation outlining the need for taking a systems approach to solving the cassava problems Discussion following this presentation centered around the fact that the systems approach would be a useful tool that should be used among other methods Steppler said one of the main advantages of the systems approach is that it gives us a much better coverage of the important parameters

Breeding Systems

D Jennings presented data showing his system of progeny testing through the use of analysis of variance for evaluation of the parental constants and interactions for the various yield components These components have not been well defined but reliable establishment of cuttings, ratio of roots to stem, number and size of tuber, leaf retention and others appear to be important

One of the fringe benefits of species crosses probably will be for incorporating specific desirable characteristics such as disease or drought resistance F_1 species hybrids are probably valuable for crossing and should be utilized to a larger extent in addition to simply backcrossing The genetic background is more important than the phenotypic rating

Magoon Breeding programs which have been successful are

a) Multiple crossing and test crossing
b) Species crosses are more for a long term program and results have been less favorable
c) Genome approach There is considerable buffering effect in breeding of a polyploid such as cassava In this approach one must consider
   1 Improvement of the genome itself
   2 Improvement of intergenome effect
d) Mutation breeding through physical or chemical mutagens This approach is useful for easily identifiable or specific purposes rather than general improvement, i e , early flowering, disease resistance, etc

Tissue culture

Feasibility studies should be conducted on tissue culture to evaluate its use within the cassava program Highly homozygous haploid material can be obtained from anthers cultured while in the uninucleate stage thus producing plants with reduced numbers of chromosomes

Before tissue culture could be utilized as a possible method for germ plasm conservation the stability of genetic characteristics and the system for plant regeneration must be evaluated

Jennings Varietal evaluation Varieties should be tested for yield over wide areas in order to evaluate these lines for adaptability This can be done by growing the lines in areas which are favorable or suited to the lines and other areas which are not The yield response in these two situations will indicate a high or low environmental response Testing of this sort will require a standardization of testing procedures

Normanha Varieties with particularly desirable characteristics are distributed to areas where insects cross pollinate the lines with locally adapted lines resulting in new cultivars with the desirable characteristic and adapted to the area Further testing of these lines is then done in the area where the characteristic is of greatest importance for utilization

Socio-Economic Factors

G Trant outlined the potential market picture for cassava as follows

I Domestic
- a) Fresh, human or animal consumption
- b) Partially processed, parboiled for humans
- c) Partially processed silage, chips for livestock
- d) Flour and starch, non-fermented fermented

II Export
- a) Fresh for human consumption as a delicacy
- b) Partially processed, mainly chips or pellets
- c) Flour and starch non-fermented, fermented

He stated that the issues related to the market are more complicated in the case of cassava than in cereals or other grains

Haynes stated that cassava can be competitive against maize and barley, since labor cost is low He emphasized that producer countries do not have control of the markets good possibilities exist for the use of cassava in bread-making

Silvestre The competition is not tough for cassava in the European common market Taxes on this product are only 6 percent compared with up to 56 pecent for cereals

- Some traditional dishes involving cassava could be industrialized

- The changes in traditional uses of cassava presuppose modification of cultural traits

- Cassava is a good crop for improving the economics at the farm level

B Nestel yuca will face competition with other crops in terms of energy sources

P Andersen no valid data is available

- Non-traditional uses may be the key to expansion of cassava production

- Second generation problems will have to be anticipated and studied in more detail

- The replacement of wheat by cassava flour in bread seems attractive What would be therefore the potential demand for this use in the future?

G Trant a Colombian law of 1947 requires the use of a certain portion (5-10 percent) of yuca flour in bread-making This law has not been enforced because the cost of the cassava flour has been too high Thus, such measures for promoting cassava are not successful unless the cost of the material is reduced

P Andersen agreed on a reduction of per unit cost, but questioned how it could be done at the farm level We do not have the necessary information He directed the following question to E Normanha "Do you know what the limiting factors are in Brazil?"

E Normanha these factors are

1 Agronomic
   a) Resistance to bacteriosis
   b) Resistance to insects, particularly Silva pendula
   c) High cost of fertilization
   d) Unfavorable weather conditions

2 Non-agronomic
   a) Price fluctuations 1970 Cr 50/ton
      1971 Cr 71/ton
      1972 planting stimulated by high price

B Nestel "Is there information on variable costs?"

