COMPARATIVE STUDY OF HAND CULTIVATION, BULLOCK CULTIVATION, AND SMALL AND LARGE SCALE MECHANICAL CULTIVATION OF RICE IN TRINIDAD.

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CONTENTS

I. INTRODUCTION.
   (a) Rice as a World Crop. 1
   (b) General Method of Production. 1
   (c) Rice in Trinidad. 3
   (d) Objects and Scope of the Present Investigation. 4
   (e) Review of large-scale Mechanised Production of Rice and Trials carried out in some of the rice-producing countries:
      (i) California. 6
      (ii) Australia. 7
      (iii) British Guiana. 8
      (iv) Review of some rice mechanisation trials. 9

II. INVESTIGATIONAL PROCEDURE.
   Hand Cultivation. 14
   Animal Cultivation. 18
   Nursery Preparation. 21
   Cultivation with Fordson Major Tractor, Two-Furrow Mould-Board Plough, Disc Harrow and York Harrow. 21
   Cultivation with the Fordson Major and Rotavator. 24
   Cultivation with the Howard Rotavator, "Gem". 26
   Cultivation with the Ransome's M.0.5 Crawler Tractor. 28
   Threshing with the "Tullos" Thresher. 29
   Threshing with the McCormick-Deering Thresher. 31
   Second Trial with the Howard Rotavator, "Gem". 32

III. RECORDED RESULTS.
   Table I. Hand Cultivation. 37
   Table II. Animal Cultivation. 38
   Table III. Cultivation with the Howard Rotavator, "Gem". 39
   Table IV. Cultivation with the Fordson Major Tractor. 40
   Table V. Threshing with the McCormick-Deering Thresher. 41
Table VI. Man-Labour, Animal-Labour, Machine-Labour, and their costs for Preparatory Tillage and Threshing by the different Methods. 42

IV. DISCUSSION AND EVALUATION OF RESULTS.

LABOUR CONSUMED AND GENERAL AGRONOMIC CONSIDERATIONS. 43

Hand Cultivation. 43

Animal Cultivation. 44

Cultivation with the Howard Rotavator,"Gem". 44

Cultivation with the Fordson Major Tractor and Rotavator. 45

Cultivation with the Fordson Major Tractor, two-furrow, mould-board plough and disc harrow. 45

Threshing. 46

COSTS. 47

Hand Cultivation. 47

Animal Cultivation. 47

Cultivation with the Howard Rotavator,"Gem". 47

Cultivation with the Fordson Major Tractor and Rotavator. 50

Cultivation with the Fordson Major Tractor, ploughing and harrowing. 51

Threshing with the McCormick-Deering Thresher. 52

Threshing by hand and by the Cambridge Roller. 52

Threshing with the "Tullos" Thresher. 53

V. CONCLUSIONS. 55

VI. SUGGESTIONS FOR FURTHER WORK. 57

VII. SUMMARY. 58

ACKNOWLEDGMENTS. 59

LITERATURE CITED. 60

APPENDICES I to IV (b).

I. Extract from the field Note Book giving the Details of the Various Operations carried out as they were entered. 62

II. Calculation of the Costs per Acre of the Various Operations carried out. 69

III. Rice Cultivation in Trinidad compared with that in some of the other rice-growing Countries. 81

IV(a). Mean Rainfall in St. Augustine, Caroni and Cropouche. 94
(b) Record of the Daily Rainfall from 1st — ^7 A
(a) RICE AS A WORLD CROP.

Rice is one of the most extensively grown and widely used foodstuffs in the world. While wheat is considered the "staff of life" as far as the inhabitants of the temperate countries are concerned, rice is the chief maintenance of the populations of Eastern and South-Eastern Asia, including the large nearby islands of Japan and Indonesia. Rice accounts for over 70 per cent. of the total calories in their diet.

The principal rice-producing countries are India, Burma, Japan and China. Large quantities are also produced in Indonesia, Indo-China, Siam and Korea. These countries together produce about 94 per cent. of the world's crop.

The chief warm-temperate areas of production are in the United States, Brazil, Spain, Italy and Egypt.

World production of rice in 1948 was estimated at approximately 145 million metric tons, and this was found to be 2.9 million tons short of the pre-war average. Against this decreased production the population of the rice-eating areas was found to have increased by nearly 100 million in the past decade. The annual increase in population in these areas has been estimated to be in the region of about 10 million.

Increasing production, to keep pace with the increase in the population, is one of the most insistent problems in rice cultivation.

(b) GENERAL METHODS OF PRODUCTION.

The methods used in the production of such an extensively grown crop as rice vary considerably according to the locality, the character of the land, the availability of irrigation facilities, labour and equipment. However, the different methods can be grouped under four general types.

(1) The clearing or primitive type of production. In this method a patch of jungle is cleared during the dry season by
cutting and burning the bush and trees, and seeds are planted in holes punched in the ground by means of a sharp pointed stick. No further attention is given to the crop until it is harvested by cutting or pulling the plants when they are mature. Yields are relatively small and uncertain.

(ii) The production of upland non-irrigated rice. This method involves ploughing or digging the land with an implement such as the hoe, and broadcasting the seed at the beginning of the rainy season. The only attention given to the crop, is the practice of frequent weeding during the growing season. The crop is rain-fed. This method is practised in many areas where there are no organised irrigation facilities. This method too results in low yields.

(iii) Wet or "Swamp Rice" cultivation, the broadcast method. This method of culture involves the construction of bunds or banks round the fields for the purpose of impounding water in them, and growing the plants in standing water. The soil is worked into a fine puddle by ploughing under water, or digging with the hoe or some such implement, and then levelled before broadcasting the seed. The crop may be either rain-fed or irrigated. This method is known to give high yields sometimes, and is the one that resembles most closely the way in which the crop is grown under mechanised conditions.

(iv) Wet cultivation, the transplanting method. This method resembles very much the one described above (iii), except that, in this case the field is planted with seedlings raised in a separate nursery.

Harvesting. This is generally done by cutting the plants about 6 to 10 inches above ground level by means of a curved, serrated knife known as a sickle. In certain countries such as Indonesia, and in parts of Malaya, only the ear-heads are cut with an implement called the "yatab", which consists of a knife about 6 inches in length fastened crosswise on a short stick.
Threshing. Methods of threshing are many and varied. Rolling with big toothed wooden rollers, flailing, beating the ear-heads on a slatted, wooden table and pulling over a sort of comb, are some of the methods used.

(c) RICE IN TRINIDAD.

As in most of the principal rice-producing countries of the world, rice is grown on a small scale in Trinidad on holdings varying from ½ acre to 3 acres in size. Rice cultivation is only a part-time occupation for the grower, and is generally carried on mainly for the purpose of feeding himself and his family.

According to estimates made by the Department of Agriculture (24), 6,000 tons of cleaned rice were produced in Trinidad in 1939 from an acreage of about 10,000. In 1948 it was found that the area had doubled to 20,000 acres with a resulting increase in production of 6,000 tons over the 1939 figure. However, in the same year Trinidad had to import a further 12,000 tons of rice from British Guiana and Brazil, from the latter country at a much higher price than was paid for British Guiana rice. It is considered that if a further 6,000 tons of rice could be obtained, it would be sufficient to feed the present population at the pre-war level of consumption. Thus Trinidad could consume 30,000 tons of rice valued at about $5,000,000. It is considered doubtful whether British Guiana could supply all the rice requirements of Trinidad, and therefore increasing its production is one of the problems of rice culture in Trinidad.

At present, as mentioned earlier, about 20,000 acres of rice are under cultivation in the colony. This acreage refers only to "wet" or "swamp" rice. This acreage is mainly distributed over the following areas: the Cropouche Lagoon area, with an estimated acreage of about 7,000 acres, the Caroni-Chaguanas area with an acreage of about 5,000 acres, and along the fringes of the Nariva swamp where there is an estimated

*See map.*
acreage of about 2,000 acres. The remaining 6,000 acres are scattered all over the island, being generally situated either on the banks of streams and rivers or in low-lying regions capable of being flooded during the wet season.

The Caroni and Nariva swamps are potential rice areas, which, if reclaimed, would add considerably to the present acreage.

Under the present methods of cultivation it is doubtful whether sufficient labour, both animal and human, would be available to bring about any appreciable expansion in the acreage cultivated. Mechanisation seems to be the answer to the problem. The large scale mechanisation of the area cultivated at the present time will not be possible without regrading and changing the layout of the holdings considerably. This would require the incurring of a large capital expenditure, besides having to cope up with many other problems incidental to the organisation of large scale mechanisation schemes. On the other hand, if it were possible to mechanise the small farmer, even to some extent, the labour thus released could be used for the cultivation of a greater acreage than grown at present.

(An account of the method of rice cultivation in Trinidad as compared with those practised in some of the other rice-producing countries of the world is given in Appendix III.)

(d) OBJECTS AND SCOPE OF THE PRESENT INVESTIGATION.

The present investigation was carried out with the main object of determining the possibility of mechanising the small farmer on an economic basis. It was also intended to study the suitability of the Ransome's M.G.5 motor cultivator, and the Fordson Major, equipped with a rotavator unit for carrying out the preparatory tillage operations for rice cultivation.

The investigation took the form of a comparative study of hand, animal, and large and small mechanical methods of
rice cultivation. It was carried out on the College rice fields by the side of Freeman Road, in the St. Augustine area. The cultivations were done only during one season, i.e., from June 1949 to December 1949. In the case of the hand and animal methods, all the necessary equipment were available from the College Farm. In the case of the mechanical methods, however, the only equipment available on the College Farm were a Fordson Major tractor with a 2-furrow, mould-board plough of the general purpose type, and a 50-inch rotavator unit, a Ransome's M.G.5 Crawler Tractor with a single furrow, mould-board plough and a McCormick-Deering Thresher. A Howard Rotavator, "Gem" with a 20-inch cut, and equipped with special large diameter, skeleton-type wheels, and a Tullos thresher, were made available through the courtesy of Messrs. H.E. Robinson and Co. The labour employed was obtained from the College Farm, except in the case of that engaged in operating the Howard Rotavator and the Tullos thresher.

It must be mentioned here, that, while the driver of the Fordson Major tractor was quite efficient in his job, the operator of the Howard Rotavator was more or less new to the machine. The soil type on which the various cultivations were carried out is, while not being representative of more than a very small part of the soils of the main rice areas in the island, easier to work than the fairly heavy, stiff clayey soils found in the latter areas.

The size of the plots, in the case of the hand and animal methods, was one-tenth of an acre, and in that of the machines, two-fifths of an acre. In the latter case, four 1/10 acre plots were joined up to form the large plots. Although an attempt was made to join up plots that were more or less on the same level, the enlarged plots showed considerable differences in level in certain spots.

Due to the above mentioned reason, and the somewhat irregular supply of irrigation water, it was not possible to
exercise the desirable water control in some of the plots, especially those cultivated with machinery. 

(e) REVIEW OF LARGE SCALE MECHANISED PRODUCTION OF RICE AND TRIALS CARRIED OUT IN SOME OF THE RICE-PRODUCING COUNTRIES.

(i) California. In California, rice is generally grown on heavy clays and clay adobes that are underlain with an impervious sub-soil at a depth ranging from about 18 to 36 inches. Most of the rice land is comparatively level, having a gentle slope varying from 2 to 5 feet per mile.

The land is generally ploughed 4 to 6 inches deep with 3- or 4-bottomed mould-board ploughs drawn by a tractor having a horse-power of around 40. A week to 10 days later the land is either disced, or harrowed with a heavy spike-toothed harrow. A few days later, the soil is dragged with a heavy drag. Under most conditions, a harrowing followed by a dragging, makes a satisfactory seed-bed. If the land is very cloddy it is dragged two or three times. Sometimes discing and harrowing are omitted, and the clods are crushed with heavy drags. In the time that elapses between ploughing and harrowing or dragging, the clods are very often subjected to the weathering action of alternate wetting and drying, and this is frequently found to be more effective than cultivations, in the preparation of a good seed-bed. Sowing seed is mostly done by broadcasting from an aeroplane. Seed that has been partially germinated by soaking in water for a period varying from 36 to 48 hours and holding it for a further 12 hours, is broadcast on about 4 inches of water. Sometimes, seed is sown dry by means of broadcast seeders, or drilled. Continuous submergence is the common method of irrigation. When seed is sown dry, the fields are immediately flooded with 4 to 8 inches of water and is held until harvest. When broadcast on the water, only 2 to 4 inches are held until seeding is completed, and the level of the water is then increased to 4 to 8 inches and held until harvest.
The crop is usually harvested from 10 to 18 days after draining, and at this stage, the moisture content of the standing grain ranges from 20 to 27 per cent. Harvesting is largely done with tractor-drawn and self-propelled combines. Push swathers and self-propelled combines are used in opening up the fields by cutting the first strip against the levees. After the combining operation, the rice is dried artificially and milled.

The following is an account of rice cultivation in the Murrumbidgee Irrigation area in Australia.

The soil is a shallow, medium to heavy clay, overlying a stiff, clay subsoil. The land is usually ploughed during the winter, and this is followed by cultivations aimed at destroying the weed growth and, at the same time, produce a good tilth. The fall from one field to the other is seldom more than 3 inches. On a majority of the farms the most convenient size of the fields varies from 4 to 6 acres. Seed is sown at the rate of 100 to 120 lbs. to the acre at a shallow depth, by means of a wheat drill, and covered by dragging a light chain harrow over the soil. Immediately after sowing, the land is irrigated in order to induce the seeds to germinate. About a week later, water is applied to the field again, and the young plants are irrigated as often as necessary to keep the soil moist, until they are about 6 inches tall. Water is then allowed to remain in the field with only their leaf tips showing. It has been found that it is not necessary to change the water as long as the amount lost by evaporation, transpiration, etc., is replaced. The most serious problem of the Australian rice farmer is weeds. Where infestation is heavy, it could be controlled or eradicated by early flooding. This is done by sowing the seed at a shallow depth of about 1 inch, then germinating it in the usual way by the application of irrigation water immediately afterwards, and submerging the weeds and the rice seedlings completely after maximum germination has been obtained.
In harvesting the crop, most growers in the Murrumbidgee area adopt the practice of employing tractors, with forecut auto-headers, to cut tracks around each field. After this is done, rice-headers, with a side-cut and driven by an auxiliary engine and drawn by a tractor, or horse-drawn headers with an 8- to 12-foot cut, are employed to complete the harvesting operation. These machines cut, thresh, winnow and clean the rice in one operation. The bagged grain is stacked on the edge of the fields for collection by trailer units and transport to the local mills.

(iii) British Guiana

Large scale as practised at the Mahaicony-Abary Rice Scheme.

The soil on which the rice is grown is described as frontland clay, granular in structure, and containing 6 to 7 percent of well-humified organic matter. Below this is a uniform, silty-clay extending to a considerable depth.

The size of each bay or field was originally fixed at 50 acres as a suitable unit for working with machinery, after due consideration had been given to the question of irrigation and drainage. However, it was found in practice that this size was not suitable. In the new layout, the fields measured 50 rods in width and 450 to 600 rods in length. In these fields very much better water control was obtained, and they were also found to be more economical to work.

It is the practice to grow two crops during the year, a Spring crop and an Autumn crop. The former is harvested in Autumn and the latter in Spring, so that there is very little time between the harvesting of one crop and the sowing of the other.

The land is ploughed in the dry season by means of disc or mould-board ploughs drawn by Case tractors. This is followed by harrowing with disc harrows and a dragging with an implement which is essentially a heavy York harrow. Recently
a system of under water cultivation has been developed, when it was found that tractors and implements could travel through water flooded fields.

Seeding is carried out with drills or by broadcast seeders. A standard seed rate of 70 lbs. per acre is used.

Harvesting is done with Case tractor-drawn combines with a 6-foot cut, and Massey-Harris self-propelled combines mounted on tracks and having a cutting width varying from 9 to 14 feet. The self-propelled combine is employed to make the first cut, and thus open up the field for harvesting with the side-cut machines. Transport of the rice from the fields to the dumps is effected by the use of rubber-tyred, steel-framed, ox carts.

