~~A GUIDE~~ GUIDE FOR CASSAVA FIELD TRIALS

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Cassava Production Systems

July, 1972

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Introduction

There is considerable expenditure for research work on different aspects of cassava. While many of these trials are properly conducted and provide useful information, others could be improved through relatively minor changes in techniques. Most experiments on cassava culture could provide useful information to a much wider audience if the experimental work included:

1. Well defined purposes, including those practical problems that stimulated the research work.
2. Uniform standarized designs and evaluation systems.
3. Proper support on ecological and climatic conditions of the area to provide background information.
4. Wide distribution of summarized results to insure broad application and prevent unnecessary duplication of experiments.

Frequently, faulty reporting of experimental work may lead other researchers to make errors. In such cases in which the objectives of the experiment were not achieved due to specific problems or unforeseen errors, it will be of great value to other researchers to expose these happenings in newsletters or circulars sent to cooperators. Unfortunately, such reports are not published very often.

The present guide for cassava trials is intended to provide a basic tool for the design of experimental work. Each research study will require additional plans, details and specific information. But it is hoped that this guide will assist the researcher in drawing up his experimental procedures and in obtaining a more complete record of his particular experimental conditions.

Through the cooperative effort of various institutions, more rapid advancement in cassava improvement should be possible. This cooperative work should in no way restrict independent and original work but rather enable the wider adoption of superior techniques and research systems, and reduce unnecessary duplication and thus, a regrettable loss of time and money.

The following are some of the items which should be given consideration in setting up experimental work.

Research objectives

Research is conducted to provide solutions to questions which cannot be obtained from available information. There is an unlimited number of interesting unanswered questions that may be asked about any subject in the universe; so one of the difficult jobs of the researcher is to define those problems which are significant, and to concentrate effort in providing solutions which will be of the greatest benefit compared with alternative uses for the inputs of time, effort and finances.

To assist in the evaluation of proposed research, it is necessary to answer questions similar to the following:

1. Is the problem important and why?
2. What information is presently available?
3. What will be the benefits from its solution?
4. Who will receive the benefits from its solution?
5. What is the cost of doing research on the problem and what might be the expected returns (cost-return ratio)?

If answers to these questions indicate that the problem is sufficiently important, clearly defined objectives or goals must be enumerated to assist in keeping work proceeding according to the plan and to provide guidelines for evaluating progress. These objectives must be specific to be of any value. As an example, "the evaluation of cassava roots" would be more clearly stated as the "measurement of diameter, length and distribution of 'Tempranita' cassava roots grown in fertilized and non-fertilized soil, nine months after planting."

A research project may have one or more objectives. List these in order of priority. It is often possible to use a single experiment for more than one purpose with relatively small additional inputs. The objective of a variety trial is usually to determine which varieties give the highest yield. Other objectives which can be included are evaluations for root size, starch, dry-matter content and plant evaluations for insect and disease resistance, growth habit, amount of planting material produced, and many others. If these are listed before the start of the work, it is easier to organize data collection.

The researcher must always be alert for the opportunity to obtain information which was not in the plan. However, if a decision must be made between meeting the requirements of the original plan and "an idea" occurring later; careful consideration must be given before making changes. If sufficient background information available from a literature review was used in drawing up the original plans, few changes are normally needed to complete the project.

CIAT is working on a collection of cassava literature which will soon be available to assist research workers in obtaining additional background information which is essential in all areas of research.

Experimental technique

No experimental plan or design will compensate for carelessness in experimental work. The use of replications and proper experimental design may help in the determination of better cultural practices, varieties, or management systems;but statistical calculations will never correct errors made in field plot technique. The objectives of the experiment must be clearly in mind before the plot layout or design can be made.

Location of experimental site

The first consideration must be to select experimental sites with environmental conditions which are representative of those where the results are to be applied. If the research is expected to give results for farm recommendations,a site with soil or other conditions typical of areas where cassava is produced must be chosen. Unfortunately, experimental farms cannot be suitable for all crops and may be on an atypical site for cassava. In this case, off-the-farm experiments should be considered. Where work has to be done on an experimental station, choose the site which is most representative of areas where the results are to be applied.

After selection of the general area, the specific site should be chosen to ensure uniformity of soil color, texture, slope, and previous cropping history. One of the best systems for evaluation of soil uniformity is to look at the proposed experimental area with a uniform crop on it, when it is under a slight moisture stress. Soil texture, moisture holding capacity, and other differences can be readily observed. Likewise, during rainy periods poorly drained areas are easily noted. If a field cannot be selected by observing a crop on the area, investigate soil depth, hard pans, plow soles etc., by using a soil auger and at the same time, take soil samples for analysis.

Avoid sites which may be on areas of old fertilizer experiments or where residues from chemicals applied for weed control in previous crops are a possibility. Low areas and banks of rivers which are likely to flood should not be used as cassava will not thrive in poorly drained soils. In laying out fertilizer trials avoid steeply sloping land which may allow movement of nutrients down the slope. Evaluation of specific conditions, such as varietal resistance to poor drainage, high or low soil pH, specific weed competition and others, must be conducted on areas where the conditions are uniform for the desired factor being tested.

Avoid placing experiments close to trees, hedges, ditches, and buildings which could influence the growth of the cassava. An experiment neatly laid in a rectangular block is the ideal of all research workers but this should not be done at the expense of experimental precision. Bad soil spots, ditches, trees, old building sites, and other poor areas can be avoided by placing individual replications wherever a uniform area with the correct dimensions can be found. Replications do not have to be adjacent to one another but the soil type should be as uniform as possible.

Laying out of plots

Transferring the experimental plan from paper to the field is normally easily done with well drawn plans. First establish a base line with a reference stake in one corner of the plot. Usually plots are located along a road, fence, or field border but provide sufficient border rows to eliminate effects of differences in fertility, compaction or other abnormal conditions often found along the edge of fields.

To finish laying out the plot a simple method for establishing square corners is the 3-4-5 system. Measure 30 feet (9.14 meters) from the plot corner along the base line, 40 feet (12.19 meters) at approximately right angles to the base line. If the corner is square the diagonal between the 30- and 40-foot points will be 50 feet (15.24 meters); if not, the angle should be adjusted so that the 30-40-and 50-foot ratio is reached. Other measurements can be used equally well but this ratio is simple to remember.

Any system for labeling plots which reduces the possibility of errors to a minimum is a good system. The amount of information included on the label depends on the treatments and purpose of the experiment. Taking unbiased notes is easier when the label only includes a plot number; however, including treatment information on the label facilitates applying treatments and makes it easy for anyone to observe differences without having to go back to the planting plan.