G Trant answered yes CIAT Agricultural Economics personnel have made a survey that includes 125 records from Colombia that include variable cost components in relation to production

F Byrnes this discussion suggests that we can not do anything until we know more about the production system and what is the relative importance of the market and of the producer

Jones the major concern is feeding people Two factors must be considered

1 There are two types of producers small farmers, and large scale commercial enterprises

2 The introduction of technology is easier with the large producers

   - The small producer should be studied
   - Dr Jones expressed hopes that CIAT will not be too concerned with only achieving high yields and called for a total systems approach

Coursey one aspect of the overall problem in cassava production is that of transforming the crop from a subsistance crop economy to a cash crop economy

- One important factor is the short storage life of cassava A massive effort is needed in food technology to process food from cassava in factories

Sam - Aggrey supports Jones's views regarding the farmer The farmer acceptance must be taken into consideration

Beintenbach try breeding cassava under marginal conditions

J Cock that is difficult because genetic variability may not express itself completely

Bolhuis it may be desirable instead to breed under full fertilization to achieve expression of genetic characters

A Pradilla in Colombia the industrialization of refined sugar jacked up the price of brown sugar (panela) formerly used by low income groups Will it happen likewise in the case of cassava?

Hernandez reemphasized Haynes' point the export markets are controlled by countries which are not producers Internal consumption has few problems

Jones We need to know where we stand in cassava, especially as it relates to the small farmer

- The strategy of introducing one trait or innovation at the time is more effective in the case of the small farmer, than introducing a whole package provided that the innovation can work on its own merits

Notes on Recommendations and Comments for CIAT's Cassava Research Program

Germ plasm and Quarantine

Cooperative project with ICA must continue to insure clean stocks

Additional efforts must be made to collect and characterize germ plasm of the wild Manihot species that may be useful in breeding, perhaps evaluating the possibilities of exchange through true seeds

Breeding

The cytology of the genus Manihot should be up-dated, particularly taking advantage of modern technology now available Perhaps this effort best suited for a Canadian University Not a prime important aspect since no evidence exists that lack of cytological knowledge has limited possibilities in breeding by interspecific crossing In the long term efforts, the cytogenetic knowledge may be helpful

CIAT must be concerned with a practical breeding approach to develop more productive cassava types in a short term Low emphasis on basic research

Crop Physiology

-All physiological research should be tied, whenever possible to biochemical interpretation Caution should be exercised in experimental work in view of the high variability found in cassava

-Do not forget importance of role of N not only in its potential to produce higher protein content, but its possible role in additional HCN Where and how it is produced

-Tuberization ability information important early in program Need to define degree of variability in this aspect among cultivars and as a function of time in ground

-Physiology of flowering must be understood and information available to breeder

-Sugar levels and characteristics should be understood to relate them to sweet or bitter taste independent of HCN

-What is the auxin effect on rooting and storage root production?

Favorable results from Brazil

-Cooperation with Tropical Products Institute in their major effort to understand storage changes in roots

-Study of biosynthesis of cyanogenic glucosides by reciprocal crosses involving cultivars and related wild species

Tissue Culture

-Wageningen has had successful attempts CIAT should become familiar with this Also leaf culture successfully achieved at University of the West Indies, Trinidad

-Meristerm culture techniques should be developed for production of virus-free stocks

Agronomy

-Use biological mechanisms to define observations and analyses Flowering initiation could be the time-basis for observations on what the plant is doing or happening to it

-Conduct experiments with farmers, in their fields

Soils

-Stress research on acid soils, reaction to lime applications tolerance to low pH drought resistance

-Look into trace elements role in nutrition and limitations

-Minimum tillage studies, for soil to plant cassava

-Define nutrient demands by cassava

Plant Pathology

-Identification and assessment of pathogens in each country Avoid movement of diseased materials

-Need for training on cassava diseases work

-Possibility of cooperative work with University of Sierra Leone to do research on African mosaic virus

-Possibility of encouraging cooperation from Dr Chant who has great experience with diseases in Nigeria presently at Chelsea College

Entomology

No comments or recommendations

Weed Control

-Put attention on residual effect of chemicals

-Monitor new products

Utilization

-Wide range of possible utilization, but cost must be lowered to make cassava move from subsistance agriculture into processing, feed uses and exotic export items to developed countries

-Cassava will be a source of caloric and protein intake for human beings for a long time Would be advantageous to have higher protein content if feasible