(iv) Review of some rice mechanisation trials.

Cultivation of rice lands with tractors, ploughs and disc harrows was tried in Siam (2) as long ago as 1912, and experiments in the use of tractors and ploughs were carried out in Cochin-China (17) in 1917 and in Malaya in 1922. In Travancore (1), India, a Fordson Tractor was used with success for ploughing in an experimental rice farm for some years, and it was found to be more efficient and less costly than cultivation with bullocks or buffaloes. At another trial in Siam (1) it was demonstrated that 15 h.p. oil driven engines, pulling a heavy disc harrow, could cultivate a hard clay soil to a depth of 4 inches, at the rate of 2½ acres per day. Further experiments in Siam (29) have shown that, for breaking up new land, disc ploughs are better than mould-board ploughs. For land that had already been under cultivation, mould-board ploughs were found to be better. It was also shown that three 12/20 h.p. Case tractors could handle 10 acres per day. It was found that ploughing once or twice to a depth of 4 to 5 inches followed by a harrowing with a double disc harrow, and finally levelling the surface with a float or drag consisting
of two heavy planks bolted together one over the other, produced a satisfactory seed-bed for transplanting or drilling rice.

Trials carried out in Malaya (27) have shown that, with rice lands that dry off during the off season, it is possible to do mechanical cultivations so as to produce a reasonably good tilth under dry conditions suitable for drilling rice seed, or to obtain a tilth fit for transplanting under wet conditions. The success of these cultivations were held to depend on the availability of adequate water supplies, either through irrigation or rainfall, soon after the drilling or transplanting process. During the same trials it was found that the Fordson Major was more successful than the "Caterpillar" D 4. under wet conditions. With the D 4. great difficulty was experienced in turning it around at the headlands and in negotiating deep, soft patches. The method of turning by means of using one track only while the other swivels round, was found to be very unsuitable, because the single track was found to be insufficient to pull the tractor and the implement round, and the other caused great displacement of soil when it swivelled. The following conclusions were reached:

(i) The D 4. is a clumsy and unmanageable tractor for use under wet soil conditions, and

(ii) the light disc-harrow is by itself valueless as a tillage implement on any but very wet land where it can slip through the soft mud easily.

A Standard Fordson, equipped with steel wheels and trailing a two-furrow mould-board plough, worked satisfactorily on land with a certain amount of standing water, but not so soft that a man walking on it would sink down to the hard layers. It was, however, found that the land wheel sank, resulting in much deeper ploughing than was thought desirable, in order not to bring up the sub-soil. To prevent this, the following measures were advocated:

(1) Raising tractor draw-bar to compensate for the
sinking of the implements,

(ii) using tractors preferably with integral implements, and

(iii) fitting extension rims to the tractor wheels and those of the implement.

In a trial carried out in the State of Pahang in Malaya, on a soil described as a coastal clay, it was found that the Fordson Major tractor, equipped with rubber-tyred wheels, could not grip the soil even under the driest conditions. Mould-board ploughs proved unsuitable on land carrying a strong growth of weeds, but was found to be quite satisfactory on land with short grass. It was also found that tractors, equipped with double-width driving wheels, could plough 4 acres in 8 hours under conditions in which a man walking on the land sank up to his knees in the mud and water.

In a trial with the Howard Rotavator, "Gem", 6 h.p. model, carried out in Salinsing in Malaya on coastal clay, it was found that the machine got bogged down frequently, and that the offside end of the rotor shaft got choked with weeds. (The machine was equipped with rubber-tyred wheels). The offside end of the rotor-shield was then cut away, with the result that there was less choking. It was observed that, under conditions of 3 to 4 inches of standing water, the blades of the rotavator and the wheels showed less tendency to become choked. Although a satisfactory tilth was obtained after the passage of the machine, which cut the weeds 2 to 3 inches below the level of the soil, a re-growth of weeds, more intense than the normal off-season growth, occurred soon after. It was therefore thought that the action of the rotavator actually stimulated weed growth, especially because normal cultural operations in the locality results in less disturbance of the soil. It has been concluded that the rotavator would achieve satisfactory results in localities where cultivation is normally done with
the plough, provided that sufficient irrigation water was available to drown the off-season weed growth that would follow the rotary hoeing operation.

A further trial\(^1\) with the Howard Rotavator, "Gem" conducted on a deep, moist, peat soil in Malaya gave the following results. The machine was found to be insufficiently powered to cope with the heavy off-season growth of tough sedges and grasses. The rotavator blades became severely clogged with weeds and these had to be cleared away before the machine could make any progress, for attempts to carry on without doing so resulted in the machine stalling even in bottom gear. It was, however, considered that the machine might be suitable for such soils if extension rims were fitted to the wheels.

The following conclusions were arrived at from a series of trials conducted with the Howard Rotavator, "Gem", equipped with pneumatic-tyred wheels, at the Talang Padi Experiment Station\(^2\) in Central Perak in Malaya:

(i) A top soil of uniform texture, low weed growth and adequate drainage, were some of the factors required for the efficient working of the machine on shallow soils of Talang type.

(ii) In soils with soft and deep patches it might prove useful to do the cultivation to the full depth desired in two or three stages.

(iii) All tall grass should be first cut and removed as most stoppages were due to the rotavator blades getting clogged up with grass.

(iv) The machine was found to work well on land with about 1 inch of water and weeds not more than 3 inches high.

(v) The fitting of a cleated cast-iron wheel on the off-side, to prevent sinking of the off-side wheel, was suggested as an improvement.
A large scale mechanised rice cultivation scheme known as the Mahaicony-Abary Scheme was initiated in British Guiana in 1942, and the first cultivations were carried out in 1944. Work at this scheme has shown that it is possible for steel-wheeled tractors to work in flooded fields. When this was first attempted, some damage was done to the tractors by operators running into drains, but they did a very good job of burying weed growth in the mud by means of harrows. It has been found that, under reasonably good conditions, an acre of land could be ploughed, harrowed, levelled and seeded in approximately 2$\frac{1}{2}$ hours with machinery. In cultivating flooded fields, it was found that a 6-inch pipe, attached behind the harrows in the final operation, helped in creating a level seedbed. Under-water cultivation was found to be very effective in the suppression of weeds. Another advantage of this type of cultivation was that fields so worked tended to dry out quicker at harvest time than the other fields, thus enabling the heavy harvesting machinery to make an early start. The main advantage of under-water cultivation is that it has enabled the carrying out of the planting programme regardless of weather conditions. In harvesting the crop, reaper/binders and threshers were tried in 1944, but they were found to be unsatisfactory due mainly to the unsuitability of the variety of rice grown to mechanised harvesting. The binders could not deal efficiently with a fallen crop. Trials with windrowing were not very successful. Harvesting with combines proved successful. It has been demonstrated that it is possible to carry out bulk harvesting in a flooded field with a combine mounted on trucks. It is thought that the water lubricates and keeps the trucks so free from mud that no bogging down would occur.
INVESTIGATIONAL PROCEDURE

The investigation involved the cultivation of a crop of rice using hand, animal, and mechanical methods. A detailed record was kept of all the cultivation operations practised, making a note of the labour employed, and the time taken to complete each operation. This record took the form of a running diary, in which continuous observations were made from the first to the last operation. Note was also made of any interruptions in the operations, together with their causes, the speed of the machines used, the time spent in making adjustments and in turning, and the fuel consumed by the machines. Observations were made on the nature of the tilth produced as a result of the various tillage operations, especially in the case of the mechanical methods, and the weediness or otherwise of the growing crop.

HAND CULTIVATION.

This was carried out on a plot approximately 1/10th of an acre in extent. The labour employed consisted of a man and a woman, representing a peasant couple. The implements used were the cutlass, fork, hoe, sickle and a wooden threshing table. (See photographs given below).
A record of the daily rainfall from the 1st of June to the 31st of December (1950), i.e., during the period when the crops were grown, is given in Appendix IV (b).

First the weeds were cut as low as possible by means of a cutlass. This was done by the man, the woman removing the cutlassed weeds away from the field. This was followed by hand forking the soil to a depth of about 5 inches, each forkful being inverted in the process. At the time the forking was done the ground was somewhat hard, although 1.57 inches of rain had fallen during the week preceding the operation. (About 3 inches of water were then introduced into the field and the clods were pulverised with the hoe). It certainly was a tedious job, and only 4 hours of work were done on the first day, the man finding...
it difficult to continue any longer. On the following day too
only 4 hours of forking were done, and the work was completed
in the morning of the third day. This was actually done 5 days
after the forking. It was intended to keep the soil covered
with water during this period so that it would serve in rotting
the mat of grass that was turned over with the soil, but it was
not possible to do so because there was a considerable leakage
of water through the bunds, and when the bunds were repaired, it
was time to do the hoeing. While the hoeing was going on, the
woman removed the weeds that were not buried in the soil by the
forking operation. Levelling and smoothing of the soil were
done more or less at the same time as hoeing. Transplanting of
the field was done three days after the hoeing and levelling.
The transplanting itself was done by the woman, the man carrying
the seedlings and throwing them within easy reach of the woman.
At the time this was done, there were about 2 inches of water in
the field. The only attention given to the crop after planting
was irrigating it, no weeding being done.

**Harvesting.** This was done on the 6th of November, i.e., 4 months and 6 days after transplanting. Weather conditions
were quite suitable, there being no rain on that day. The plants
were cut about 6 inches from ground level with the sickle, the man
and the woman both being engaged in the work. The plants (as many
as could be held in one hand) were gripped just below the ear-heads
with one hand and the sickle, held in the other, was drawn across the
straw in a horizontal motion, and the cut bundles were dropped on
the ground which was dry enough for the purpose.

**Threshing.** This was done almost immediately after
harvesting. A bundle of plants (as many as could be conveniently
held with both hands) was swung back above the head and struck
on the wooden threshing table with some force. (See photographs
at the top of page 17). The beating of the rice on the table was
done by the man while the woman was occupied in carrying it from the field and placing it in a heap within the man's reach. The process obviously required a considerable amount of muscular effort but the separation of the grain from the straw was quite effectively done as seen by carefully examining several bundles of straw. Very few grains of rice were thrown off during the upward or downward swing of the bundles, so that the loss resulting from this did not appear to be as great as it is generally supposed to be. However, any loss that may occur by being thrown off during the more vigorous downward swing of the bundles could be prevented by using a threshing table screened as shown in the photograph given below.
Winnowing. This was done by dropping the rice (contained in flat metal pans) against the wind, from a convenient height (see photograph at the foot of page 17).

ANIMAL CULTIVATION.

This was, as in the case of the hand method, carried out on a plot approximately 1/10th of an acre in size. The implements used were the cutlass as before, the Ransome's Victory plough, the wooden York harrow, the sickle for harvesting, and the Cambridge Roller for threshing.

The weeds were first cutlassed as before and the land ploughed with a Ransome's Victory plough drawn by a pair of Zebu oxen after introducing about 2 inches of water into the field. (A photograph of the plough is shown below). The depth of ploughing was approximately 5 inches. The animals appeared to get tired very easily and they had to be rested on several occasions when they refused to budge an inch. It is possible that the draught of the plough, (approximately 12 lbs. to the square inch as measured by means of a dynamometer), was too high. Ploughing was immediately followed by harrowing with the wooden York harrow. (See photographs at the top of page 19). When it was thought that the soil was sufficiently puddled, the harrow was turned over so that the spikes were on the upper side, and used to do the levelling. Both harrowing and levelling were done with about 3 inches of water on the field.

Transplanting. This was done, 6 days after the harrowing and levelling with about 2 inches of water on the field,
by women in the same way as in the case of the hand-cultivated plot. (See photograph shown below). Two seedlings were planted together at a spacing of approximately 9 inches apart. The water was allowed to remain in the field after transplanting. Here again, no weeding was done during the growth of the crop. Water control in this plot was better than that in the hand-cultivated plot, mainly because the former was at a somewhat lower level than the latter with respect to the level of the water in the irrigation channel, and it was therefore possible to control the weed growth to some extent.

**Harvesting.** This was done by cutting with the sickle. (See photograph at the top of page 20).
HARVESTING RICE

Threshing. This was done by means of the Cambridge Roller drawn by a pair of oxen. Two men were employed, one driving the oxen and the other helping in spreading the bundles of rice on the threshing floor, and removing the threshed grain and straw as the work progressed. The bundles of rice were spread out on the cemented yard of the College Farm so as to form a circle about 6 yards in diameter up to a height of about 3 inches, and the roller was passed over the lot, the oxen walking on it in a circular manner. When one lot of rice was threshed another lot was arranged in a similar manner after sweeping away the separated grain and the straw from the preceding lot. (See photograph given below). The separation of the grain from the straw was effectively done. A small amount of grain was crushed in the process, and it was judged to be negligible. Winnowing of the threshed grain was done as in the hand method.
NURSERY PREPARATION.

The nursery was prepared entirely by hand methods using the cutlass, the fork and the hoe. The weeds were first cutlassed and the soil forked and pulverised. All the operations were done with the soil in a dry condition. Pen manure (at the rate of four basketfuls per nursery plot of 150 square feet) was then spread on the plot and incorporated into the soil by means of the fork. About an inch of water was then introduced into the plot, and seed (at the rate of 4 lbs. per 150 square feet), which had been soaked in water for a period of 24 hours, was sown on the water. After allowing sufficient time for the seeds to settle in the soil, the water was drained slowly. The plot was then covered with coconut leaves to protect the seed from the attacks of birds. No further attention was given to the nursery until the seedlings were ready for planting in the main field. Uprooting of the seedlings was done by women. Water was introduced into the nursery on the evening of the previous day in order to facilitate the removal of the plants with as little damage to the root system as possible.

CULTIVATION WITH THE FORDSON MAJOR TRACTOR, TWO-FURROW MOULD-BOARD PLOUGH, DISC HARRROW AND YORK HARRROW.

The size of the plot was approximately 2/5th of an acre, being 325 ft. by 52 ft.

The tractor used was the Fordson Major, land utility model, and the plough used was of the general purpose type. The land carried a weed growth about 15 inche. high and was in a somewhat moist condition, .33 of an inch and .70 of an inch of rain having fallen on the two days prior to the trial. On the day of the trial the weather was bright and clear (24th June, 1950). (A record of the daily rainfall from the 1st June to the 31st December, 1950, is given in Appendix IV.) An attempt to do the ploughing with the tractor equipped with standard wheels with pneumatic tyres proved a failure owing to wheel-slip, which was
almost 100 per cent. Steel wheels with spade lugs were then fitted to the tractor and the work was done without any interruptions. The speed of the tractor was measured by counting the number of paces travelled by the tractor in 20 seconds and dividing this figure by 10. (This gives the approximate speed in miles per hour). This worked out to be 2½ miles per hour approximately. The method of ploughing was to work in a clockwise direction, beginning at the centre of the field and throwing the furrow slices inwards. A headland of about 4 yards was left at either end of the field for purposes of turning. A considerable amount of time was spent in turning and this was measured by means of a stop watch. The method of ploughing is illustrated in the diagram on page 23.

Harrowing. This operation was done soon after the ploughing with a 16-disc harrow trailed behind the tractor, there being no harrow suitable for use with the hydraulic system. There was a considerable delay in the work due to wheel-slip, in spite of the tractor being equipped with steel wheels fitted with spade lugs. The discs got choked with soil very frequently and they had to be
cleaned before continuing with the work. It was therefore clear that the soil was actually too wet for harrowing. The speed of the tractor (measured as before) was approximately 1½ miles per hour. The tilth produced was judged to be too rough for sowing seed broadcast, and it was decided to smoothen the soil by means of the York harrow. It was not possible to do this on the same
day as the harrowing for lack of time. On the following day, i.e. on the 25th, .30 inch of rain fell, followed by .01 inch on the next day. Work with the York harrow was finally done on the 27th. However, after working for about 10 minutes the tractor got bogged down in a soft spot in the field and two hours were spent in extricating it. No further work could be done with the tractor and the trial was therefore terminated.