Regardless of the system used for coding treatments on the label, a standard system for positioning the label for each plot helps to avoid confusion among workmen and other persons looking at the plot. Labels fixed to stakes placed in the front left corner as one looks at a plot has some advantages over other locations. With that system there is no confusion as to the number of rows on each side of the stake as happens with center-placed stakes.

Plot size

Evaluation made on the basis of one or two plants is often useless due to plant-to-plant variation in the particular trait being measured. A preliminary review of the literature indicates that a minimum of between 16 to 32 sample plants are needed to give a reliable estimate of yield for particular treatments. Where plants are missing or stands are lacking in uniformity a larger number of plants must be available so that plants with normal competition can be harvested for yield purposes.

The plot area for yield determination should be readily converted to a universally acceptable large unit, e.g. hectares. One hundred square meters is a convenient unit which can be further subdivided into smaller areas as required. In this way the raw data can be converted into large units by moving the decimal place and multiplying by small whole numbers, and errors in calculation can be easily identified.

As an example: 130 kg of roots from 25 plants spaced 1 x 2 meters is easily converted to 26 tons per hectare by multiplying by 2 and adding 2 zeros (x200), where as the conversion of the yield of 114.4 kg from 22 plants would require a conversion factor of 227.27 which would be difficult to evaluate under field conditions.

Normally, it is desirable to have equal size plots for all treatments. However, in row-spacing and plant-population studies it is often difficult to maintain this equality. To obtain sufficient plants in wide-row spacing at low populations the plots may be excessively large at narrow spacings. Using equal numbers of rows may not be satisfactory either, since more rows may be needed to eliminate border effects in the narrow row spacing than in wide rows. For these reasons it usually is advantageous to use a combination of area and number of rows to secure reliable information from this type of study.

At present, spacing experiments are underway at CIAT using a systematic design resembling a fan. When the results become available it will be decided whether this type of design can be recommended for cassava.

Where yield samples are taken from plots of different areas, precautions must be taken to insure using the correct factor to convert sample yield to the standard yield per hectare. Conversions of yields obtained on a per-plant basis to a yield per hectare is meaningless unless there is a perfect stand and the border effect has been eliminated. Even then, yield overestimation is to be anticipated.

Replications

Experimental projects often fail to provide results because of over-complex plans involving too many treatments instead of sufficiently replicated simple experiments. Because of the variability observed in cassava it appears that four replications in simple experimental designs is the minimum. The purpose of replicating or repeating each treatment several times in an experiment is to obtain an average measurement of a particular treatment and, secondly, to provide a method of evaluating the variability and comparative "yield" between the different treatments within an experiment. Unless the difference between treatments within replications is greater than the variation between replications the differences one may find between treatments is probably due to chance alone. Uniformity within a replication is important. Differences between replications are not serious as long as the results of individual treatments remain in the same sequence. That is, if treatment A is higher than B in all replications one can be relatively sure that A is better than B even if the yield of all treatments in one or more of replications is considerably above or below those of the other replications.

Border rows

Most experiments will require border rows around each plot in order that edge effects and unequal competition effects between varieties or treatments producing different growth habits are eliminated. Fertilizer applications are difficult to distribute uniformly and accurately to an exact line, especially when incorporated by machinery, thus roots of plants take in nutrients from adjacent plants unless sufficient borders are provided for plot separation.

The number of border rows required will vary with the type of experiment, experimental plan, row spacing and other factors. Normally, at least two border rows are desirable around the outside of an experimental area. Within the experimental block, at least one row around the plants to be sampled is required. Additional rows will be required where close row spacing, widely contrasting plant types or other specific experimental conditions exist.

Where evaluations are to be made before there is competition between adjacent plants for light, moisture, or other factors necessary for growth, plants may be left unbordered but care must be exercised when such decisions are made. Germination studies may be left unbordered.

Border rows always enlarge the area needed for an experiment but neglecting to provide these borders may completely change the results of an experiment. Border plants can be used for developing sampling systems, testing materials and for other purposes before entering the experimental plot _per se_, providing that the destruction or reduction of the competitive effect of the border row does not occur more than a few days before taking the actual data from the experimental plot.

Management of experimental material

Seed material and planting system must be as uniform as possible for critical experimental work.

Cuttings should be selected from parent material of the same age grown under the same conditions and taken from similar positions on each plant. Cuttings taken from plants produced under very favorable conditions and moved to a new location to be compared with cuttings produced under unfavorable conditions may give biased or erroneous results. One research worker reported getting excellent results the first year when growing newly introduced varieties in a particular area. The second and following years most of the varieties were only ordinary in tests. Consistently reliable results were obtained only after using seed material produced under local conditions.

This requires planning trials at least a year ahead of time to have locally produced cuttings for all varieties being tested. The practice of taking seed material from uniform nurseries established for supplying cuttings should be followed whenever possible.

Seed material should always be handled carefully to avoid bruising which damages the buds and stem tissue. This can allow entry of disease organisms and cause drying out which reduced germination and seedling vigor where long time storage is required. The practice of dipping cassava cuttings in paraffin has been recommended. Experimental evidence will soon be available.

Planting systems

The system of planting varies greatly from one area to another. Therefore, length of cutting, position or depth of placement, planting on level land or ridges are factors to be decided by the experimenter in accordance with previous experience and experimental results. Whatever system is used should be clearly reported and the same system should be used throughout the entire trial.

The spacing of plants within the plot is very important if sample plants of uniform size are to be obtained. If the plants are to be grown on ridges formed either by hand or with machinery, care must be taken to assure that the rows are equally spaced at the desired distance apart. Check the distance between ridge tops after the first few passes of the tractor and adjust the implement if necessary. Never set up a ridging plow without checking the ridge it produces.

To obtain equal distances along each row use poles or wires the length of the plot, marked out at the desired distance between plants. Where labor is plentiful use two marked poles or wires, placing one down each outside row of the plot. Then, having squared the plot using the mentioned 3-4-5 triangle system,stretch string or something similar between the marks on the pole. In this manner, all rows can be planted simultaneously using a man for each row and a very uniform spacing can be achieved.

A stick cut to the desired distance between plants can be satisfactory but great care is required to do this. This method is not recommended because errors made in estimating the starting point for each distance can be easily introduced.