-Additional uses will develop if starch price becomes low

-Possibility of developing cassava-based foods with enrichment protein content, by mixture addition or fermentation

-Better chances of success in acceptance for a genetically improved protein content in cassava than by artificial enrichment (case of Incaparina)

Agricultural Engineering

-Mechanical harvest and fresh storage highly important and limiting for large cassava production

-Needed short storage technology as buffer for processing plants, to lower losses

-Investigate simple farm practices for storage of fresh roots

-Large number of machines already developed for handling chopping drying Avoid duplication TPI has list of equipment manufacturers

-Pursue investigation of paraffine for root preservation

-CIAT should help early dissemination of knowledge on cassava processing equipment

Agricultural Economics

-Avoid areas of economic research highly dependent on country's conditions

-Needed economic study of processing

-Macroeconomic studies urgently needed

Documentation Services

-CIAT must publish promptly its results, in as many ways as it chooses to do so

-The international bibliography of cassava research should be available to all interested parties as soon as available

-CIAT must make the effort to secure financing to pay for duplication of personal and specialized bibliographies

-CIAT must cooperate closely with the International Society of Tropical Roots, participating in their events and taking advantage of the wealth of expertise available in different fields CIAT should use their symposia to disseminate information

Cassava Program Review Conference

Synthesis of Discussion

Future uses of cassava - Role of Cassava

Considerable divergence of opinions

-Raw material
-Staple food for a long time
-Animal feed will become more important
-Small importance as source of proteins
-Energy source
-Production for industrial and feed purposes (export) will be based on large scale mechanized farms

Productivity Factors

Suggested Yield Target 80/90 tons roots/ha/annum - feasible target

Indications of 84 tons/ha
150 tons/ha -24-26 mo

Plant Type Desirable one that maintains maximum leaf area and retains it longer Can be obtained from crossing with M glaziovii
-Leaf orientation to allow light penetration
-Effic in translocation
-Not excessively branched

Cultural Practices Interesting descriptions of practices
-Planting angles function of local environment
-Variable results from nutrition and spacing experiments— local conditions National program research
-Ridging, variable results
-Basic need to define the nutrient requirements of cassava cultivars became apparent from wealth of variable results discussed

Crop Protection
-Mosaic virus most important Virus diseases most important in Africa and South America
-Need to define and characterize virus of Africa and South America
-Sources of resistance - resistant varieties by breeding Pseudomonas most serious in America Phoma also

Product Characteristics

-Starch most important constituent
-Very uniform quality
-Different views on how to express yields in forms of D M , calories, starch, per area and time unit

N-Fraction

-Only 40-50 percent of N is protein nitrogen and 1/2 of non-protein N issue free A A
-40 percent of crude protein is digestable by monogastric animals It seems that ruminants can digest some of the non-protein N
-Consensus that protein level is too low and cassava should be considered as an energy rather than as a protein source

HCN

-Very few varieties free of cyanogenic glucosides
-Feeling of danger from ingestion of so-called "sweet" types
-Leaves have high HCN content
-HCN inactivates sulphur-containing amino acids
-Need for standard sampling and techniques

Agricultural Engineering

-Little critical information on mechanization
Need to develop models for the different aspects that might need help, from planting to processing
-Planter in Brazil
-Cultivars developed for hand cultivation might lend themselves to mechanization
-Research needed on land preparation in the tropics
-Possibility of reducing mechanization by chemical energy

Varietal Improvement

-Ample discussion on Germ plasm Center -
Needed not clear definition on how to operate it scale and cost must be defined
-Breeding Techniques Systems analysis has a role to play in identifying parameters and establishing priorities
Simple and sophisticated breeding Techniques were reviewed and discussed
More evaluation required of certain techniques such as the production of diploids and haploids

Varietal Evaluation

-Consensus that evaluation must be developed along uniform methods to produce comparable and meaningful results

Communications Systems

-The need for a cassava documentation center was recognized and several valuable suggestions were made on the services that it might provide to cassava researchers and institutions

Socio-Economic Factors

-Several potential markets for cassava and cassava products were reviewed, from fresh domestic human market to the export starch market

-Became apparent that the same type of root would satisfy the domestic market for human and animal feed However different root types would have to be developed to meet other market requirements

-More attention must be paid initially to domestic markets and to new uses in these markets

-Macroeconomic studies available are badly needed to develop realistic price policies