HARROWING WITH 16-DISC HARROW DRAWN BY THE FORDSON MAJOR TRACTOR

TRACTOR BOGGED DOWN WHILE LEVELLING WITH YORK HARROW

CULTIVATION WITH THE FORDSON AND ROTAVATOR.

The size of the plot was again approximately 2/5th of an acre, being 176 ft. long and 104 ft. wide. The rotavator unit had a cutting width of 50 inches and was hydraulically mounted on the Fordson Major tractor which was equipped with standard wheels with pneumatic tyres. There was a weed growth about 15 inches high at the time the rotary hoeing was done. The trial was carried out on the 21st June. There were .02 inch and .08 inch of rain on the two days preceding the trial. There was no noticeable wheel-slip, but the rotor blades got choked up with soil very frequently. Whenever this happened the tractor had to be stopped, the rotavator lifted off the ground and allowed
to rotate freely until the soil got dislodged. The speed of the tractor, as measured by dividing the number of paces travelled in 20 seconds by 10, was approximately 2 miles per hour. The tilth produced was judged to be too rough for sowing seed broadcast. However, it was not possible to do any further work on this plot until the 1st July owing to bad weather. (The only rainless day was the 24th June and on this day the tractor was occupied in ploughing and harrowing another experimental plot). The next operation was a harrowing with an 8-disc harrow trailed behind the tractor which was equipped with steel wheels fitted with spade lugs.

| CONDITION OF FIELD | CONDITION OF FIELD AFTER ROTARY HOEING AND HARROWING WITH 8-DISC HARP | CONDITION OF FIELD BEFORE ROTARY HOEING |

The work was done without any interruptions. The tilth obtained was considered to be suitable for broadcasting seed, but it was thought desirable to do a levelling with an implement such as the York harrow before sowing. However, bad weather conditions prevented any further work on the plot. Therefore, 40 lbs. of seed which had previously been soaked in water for 24 hours were sown broadcast on the plot. The germination of the seed was satisfactory, but the young seedlings were soon smothered by weeds which came up unchecked. It was not possible to introduce
irrigation water into the field in sufficient quantities, and what little that got in tended to accumulate in one section of it that corresponded more or less with the lowest of the four plots that were joined in making it. Only this particular section of the plot carried a crop worth harvesting although it was infested with a fair amount of weeds.

**CULTIVATION WITH THE HOWARD ROTAVATOR, "GEM".**

The size of the plot was approximately 2/5th of an acre, being 344 ft. long and 52 ft. broad. The weeds were cutlassed about two weeks earlier and at the time the trial was carried out they had again come up to a height of about 4 inches.

The machine used in the trial had a cutting width of 20 inches and was fitted with large diameter, skeleton-type wheels with a reduction gear and independent steering brakes. The plot was flooded with water before putting in the machine. Due to the lack of levelness in the plot the water distributed itself rather unevenly, there being more of it in the lower sections than in the higher ones. The rotavator blades were set to work to a depth of approximately 5 inches. Two men were employed to work the machine, one being at the controls and guiding it while the other was helping during the turns at the ends of the field.

It was observed that the machine worked better and produced a finer tilth where there were about 3 inches of water or more than where there was less or no standing water at all. In fact, where there was no water, the rotavator blades showed a tendency to become choked with soil and weeds, and the land showed a corrugated effect. The tilth obtained over the
entire field was, however, quite satisfactory for transplanting. But, as no provision was made for transplanting this plot when the nurseries were being laid down, the only alternative was to sow seed broadcast. Because of the uncertainty of controlling the irrigation water, it was thought desirable to first level the field by means of the York harrow drawn by a pair of oxen, before sowing the seed. Accordingly, the field was levelled with the York harrow, and 40 lbs. of partially germinated seed were sown broadcast. The germination of the seed was satisfactory, but when the seedlings were about two days old floods came and washed away some of them. However, the water subsided rapidly leaving a sufficient number of seedlings that could be thinned out and used to supply the vacancies. The irrigation of the crop was very unsatisfactory due both to the irregularity of the supply and the differences in level in the field. As a result, the weeds could not be checked by drowning them as hoped, and a hand weeding was done at the time of thinning out and supplying of vacancies.
CULTIVATION WITH THE RANSOME’S M.G.5 CRAWLER TRACTOR.

An attempt to plough the field that was subsequently worked with the Ransome’s M.G.5 Tractor, was a failure because the land was too wet and the tracks were slipping. However, a plot of land, approximately 1/5th of an acre in extent, and which happened to be in a fairly dry condition because it was situated at a higher level than the first field, (in fact it was the highest field in the whole of the College rice area), was ploughed with the machine pulling a trailed single-furrow, mould-board plough. (See photographs given below).
It was not possible to do any further work on the plot with the machine as the tracks were slipping on the wet soil turned up in ploughing. Apparently only the surface of the land was dry enough for the machine to obtain sufficient traction. Another factor that probably helped traction in the former case was the presence of a mat of vegetation.

**THRESHING WITH THE "TULLOS" THRESHER.**

This is a small, portable machine consisting of a drum made of sheet metal and carrying four cast-steel, peg-type beaters, a feed-plate and stripper bar, a concave which is ribbed and knobbed to assist in the separation of the grain from the straw, and two shakers which are carried on a separate frame and driven by means of a belt from the drum-shaft. Although the machine is actually meant to be worked by turning the drum by hand, provision is made for attaching a 1 to 1½ h.p. engine.

Three men were employed to do the threshing, one man feeding the machine, one carrying the bundles of rice to the feeder, and the third sweeping away the straw discharged by the shakers. Two methods of threshing were tried. In the first
method the threshing was done almost immediately after cutting the rice, and in the second method the cut rice was first dried for two days in the sun in shocks of 8 bundles each. The rice that was to be shocked was cut closer to the ground level than the other lot, so that there would be a sufficient length of straw to enable the bundles to stand without falling over. The rice was shocked in the field for purposes of recording the labour consumed and the time taken, and then transported to the yard of the College farm and re-shocked. (This was done to guard against their being stolen).
In order to obtain an accurate figure for the rate of threshing three samples of threshed grain and straw were collected while the threshing was being done. Each sample consisted of the output of grain and straw given during a time interval of exactly 1 minute. The grain was collected by holding a gunny bag underneath the grain discharge opening, and the straw discharged during the same time interval was swept away into a separate heap having first cleared the ground below the straw shakers. The straw and grain obtained from these samples were weighed separately. The average speed of rotation of the threshing-drum was determined by means of a special speed gauge.

When the rice that was dried in the sun for two days was being threshed, the threshing-drum became choked with straw very frequently, and this slowed down the work very considerably. When the batch of rice that was not dried at all was being threshed, however, there was no choking of the threshing-drum resulting in a much smoother working of the machine than in the former case.

**THRESHING WITH THE McCORMICK-DEERING THresher.**

This machine was driven by means of the power take-off of the Fordson Major tractor. 5 men were employed in doing the threshing; the tractor operator, one man to feed the bundles of rice into the thresher, one carrying the bundles to the former,
one attending to the bagging of the threshed grain, and the fifth man sweeping away the straw. The work was done without any interruptions.

SECOND TRIAL WITH THE HOWARD ROTAVATOR, "GEM".

Since the first trial though beset with several difficulties, such as the lack of levelness in the field and the absence of proper water control, gave some indication of the capabilities of the machine, it was decided to do a second trial under better conditions. This was carried out on a small block of land south of the pond in the College Farm (Old Farm). This site was selected because of its nearness to the pond, thereby securing a dependable and convenient supply of irrigation water.

Two methods of doing the preparatory tillage, namely, dry cultivation and wet cultivation, in conjunction with broadcasting and transplanting were carried out; i.e., four combinations, namely (1) wet cultivation and transplanting, (2) wet cultivation and broadcasting, (3) dry cultivation and transplanting, and (4) dry cultivation and broadcasting. The smallness of the area permitted only one plot for each combination. All the plots were 150 ft. long, but the widths varied slightly. In each plot...
there was a small drop in level from the northern to the southern end. In order to control the irrigation water in the desired manner, a series of small bunds were therefore thrown across each plot.

For wet cultivation the model with large diameter, skeleton-type wheels was used, and for dry cultivation the one with small wheels fitted with pneumatic tyres was used. The weeds in each plot were first cutlassed. In the case of dry cultivation it was not possible to work the rotavator to the full depth of approximately 5 inches in one operation because there was a considerable wheel-slip when it was attempted to do so. The land was on the wet side, .32 inch of rain having fallen on the previous day and some a few minutes before the trial. Therefore, the rotary hoeing was done in two stages, working up to a depth of only 3 inches in the first stage, and the full depth of 5 inches in the second. Both machines were worked by one operator without any assistance. Due to the small width of the plots some difficulty was experienced in turning the machine at the corners, especially in the case of the model with the large-diameter, skeleton-type wheels.

ROTARY HOEING WITH THE "GEM" MODEL WITH LARGE-DIAMETER, SKELETON-TYPE WHEELS.
Apart from this the machines worked quite smoothly, producing a satisfactory tilth for either transplanting or broadcasting.

Transplanting and broadcasting were both done on the same day. In the case of the former, the seedlings were 44 days old. The broadcast seed-rate was 8 lbs. per plot of approximately 1,500 square feet, i.e., 230 lbs. per acre. This seed-rate, which was more than double the usual one, was used as a guard against poor germination. However, the germination was quite good and a considerable number of seedlings had to be removed at the time of thinning out which was done when they were 34 days old.

One difficulty that was experienced in the irrigation of the crop was that the plots could not hold the water for more than a day or two. Irrigation water had to be therefore introduced once in every three days, in order to keep up the level at the desired height. None of the plots was weeded.

Harvesting and threshing of the crop were done by hand methods.
RECORDED RESULTS

The costings are based on the cultivations carried out on 1/10th acre plots in the case of the hand and animal methods, and on 2/5th acre plots in that of the large and small mechanical methods. In calculating wages, the rates paid at the College Farm, namely, $1.76 per man per day, $1.34 per woman per day, $4.20 per day for the tractor operator and $2.66 per day for the assistant, have been used. One working day has been taken as consisting of 8 hours. The costs of irrigation, nursery maintenance, cartage and drying have not been included in the calculations. The irrigation of the various plots was rather irregular and spasmodic, and therefore it was thought that the time spent by the man who was doing it could not be taken as a true estimate of what would be spent in the normal irrigation of a rice crop. No labour was actually spent on the maintenance of the nurseries which were of the dry type and rain-fed. As regards the costs of cartage and drying, it was not possible to obtain figures accurate enough to be included in the costings.

In the case of implements such as the cutlass, fork, hoe, plough and York harrow, no allowance has been made for depreciation because they are considered negligible. No charge has been made for the transport of the machines either under their own power as in the case of the Fordson Major tractor, or in a truck as in the case of the Howard Rotavator, "Gem".

When necessary for purposes of making calculations the yield of rice per acre has been taken as 2,800 lbs., as this is the average yield obtained in Trinidad as given in the Report of the Rice Committee of Trinidad and Tobago, Council Paper, No. 2 of 1950.

The costs of feeding and maintaining a pair of oxen have been taken from such records kept in the College Farm. (Details of the costs are given in Appendix II).
In calculating items such as depreciation, repairs and maintenance, housing, taxes and insurance, more or less arbitrary values had to be given because there was no way in which they could be determined. The calculations of the costs of the various operations are given in Appendix II.
<table>
<thead>
<tr>
<th>OPERATION</th>
<th>HOURS PER ACRE</th>
<th>COST</th>
<th>COST PER ACRE EXPRESSED AS PERCENTAGE OF TOTAL COST</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MAN</td>
<td>WOMAN</td>
<td>PER ACRE $</td>
</tr>
<tr>
<td>Cutlassing Weeds</td>
<td>40.3</td>
<td>-</td>
<td>8.86</td>
</tr>
<tr>
<td>Removing cut weeds and cleaning field during levelling</td>
<td>-</td>
<td>38.2</td>
<td>5.45</td>
</tr>
<tr>
<td>Forking</td>
<td>100.0</td>
<td>-</td>
<td>22.00</td>
</tr>
<tr>
<td>Hoeing and Levelling</td>
<td>57.6</td>
<td>-</td>
<td>12.67</td>
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<tr>
<td>Preparing and Sowing Nursery</td>
<td>24.8</td>
<td>23.2</td>
<td>9.08</td>
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<tr>
<td>Uprooting Seedlings from nursery</td>
<td>-</td>
<td>40.0</td>
<td>6.70</td>
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<td>Transplanting</td>
<td>23.0</td>
<td>44.8</td>
<td>12.56</td>
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<td>Harvesting</td>
<td>12.8</td>
<td>12.8</td>
<td>4.75</td>
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<td>Threshing</td>
<td>23.2</td>
<td>18.3</td>
<td>7.70</td>
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<tr>
<td>Winnowing and Bagging</td>
<td>4.8</td>
<td>4.8</td>
<td>1.76</td>
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<tr>
<td>Total Number of Hours</td>
<td>286.5</td>
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<tr>
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<td>0.10</td>
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<td>TOTAL COST</td>
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<td>OPERATION</td>
<td>TIME PER ACRE IN HOURS</td>
<td>COST</td>
<td>COST EXPRESSED AS PERCENTAGE OF TOTAL COST</td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>------------------------</td>
<td>------</td>
<td>-------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>MAN</td>
<td>WOMAN</td>
<td>ANIMAL</td>
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<td>Cutlassing Weeds</td>
<td>40.3</td>
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</tr>
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<td>Removing cutlassed weeds</td>
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<td>33.3</td>
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</tr>
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<td>Ploughing</td>
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<td>36.0</td>
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<td>Harrowing</td>
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<td>5.8</td>
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<td>11.6</td>
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<td>Preparing &amp; Sowing Nursery</td>
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<td>23.2</td>
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<td>Uprooting seedlings from nursery</td>
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<td>Transplanting</td>
<td>23.0</td>
<td>44.8</td>
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<td>Harvesting</td>
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<td><strong>Total Cost</strong></td>
<td>64.97</td>
<td>1.96</td>
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</tbody>
</table>

Yield: 3267 lbs. per acre.
**TABLE III**

**CULTIVATION WITH THE HOWARD ROTAVATOR, "GEM".**

<table>
<thead>
<tr>
<th>OPERATION</th>
<th>HOURS PER ACRE</th>
<th>WAGES Man</th>
<th>FULL CONSUMED gals.</th>
<th>COST OF FUEL $</th>
<th>DEPRECIATION $</th>
<th>REPAIRS AND MAINTENANCE $</th>
<th>HOUSING $</th>
<th>INTEREST $</th>
<th>TOTAL COST OF OPERATION Per Acre</th>
<th>Per 100 lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotary Hoeing</td>
<td>10.0</td>
<td>5.0</td>
<td>4.30</td>
<td>2.5</td>
<td>1.03</td>
<td>6.25</td>
<td>3.75</td>
<td>0.75</td>
<td>0.35</td>
<td>16.43</td>
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<tr>
<td>Threshing</td>
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<tr>
<td>Rice</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immediately</td>
<td>29.4</td>
<td>9.3</td>
<td>6.46</td>
<td>1.8</td>
<td>0.73</td>
<td>2.35</td>
<td>0.98</td>
<td>0.88</td>
<td>0.29</td>
<td>11.78</td>
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<tr>
<td>after Cutting</td>
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<tr>
<td>After Drying for</td>
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<td>13.3</td>
<td>8.73</td>
<td>2.4</td>
<td>0.98</td>
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<td>1.33</td>
<td>1.20</td>
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<td>PETROL CONSUMED</td>
<td>COST OF PETROL</td>
<td>DEPRECIATION</td>
<td>HOUSING</td>
<td>REPAIRS AND MAINTENANCE</td>
<td>INTEREST</td>
<td>TOTAL COST OF OPERATION</td>
<td></td>
<td></td>
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<td>-----------------</td>
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<tr>
<td></td>
<td>gals.</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>Per Acre</td>
<td>Per 100 lbs.</td>
<td></td>
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<tr>
<td>39</td>
<td>0.40</td>
<td>0.16</td>
<td>1.46</td>
<td>3.60</td>
<td>0.37</td>
<td>1.88</td>
<td>2.45</td>
<td>0.16</td>
<td>0.17</td>
<td>15.49</td>
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<tr>
<td>37</td>
<td>0.30</td>
<td>0.12</td>
<td>0.66</td>
<td>0.35</td>
<td>0.17</td>
<td>0.84</td>
<td>0.39</td>
<td>0.08</td>
<td>0.08</td>
<td>5.40</td>
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<tr>
<td>90</td>
<td>0.20</td>
<td>0.08</td>
<td>1.28</td>
<td>0.20</td>
<td>0.32</td>
<td>1.76</td>
<td>0.23</td>
<td>0.14</td>
<td>0.02</td>
<td>8.40</td>
</tr>
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</table>
### TABLE V