Missing plants

The loss of plants in many experiments masks the treatment effect which is being evaluated. As an illustration, in a comparison of size of seed pieces, the small cuttings germinated only 50 percent but, because of moisture shortage, the reduced population produced a higher yield-per-unit land area. The conclusions might be that small seed pieces are better than large, whereas in fact the experiment more correctly evaluated effect of populations and under more normal conditions the higher population would be expected to give better yields.

Where treatments might be expected to reduce populations, yield measurements can be misleading. A better evaluation of the treatments would be to count the cuttings which germinate and become established and express this as a percentage of the number of cuttings planted.

Almost perfect stands are desired in experimental work. Therefore, it may be advisable to put in extra cuttings when the trial is planted. Where adequate cuttings are available, perfect stands can be obtained by planting two cuttings for every plant desired and removing the extra plant after the seedlings are established. It cuttings are not plentiful, 20-30 percent more should be prepared and planted adjacent to the experimental site or in between border plants aroung the plots. These can later be transplanted to fill in for missing plants. Transplanting should be done as early as possible. "Hardening" the plants before transplanting by restricting water, avoiding root damage and giving abundant water after transplanting will help assure normal plant and root development.

Growing extra plants in soil-filled plastic bags will provide transplant material of the same age and origin as the original material. Care should be taken to avoid damaging the fragile root system of the young plant. Do not remove the bag from around the roots until after it is placed in the hole. Then, fill back the soil and press firmly around the plant. Since there is no root pruning when transplanting under this system, the plants will continue to grow more uniformly than where plants are dug out of the field and moved. The plastic bags are relatively cheap and plants can be maintained for up to 60 days with a minimum of effort to improve experimental results.

Experimental plot management

Experimental work should normally be conducted under cultural practices which can be followed by the majority of cassava producers regardless of the size of their operation. Different methods may be used by large commercial producers but the principles remain the same as for growers with only a few plants.

Unrealistic practices may lead to misleading experimental results. As an example, the practice of irrigating a variety trial in an area where water is unavailable to commercial growers may lead to the recommendation of a variety which will not maintain its yielding ability in the absence of irrigation.

On the other hand, good farming practices such as drainage, control of excess water, regular weeding (especially during the early growing period), attention to nutrient requirements, and pest and disease control, are essential. Of course, specific objectives of many experiments will require special management practices.

Application of fertilizer and chemicals

Several cassava field trials will be designed to determine what levels of plant nutrients are required for specific varieties, under different soil conditions during different stages of crop growth.

Simple "with or without" fertilizer trials can make use of granular formulations of a complete N-P-K type from commercial sources. If there is any doubt about the reliability of the grade used, a laboratory test should be made to confirm the analysis.

These formulations may not be available or be satisfactory for specific experimental requirements. If individual nutrients are to be mixed to make complete fertilizers they should be applied separately, or thoroughly mixed in the field immediately before making the application. Shaking mixtures of different-sized particles, while driving to the experimental site, can cause separation of the material resulting in uneven distribution in the field.

For hand application of fertilizers or chemicals the amount of material for each plot should be divided into half, and each portion spread separately over the entire plot to assure uniform application. Spreading half the material on the plot in one direction and the other half at right angles in regard to the first, also contributes to give better uniformity. Where a small amount of material is to be applied it should be mixed with some relatively inert substance such as soil, sand, or sawdust to provide enough volume to get an efficient coverage.

Spraying and dusting equipment must be well calibrated and carefully handled to assure complete coverage and uniform application rates. Care must be taken with the use of wettable powders in spray equipment that does not have an agitator in the tank. Settling to the bottom of the tank results in uneven applications and this will cause damage to plants when the last few liters of liquid in the tank are sprayed.

Testing or calibration of equipment should be done under field conditions but should not be done in the experimental plot. Extra plots or extra border rows in the field are often useful for testing of equipment or techniques.

It is desirable to have separate sprayers for herbicides and insecticides. However, when this is not possible, thorough cleaning between materials is essential. A 1 percent solution of ammonia left overnight in the sprayer will normally reduce the danger of damage from residues of hormone chemicals. It is important to pump the ammonia solution into all hoses and valves to be sure that residues in these parts are also neutralized. Soap and water solution work well for cleaning sprayers which have used nonhormone substances.

Weed control

Maintain experimental plots free of weeds. Better cassava producers follow this practice,so allowing weed growth in an experiment to "evaluate competition differences between varieties" could hardly be justified. Herbicides, hand weeding, or mechanical cultivation can all be used satisfactorily. Keep in mind the possibility of damage by incorrect choice or dosages of chemicals. Consult compatibility charts before mixing chemicals. Hand weeding and mechanized cultivation need careful supervision to avoid root damage by too deep penetration, erosion of ridges by hoeing,or damage to leaves and branches when the plants are large. All practices by hand, machinery or chemicals must be uniform throughout the experiment.

Insect control

The amount of insect damage that one can allow before applying control measures is always a difficult decision. Regular application of insecticides regardless of insect infestation are justified only for specific types of experiments where freedom from injury is the objective. Often,if a low level of damage can be tolerated,the insect's natural enemies may increase and provide satisfactory biological control. Application of insecticides at the first indication of the insect presence often reduces the natural predators or other biological control system so that continued measures are required. Daily observations of plants with potential problems is the best system for evaluating the need for control measures. If an infestation continues to increase, control measures can be taken at the point where damage no longer can be tolerated. Experience is the best guide to what that level of damage by a particular insect might be, before yield reduction occurs.

Plant diseases

After a disease infection is found there is little that can be done to eliminate it. This is the case with the majority of disease. Precautions should always be followed to prevent the introduction of new disease by spreading infection from one planting site to another. Several diseases are spread by using infected planting material. To prevent this, careful selection of disease-free planting stock is essential. Any plant which appears to be somewhat abnormal in growth habit should be avoided. Field sanitation procedures, such as crop rotation, weed control, destruction of all old plant material or complete coverage of such material by clean plowing, will reduce chances of infection by several diseases.

Extra precautions are needed to avoid transferring disease problems to new areas when planting material is transported. Whenever possible, a plant pathologist should inspect plantations before cuttings are taken for this purpose.

Identification and evaluation of new diseases should be made as quickly as possible by a plant pathologist. Where facilities are not available for immediate identification of diseases, samples of the affected plant or plant part can be taken, and forwarded to a laboratory for identification. Appendix A-7 gives instructions concerning the method for handling these samples and information to be submitted with the sample.

Harvesting and yield evaluation

Harvesting probably requires more labor than any other operation in cassava research and the system used will depend on availability, dependability and cost of labor. At present, no machine is available specifically for cassava harvesting. Various plows, disk hillers, subsoiling tines, cultivator shovels, and other types of equipment are used to assist in harvesting with varying degrees of success. The harvesting rate can be increased some but usually there is an increase in damaged roots and roots left in the field. Hand harvesting using shovels, pick axes, poles, and other hand tools still remains one of the most reliable systems for harvesting experimental plots.

The ideal situation for experimental work requires that conditions for all comparisons are identical except for those which are being evaluated. Harvesting procedures are no different and should be completed as rapidly and uniformly as possible, with emphasis on care and precision when yields are measured. A rain occurring at night, after part of an experiment has been harvested, may result in more soil adhering to the roots. Unless this soil is removed before weighing, the experimental results will be inaccurate. In a plot of 25 square meters, a weight variation of only 1.25 kilograms will result in a change in yield of half a ton per hectare. This would be the equivalent of only 50 grams per plant for an experiment spaced 1 m x 1 m. It is easy to see that care must be taken to harvest all roots and pieces of roots as well as removing dirt, stem pieces and other unwanted material before weighing.

Harvesting one replicate at a time rather than individual treatments in an experiment helps to insure uniform conditions. Weighing, dry-matter determination etc., should be done as soon after harvest as possible. A reliable scale must be used for field weighing. A portable "clock-type" spring balance, with a tripod and basket, is convenient for direct field weighing but it has a relatively low capacity and may be inadequate where large amounts of cassava are to be weighed. A platform scale which has a larger capacity can also be used in the field. However, it is more difficult to move and is more likely to be damaged by rough handling.

Regardless of the type used, the scale should be checked periodically for accuracy. Metal weights of precisely five or ten kilos should be obtained to test the scale up to its capacity or, at least, to the usual amount weighed on it. If the weights can not be bought locally, some kind of metal blocks can be accurately weighed, marked and used for calibration. Platform scales should not only be checked with different weight loads but with the weights located on different areas on the platform.

All scales are precision instruments and require careful handling to maintain them in proper working condition.

Under present marketing practices fresh root weight, total dry-matter and total starch are all important for yield considerations. Fresh root weight as discussed can be determined simply and easily. In evaluating varieties, fertilization practices and other experimental treatments — where there may be a change in starch content and thus in dry matter — some system for evaluating this material must be used.

Dry-matter determination sufficiently accurate for most purposes can be quite readily made by taking fresh root weight, chipping and drying the cassava chips to a constant weight in an oven at approximately 55-60° C. To determine the percent of dry matter, divide the oven dry weight by the original fresh weight and multiply by 100.

The length of time required to complete the oven drying will depend on type of oven, air circulation, thickness of the chips and other factors, but normally 24-36 hours should be sufficient. Preliminary tests made by weighing a few samples each 4-8 hours until a constant weight is reached will give a good indication of the time needed. Because the gelatinization temperature of starch is from 60-85° C, drying at too high a temperature may cause gelatinization and actually slow down the drying process.

Where oven facilities are not available for dry-matter determination, root samples can be weighed, chipped and sun-dried to prevent spoilage. In this form, the samples can be later taken to some other facility for determination of residual moisture through oven drying. For this system, larger samples (up to 10 kg) are recommended. Where dry-matter estimates for different varieties or treatments are not required, bulked samples may be used to give some idea of dry matter to supplement the fresh weight yield data.

Analysis for starch content is complex and requires precision equipment for accurate results. Standard methods for determination of starch and dry matter are described in the publication Official Methods of Analysis, published by the Association of Official Agricultural Chemists, must be followed where precise analysis is required. Estimates of starch can be made based on dry-matter content by subtracting a constant. The constant 7.3 has been utilized by several workers. However, it is recommended that workers determine constants under their own conditions and for each new set of circumstances such as change of variety or cultural practice.

Similarly, estimates of starch content can be made from specific density of the root. Appendix B-3 gives a conversion for root density to total and industrial starch content prepared by Cours (3). It is recommended that a similar table be prepared for use under local conditions. Root density is obtained by weighing a sample of roots in the air and again under water and then calculated using the following formula:

$$\text{Density} = \frac{\text{Root weight in air}}{(\text{Root weight in air}) - (\text{Root weight in water})}$$

By using large samples (5-10 kg) for density evaluation, small variations between samples can be detected.

A relatively simple mechanical starch analysis system reported by Krochmal & Kilbride (7) can be used to give a close approximation of starch recovery to that of a commercial mill. Duplicate fifty-gram samples of fresh cassava roots in 500 ml of water are macerated in a blender for five minutes and the starch washed out of the pulp through a 200 mesh screen with 500 ml of water. The washings are dried in a convenient-sized pan in a forced-draft oven at 85 °C and then weighed. The results are expressed as a percentage of the fresh root weight.

Recording of data

The recording of data is simply making notes of evaluation through observation or measurement. The notes should be sufficiently complete and organized to permit comparison and to serve as a reminder to the researcher and others. This requires that they are brief, accurate and easily interpreted after one has forgotten many of the little details which were observed at the time they were taken. Photographs are very helpful for giving overall impressions but cannot replace accurately taken notes.

Notes are best taken in field books or directly in specially designed data sheets; the last method does not require unnecessary transfer of data. A somewhat soiled book is often more reliable than an immaculate typewritten sheet where errors have been made in the transfer of data. Wherever possible, the use of numbers or letters which can be converted to numbers is advisable for recording of data. Almost all types of information can be grouped and assigned numbers which facilitate analysis. The careful choice of units for recording data can help avoid errors during transfer and calculations. Yields in pounds per plot requires an additional conversion when the yields are to be reported in kilograms per hectare.

Because of the wide variation in growth period of cassava, yields are more easily compared if they are reported in kilograms of dry matter per hectare per day (kg/day) in addition to unit weight per unit land area (kg/ha). In areas where possibilities exist for continuous cropping programs the yield per unit time is as important as the yield per unit land area.

Numbering the days in the year beginning with "1" for January 1 and running through "365" for December 31, can facilitate calculation of time intervals between various growth stages, observation, or treatment periods.

Presentation of results

Maximum utilization of information collected and recorded by an investigator must be encouraged. Other persons will benefit from the widespread distribution of pertinent information. If the results of the research are not of sufficient importance to warrant publication in journals, other types of publications can be used (leaflets, progress reports, and other informal types of communication). Nevertheless, the results, with explanations of problems or discrepancies, should be published in order to insure that other investigators who may encounter similar problems may benefit from the experience.

Opinions without factual evidence may also be included as long as they are clearly stated as such.