**McCORMICK-DEERING THRESHER DRIVEN BY THE POWER TAKE-OFF OF THE FORDSON MAJOR TRACTOR**

<table>
<thead>
<tr>
<th>COST OF PETROL</th>
<th>DEPRECIATION</th>
<th>REPAIRS AND MAINTENANCE</th>
<th>HOUSING</th>
<th>INTEREST</th>
<th>COST OF THRESHING</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Thresher</td>
<td>Tractor</td>
<td>Thresher</td>
<td>Tractor</td>
<td>Thresher</td>
</tr>
<tr>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
</tr>
<tr>
<td>0.09</td>
<td>0.68</td>
<td>0.75</td>
<td>0.37</td>
<td>0.95</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6.89</td>
<td>0.25</td>
<td>6.89</td>
</tr>
</tbody>
</table>
## TABLE VI

**MAN-LABOUR, ANIMAL-LABOUR, MACHINE-LABOUR AND THEIR COSTS FOR PREPARATORY TILLAGE AND THRESHING BY THE DIFFERENT METHODS.**

<table>
<thead>
<tr>
<th>OPERATION</th>
<th>METHOD</th>
<th>HOURS PER ACRE</th>
<th>LABOUR COSTS</th>
<th>TOTAL COST PER ACRE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>MAN</td>
<td>ANIMAL</td>
<td>MACHINE</td>
</tr>
<tr>
<td>PREPARATORY TILLAGE FOR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRANSLANTING</td>
<td>MAN - Cutlassing, forking, hoeing and levelling</td>
<td>223.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>ANIMAL - Cutlassing, ploughing, harrowing and levelling</td>
<td>93.5</td>
<td>56.4</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>HOWARD ROTAVATOR, &quot;GEM&quot; Cutlassing weeds</td>
<td>10.0</td>
<td>-</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td>FORDSON MAJOR - Rotary hoeing</td>
<td>6.6</td>
<td>-</td>
<td>3.3</td>
</tr>
<tr>
<td></td>
<td>FORDSON MAJOR - Ploughing and harrowing</td>
<td>8.8</td>
<td>-</td>
<td>4.4</td>
</tr>
<tr>
<td>THRESHING</td>
<td>MAN - beating on threshing table</td>
<td>35.5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>CAMBRIDGE ROLLER - drawn by two oxen</td>
<td>29.4</td>
<td>29.4</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>TULLOS THRESHER - (without prior drying)</td>
<td>29.4</td>
<td>-</td>
<td>9.3</td>
</tr>
<tr>
<td></td>
<td>MCCORMICK-DEERING THRESHER</td>
<td>8.5</td>
<td>-</td>
<td>1.7</td>
</tr>
</tbody>
</table>

*Calculated at the rate of 58¢ per 8-hour working day.*
DISCUSSION AND EVALUATION OF RESULTS

LABOUR CONSUMED AND GENERAL AGRONOMIC CONSIDERATIONS.

Hand Cultivation. The results obtained give 286.5 man-hours and 182.1 woman-hours as the quantity of labour consumed in the cultivation of one acre of rice by the hand method (Table I). Forking, which can be considered as being equivalent to ploughing, was the most labour-consuming operation, with 100 man-hours to its credit. The preparatory tillage operations, i.e., cutlassing weeds, forking, hoeing and levelling, consumed 197 man-hours and 36 woman-hours. A peasant couple working without hiring any outside labour would therefore take approximately 24 days to prepare one acre of rice-land for transplanting, taking a working day as consisting of 8 hours. It is not possible to begin any preparatory tillage operations using hand implements such as the fork and the hoe until the land is sufficiently soft and wet. The farmer therefore has to wait for the rains which, in the St. Augustine area for instance, do not begin until the latter part of May or the early part of June. (See graph showing the distribution of the annual rainfall given in Appendix III). Assuming that the farmer begins his tillage operations during the first week of June, he cannot have his plot ready for planting until about the end of June, that is, if he is cultivating one acre of land. Planting is consequently delayed.

The results of an experiment conducted by the Botanist of the Trinidad Department of Agriculture show that delayed planting brings about a reduction in the yield of the crop. (The results are shown in the histogram at the top of page 44). The delay in the preparation of the land is compensated for, to a certain extent, by transplanting, as it is possible to prepare and sow the nursery with the first rains in the latter part of May.
Animal Cultivation. In the case of the animal cultivation, preparatory tillage, including cutlassing weeds, required 68 man-hours and 38 woman-hours (Table III). Although this method required less labour than the hand method, it suffers from the same drawback in that no tillage operations can be done until the rainy season is well on. However, it is possible to plant the crop somewhat earlier than in the case of the hand method. A feature common to both methods is the removal of the cutlassed weeds from the field, and this can only have an adverse effect on the fertility of the land. In the hand method, it is done in order to make the forking operation easy, and in the animal method, to prevent the weeds from choking the plough.

Cultivation with the Howard Rotavator, "Gem". Working with the Howard Rotavator, "Gem", (see Table III) it was found that an acre of land could be worked into a condition suitable either for transplanting or sowing seed broadcast at the expense of 10 hours of human and 5 hours of machine labour, the machine being worked by two men, the operator and an assistant, (excluding the labour used in cutlassing weeds). The second trial carried out with the machine showed that it could be operated without much difficulty by one man. However, it is
doubtful whether one man could continue working for long periods without any assistance at the same level of efficiency. This trial also gave some indication as to the possibility of using this machine to grow a reasonably good crop of rice by sowing the seed broadcast and thinning out after a period of about a month, no levelling being done after the passage of the machine, nor any weeding if facilities for good water control are available. Although four different methods of cultivation were tried, namely, wet cultivation and transplanting, wet cultivation and broadcasting, dry cultivation and transplanting, and dry cultivation and broadcasting, it is not possible to say with any degree of certainty which was the best method, because there was only one plot for each of the methods. One fact that stands out, however, is that it is possible to grow a fairly satisfactory crop of rice with any of the methods tried, thus demonstrating the possibilities of the machine.

Cultivation with the Fordson Major Tractor and Rotavator. Cultivations with the Fordson Major tractor and rotavator, though successful from the point of view of being able to obtain a reasonably good tilth in the soil for transplanting, were disappointing because of the very poor crop produced. However, it must be mentioned that the inability of introducing irrigation water in sufficient quantities and in the desired manner was a factor that contributed much to the low yield obtained. The frequent choking of the rotavator blades with soil that occurred during the trial shows that drier conditions (than those which prevailed during the trial) are desirable for the efficient working of the rotavator.

Cultivation with the Fordson Major Tractor, Two-Furrow, Mould-Board Plough and Disc Harrow. Ploughing with the Fordson Major tractor and the two-furrow, mould-board plough was quite satisfactory, although the land was in a somewhat wet
condition. The fact that approximately 21 per cent. of the time taken to plough a 2/5th acre plot was spent in turning shows that even such a size of plot (which is several times larger than the plots normally cultivated by the small grower) is not quite large enough for the economical working of a large machine such as the Fordson Major tractor.

**Threshing.** Of the four methods of threshing tried, that with the McCormick-Deering thresher (Table V) turned out to be the quickest, consuming only 8.5 man-hours in threshing an acre of rice, i.e., 2,800 lbs. Threshing with the Tullos thresher (Table III) and the Cambridge Roller (Table II) drawn by a pair of oxen consumed an equal amount of human labour, viz., 29.4 man-hours (threshing rice immediately after cutting).

However, the machine still has the advantage that it could be worked continuously for much longer periods than the animals. Of the two methods of threshing tried with the Tullos thresher, i.e., threshing rice immediately after cutting, and, after drying in the sun for two days, the former turned out to be the quicker of the two. However, it is not possible to say with certainty whether the first method is better than the second, because of two other factors that might have affected the efficiency of the operation. First, the rice that was dried in the sun was shocked and was cut with a longer straw for the purposes of shocking than that threshed immediately after cutting. Secondly, the shocked rice was threshed first, and it is possible that by the time the other lot of rice was threshed the machine was working better as a result of the adjustments made when the first lot was being threshed, and also that the man feeding the bundles of rice into the machine was probably doing it quicker as he got accustomed to it. Yet, it is reasonable to suppose that the longer straw which the machine had to cope with in the first case was one of the main causes that contributed to the
slower rate of threshing. Therefore, it appears that the
course of shocking rice hindered, rather than helped, in the
threshing operation. Drying rice should normally facilitate
the separation of the grain from the straw. If, for instance,
rice is harvested by cutting it with short straw by means of
a swather, which implement cuts and lays the crop in windrows
supported by the stubble, where it is left for a day or two
or more to dry out, threshing with the machine can be expected
to consume less time than when it is done when the rice is in
a fresh condition. Rice has to be dried in any case before it
can be milled, and if it is threshed soon after harvesting or
combined, the drying has to be done when it is in the grain
stage.

COSTS

Hand Cultivation. The hand method of doing the
preparatory tillage (Table I) was the most expensive of the
different methods tried, accounting for 52 per cent. of the
total cost of growing one acre of rice, excluding land rent,
cost of irrigation, nursery maintenance and cartage. 23 per
cent. of this cost was spent in forking.

Animal Cultivation. In the case of the animal
method (Table II) preparatory tillage consumed 42 per cent.
of the total cost, excluding the cost of feeding and maintaining
the oxen employed. Assuming that the oxen would be used every
day throughout the year, i.e., in doing other work besides rice
cultivation, a sum of $4.06 must be added to the figure of $20.39
(as given in Table II), thus making up a total of $24.45 per acre.
(The costs of feeding and maintaining an ox is given in Appendix
III).

Cultivation with the Howard Rotavator, "Gem". The
cost of preparing one acre of land with the Howard Rotavator,
"Gem", (Table III) was $25.29 (including the cost of cutlassing
the weeds). Of this a sum of $11.10 was contributed by the
Indirect costs of the machine (depreciation, repairs and maintenance, housing, taxes and insurance, and interest) of which depreciation alone amounted to $6.25. The indirect costs were calculated on the basis that the machine would be used only for one rice cultivation season, giving an annual use of 250 hours. It was also assumed that the useful life of the machine would be 4 years, thus giving it a total useful life of 1,000 working hours. If the machine could be used in the cultivation of either a second crop of rice during the year, or a vegetable crop, it would be possible to extend the annual use of the machine for a further period of 250 hours, and thus appreciably reduce the indirect costs per hour of use, although the total useful life of the machine would then be somewhat less than 4 years. Since the indirect costs accounted for nearly 40 per cent. of the total cost of preparatory tillage, it can be expected that reducing the former would also reduce the latter considerably.

The relationship between (i) the number of hours of annual use and the useful life of a machine, and (ii) the decrease in the cost per hour of use with the increase in the number of hours used per year is shown in the following two diagrams:
Actually the former applies to a durable, medium-sized tractor and the latter to a typical two-plough tractor, but, if such diagrams are worked out in the case of the machine under discussion, they can be expected to follow a similar pattern.

Even if the cost of doing the preparatory tillage with the Howard Rotavator was not appreciably less than that incurred by the animal method, the machine still has the advantage that it could do the job at the expense of much less human labour, viz., 18 man-hours per acre less than with the animal method. Further, the machine could be worked continuously for much longer periods than a pair of oxen, and it could also do the job in less than one-quarter of the time required by the latter, the machine taking 5 hours to rotary hoe one acre (an operation that can be considered as being equivalent to ploughing and harrowing), and the oxen 22.2 hours to plough and harrow the same acreage.
Cultivation with the Fordson Major Tractor and Rotavator. Rotary hoeing with the Fordson Major tractor and rotavator with a 50-inch cut used up 6.6 man-hours and cost $15.49 per acre (Table IV), thus taking 4.4 man-hours less, and costing $9.80 less, than doing with the Howard Rotavator, "Gem". The indirect costs of the machine and rotavator amounted to $10.08, i.e., over 66 per cent. of the total cost of the operation. The indirect costs of the rotavator itself worked out to be $6.22, a figure much higher than that obtained for the tractor. This is explained by the fact that the total useful life of the rotavator unit was taken as only 4 years, together with an annual use of only 250 hours (in contrast to 8 years useful life and 600 hours of annual use given to the tractor) in consideration of its high rate of wear and tear due to its rotatory motion through the soil at high speed. Although a suitable tilth was not obtained in the trial with one rotary hoeing operation alone, it is reasonable to suppose that it would be possible to do so under more suitable conditions. (It is also very likely that under better conditions than those that prevailed during the trial, the time taken to rotary hoe an acre of land would be less than the 3.3 hours used up in the trial). In calculating the indirect costs of the tractor 600 hours have been taken as its annual use. At this rate of annual use it is seen from the figures given in the recorded results that the indirect costs of the tractor amount to nearly 30 per cent. of the total cost of rotary hoeing. If the rotavator unit is to be used for 250 hours per year (in rice cultivation alone) about 75 acres have to be cultivated on the basis of 3.3 hours per acre. Under the present layout of the rice fields, this would mean that the tractor will have to cross innumerable bunds and move considerable distances.
Cultivation with the Fordson Major Tractor, Ploughing and Harrowing. Ploughing with a two-furrow, mould-board plough drawn by the Fordson Major tractor cost $8.40 per acre, the indirect costs being $4.95, i.e., more than 50 per cent. of the total cost. Working costs amounted to $1.15 per hour. These figures have been based on the assumption that the tractor would work 600 hours per year as in the case of rotary hoeing. The ploughing was done in less than half the time taken for rotary hoeing, the condition of the land in both cases being nearly the same. The speed of the tractor when ploughing was approximately 2$\frac{1}{2}$ miles per hour, and 2 miles per hour when rotary hoeing. One of the factors that probably accounts for the shorter time taken in ploughing is that the tractor was equipped with steel wheels fitted with spade lugs when ploughing, as against standard wheels with pneumatic tyres when rotary hoeing. Harrowing with a 16-disc harrow took 4.2 hours, i.e., 1.3 hours more than the time taken to plough. Very little significance can be attached to this figure because the soil was actually too wet, and hence the work was heavier than it would have been under more suitable conditions. Harrowing the rotary-hoed field took 1.5 hours, i.e., approximately half the time taken for ploughing, and less than half that taken for rotary hoeing. This was done with a trailed 8-disc harrow and cost $5.40 per acre. Taking this figure as being a more likely one for harrowing the ploughed field if done under suitable conditions, it is seen that the two operations (ploughing and harrowing) cost $13.80 per acre as compared with $15.49 per acre (Table VI) for rotary hoeing. However, rotary hoeing has the advantage that what can be considered as being equivalent to both operations, if done under suitable conditions, is achieved in one. In this case as in that of the rotary hoeing, the indirect costs of the tractor have been calculated on the
assumption that it would be used for a period of 600 hours per year. This annual usage (in rice cultivation only) is certainly an overestimate under present conditions in Trinidad, when compared with a figure of 700 hours of annual use given by a survey of some 65 rice-farms (19) in Texas with 108 acres per tractor. It is estimated that a tractor should be used for at least 1,200 hours per year, if high efficiency is to be realised.