Results should be reported initially in terms that will be meaningful to the individuals using the results. This will include the farmer or producer in such areas where the same local units of measurement are used. To avoid confusion to collaborators in other countries it is helpful to convert the obtained results into standarized terms which are easily comparable from one area to another, such as kg/ha, or include a conversion factor for this purpose.

Selected references

About two thousand individual articles dealing directly with cassava appear in the literature. These articles are widely distributed throughout journals, experimental station annual reports, bulletins, etc. They are written in any one of six languages.

CIAT is currently collecting much of the published material and is publishing relevant references in order to assist interested workers in obtaining copies or abstracts of papers. Requests should be sent to The Librarian, Centro Internacional de Agricultura Tropical, Apartado Aéreo 67-13, Cali, Colombia, S.A.

A list of references which should help in obtaining background information and assist in finding specific information is presented below.

1. Albuquerque, Milton. 1969. A Mandioca na Amazonia. Superintendencia do Desenvolvimiento da Amazonia. Belem, Para, Brazil. (a).

2. College of Tropical Agriculture. 1970. Proceedings of the Second International Symposium on Tropical Root and Tuber Crops. University of Hawaii. Volume I. (a).

3. Cours, G. 1951. Le Manioc a Madagascar. Memoires de L'Institut Scientifique de Madagascar. Tome III. Series B. 203-400. (b).

4. Hermann, Luiza S.E. 1968. Bibliografia da Mandioca. Secretaria da Agricultura do Estado de Sao Paulo. Instituto Agronomico. Campinas, Brasil. (c).

5. Jennings, D.L. 1970. Cassava in Africa. Field Crop Abstracts 23: (3): 271-8. (b).

6. Jones, W.O. 1959. Manioc in Africa. Stanford University Press. Stanford, California. 315 p. (a).

7. Krochmal and Kilbride. 1966. An inexpensive laboratory method for cassava-starch extraction. University of Puerto Rico. Jour. Agric. 50(3):252-253. (b).

8. Montaldo, Alvaro. 1967-1969. Bibliografia de Raices y Tuberculos Tropicales. Universidad Central de Venezuela, Facultad de Agronomia. Maracay, Venezuela. Alcance No. 13 (Diciembre 1967) & Alcance No. 13 Supl. 1 (Diciembre 1969). (c).

9. University of the West Indies. 1967. Proceedings of the International Symposium on Tropical Root Crops. St. Augustine, Trinidad. Volumes I & II. (a).

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a = books; b = articles; c = bibliographies.

Supplementary Information

Keeping an experimental diary with careful recording of treatments and observations is essential in order to interpret results correctly. With this purpose in mind we are including pertinent supplemental information to help the researcher organize his experimental work. Permission is here given to anyone wishing to use or copy these forms. Individual preferences and experiment design will require modification of these forms. Any comments, changes or additions concerning any of them would be appreciated by the authors. In some cases, it will be impossible to obtain or supply all the information called for but, in many instances, the blanks will serve as reminders of information that is readily available. The following list includes the supplementary information that we can offer at the present time:

Appendix A-1: Form for planning the experiment.

The planning form includes objectives for the work, treatments planned, organization of plants within the plots and the plots within the field. Also included is a sheet for calculation of fertilizer applications, but this could be used for insecticide or herbicide applications as well.

Appendix A-2: Background information.

A properly filled out background information form will supply information on soil, climate and previous crop history of the experimental site.

Appendix A-3: Diary of experimental procedures.

Information for the diary of experimental procedures forms normally is well known to the researcher but often neglected when the work is described to someone else. Proper use of a form similar to this can provide a record of all field operations.

Appendix A-4: Economic evaluation form.

This form includes two parts; the first is intended to provide a brief frame of reference for the monetary value of a particular country at a particular time. This would enable a comparison of production costs between different countries or within a country for different time periods. Admittedly the data would be rather crude but would be better than no information at all.

The second part of this form provides opportunities for recording production costs.

Appendix A-5: Harvest data form.

This form will provide an idea of some of the items which might be considered important at harvest. When possible, dry-matter determinations should be made for all items when fresh weight values are made. For some items such as weeds a single bulk sample may be sufficient rather than a moisture determination for each plot.

Individual research objectives will determine the actual information needed on this form.

Appendix A-6: Climatic data form.

Some type of form or book should be used to record weather data. These records must be maintained in a permanent file. Standard reporting forms are often available from the national weather services.

Appendix A-7: Instructions for handling plant-disease samples for identification.

Instructions for preparing disease samples and information needed to assist in identification of specimens.

Appendix B: Conversion factors for:

B-1 English and metric units
B-2 Calendar date and day number
B-3 Root density and starch content

Appendix A-1

Form for planning the experiment

Experimental number ________

Date ____________________

Title of experimental work: ____________________

____

Objective or objectives: ____________________

____

____

____

Factors in experiment A ________ B ________ C ________

Levels for each factor ________ ________ ________

________ ________ ________

________ ________ ________

________ ________ ________

________ ________ ________

________ ________ ________

________ ________ ________

________ ________ ________

________ ________ ________

________ ________ ________

________ ________ ________

Experimental design: ____________________

____

Main plots ____________ Sub-plots ____________

Other ____________________

Total treatments ____________________

No. of replications (minimum 4) ____________________

Total No. of plots (total treatments x reps) ____________________

Summary of treatments:

Treatment	Plot number			
	I	II	III	IV

Experimental Layout

Diagram of Individual Plot

Individual Plot

No. of sample plants ______

No. of guard plants ______

Total No. of plants (A) ______

Width between rows ______

Distance between plants ______

Plants per hectare =
10000 ÷ area per plant ______

Sample area:

______ ______ M x ______ M = ______ M^2

______ ______ M x ______ M = ______ M^2

Yield conversion factor:

10, 000 ÷ ______ M^2 = ______

10, 000 ÷ ______ M^2 = ______

Diagram of Replicate

No. of plots per replicate (B) ______

No. of plants per replicate (AxB) ______

Diagram of Experiment

No. of replicates (C) ______

Total No. of plants = (A x B x C)

______

Extra cuttings needed:

Poor germination, etc. + 10-15% ______

Extra border, fill, etc. ______

Total cuttings needed ______

Land area:

Net experimental area (plots) ______ M

Alleys and roads ______ M

Extra borders, etc. ______ M

Total land area ______ M

Fertilization plan

Plot size: ________m x ________m = ________m^2

Element needed	Material to be used, analysis and system of application	Nutrient per ha.	Amount needed material		No. of plots	Total material needed
			per ha.	per plot		

Appendix A-2

Form for background information to the experiment

Background information:

Person responsible: Name, address and organization ____________________

____

____

____

Cooperating individuals or groups ______________________________

____

____

Location of experiment ____

Latitude ______________________________ Elevation ________________

Brief description of climate: annual rainfall ________ mm

Dry months ______________________ Rainy months __________________

Temperature (approx): max. ________ min. ________.

Nearest meteorological station, name and address ____________________

____

Slope ________________________%. Direction ____________________

Soil textural class (sand, silt, clay, etc): top soil ________ subsoil ______

Soil depth - topsoil ____

Official soil classification or name ____________________________

Drainages surface: good, medium, poor. Internal: good, medium, poor

Water holding capacity: high ________ medium ________ low __________

Is irrigation available if needed? ______________________________

Laboratory soil test:

Name and address of laboratory ______________________________

____

Type of tests used for pH __________ Phosphorus ________ Other __________

Results:

Organic matter ______________ Available Phosphorus ____________ Exchangeable Potassium _______

pH in H_2O _______ in KCl _____ Other tests: exchangeable Al ____ Ca ________

Mg ________

Previous Cropping History

Previous crop ____________________ Yield ____________________

Fertilizer or amendments added: kind and amount ____________________

____

____

Deficiency symptoms? ______________________________

Weed problem? ______________________________

Control measures used ______________________________

____

____

Insect problems ______________________________

____

Control measures ______________________________

____

Appendix A-3

Form for diary of experimental procedure

Management of previous crop residues ______________________

____

Primary tillage

Plowing or hand tillage ______________________

____

Secondary tillage

Disking,etc. ______________________

____

Other ______________________

____

Fertilization: See fertilization plan.

Planting

Time of planting: Day No. ________

Planting system used:

flat bed ______________

ridged ______________

other ______________

Stake: length _____cm, diameter _____cm, number of buds_____,

diameter of buds _____.

Origin of stake: apical ________ basal ________ mixed ________

Stake position in the ground:

horizontal ________ depth ________

vertical ________

inclined ________ approx. ________° angle

Depth to bottom of vertical or inclined stake ________ cm

Location of top of vertical or inclined stake

a) Below the surface ________ cm

b) Above the surface ________ cm

Germination and transplanting

Date of emergence (approx. 50% of plants emerged) Day No. ________

Percentage of germination (approx. 30 days after planting) ________

Transplanting completed or excess plants removed. Day No. ________

Height of plants ________ cm

Results of transplanting: Percent survival ________ %

Weed control

Chemical applied ________________________

Rate of application (Active ingredient) ________________________

Time of application: Day No. ____. Indicate application system: pre-plant, pre-emerge, post-emerge, overall coverage, post emerge directed.

Results ________________________

Cultivation or hand weed control: system used ________________________

Time of cultivation(s): Day No. ________ ________ ________

Type of weeds present and percent ground covered by weeds at time of cultivation or chemical application and at harvest: dry-weight yield of weeds per hectare at harvest is a good indication of weed present ________

____

____

Insect control

	Applications 1st	2nd	3rd
Problem encountered			
Degree of infestation			
Control used			
Day No.			
Material			
Rate active ingredient			
System of application			
Results			

Appendix A-4

Economic evaluation form

Date ____________, 19___

Local monetary Unit ________ Exchange rate _________ equals $1.00 U.S.

Interest rate for money loaned for agricultural purposes where available

______% p/year

Cost-of-living reference, consumer prices for:

rice ______ per kg; corn ______ per kg; bread _____ per _____ gm loaf.

beer _____ per bottle; cigarette(s) ______ per package.

Cassava market prices

1. Fresh edible root
   Wholesale or farmers price ______ per kg.
   Retail or consumer price ______ per kg.

2. Roots for processing or feed purposes: i.e. starch, flour, chips, etc.
   Wholesale or farmers price _____ per kg of roots.

   Product produced ____________ value per kg.
   Approximate yield of product per 100 kg of fresh roots ____________

Production costs:

1. Labor (time basis)
   Cost per hour ________, day _________, or month ________
   Include insurance, retirement, and other benefits where applicable

2. Labor (job basis)

	Job	Unit of measurement	Price	Yield per worker per day
Example	Harvesting cassava	per plant	0.25 Col.	75 plants
	Weeding cassava	per. sq. m.	0.05 Col.	500 m^2

Mechanization Costs:

	Machine	Cost	Unit of measurement	Yield per hour or day
Example	Tractor and plow	$80.00 Col.	per hour	1/2 ha/hour

Plant protection:

	Material	Cost	Unit of measurement	Quantity used	Price/ha
Example	Cotoran	198.86	kg 50% A.I.	6 kg/ha	$1,157.00

Other additional costs:

Seed Material

Watchmen for guarding fields
Sacks or other marketing packages
Transportation of market products

Appendix A-5

Harvest data form

Name of experiment ______________________________

Person in charge of harvesting ______________________. Field conditions at harvest, (wet, dry, etc) ______________________________

a. Harvest date __________ Day No. _____. b. Planting date __________ Day No. _____. Total growing period __________ days
(a–b if over 1 year + 365 = age).

Plot size: No. of plants _____, Spacing ____ m x ____ m, Area ____ m^2 Conversion factor ______________________________

Plot No.	Total weeds per 4 m^2 sample	Stem number per seed piece	Stem diameter 10 cm above ground level. 4 stem ave.	Number of plants harvested per plot	Number of Roots			Fresh field weight				Dry matter determination			Root dry matter	
					Per Plot		Average market-able per plant	Average size	Roots Total	Market-able	Stems and Leaves	Wet wt	Dry wt	% DM	per/ha	per/day
					Total	Market-able __cm long __cm dia.										
	kg							kg	kg	kg	kg	gm	gm	gm		

Climatic Data Form

Year ______________ Station ______________ Country ______________ State ______________ City ______________

Month																		
Date	Prec.	Temp. Max.	Temp. Min.	Prec.	Temp. Max.	Temp. Min.	Prec.	Temp. Max.	Temp. Min.	Prec.	Temp. Max.	Temp. Min.	Prec.	Temp. Max.	Temp. Min.	Prec.	Temp. Max.	Temp. Min.
1																		
2																		
3																		
4																		
5																		
6																		
7																		
8																		
9																		
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24																		
25																		
26																		
27																		
28																		
29																		
30																		
31																		
Total																		
Monthly Ave.																		
Long time Ave.																		