Threshing with the McCormick-Deering Thresher. Of the methods of threshing tried, that with the McCormick-Deering thresher appeared to be the cheapest being $6.89 per acre (Table V), (calculated on the basis of an average yield of 2,800 lbs. per acre). In calculating the indirect costs of the machine, the useful life was fixed at 8 years, and an annual use of 384 hours was assumed (on the basis of eight 48-hour weeks of work per year). Doing 384 hours of work per year means that the machine would thresh the crop obtained from approximately 226 acres (if only rice were threshed). Actually the machine can be used to thresh other crops such as soya bean, sorghum, etc., so that if such crops are grown during the dry season, it will be possible to employ the machine more fully, and thus bring about a reduction in the indirect costs.

Threshing by Hand and by the Cambridge Roller. Hand threshing was the next in order of cheapness, being $7.70 per acre. As mentioned earlier, this method suffers from the drawback that it requires too much human labour. Threshing with the Cambridge Roller drawn by a pair of oxen cost $8.59 per acre (including the cost of feeding and maintaining the oxen). This process of threshing needs a fairly smooth and hard threshing floor in order that it could be done efficiently, and this may be considered as an obstacle to the practicability of employing this method. Another drawback of the method from the point of view of animal
labour, is that it involves the use of a pair of animals for a period of approximately 29 hours to thresh the crop obtained from one acre. The shortage of work-oxen in the Colony may therefore limit the use of this method of threshing.

**Threshing with the Tullos Thresher.** Threshing with the Tullos thresher gave a figure of $11.78 as the cost per acre (threshing rice soon after cutting). Threshing after drying in shocks for two days in the sun cost $20.41 per acre including the cost of shocking. The threshing itself cost $15.88 per acre. When the first figure of $11.78 per acre is analysed, it is seen that indirect costs amount to approximately 46 per cent. of the total costs. The indirect costs of the threshing part of the machine (the engine being considered separately) were based on an annual use of only 240 hours, i.e., working for 30 days in the year, a working day being taken as consisting of 8 hours. Considering the big share contributed to the total costs by the indirect costs, it can be expected that the former could be appreciably reduced by extending the annual use. An annual use of 240 hours means dealing with an acreage of only about 25 on the basis of 9.8 hours per acre (see Table III). The machine could easily deal with a further 25 acres, thus reducing the indirect costs per hour of use, and hence the total cost of threshing. The detachable 1 - 1½ h.p. engine used to drive the thresher could be used in doing other work, such as working a pump, thus increasing its annual use with a consequent reduction in cost per hour of use.

If preparatory tillage is done with the Howard Rotavator "Gem", (and transplanted), threshing with the Tullos thresher and all other operations involved in growing rice are done by the

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*The 1946 Census gives a figure of 1,100 neat cattle and 1,171 buffaloes under draft animals, i.e., 1 animal for approximately 10 acres of rice, on the assumption that both neat cattle and buffaloes could be used for draft, and that there is a total acreage of around 20,000.*
present methods, the cost of production per acre would be as follows:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparing and sowing nursery</td>
<td>$9.08</td>
</tr>
<tr>
<td>Nursery maintenance</td>
<td>$2.00</td>
</tr>
<tr>
<td>Preparing main field (for transplanting)</td>
<td>$25.29</td>
</tr>
<tr>
<td>Uprooting seedlings from nursery</td>
<td>$6.70</td>
</tr>
<tr>
<td>Transplanting</td>
<td>$12.56</td>
</tr>
<tr>
<td>Harvesting</td>
<td>$4.75</td>
</tr>
<tr>
<td>Threshing</td>
<td>$11.69</td>
</tr>
<tr>
<td>Winnowing and Bagging</td>
<td>$1.76</td>
</tr>
<tr>
<td>*Cartage</td>
<td>$5.00</td>
</tr>
<tr>
<td>*Drying</td>
<td>$13.50</td>
</tr>
<tr>
<td><strong>Total Cost of Production</strong></td>
<td>$92.33</td>
</tr>
</tbody>
</table>

Taking an average yield of 18 barrels (1 barrel approximately equals 160 lbs.), the cost would be $5.13 per barrel. The cost of milling, and transport to and from the miller (as given in the Report of the Rice Committee, Council Paper No. 2 of 1950) is $84 per barrel. Hence 104 lbs. of clean rice (60 - 70 per cent. conversion from rough to clean rice) would cost $5.97, i.e., $5.97 per pound approximately. Even if the locally grown rice were sold at the same price as the imported rice, viz., 7½ per lb., there would still be a profit of 1½ per lb. for the local grower.

CONCLUSIONS

Taking the period between the beginning of June and the middle of August as the normal planting season, it is not possible for a peasant couple to cultivate more than approximately two and a half acres of rice using hand methods, without hiring any outside labour. If the preparation of the land is done using the animal method, about 10 acres of land can be cultivated using only one pair of oxen. However, only about half the number of acres cultivated would be planted early enough to ensure a reasonably high yield. Using the Howard Rotavator, "Gem", an acreage of approximately 45 could be prepared for planting within a period of about one month, if the peasant hires a man to assist him, or probably half this acreage if the machine is worked without any assistance. Thus, with this machine it is possible not only to extend the acreage cultivated, but also to have the crop planted much earlier than with the hand or animal methods. It is reasonable to expect that the little extra cost involved in doing the preparatory tillage with the Howard Rotavator as compared with the animal method would be more than compensated for by the higher yields that would result in planting the crop early. It is very likely that the fairly high cost of the machine would not be within the means of the peasant. This problem could be solved either by co-operation or by the provision of credit facilities.

The indications are that the Howard Rotavator cannot cope up with a weed growth of more than about 4 to 6 inches, so that it is necessary to cut the weeds, at least to this height, before using the machine on the land. Further, the land must be either reasonably dry or have about 2 to 3 inches of standing water for the machine to work properly. The indications are that the machine works better with standing water on the land than when the latter is dry. It is possible for the machine to work in small plots such as are cultivated by the average
Although the trials carried out gave some indication as to the possibility of producing a satisfactory tilth in the soil for transplanting or broadcasting with the Fordson Major tractor and the Rotavator, it is doubtful whether the conditions that must be satisfied so as to make the method economic, such as the annual use of the tractor for a period of at least 600 hours and the rotavator for 250 hours, would be fulfilled. Further, there is the practical difficulty of working the tractor on very small plots.

As regards the Ransome's M.G.5 Crawler tractor, it can only be said that it is not suitable for use under wet conditions.

Threshing rice with the McCormick-Deering thresher, though it proved to be the cheapest of the methods tried, involves dealing with too large an acreage to be a practicable possibility under the present conditions.

It appears to be economic to thresh rice by means of the Cambridge Roller, but the shortage of draft oxen in the Colony is likely to limit the possibility of using this method.

Although threshing with the Tullos thresher was more expensive than the hand method, there is the possibility that the costs can be reduced to the point where its use would be economical, by extending the number of hours worked per year.

It appears that the only processes that could be mechanised on an economical basis as far as the small rice grower is concerned, are preparatory tillage and threshing, both consuming large amounts of human labour measured in man-hours per acre under the present methods and conditions of cultivation.

The organisation of the rice farmers into groups of about 40 acres each, each group owning one Howard Rotavator, appears to be necessary for the economical use of the machine. If it is possible to grow two crops of rice a year, this acreage
can be reduced by half. The Tullos thresher too could be used on the same basis. The contractor system of employing the machines does not seem to be possible because the additional item of profit (for the contractor) may raise the costs above the economic rates.

SUGGESTIONS FOR FURTHER WORK

1. Since the present investigation has indicated the possibility of using the Howard Rotavator, "Gem", in doing the preparatory tillage, it is thought worthwhile determining, by means of a statistically designed experiment, the best method of using the machine, both from the point of view of yield of the crop and the costs. The following four methods are suggested:

   (i) wet cultivation and transplanting,
   (ii) wet cultivation and broadcasting,
   (iii) dry cultivation and transplanting, and
   (iv) dry cultivation and broadcasting.

2. As regards threshing with the Tullos thresher, it is suggested that a trial should be carried out to determine whether, cutting the rice with a short straw, and drying it in the sun for a day or two would make the process more economical than when done with the rice in a freshly cut condition.

3. As the use of the Howard Rotavator involves the preliminary cutlassing of the weed growth by hand, consuming a large amount of labour and expense, investigating the possibility of economically using a machine such as a grass mower, to cut the weeds, is worthy of a trial.

4. It is thought desirable that a further trial be carried out with the Ransome's M.G.5 Crawler tractor under dry conditions.
SUMMARY

(1) The present investigation compares hand, animal, and small and large mechanical methods of cultivating a crop of rice in Trinidad. The hand and animal methods are complete, but in the case of the mechanical methods only preparatory tillage and threshing have been carried out with machines, planting and harvesting being done by hand methods. The machines used are the Fordson Major tractor with a rotavator unit, two-furrow, mould board plough and disc harrow, the Howard Rotavator, "Gem", and the Ransome's M.G.5 Crawler tractor, for the preparatory tillage, and the Tullos and McCormick-Deering threshers for threshing.

(2) A detailed account of the various operations carried out, together with the difficulties experienced in the processes, general agronomical considerations, and the time spent, the labour consumed and the costs incurred, is given.

(3) The results obtained are discussed from the point of view of practical and economic considerations.

(4) It is concluded that the only operations that can be mechanised as far as the small farmer is concerned, are preparatory tillage and threshing. The possibility of using the Howard Rotavator, "Gem", for the preparatory tillage, and the Tullos thresher for the threshing operation is indicated.

(5) A comparative account of rice cultivation in some of the rice-producing countries, including Trinidad, is also given.
ACKNOWLEDGMENTS

The writer wishes to tender his thanks to Mr. J.E. Mayne, Senior Lecturer in Agriculture, at the College, for his valuable suggestions and guidance, and for making arrangements with Messrs. H.E. Robinson & Co., concerning the trials with the Howard Rotavator, "Gem", and the Tullos thresher. Thanks are also due to Mr. C.W. Lynn, Acting Professor of Agriculture, for arranging the trips to British Guiana, and to the Director of Agriculture, British Guiana, for making arrangements in connection with the visits to the Mahaicony-Abary Rice Mechanisation Scheme, and also to the officers attached to the said scheme for showing him around and explaining the working of it. The kind co-operation of Messrs. H.E. Robinson & Co., without which the trials with the Howard Rotavator and the Tullos thresher would not have been possible, is gratefully acknowledged. Thanks are extended to Mr. J.B. Swift of the College Farm who helped in the organisation of the labour employed in carrying out the trials.
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(26) SHEN, T.H.


(27) SIMPSON, H.J. and HARTLEY, C.W.S.


(28) TEMpany, H.A., JACK, H.W., and SANDS, W.N.


(29) WICKRAMASEKERA, G.V.

APPENDIX I

EXTRACT FROM THE FIELD NOTE BOOK GIVING THE DETAILS OF THE VARIOUS OPERATIONS CARRIED OUT AS THEY WERE ENTERED.

HAND CULTIVATION.

Preparation of the Nursery. 1 plot, 150 sq. ft. in area.
Cutlassing weeds - man started at 7.10 a.m., stopped at 7.20 a.m. to sharpen the cutlass. Started again at 7.24 a.m. and finished at 7.35 a.m.
Removing cut weeds and raking the plot - man and woman started at 7.30 a.m., the man stopped at 7.52 a.m., the woman continued till 7.55 a.m.
Forking the plot - man started at 7.45 a.m. and finished at 8.48 a.m.
Making a bund round the plot - man started at 9 a.m. (after an interval of 12 minutes for tea) and stopped at 9.56 a.m. The woman started at 9.15 a.m. and finished at 9.55 a.m.
Levelling the plot - The man started at 10 a.m. and finished at 10.11 a.m., the woman started at the same time and finished at 10.15 a.m.
Transporting 4 basketfuls of pen manure - 20 minutes taken by the woman.
Sifting the manure - the woman started at 10.15 a.m. and finished at 10.35 a.m.
Spreading the manure - the woman started at 10.35 a.m. and finished at 10.50 a.m.
Introducing water into the plot - 7 minutes taken by the woman.
Sowing seed on the water and then draining the water - 8 minutes taken by the woman.
Covering the seed with coconut leaves - 5 minutes spent by both the man and the woman.

Preparation of the main field.
Cutlassing weeds - man started at 7.58 a.m., stopped to sharpen the cutlass at 9.45 a.m. Resumed cutlassing at 9.50 a.m. and
stopped again to sharpen cutlass at 11.05 a.m., started at 11.09 a.m. and finished the operation at 12 noon.

Forking - done on the following day. Man began at 8 a.m. and stopped at 8.45 a.m. for an interval of 15 minutes for breakfast. Stopped again at 11.20 a.m. for 10 minutes owing to rain. Stopped work at 12 noon for the day, (the man complaining that he was too tired to continue work in the afternoon). Started again on the following day at 8 a.m. and finished the job at 2 p.m.

Hoeing and levelling - man started at 1.15 p.m. and stopped at 2.20 p.m. for short rest of 10 minutes. Resumed work at 2.30 p.m. and continued till 3.30 p.m. when work was stopped for the day. Started the operation at 7.50 a.m. on the following day and stopped at 11.23 a.m.

Removing cutlassed weeds - woman started at 7.50 a.m. and finished at 11.38 a.m. with a break of 15 minutes at 9 a.m. for tea.

Uprooting seedlings from nursery - 4 women started at 7.45 a.m. and finished at 8.45 a.m.

Transplanting - man started washing the roots of the seedlings at 9 a.m. and carrying the seedlings to the woman doing the transplanting. The woman started transplanting at 9.10 a.m. and finished at 1.38 p.m. The man finished washing the roots of the seedlings and carrying them to the field at 11.20 a.m.

Harvesting - a man and a woman started cutting at 8.15 a.m. and finished at 9.31 a.m.

Threshing - a man and a woman started at 10 a.m. The man was doing the actual threshing while the woman was carrying the sheaves of rice and heaping them near the threshing table. The time taken to beat out a sheaf of rice, i.e., as much of it that could be held with both hands, varied from 15 to 20 seconds, and each sheaf was struck 6 to 8 times on the threshing table. The woman finished carrying the sheaves of rice at 11.55 a.m. and the man finished threshing at 12.17 p.m.

Winnowing and bagging - the woman started winnowing at 11.55 a.m.
and the man started bagging the winnowed rice at 12.20 p.m. The winnowing finished at 12.34 p.m. and the bagging at 12.49 p.m. The winnowing was done partly by the woman and partly by the man.

**ANIMAL CULTIVATION.**

Ploughing - one man started with a pair of oxen and the Ransome's Victory plough at 8.10 a.m. The plough draft was measured by means of a dynamometer. The dynamometer reading varied from 18 to 24 lbs. The ploughing finished at 9.58 a.m. Water introduced into the field immediately after ploughing.

Harrowing - started harrowing with the York harrow drawn by a pair of oxen at 10 a.m., finished at 10.25 a.m. when the harrow was turned over and the levelling begun. Finished levelling at 11 a.m. (The operations of cutlassing weeds, nursery preparation, transplanting and harvesting were not recorded in this case as they were done exactly in the same way as in the case of the hand method of cultivation.)

Threshing with the Cambridge Roller - Roller drawn by a pair of oxen. Two men employed, one man driving the oxen and the other carrying and spreading the sheaves of rice on the floor, and helping in the removal of the threshed rice. Started threshing at 9.40 a.m. Batch 1 started at 9.40 a.m. and finished at 10.10 a.m. Batch 2 started threshing at 10.40 a.m. and finished at 11.15 a.m. Batch 3 started at 11.20 a.m. and stopped at 11.45 a.m. Started again at 1.10 p.m. and stopped at 1.25 p.m. Resumed threshing at 2.10 p.m. and finished at 2.30 p.m.

**CULTIVATION WITH THE FORDSON MAJOR TRACTOR, TWO-FURROW MOULD-BOARD 16-DISC HARROW AND THE YORK HARROW.**

Ploughing with the 2-furrow mould-board plough - started ploughing at 9.15 a.m. with the tractor equipped with standard wheels with pneumatic tyres. Stopped at 9.18 a.m., wheels slipping, reversed a short distance and started again. Stopped again at 9.30 a.m. to make adjustments to the plough, and resumed work at 9.35 a.m. and continued till 9.50 a.m. Wheels slipping again, and work was stopped for the day. Started ploughing again on the following
day with the tractor equipped with steel wheels fitted with spade lugs. Started ploughing at 8.40 a.m. and finished at 9.50 a.m. without any stoppages.

Time taken for the tractor to turn - 45, 40, 30, 30, 35, 40, 32 and 40 seconds (the average of these 8 readings was used to calculate the total time spent by the tractor in turning, by multiplying this figure by the total number of turns made).

Number of turns made by the tractor - 25.

No. of paces travelled by the tractor in 20 seconds - 23, 23 and 22. Finished ploughing at 9.50 a.m. Vaporising oil consumed - 4 quarts.

Harrowing with the 16-disc harrow - tractor equipped with steel wheels fitted with spade lugs. Disc harrow was trailed, no harrow suitable for use with the hydraulic system of the tractor being available. Started harrowing at 1.50 p.m.

Time taken by the tractor to run the length of the plot - 2 mins. 25 secs., 2 mins. 25 secs., and 2 mins. 20 secs.

Number of turns made by the tractor in completing the harrowing - 18.

Time taken to make 1 turn - 1 min., 55 secs., 65 secs., 50 secs., 48 secs., and 52 secs. Average time spent in making 1 turn - 55 secs.

Stopped for 5 mins. wheels slipping; reversed a short distance and started again. Stopped again for 3 mins., discs choked with soil, cleaned the discs and started again. Stopped again for 3 mins. 30 secs. to clean discs. Cleaned discs and started after 10 mins.

Finished harrowing at 3.30 p.m. Fuel consumed - 6 quarts (vaporising oil).

Levelling with the York harrow - tractor equipped with steel wheels as before, and the harrow was trailed. Started at 1.15 p.m. after working for 10 mins. the tractor got bogged down. 2 hours were spent in extricating the tractor.

CULTIVATION WITH THE HOWARD ROTAVATOR, "GEM", WITH A 20-INCH CUT.

Rotavator blades set to work to a depth of 5 inches. Started at 1.25 p.m., stopped at 1.40 p.m. to make adjustments, the depth control skid not functioning properly. Started again at 2.20 p.m.
Stopped at 3.35 p.m. to dislodge a piece of brick that had got wedged in between the rotavator shaft and the housing. Resumed work at 4.15 p.m. and finished at 4.45 p.m.

Time taken by the machine to travel the length of the plot - 4 mins. 20 secs., 4 minutes 52 secs., and 4 mins. 30 secs.

Fuel consumed - \( \frac{2}{3} \) quarts.

**Second Trial with the Howard Rotavator.**

Plot (1) Wet cultivation. Started at 1.30 p.m. and finished at 2.30 p.m.

Plot (4) Wet cultivation. Started at 1 p.m. and finished at 1.30 p.m.

Plot (3) Dry cultivation. First cut started at 9.15 a.m. and finished at 9.40 a.m. Second cut started at 9.45 a.m. and finished at 9.55 a.m.

Plot (2) Dry cultivation. First cut started at 8.20 a.m. and finished at 8.35 a.m. Second cut started at 8.35 a.m. and finished at 9 a.m.

**CULTIVATION WITH THE FORDSON MAJOR AND ROTAVATOR (50 inch cutting width), AND 8-DISC HARROW.**

Rotary hoeing - tractor equipped with standard wheels with pneumatic tyres. Rotavator set to work at a depth of 5 inches. Started at 8.30 a.m. and at 8.35 a.m. stopped for ½ min. to clean the soil sticking to the rotavator blades. At 8.45 a.m. stopped again for 4 mins. to clean the rotavator blades. Stopped to clean the rotavator blades - 8 secs., 8 secs., 10 secs., and 8 secs. Finished rotary hoeing at 9.50 a.m.

Distance travelled by the tractor in 20 secs. - 21, 16 and 20 paces.

Number of turns made by the tractor in doing the work - 36.

Time spent in making turns - 6 secs., 8 secs., 5 secs., 5 secs., and 7 secs. Vaporising oil consumed - 6 quarts.

Sowing - woman started sowing the field with 40 lbs. of seed at 1.10 p.m. and finished at 1.55 p.m.

Harvesting of the crop was done by hand.
THRESHING WITH THE TULLOS THRESHER.

Threshing rice cut the same day - started threshing at 2.05 p.m. and finished at 3.05 p.m. No stoppages.

Average speed of the threshing drum - 500 revolutions per minute.

Samples of straw and threshed grain collected during the operation:

<table>
<thead>
<tr>
<th>Time (min.)</th>
<th>Weight of Grain (lbs. ozs.)</th>
<th>Weight of Straw (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample (1)</td>
<td>1 5 7</td>
<td>16</td>
</tr>
<tr>
<td>&quot; (2)</td>
<td>1 4 2</td>
<td>12</td>
</tr>
<tr>
<td>&quot; (3)</td>
<td>1 4 10</td>
<td>14</td>
</tr>
<tr>
<td>Total</td>
<td>14 3</td>
<td>42</td>
</tr>
<tr>
<td>Average</td>
<td>4 12</td>
<td>14</td>
</tr>
</tbody>
</table>

Rate of threshing - (output of grain) 285 lbs. per hour.

Throughput of rice - (grain and straw) 1,125 lbs. per hour.

Threshing rice dried for two days in the sun after cutting. Started threshing at 10 a.m. Stopped at 10.20 a.m. to adjust the speed of the threshing drum, which was getting choked with straw as a result of its being too slow. Started again at 10.30 a.m., stopped at 11.05 a.m., the drum still getting choked with straw. Started at 11.15 a.m. and stopped again at 11.20 a.m. Resumed threshing at 11.30 a.m. and finished at 11.40 a.m. The best speed of the threshing drum was found to be 500 revolutions per minute.

Samples of straw and threshed grain collected during the threshing:

<table>
<thead>
<tr>
<th>Time (min.)</th>
<th>Weight of Grain (lbs. ozs.)</th>
<th>Weight of Straw (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample (1)</td>
<td>1 3 8</td>
<td>12</td>
</tr>
<tr>
<td>&quot; (2)</td>
<td>1 3 4</td>
<td>11</td>
</tr>
<tr>
<td>&quot; (3)</td>
<td>1 3 7</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>10 3</td>
<td>33</td>
</tr>
<tr>
<td>Average</td>
<td>3 6</td>
<td>11</td>
</tr>
</tbody>
</table>

Rate of threshing - (output of grain) 203.5 lbs. per hour.

Throughput of rice - (grain and straw) 863.5 lbs. per hour.
SHOCKING RICE

1 man tying the cut rice into bundles and making them into shocks of 8 bundles each. Work began at 7.40 a.m.

1st shock took 11 mins. 2nd shock took 13 mins.
3rd " 13 " 4th " 11 "
5th " 11 " 6th " 10 "
7th " 10 "

Average time taken by one man to make one shock - 11 mins. 17 secs.

1 man spent 79 mins. in making 7 shocks.
2 men " 55 " " 10 "
2 " 25 " " 3 shocks.

The rice was made into 20 shocks of 8 bundles each in 3 hrs. 43 mins. 10 secs.

THRESHING WITH THE McCORMICK-DEERING THRESHER.

Labour employed - 5 men; 1 man feeding the machine, 1 sweeping away the straw, 1 attending to the bagging, 1 carrying the bundles of rice to the feeder, and the tractor operator.

Started threshing at 8.15 a.m. and finished at 8.50 a.m.

Weight of thresher rice - 868 lbs.

Rate of threshing - 1,488 lbs. of rice per hour.

THRESHING WITH THE CAMBRIDGE ROLLER.

1 man driving the pair of oxen pulling the Cambridge Roller, and 1 man spreading the rice to be threshed on the floor and sweeping aside the thresher grain and straw.

Batch 1 - started at 9.40 a.m. and finished at 10.10 a.m.

Weight of thresher grain - 207 lbs.

Batch 2 - started at 10.40 a.m. and finished at 11.15 a.m.

Weight of thresher grain - 104 lbs.

Batch 3 - started at 11.20 a.m. and stopped at 11.45 a.m. Started again at 1.10 p.m. and stopped again at 1.25 p.m. (oxen being used for some other more urgent work). Started again at 2.10 p.m. and finished at 2.30 p.m.

Weight of thresher grain - 147 lbs.
APPENDIX II

CALCULATION OF THE COSTS PER ACRE OF THE VARIOUS OPERATIONS CARRIED OUT

HAND CULTIVATION - Size of plot: approximately 1/10th of an acre.

Cutlassing weeds - 1 man spent 4 hrs. 2 mins.
Per acre - 40 hrs. 20 mins.
i.e., 40.3 man-hours.
Cost per acre $22.00 per hour .... 8.86

Removing cut weeds & cleaning field during levelling
1 woman spent 3 hrs. 49 mins.
Per acre - 38 hrs. 10 mins.
i.e., 38.2 woman-hours
Cost per acre 17¢ per hour .... 5.45

Forking - 1 man spent 10 hrs.
Per acre - 100 hrs.
i.e., 100 man-hours.
Cost per acre ................. 22.00

Hoeing & levelling - 1 man spent 5 hrs. 45 mins.
Per acre - 57 hrs. 30 mins.
i.e., 57.6 man-hours
Cost per acre ................. 12.65

Preparing & Sowing Nursery

Uprooting seedlings - 1 woman spent 4 hrs.
from Nursery
Per acre - 40 hrs.
i.e., 40 woman-hours.
Cost per acre ................. 6.70

Transplanting - 1 woman spent 4 hrs. 28 mins.
1 man spent 2 hrs. 20 mins.
Per acre - 1 man - 23 hrs. 20 mins.
1 woman - 44 hrs. 40 mins.
i.e., 23 man hours & 44.8 woman-hours.
Cost per acre ................. 12.56

Harvesting - 1 man spent 1 hr. 16 mins.
1 woman spent 1 hr. 16 mins.
Per acre - 1 man - 12 hrs. 40 mins.
1 woman - 12 hrs. 40 mins.
i.e., 12.8 man-hours & 12.8 woman-hours.
Cost per acre ................. 4.75

Threshing - 1 man spent 2 hrs. 17 mins.
1 woman spent 1 hr. 53 mins.
Per acre - 1 man - 23 hrs. 10 mins.
1 woman - 18 hrs. 50 mins.
Cost per acre ................. 7.70

Winnowing & Bagging - 1 man spent 29 mins.
1 woman spent 29 mins.
Per acre - 1 man - 4 hrs. 50 mins.
1 woman - 4 hrs. 50 mins.
i.e., 4.8 man-hours & 4.8 woman-hours.
Cost per acre ................. 1.76

Cost of Seed (40 lbs. @ 8¢ per lb.) ................. 3.20

TOTAL COST 94.72

Total Amount of Labour Consumed - Man: 162 hours 10 mins.
Woman: 159 hours. 10 mins.
**ANIMAL CULTIVATION**

- **Size of plot**: approximately 1/10 th acre.

### Cutlassing weeds
- The cost is the same as in the case of the hand-cultivated plot: $8.86

### Removing cutlassed weeds
- *ditto*: $5.45

### Ploughing
- **Man and 2 oxen - 1 hr. 48 mins.**
  - per acre - 18 hrs. 0 mins.
  - i.e. 18 man-hours & 36 animal-hours
  - Cost per acre:
    - Man @ 22½ per hour = $3.96
    - Animals @ 62½ per hour per ox = $2.34
  - Total cost: $6.30

- **Man and 2 oxen - 25 mins.**
  - per acre - 4 hrs. 10 mins.
  - i.e. 4.2 man-hours & 8.4 animal-hours
  - Cost per acre:
    - Man @ 22½ per hour = $0.92
    - Animals @ 62½ per hour per ox = $1.11
  - Total cost: $2.03

### Harrowing
- **Man and 2 oxen - 35 mins.**
  - per acre - 5 hrs. 50 mins.
  - i.e. 5.8 man-hours & 11.6 animal-hours
  - Cost per acre:
    - Man @ 22½ per hour = $1.27
    - Animals @ 62½ per hour per ox = $2.13
  - Total cost: $3.40

### Levelling
- **Man and 2 oxen - 33 mins.**
  - per acre - 5 hrs. 50 mins.
  - i.e. 5.8 man-hours & 11.6 animal-hours
  - Cost per acre:
    - Man @ 22½ per hour = $1.27
    - Animals @ 62½ per hour per ox = $2.13
  - Total cost: $3.40

### Preparing and Sowing Nursery
- Cost: $9.08

### Uprooting Seedlings from Nursery
- Cost: $6.70

### Transplanting
- Cost: $12.56

### Harvesting
- Cost: $4.75

### Threshing with Cambridge Roller
- **2 men and 2 oxen - 1 hr. 20 mins.**
  - per acre - 14 hrs. 40 mins.
  - i.e. 29.4 man-hours & 29.4 animal-hours
  - Cost per acre:
    - Men @ 22½ per hour = $6.46
    - Animals @ 62½ per hour per ox = $2.13
  - Total cost: $8.59

### Winnowing & Bagging
- Cost: $1.76

### Cost of seed
- Total cost: $3.20

**TOTAL COSTS**
- Total cost: $70.52

**Total costs exclusive of cost of animal labour**
- $64.97

**Cost of animal labour**
- $5.55
Cost of Feeding and Maintaining a Working Ox per day (as taken from records kept on the College Farm).

Concentrates fed - 2 lbs. - .16
Fodder - 75 lbs. - .18
Cost of attendant (1/8th paid per day) (i.e., 1 hour per day) - .22
Sundries - i.e., medicine and medical attention - .02

Total Cost 0.58¢
CULTIVATION WITH THE FORDSON MAJOR TRACTOR.

INDIRECT COSTS OF TRACTOR

Based on an annual use of 600 hours.

<table>
<thead>
<tr>
<th>Description</th>
<th>Calculation</th>
<th>Cost per hour of use</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Depreciation*</td>
<td>$2253.00 / 4800 = .44¢</td>
<td></td>
</tr>
<tr>
<td>(2) Repairs and Maintenance</td>
<td>$337.95 / 4800 = .56¢</td>
<td></td>
</tr>
<tr>
<td>(3) Housing</td>
<td>$67.59 / 4800 = .11¢</td>
<td></td>
</tr>
<tr>
<td>(4) Interest+</td>
<td>$27.91 / 4800 = .43¢</td>
<td></td>
</tr>
</tbody>
</table>

ROTAVATOR

Based on an annual use of 250 hours.

<table>
<thead>
<tr>
<th>Description</th>
<th>Calculation</th>
<th>Cost per hour of use</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Depreciation</td>
<td>$1015.00 / 2500 = $1.02</td>
<td></td>
</tr>
<tr>
<td>(2) Repairs and Maintenance</td>
<td>$152.25 / 250 = .61¢</td>
<td></td>
</tr>
<tr>
<td>(3) Interest</td>
<td>$5 / 250</td>
<td></td>
</tr>
</tbody>
</table>

* Calculated on $\frac{1}{2}$ the first cost and this amount is used all through the useful life of the machine or implement.

* It is assumed that the machine or implement will have no junk value at the end of its useful life.
TWO-FURROW MOULD-BOARD PLOUGH
Based on an annual use of 600 hours.

Depreciation - Based on a total useful life of 8 years.

- First cost of plough: $320
- Depreciation per hour of use: $320 / 4800 = $0.07

Repairs and Maintenance - Based on 15% of first cost per year.

- Cost per year = $15 x $320 / 100 = $48
- Cost per hour of use = $48 / 600 = $0.08

Interest - at 2\% of half the first cost.

- Interest at 2\% of first cost = $4800 / 2 = $48
- Cost per hour of use = $48 / 600 = $0.08

8-DISC DISC HARRROW
Based on an annual use of 250 hours.

Depreciation - Based on a useful life of 8 years.

- First cost: $468
- Depreciation per hour of use: $468 / 250 x 8 = $23

Repairs and Maintenance - Based on 15% of first cost per year.