Appendix A-7

Plant disease identification form

See following page for instructions on how to collect and ship specimens for disease diagnosis.

Please supply the following information:

Sender ______________ Title ______________ Address ______________
Farm's name ______________ County ______________ State ______________ Country ______________
Date received ______________ Date collected ______________
Previous crops ______________ Actual crop ______________ Variety ______________
Plant part injured: roots ______________ stems or branches ______________
Leaves ______________ flowers ______________ fruits ______________
General appearance of plants: wilted ______________ yellowed ______________ stunted ______________
Abnormal leaf or stem growth ______________ leaf spot or blight ______________
Leaf-mottle ______________ other ______________
Distribution of disease: scattered ______________ group of plants ______________
most of field ______________ on slopes ______________ low areas ______________ upland areas ______________
Weather conditions of previous weeks: rainfall ______________ highest temperature ______________
______________ lowest temperature ______________ wind ______________ others ______________
When were symptoms first noticed? ______________
Cropping history: ______________
Chemicals applied and rates during current growing season and previous year:

	Chemical applied	Rate + frequency	Date
Fertilizer			
Fungicide			
Herbicide			
Insecticide			
Nematocide			

When was the last soil test taken? ______________ pH of soil ______________

Diagnosis and control measures:

____
____
____
____

Date: ______________

Instructions for handling plant disease samples for identification

You can help the local plant pathologist by reading these instructions before sending him the samples.

The accurate diagnosis of a plant disease depends upon receiving a fresh sample. All specimens should be fresh when collected and shipped immediately. When specimens arrive unidentified, wilted, crushed, or in advanced stages of decay, diagnosis is often impossible. If the sample is in good condition the disease can be diagnosed more rapidly.

Collecting Specimens

Small Plants

1. Collect the whole diseased plant, including roots, if possible, and at least one pint of moist soil. Dig (don't pull) plants with a fork, shovel or trowel.

2. Collect more than one plant if various stages of decline are evident. Completely dead or dry plant material is of no value. When possible, include healthy plants or plant parts for comparison.

Large Plants

3. Collect the portion of the stem, root, or other plant part that displays the symptom and pack it so it will remain as fresh and typical as possible.
   When distinct spots on the leaves are the only symptoms, include several leaves wrapped between dry strips of cardboard or in a thin magazine. Do not wrap leaves in wet paper towels. However, enclose a wet paper towel in the plastic sack.

Packaging Plant Specimens

1. Immediately after digging small plants, place the moist root ball in a plastic bag and tie the top around the stem just above the soil line. This will prevent the soil from drying during transit. Enclose the tops of the plants in a ventilated plastic bag. Do not wet the tops before packaging.

2. Specimens should be packed in a sturdy container to prevent damage in transit. Avoid exposure to high temperatures. Whenever possible avoid weekend lay-overs in the post.

3. Complete the plant disease identification form, and attach to the outside of the shipping container.

Appendix B-1

Conversion Factors for English and Metric Units

To convert column 1 into column 2, multiply by	Column 1	Column 2	To convert column 2 into column 1, multiply by
		Length	
0.621	kilometer, km	mile, mi	1.609
1.094	meter, m	yard, yd	0.914
0.328	decimeter, dm	feet, ft	3.048
0.394	centimeter, cm	inch, in	2.540
		Area	
0.386	kilometer^2, km^2	mile^2, mi^2	2.590
247.1	kilometer^2, km^2	acre, acre	0.00405
2.471	hectare, ha(0.01 km^2)	acre, acre	0.405
10.76	meters^2, m^2	feet^2, ft^2	0.0929
		Volume	
35.31	meters^3, m^3	feet,^{3} ft^3	0.0283
0.00973	meter^3, m^3	acre-inch(3,630 ft^3)	102.8
3.532	hectoliter, hl	cubic foot, ft^3	0.2832
2.838	hectoliter, hl	bushel, bu (.8036 ft^3)	0.352
1.057	liter	quart, qt (U.S. liquid 946 cc)	0.946
0.880	liter	quart, qt (English liquid 1136 cc)	1.1365
		Mass	
1.102	ton (metric)	ton (English)	0.9072
220.5	quintal, q	pound, lb	0.00454
2.205	kilogram, kg	pound, lb	0.454
0.0353	grams, g	ounces (avdp), oz	28.35
		Yield or rate	
0.446	ton (metric)/hectare	ton (English)/acre	2.242
0.892	kg/ha	lb/acre	1.121
0.892	quintal/hectare	hundredweight/acre	1.121
		Pressure	
14.22	kg/cm^2	lb/inch^2, psi	0.0703
14.50	bar	lb/in^2, psi	0.06895
0.9869	bar	atmosphere, atm*	1.013
0.9678	kg/cm^2	atmosphere, atm*	1.033
14.70	atmosphere, atm*	lb/in^2, psi	0.06805

*An "atmosphere" may be specified in metric or English units.

Plant Nutrient Conversion

2.29	P (element)	P_2O_5	0.437
1.20	K (element)	K_2O	0.833

Temperature

1.80C + 32	Celsius, C	Fahrenheit, F	0.555(F-32)

Light

0.0929	lux	foot-candle, ft-c	10.764

Conversion table for calendar date to day number

Calendar Date	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Calendar Date
1	1	32	60	91	121	152	182	213	244	274	305	335	1
2	2	33	61	92	122	153	183	214	245	275	306	336	2
3	3	34	62	93	123	154	184	215	246	276	307	337	3
4	4	35	63	94	124	155	185	216	247	277	308	338	4
5	5	36	64	95	125	156	186	217	248	278	309	339	5
6	6	37	65	96	126	157	187	218	249	279	310	340	6
7	7	38	66	97	127	158	188	219	250	280	311	341	7
8	8	39	67	98	128	159	189	220	251	281	312	342	8
9	9	40	68	99	129	160	190	221	252	282	313	343	9
10	10	41	69	100	130	161	191	222	253	283	314	344	10
11	11	42	70	101	131	162	192	223	254	284	315	345	11
12	12	43	71	102	132	163	193	224	255	285	316	346	12
13	13	44	72	103	133	164	194	225	256	286	317	347	13
14	14	45	73	104	134	165	195	226	257	287	318	348	14
15	15	46	74	105	135	166	196	227	258	288	319	349	15
16	16	47	75	106	136	167	197	228	259	289	320	350	16
17	17	48	76	107	137	168	198	229	260	290	321	351	17
18	18	49	77	108	138	169	199	230	261	291	322	352	18
19	19	50	78	109	139	170	200	231	262	292	323	353	19
20	20	51	79	110	140	171	201	232	263	293	324	354	20
21	21	52	80	111	141	172	202	233	264	294	325	355	21
22	22	53	81	112	142	173	203	234	265	295	326	356	22
23	23	54	82	113	143	174	204	235	266	296	327	357	23
24	24	55	83	114	144	175	205	236	267	297	328	358	24
25	25	56	84	115	145	176	206	237	268	298	329	359	25
26	26	57	85	116	146	177	207	238	269	299	330	360	26
27	27	58	86	117	147	178	208	239	270	300	331	361	27
28	28	59	87	118	148	179	209	240	271	301	332	362	28
29	29	--	88	119	149	180	210	241	272	302	333	363	29
30	30	--	89	120	150	181	211	242	273	303	334	364	30
31	31	--	90	--	151	--	212	243	--	304	--	365	31