- Cost per year = 15% of $468 = $70.20
- Cost per hour of use = $70.20 / 250 = $0.28

Interest - at 2\% of half the first cost each year.

- Interest at 2\% of first cost = $468 / 2 = $23.40
- Cost per hour of use = $23.40 / 250 = $0.09
CULTIVATION WITH THE FORDSON MAJOR TRACTOR - PLOUGHING WITH 2-FURROW MOULD-BOARD PLOUGH

Size of plot - 2/5th of an acre (approximately).
Time taken - (operator and assistant) - 1 hr. 10 mins. per acre - 2 hrs. 55 mins.

i.e., 5.8 man-hours and 2.9 tractor-hours per acre.

*Wages of tractor operator (@ 53¢ per hour) $1.52
" " assistant (@ 33¢ per hour) .95

Fuel consumed:

Vaporising oil - 2.50 gals (4 qts. for working trial plot)
Cost of vaporising oil @ 36¢ per gal. .90

Petrol - .2 gals. - Cost of petrol @ 41¢ per gal. .08

Depreciation:

Tractor @ 44¢ per hour for 2.9 hours 1.28
Plough @ 7¢ per hour for 2.9 hours .20

#Repairs and Maintenance:

Tractor @ 56¢ per hour for 2.9 hours 1.76
Plough @ 8¢ per hour for 2.9 hours .23

Interest:

Tractor @ 43¢ per hour for 2.9 hours .14
Plough @ 23¢ per hour for 2.9 hours .02

Housing: Tractor @ 11¢ per hour for 2.9 hours .32

Total Cost of Ploughing 8.40

#The cost of grease, oil, etc. are included in the repairs and maintenance.

*Wages of operator as paid at the College Farm, $4.20 per day (8 hours), and assistant $2.66 " " " .

+The amount of petrol consumed was not measured, but taken as 1/12th the amount of vaporising oil consumed, based on experience at the College Farm.
CULTIVATION WITH THE FORDSON MAJOR TRACTOR - ROTARY HOEING WITH
ROTAVATOR HAVING A 50-INCH CUTTING WIDTH

Size of plot - approximately 2/5th of an acre.
Time taken - (operator and assistant) 1hr. 20 mins.
" " " " per acre - 3 hrs. 20 mins.
1.e., 6.6 man-hours and 3.3 tractor-hours per acre.

Wages - operator @ 53¢ per hour - $1.75
assistant @ 33¢ per hour - $1.10

Fuel consumed:
Vaporising oil - 6.25 gals. (10 qts. to work trial plot) - Cost @ 36¢ per gal.
Petrol - .4 gal. Cost @ 41¢ per gal.

Depreciation:
Tractor @ 44¢ per hour for 3.3 hours
Rotavator @ $1.02 per hour for 3.3 hours

Repairs and Maintenance:
Tractor @ 56¢ per hour for 3.3 hours
Rotavator @ 61¢ per hour for 3.3 hours

Interest:
Tractor @ 4½¢ per hour for 3.3 hours
Rotavator @ 5¢ per hour for 3.3 hours

Housing:
Tractor @ 11¢ per hour for 3.3 hours

Total Cost of Rotary hoeing

$ 2.85
2.39
.16
1.46
3.60
1.88
2.45
.16
.17
.37
15.49
CULTIVATION WITH THE FORDSON MAJOR TRACTOR - HARROWING WITH 8-DISC HARROW. (Field rotary-hoed earlier).

Size of plot - approximately 2/5th of an acre.

Time taken - (operator and assistant) - 36 mins.
" " " " " per acre - 1 hr. 30 mins.

i.e., 3.0 man-hours and 1.5 tractor-hours.

| Wages:       | operator @ 53¢ per hour | 90¢ | 1.39 |
|             | assistant @ 33¢ per hour | 49¢ | 0.49 |

Fuel consumed:

- Vaporising oil - 3.80 gals. (6 qts. for working trial plot) - Cost @ 36¢ per gal. - 1.37
- Petrol - .3 gal. - Cost @ 41¢ per gal. - .12

Depreciation:

- Tractor @ 44¢ per hour for 1.5 hours - .66
- Harrow @ 23¢ per hour for 1.5 hours - .35

Repairs and Maintenance:

- Tractor @ 56¢ per hour for 1.5 hours - .84
- Harrow @ 26¢ per hour for 1.5 hours - .39

Interest:

- Tractor @ 43¢ per hour for 1.5 hours - .08
- Harrow @ 2¢ per hour for 1.5 hours - .03

Housing: Tractor @ 11¢ per hour for 1.5 hours - .17

Total Cost of Harrowing - 5.40
CULTIVATION WITH HOWARD ROTAVATOR "GEM"

INDIRECT COSTS OF THE MACHINE - Based on an annual use of 250 hours.

Depreciation - Total useful life of the machine taken as 4 years, i.e., 1,000 hours.
First cost of machine - $1250.
Depreciation per hour of use - \( \frac{1250}{1000} = \$1.25 \).

Repairs and Maintenance - Based on 15% of first cost per year.
Total cost per year = 15% of $1250 = $187.50.
Cost per hour of use = \( \frac{187.50}{250} = .75\) $.

Housing - 3% of first cost per year = $37.50 per year.
Cost per hour of use = \( \frac{37.50}{250} = .15\) $.

Interest - calculated at 2% of \( \frac{1}{2} \) first cost per year = $15.63.
Cost per hour of use = \( \frac{15.63}{250} = .07\) $.

Size of plot - approximately 2/5th of an acre.

Time taken to work plot (operator and assistant) 2 hours.
" " " " " per acre 5 hours.
" " " " " i.e., 10.0 man-hours and 5.0 machine-hours.

Wages: operator @ 53¢ per hour $2.65
assistant @ 33¢ per hour $1.65

Fuel consumed: Petrol - 2.5 gals. @ 41¢ per gal.

Depreciation of Machine: @ $1.25 per hour for 5 hours

Repairs and Maintenance: @ 75¢ per hour for 5 hours

Interest: @ 7¢ per hour for 5 hours

Housing: @ 15¢ per hour for 5 hours

Total cost of Rotary hoeing 16.43
THRESHING WITH THE TULLOS THRESHER

The engine which is used to work the threshing system of the machine has been considered separately in calculating the indirect costs.

INDIRECT COSTS OF THE THRESHER (without engine).

Based on an annual use of 240 hours.

Depreciation - Based on a total useful life of 10 years.

First cost of thresher $4.85
Depreciation per hour of use = \( \frac{4.85}{10 \times 240} \) = 20¢

Repairs and Maintenance - 15% of first cost per year.

Cost per hour of use = \( \frac{15}{100} \times \frac{4.85}{240} \) = 6¢

Interest - @ 2½% of half first cost per year.

Cost per hour of use = 2½¢

Housing - @ 3% of first cost per year.

Cost per hour of use = 9¢

INDIRECT COSTS OF ENGINE - Based on an annual use of 500 hours.

Depreciation - Based on a total useful life of 10 years.

First cost of engine $200
Depreciation per hour of use = \( \frac{200}{10 \times 500} \) = 4¢

Repairs and Maintenance

This was determined by comparison with similar costs incurred for a tractor. Tractor costing $2250 cost 56¢ per hour of use for this item, therefore for engine costing $200, a value of 4¢ per hour of use is considered reasonable.

Interest - @ 2½% of the half the first cost per year.

Cost per hour of use = 2½¢

THRESHING IMMEDIATELY AFTER HARVESTING

Time taken to thresh (2800 lbs. of rice) - 3 men - 9.8 hrs.
1.e., 29.4 man-hours and 9.8 machine-hours.

Wages - @ 22¢ per hour per man
6.46

Fuel consumed - Petrol, 1.8 gals. @ 41¢ per gal.

Depreciation - @ 24¢ per hour (both thresher & engine) for 9.8 hours

Repairs and Maintenance - @ 10¢ per hour for 9.8 hrs.

Interest - @ 3¢ per hour for 9.8 hours

Housing - @ 9¢ per hour for 9.8 hours

Total Cost of Threshing 11.78

2,800 lbs. of rice taken as the yield per acre as it is the average yield obtained in Trinidad.
THRESHING AFTER SHOCKING AND DRYING IN THE SUN FOR 2 DAYS
(Excluding the cost of Shocking)

Time taken to thresh (2,800 lbs. of rice) - 3 men - 13.3 hours.
  i.e., 39.9 man-hours and 13.3 machine-hours.

Wages - @ 22¢ per man per hour $ 8.78
Fuel consumed - Petrol, 2.4 gals. @ 41¢ per gal. .98
Depreciation - @ 24¢ per hour for 13.3 hours 3.19
Repairs and Maintenance - @ 10¢ per hour for 13.3 hrs. 1.33
Interest - @ 3¢ per hour for 13.3 hours .40
Housing - @ 9¢ per hour for 13.3 hours 1.20

Total Cost of Threshing 15.88

SHOCKING RICE

Total number of bundles shocked - 20.
Average time taken by 1 man to make one shock - 11 mins. 17 secs.
Therefore, total time spent in making shocks - 3 hrs. 46 mins. (approx.)

Cost @ 22¢ per man per hour = 82¢.
Yield of grain obtained from the 20 shocks = 868 lbs.
Total cost of shocking an acre of rice on the assumption of an
  average yield of 2,800 lbs. = $4.53.
THRESHING WITH THE McCORMICK-DEERING THRESHER

(driven by the power take-off of the Fordson Major Tractor)

INDIRECT COSTS OF THRESHER - Based on an annual use of 584 hours.

**Depreciation** - Based on a total useful life of 8 years.

First cost of thresher = $1245

Depreciation per hour of use = \( \frac{1245}{8 \times 34} \) = 40\%

**Repairs and Maintenance** - A value of 20\% per hour of use was given based on figures obtained for a similar machine by Berglund and Löhnmaker (Sweden) in 1943.

**Interest** - @ 2\% of half first cost each year.

Cost per hour of use = \( \frac{5}{200} \times \frac{1245}{2 \times 384} \) = 5\%

**Housing** - @ 3\% of first cost per year

Cost per hour of use = \( \frac{3}{100} \times \frac{1245}{384} \) = 10\%

Time taken to thresh (2,800 lbs. of rice) - 5 men - 1.7 hours.

i.e., 8.5 man-hours and 1.7 machine-hours.

**Wages** - @ 22\% per man per hour

\[ \frac{2.39}{5} \]

**Fuel consumed** - By tractor:

- Vaporising oil - 3.1 gals
- Petrol - .2 gal.

\[ \frac{1.12}{5} = .22 \]
\[ \frac{.09}{5} = .018 \]

**Depreciation** - Thresher @ 40\% per hour for 1.7 hours

\[ \frac{.68}{5} = .136 \]

Tractor @ 44\% per hour for 1.7 hours

\[ \frac{.95}{5} = .19 \]

**Repairs and Maintenance** - Thresher @ 20\% per hour

\[ \frac{.37}{5} = .074 \]

Tractor @ 56\% per hour

\[ \frac{.95}{5} = .19 \]

**Interest** - Thresher @ 5\% per hour for 1.7 hours

\[ \frac{.09}{5} = .018 \]

Tractor @ 5\% per hour for 1.7 hours

\[ \frac{.09}{5} = .018 \]

**Housing** - Thresher @ 10\% per hour for 1.7 hours

\[ \frac{.17}{5} = .034 \]

Tractor @ 11\% per hour for 1.7 hours

\[ \frac{.19}{5} = .038 \]

Total Cost of Threshing = 6.89
APPENDIX III

RICE CULTIVATION IN TRINIDAD COMPARED WITH THAT IN SOME OF THE OTHER RICE-GROWING COUNTRIES

As mentioned earlier, rice is cultivated solely on a peasant scale in Trinidad, on holdings varying from about \( \frac{1}{2} \) to 2 acres, and consisting of plots rarely exceeding \( \frac{1}{10} \)th of an acre in size.

By far the greater part of the crop is grown under rain-fed conditions. (The monthly rainfall in the main rice areas are shown on the graph given on page 82). It is seen that the rainy season is from May to December (with a relatively dry period from September to November), and January, February, March and April are dry. Actually, the heavy rains do not begin until the latter part of May, or sometimes the early part of June.

The cropping season coincides more or less with the rainy season, and only one crop is generally planted. The preparation and sowing of the nursery are done from the end of May to the end of June, and planting goes on till about the middle of August. The crop is harvested from the latter part of November to December.

Practically all the varieties of rice grown in Trinidad at present have a normal period of maturity of approximately 5 months and are all photoperiodic.

The whole of the rice crop in Trinidad is transplanted, while in countries such as Burma, India and Siam, both transplanting and broadcasting are practised, the former method prevailing where abundant labour is available. In an experiment comparing broadcasting, drilling and transplanting carried out by the Botanist of the Department of Agriculture in Trinidad, it was found that there was no significant difference in yield in the three methods of planting. Nevertheless, transplanting appears to be the method suitable under the conditions prevailing at the present time in Trinidad. Among these conditions may be included the fact that
Graph showing the mean monthly rainfall of the main Rice areas in Trinidad.

(The figures used in the graph are given in Appendix IV (a)).
the rice farmer seldom has the time to prepare the field early enough for the practice of broadcasting. Moreover, with the transplanting method he can more easily remove the profuse crop of weeds that is the outcome of his rather hasty and inefficient preparatory tillage operations and haphazard irrigation methods. In other rice-growing countries transplanting has been found to give higher yields.

In Italy a portion of the crop is transplanted, and it was reported by Tempany that higher yields are obtained from this method as against broadcasting. In Spain too, transplanting is a common practice and the yields are high. In Ceylon according to Lord transplanted rice produced 31 per cent. more than that sown broadcast. Ramiah in India also obtained higher yields from transplanted than from broadcasted rice. In China, however, Shen found in nursery tests that direct seeding and transplanting gave no difference in yields when the rice was sown on the same date. In Japan, transplanting is the common method, but high yields are also obtained from direct seeding. De La Paz at the Philippine College of Agriculture, found that in drilled rice plots that were cultivated by bullocks, germination was more uniform. He also found that drilled rice was more resistant to drought as compared with broadcast rice. His work also indicates that it costs less to cultivated drilled rice with bullocks than to hand-weed a broadcast field.

NURSERY PREPARATION. In Trinidad nurseries are very often situated in an area adjacent to, or as close as possible to, the farmer's house. In this way the growing seedlings can be well cared for. The small size of the nursery, required to raise the quantity of seedlings needed for transplanting the small acreage that the farmer usually cultivates, enables him to have it in the backyard of his house. The size of the nursery ranges from 1/12th to 1/20th acre in the Oropouche lagoon area, and 1/35th acre in the Caroni area, per acre of transplanted rice. A nursery seed-rate of
50 to 60 lbs. is used for each acre to be transplanted.

The nursery seed-rate is rather high when compared with that used in some of the other countries. In Ceylon, for instance 40 to 45 lbs. of seed are sown in a nursery having an area of about 1/10 acre, and this provides sufficient seedlings to transplant about 10 acres. However, the large number of seedlings planted per hill in Trinidad partly accounts for the high nursery seed-rate.