To determine the number of days between two dates, subtract the day number of the first from the second. If the second is smaller than the first or the interval is over a year add 365 to the second number. Example: Cassava planted June 24, 1972 determine the age of the crop when various treatments are applied.

Treatment	Date	Day No.	Calculations	Age in Days
Planting date	June 24	175	-	
Fertilizer applied	July 15	196	196-175	21
Insecticide applied	Aug. 10	227	227-175	47
Harvest dates	Apr. 24	104	104+365-175	294
	Aug. 24	236	236+365-175	426

Appendix B-3

Conversion factors for root density and starch content
(From Cours)

Density	% Starch T*	% Starch I	Density	% Starch T	% Starch I	Density	% Starch T	% Starch I
1064 ..	8,8	0,34	1110 ..	20,5	13,63	1156 ..	31,2	25,78
1065 ..	9,1	0,68	1111 ..	20,7	13,85	1157 ..	31,5	26,12
1066 ..	9,3	0,90	1112 ..	21.—	14,20	1158 ..	31,7	26,35
1067 ..	9,6	1,24	1113 ..	21,2	14,42	1159 ..	31,9	26,58
1068 ..	9,9	1,59	1114 ..	21,5	14,76	1160 ..	32,1	26,80
1069 ..	10,1	1,81	1115 ..	21,7	14,99	1161 ..	32,4	27,15
1070 ..	10,4	2,15	1116 ..	21,9	15,22	1162 ..	32,6	27,37
1071 ..	10,6	2,38	1117 ..	22,2	15,56	1163 ..	32,8	27,60
1072 ..	10,9	2,78	1118 ..	22,4	15,79	1164 ..	33.—	27,83
1073 ..	11,2	3,06	1119 ..	22,7	16,13	1165 ..	33,2	28,05
1074 ..	11,4	3,29	1120 ..	22,9	16,35	1166 ..	33,5	28,40
1075 ..	11,7	3,64	1121 ..	23,1	16,58	1167 ..	33,7	28,62
1076 ..	11,9	3,86	1122 ..	23,4	16,92	1168 ..	33,9	28,85
1077 ..	12,2	4,20	1123 ..	23,6	17,15	1169 ..	34,1	29,08
1078 ..	12,5	4,54	1124 ..	23,8	17,38	1170 ..	34,3	29,30
1079 ..	12,7	4,77	1125 ..	24,1	17,72	1171 ..	34,6	29,64
1080 ..	13.—	5,11	1126 ..	24,3	17,94	1172 ..	34,8	29,87
1081 ..	13,2	5,33	1127 ..	24,6	18,28	1173 ..	35.—	30,10
1082 ..	13,5	5,68	1128 ..	24,8	18,51	1174 ..	35,2	30,33
1083 ..	13,7	5,90	1129 ..	25.—	18,74	1175 ..	35,4	30,55
1084 ..	14.—	6,24	1130 ..	25,3	19,08	1176 ..	35,6	30,78
1085 ..	14,3	6,58	1131 ..	25,5	19,31	1177 ..	35,9	31,12
1086 ..	14,5	6,81	1132 ..	25,7	19,53	1178 ..	36,1	31,35
1087 ..	14,8	7,15	1133 ..	26.—	19,88	1179 ..	36,3	31,58
1088 ..	15.—	7,38	1134 ..	26,2	20,10	1180 ..	36,5	31,80
1089 ..	15,3	7,72	1135 ..	26,4	20,33	1181 ..	36,7	32,03
1090 ..	15,5	7,95	1136 ..	26,7	20,67	1182 ..	36,9	32,26
1091 ..	15,8	8,29	1137 ..	26,9	20,90	1183 ..	37,2	32,60
1092 ..	16.—	8,52	1138 ..	27,1	21,12	1184 ..	37,4	32,83
1093 ..	16,3	8,86	1139 ..	27,4	21,47	1185 ..	37,6	33,05
1094 ..	16,5	9,08	1140 ..	27,6	21,69	1186 ..	37,8	33,28
1095 ..	16,8	9,42	1141 ..	27,8	21,92	1187 ..	38.—	33,51
1096 ..	17.—	9,65	1142 ..	28,1	22,26	1188 ..	38,2	33,73
1097 ..	17,3	9,99	1143 ..	28,3	22,49	1189 ..	38,4	33,96
1098 ..	17,5	10,22	1144 ..	28,5	22,72	1190 ..	38,6	34,19
1099 ..	17,8	10,56	1145 ..	28,7	22,94	1191 ..	38,9	34,53
1100 ..	18.—	10,79	1146 ..	29.—	23,28	1192 ..	39,1	34,76
1101 ..	18,3	11,13	1147 ..	29,2	23,51	1193 ..	39,3	34,98
1102 ..	18,5	11,36	1148 ..	29,4	23,74	1194 ..	39,5	35,21
1103 ..	18,8	11,70	1149 ..	29,7	24,08	1195 ..	39,7	35,44
1104 ..	19.—	11,92	1150 ..	29,9	24,31	1196 ..	39,9	35,67
1105 ..	19,3	12,26	1151 ..	30,1	24,53	1197 ..	40,1	35,89
1106 ..	19,5	12,49	1152 ..	30,3	24,76	1198 ..	40,3	36,12
1107 ..	19,7	12,72	1153 ..	30,6	25,10	1199 ..	40,5	36,35
1108 ..	20.—	13,06	1154 ..	30,8	25,33	1200 ..	40,7	36,57
1109 ..	20,2	13,29	1155 ..	31.—	25,56			

* Total starch content indicated by T
  Industrial starch content indicated by I

The figures listed are for two year old Cassava roots. Younger roots would have higher proportions of foreign material and a lower amount of starch.