The preparation of the nursery involves the cutlassing of the weeds, followed by digging the soil by means of hand-forks and pulverising the clods with a hoe. At the time these operations are done, the soil is just moist enough to enable a suitable tilth to be obtained. The nursery can be described as a "dry" type in contrast to the "wet" type that prevails in countries such as Burma. The "dry" type has the advantage that the seedlings accommodate themselves to the rate of rainfall that prevails during their growth, thus making it possible to keep them in the nursery for a longer or shorter period as necessitated by a delay or earliness in the on-set of the main rains. In Burma, in common with some of the other countries where wet nurseries are the usual type, their preparation exactly resembles that of the main planting area. In fact, more attention is given to the preparation of the nursery than to that of the main field. In the Caroni area of Trinidad, the seed is sown dry in the nursery while in the Oropouche area it is soaked in water for about 48 hours prior to sowing. In order to prevent birds from eating the seed, it is usually covered with coconut leaves until germination occurs. In certain parts of Malaya the nursery consists of a sort of raft built with bamboo strips, having a layer of banana leaves at the bottom, with a layer of soil on top of which the seed is sown. The raft is always kept near the farmer's house. This system is practised where there is a danger of attack by birds and other pests, such as caterpillars.
The first operation carried out by the Trinidad rice farmer is the removal of all weeds from the field by slashing them as low as possible by means of a cutlass. This is essential when the subsequent preparatory tillage operations are done with the fork and the hoe. However, it seems to be the common practice even when a mould-board plough and wooden harrow are used. In some of the other rice-producing countries such as India, Burma and Siam no preliminary cutting of weed growth is done even when the so-called country plough is used. After cutlassing the weeds, the field is flooded with water up to a depth of an inch or two (where irrigation facilities are available) and ploughed either by means of a Ransome's Victory plough drawn by a pair of oxen or a smaller mould-board plough hitched on to one ox. The oxen used are of the Indian zebu type. While these animals are strong enough to pull the implements generally used, they are rather slow workers. After ploughing, the field is harrowed with the wooden yoke harrow which consists of a rather heavy wooden frame, rectangular in shape, to which are attached cross bars with a number of flat iron spikes about 6 inches long fixed about 8 inches apart. A smaller modification of this is sometimes used, and this consists of a flat wooden board about 6 ft. long and 18 inches wide with iron spikes fixed on the lower surface. The harrowing is done until the soil is well pulverised, and the same implement is used for the levelling process after turning it over so that the spiked surface is on the upper side. The field is now ready for transplanting. In the south of the island no ploughing is done, the tillage operations consisting of harrowing and levelling with the wooden harrow described above. This has a parallel in some parts of the East where trampling by teams of water-buffaloes is the only operation that precedes planting. When the farmer does not own a plough and harrow or cannot hire them, he resorts to the fork and the hoe to do his preparatory tillage operations. The weeds are cutlassed as
before, and the soil is forked to a depth of about 4 inches and
pulverised and levelled with the hoe. This method of preparing
the field is tedious, time-consuming and expensive.

Ploughing, harrowing and levelling are the three
main operations carried out in the preparation of the soil in
most of the other rice-growing countries of the world, and the
final consistency of the soil aimed at, is essentially the same.
There is, however, a variation in the type of implements used,
the time interval between the various operations, and the thorough­ness with which they are performed.

In Burma(9) ploughing is, for the most part, done with
the "Burmese" plough, which consists essentially of a wooden sole,
shod with a slightly concave piece of iron, a handle and pole
for attachment to the yoke on the neck of the bullocks. Here
again, as in Trinidad, the ploughing is done with a certain
amount of water in the field. The soil is then harrowed about
8 to 12 times in all directions with an implement called the
"Burmese" harrow. This implement consists of a log of wood, 5
to 6 feet in length, to which are fixed 3 to 7 wooden teeth about
8 inches long. On the side of the log opposite to that on which
the teeth are fixed is a cross bar, by means of which the implement
can be lifted off the ground when necessary, and two poles for
draught which are attached to the yoke. In some cases the teeth
are shod with iron, but a harrow strong enough for iron-shod
teeth is generally too heavy to be drawn by cattle. Usually
there is an interval of about 3 to 4 days between ploughing and
harrowing. Apart from the "Burmese" harrow described above, two
forms of rotatory harrow are in use. One form is known as the
"Gwinset" and the other, the "Dahset". The "Dahset" consists
of a wooden roller about 3 to 4 inches in diameter to which
five iron blades are attached transversely. When in use it turns
like a wheel, the cutting edges of the iron blades being on the
soil. The "Gwinset" is similar to the "Dahset" in action, but
with small iron blades about 3 inches in length fixed into the beam, at intervals of 3 inches. The former is said to be the cheaper of the two, while the latter is the more efficient implement. In areas where there is a profuse growth of weeds the "Dahset" is used to cut and bury the weeds, but where the weed growth is comparatively small, the "Gwinset" is satisfactory enough according to Grant. In Ceylon, a country plough similar to the Burmese one is used for ploughing. Sometimes a locally made iron plough modelled on the lines of the Ransome's Victory plough is used, and this has been found to be more efficient than the country plough. This is somewhat smaller than the Victory plough and considerably lighter. The draught required to work it is therefore appreciably less than that needed by the Victory plough. It has been found that this plough is well suited to the small work oxen sometimes employed for draught purposes in Ceylon. When the country plough is used for ploughing, the subsequent operations of harrowing and levelling are also done with it, though not very efficiently. When the iron plough is used, the next operation (harrowing) is usually done with the Burmese harrow after turning it over so that the teeth are on the upper side. Wickramasinge (30) of the Department of Agriculture, Ceylon, has shown that using the Burmese harrow on a growing crop of broadcast rice when 3 to 4 weeks old gave a mean increase in yield of 33 per cent over the control plots. He advocates the process of broad-casting and harrowing the growing crop as an alternative to the more expensive and laborious one of transplanting. Wickramasinge has shown that using the Burmese harrow on a growing crop of broadcast rice when 3 to 4 weeks old gave a mean increase in yield of 33 per cent over the control plots. He advocates the process of broad-casting and harrowing the growing crop as an alternative to the more expensive and laborious one of transplanting. Wickramasinge has shown that using the Burmese harrow on a growing crop of broadcast rice when 3 to 4 weeks old gave a mean increase in yield of 33 per cent over the control plots. He advocates the process of broad-casting and harrowing the growing crop as an alternative to the more expensive and laborious one of transplanting.
In parts of Italy the last operation prior to sowing is done with an implement known as the "Spanione", which consists essentially of a long plank of wood. This implement is drawn over the soil by a horse with the driver standing on it. In some areas of Brazil the final preparation of the soil is done with disc harrows hitched to either a team of animals or a tractor.

**TRANSPLANTING.** The following procedure is adopted in Trinidad. The seedlings are uprooted from the nursery when they are from 35 to 45 days old. There are occasions, however, when the age of the seedlings at the time of transplanting is less than 35 days and more than 45 days. Actually, the time the seedlings are kept in the nursery depends on when the main field is ready. In Ceylon, the Department of Agriculture advocates the following general rule as a rough guide as regards the suitable age of seedlings at the time of transplanting: the age of the seedlings should be as many weeks old as there are months in the period of maturity of the crop. Thus, a variety that has a period of maturity of five months should be transplanted when the seedlings are about five weeks old. To facilitate the uprooting of the seedling the nursery is flooded when possible. The roots of the seedlings are washed and the tops of the leaves are twisted off by hand before transplanting. This operation is, as in most countries, generally done by women. The number of seedlings planted per hill varies from 4 to 9 and sometimes it may be as high as 15. If the seedlings are small and weak at the time of transplanting, a large number are planted per hill, and if they are big, a small number is put in per hill. The hills are spaced 8 to 12 inches either way. (The number of plants per hill and how far apart they should be planted are problems that should be worked out in each rice-growing area to suit local conditions.) Richards in an experiment carried out in Trinidad found that
one plant per hill spaced 12 inches apart was the best procedure. Haigh in Ceylon found that 3 seedlings per hill was better than one seedling, and that of the spacings 4, 8, 12 and 18 inches, the 18-inch spacing was inferior to all the others. Jack in Malaya, has shown that of the five treatments in respect of the number of plants per hill, namely, 1, 2, 3, 4 and 5 plants, the best number per hill in respect of yield of grain was 3. Follett-Smith in British Guiana found that of the spacings 5, 8 and 11 inches tried, 5 inches gave the best yield followed by 8 inches, 11 inches being the worst.

WEEDING. In Trinidad two to three weedings are done during the growing period of the crop depending on the availability of labour. If no labour is available no weeding is done. The same is true of most of the other rice areas where similar methods are practised. The intensity of weed growth depends on the thoroughness with which the preliminary cultivations are done, and also on the care given to the irrigation of the crop, particularly during the early stages of growth. In Trinidad the conditions under which the crop is grown seldom permits keeping the land covered with water for some time after the first ploughing so that all subsequent weed growth would be effectively checked. In most of the other countries there is, except in very rare cases, an interval of at least a fortnight between the initial and final cultural operations, during which period the field is kept flooded, so that the weeds are well rotted before the broadcasting or transplanting operation. Any weeds that resist these treatments are generally kept under control by submerging them with irrigation water where possible.

IRRIGATION. By far the greater acreage of rice in Trinidad is grown under rain-fed conditions. Even in the areas where irrigation is provided, as in the Bejucal area, there does not seem to be any organised system of distribution. The absence of any well defined planting dates makes any organised distribution of irriga-
tion water impossible. Here again, the problem is aggravated by the essentially family nature of rice cultivation in Trinidad. In countries such as Burma, Siam and Ceylon, where rice cultivation forms a part of the business activities of the peasant, and very often is his only means of earning a livelihood, more attention is given to the irrigation of the rice crop on an organised basis. In Ceylon, for example, the rice farmers of any particular area get together at what is known as a "cultivation meeting", and fix definite dates by which the preparatory tillage operations and planting should be completed, and their decisions form the basis for the organisation of the distribution of irrigation water. In these countries it is usual to drain off all the water from the field a day or two after transplanting, but in Trinidad, the farmer's anxiety to keep the water in the field as long as he can because he is rather uncertain as to when next his field will be supplied with irrigation water, prevents him from doing the same. Draining the water after transplanting gives the plants the opportunity to settle properly in the soil. About a week after draining, water is again introduced into the field and then gradually increased in depth until it reaches a maximum of about 6 inches and this level is maintained until the plants have matured. In Trinidad the procedure adopted is, introducing water when available and trying to keep it in the field as long as possible. It is not a rare occurrence in Trinidad for any water that has been introduced into the field to disappear overnight due to leakage through the bunds. This is not surprising because very little attention is given to the consolidation of the bunds at any time during the cultivation period. In the rice-growing countries of the East, the bunds are consolidated by plastering them with mud, sometimes even before doing the tillage operations.

HARVESTING. In Trinidad, the harvesting of rice is done by cutting the plants about six inches from the ground level by
means of the sickle. This is the method adopted in most of the other countries where harvesting is not mechanised. In parts of Malaya and Indonesia, the rice is harvested by cutting only the earheads by means of an implement called the Yatab, which consists of a knife about six inches long, fastened crosswise on a short stick.

THRESHING. No other operation in rice culture shows such a diversity in methods as threshing. The treatment given to the sheaves of rice before the threshing operation also shows a certain amount of variation. In Trinidad the cut rice is generally heaped on the bunds of the field and threshed on the same day if possible. In some of the countries of the East the rice is allowed to cure in the sun for a period varying from a week to ten days before it is threshed. Sometimes, the sheaves are stacked in heaps and kept for several months before threshing. The stacks are so built that the rice does not get wet even if it is exposed to the rain as sometimes happens. This not only serves as a method of storing the rice in the earhead form, but also enables the farmer to do the threshing after the rush period, and thus distribute his work to suit the availability of labour.

In Trinidad, threshing is most commonly done by beating the earheads on a slatted, wooden platform built to a convenient size and height. During the process, the grain that is separated drops through the gaps in the platform on to a mat placed below. This is a tedious process, but the separation of the grain from the earheads is very effectively done. In very rare cases, threshing is done by beating the earheads with sticks. A practice that is common in the East is one that is known as bull mashing. This method involves the use of teams of cattle of varying ages which tread out the grain by walking over the sheaves which are spread out in the form of a circle. It is usually done in the open on a specially prepared threshing floor situated on high ground in the vicinity of the rice fields. About 400 to 500
sheaves are heaped upon the floor at one time to a height of about 6 inches. As the operation proceeds, the straw that is freed from the grain is raked aside from time to time, and the grain and chaff are swept into a heap apart. One lot of sheaves is completed before another lot is placed on the floor. The arrangement of the sheaves on the threshing floor, to a certain extent, determines the effectiveness of the method. In some countries where this method of threshing is adopted, there is no systematic arrangement of the sheaves. In Burma the following procedure is adopted: the sheaves are first arranged in a slanting manner, one leaning over the other, with the earheads lying towards the centre in a concentric manner. After a considerable portion of the grain has been threshed out, the sheaves are untied and the crop is threshed in a loose state until a thorough separation of the straw and grain has been effected. This method is found to be more effective than threshing in a loose state. In Ceylon, bull-mashing is the common method of threshing, and the sheaves are placed in a loose state but they are arranged so that the earhead ends are towards the centre of the floor. The surface of the threshing floor is, in the case of bull-mashing, prepared by first clearing the ground of all weeds and levelling the surface by means of hoes, and then plastering it with a mixture of equal amounts of cattle dung and mud. Bull-mashing is quicker than hand threshing, but with the latter method, a cleaner sample of grain is obtained. In the case of the former method there is always a chance of the grain being contaminated by the urine or dung of the animals that are employed. Another disadvantage of bull-mashing is, that it involves the use of a fairly large number of animals. It is usual to employ a team of at least six animals at a time.

WINNOWING. In Trinidad and other countries where hand methods are employed, winnowing is usually done by dropping the grain and chaff mixture, contained in flat baskets, from a convenient
height so that the chaff is carried away by the wind while the grain falls on a mat placed below. This operation cannot be done when there is no fairly strong wind. A small number of winnowing machines are in use in some of the rice areas of the East.
## APPENDIX IV (a)

### MEAN MONTHLY RAINFALL (IN INCHES) IN ST. AUGUSTINE, CARONI** AND CROPUCHE** (10-YEAR AVERAGE)

<table>
<thead>
<tr>
<th>MONTH</th>
<th>ST. AUGUSTINE</th>
<th>CARONI</th>
<th>CROPUCHE</th>
</tr>
</thead>
<tbody>
<tr>
<td>JANUARY</td>
<td>2.70</td>
<td>3.30</td>
<td>3.47</td>
</tr>
<tr>
<td>FEBRUARY</td>
<td>1.26</td>
<td>1.06</td>
<td>1.24</td>
</tr>
<tr>
<td>MARCH</td>
<td>1.12</td>
<td>1.11</td>
<td>1.09</td>
</tr>
<tr>
<td>APRIL</td>
<td>1.62</td>
<td>0.35</td>
<td>1.73</td>
</tr>
<tr>
<td>MAY</td>
<td>6.24</td>
<td>14.20</td>
<td>5.07</td>
</tr>
<tr>
<td>JUNE</td>
<td>9.75</td>
<td>12.43</td>
<td>7.62</td>
</tr>
<tr>
<td>JULY</td>
<td>8.59</td>
<td>9.66</td>
<td>8.18</td>
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<tr>
<td>AUGUST</td>
<td>9.48</td>
<td>13.16</td>
<td>9.46</td>
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<td>6.73</td>
<td>6.68</td>
<td>8.15</td>
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<td>OCTOBER</td>
<td>6.40</td>
<td>6.44</td>
<td>7.92</td>
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<tr>
<td>NOVEMBER</td>
<td>6.67</td>
<td>6.54</td>
<td>7.90</td>
</tr>
<tr>
<td>DECEMBER</td>
<td>6.18</td>
<td>9.66</td>
<td>7.85</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>66.74</strong></td>
<td><strong>84.79</strong></td>
<td><strong>69.70</strong></td>
</tr>
</tbody>
</table>

*Taken from records at the College Meteorological Station.

**Obtained from the Department of Agriculture, Trinidad.
APPENDIX IV (b)

RECORD OF THE DAILY RAINFALL (INCHES) FROM 1ST JUNE - 31ST DECEMBER, 1950.
(Obtained from the Records of the College Meteorological Station).

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<td>.96</td>
<td>-</td>
<td>.26</td>
<td>.50</td>
<td>-</td>
<td>.03</td>
<td>.32</td>
</tr>
<tr>
<td>2nd</td>
<td>.35</td>
<td>.51</td>
<td>1.69</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>.01</td>
</tr>
<tr>
<td>3rd</td>
<td>.42</td>
<td>.05</td>
<td>.12</td>
<td>-</td>
<td>-</td>
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<td>-</td>
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