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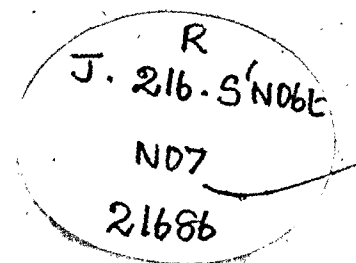
Madras

Scientific Report of the

Samalkota Agricultural

Station

1906



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Department of Agriculture, Madras.



SCIENTIFIC REPORT

OF THE

SAMALKOTA AGRICULTURAL
STATION

For the Official year ending 31st March 1906.

BY

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Government Botanist.

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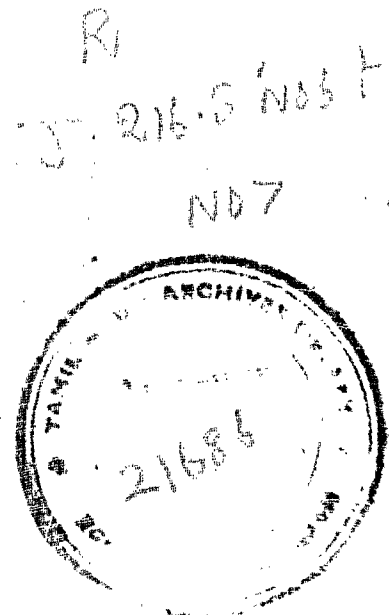
SCIENTIFIC REPORT OF THE SAMALKOTA AGRICULTURAL STATION, 1903-06

As this is the first "Scientific Report" called for on the work at the Samalkota Agricultural Station, and as it is intended that the series should present a connected history of its progress, it will be of advantage briefly to summarise the various steps which led to its formation and also to state the exact functions which it was intended to perform. It is necessary to do this, because the scope of the farm has been extremely limited and, as will be seen, the disadvantages under which it has been worked have been considerable. Although the most various subjects have come under investigation from time to time these have merely been by the way and the results obtained must be regarded as tentative and suggestive rather than conclusive. The main object of the farm from the commencement has been the discovery of a more healthy variety of cane and its distribution to the ryots of the district.

2. A disastrous disease having appeared among the canes in the Gôdâvari delta, and the cultivation being in danger of extinction, the attention of Government was directed to the matter. It was discovered that this disease was caused by a fungus which had been met with some years previously in Java and described by the Director of the West Java Sugarcane Station as *Colletotrichum fulcatum*. And shortly afterwards it was ascertained that this fungus was widely distributed over India and was the real cause of the celebrated West Indian cane disease. It was thus seen to be world wide in its distribution, and may perhaps be considered as the main cane disease of recent years.

3. As no satisfactory remedy had been discovered, it was decided to import canes from a healthy locality and distribute them to the ryots of the Gôdâvari delta. Hospet in the Bellary district was selected and eight tons of canes were brought over in 1901 and planted in various places in the cane growing tracts. The experiment turned out to be a failure and the Government Botanist was directed to enquire into the matter and report upon it. In his report he pointed out that far greater study was necessary both into the local practices and the characters of the different canes before any such introduction or acclimatisation could be attempted. He proposed therefore that a small piece of land should be rented and that all the available varieties should be collected and grown there for comparison, while a simple series of experiments in manuring and cultivation might be added.

4. But the first step taken to ensure the success of such a farm was to make a very careful study of the cultivation as practised in the delta, the canes grown, irrigation facilities and rainfall, the character and



* செப்பனிடும் வகை எடுத்துக் *
* கொள்ளப்பட்ட *
* பிப்ரவரிமாதம் வருடம் 1928 *
* செப்பனிடும் முடித்த *
* பிப்ரவரிமாதம் வருடம் 1928 *
* ஆராய்ச்சி உதவியாளரின் *
* கையொப்பம் *

composition of the soil and the customary manurial supplies. The local practice has been carefully followed on the farm alongside of methods adopted in other countries in order that improvements might suggest themselves, and the criticism of the local cultivators has been sought, and, when given, has been carefully weighed.

5. Before proceeding further it will be well to indicate the local conditions in the Gôdâvari delta somewhat in detail. The work of the Samalkota farm must not be applied, without adaptation, to other parts of the Presidency.

The first fact that strikes one is the number of different kinds of cane met with locally. This appears to indicate either a very ancient cultivation or a series of attempts against adverse circumstances. There are the smaller Bonta, Valu and Desavali passing through the Bombei and Palabonta to the larger and softer Namala, Keli, Scema, Yerra and ending up with the giant Mogadi. Occasionally the Verri, the mad cane, is also found, from which no jaggery can ever be made, but which is used for medicinal purposes.

From a somewhat careful enquiry it appears that there has been a succession of canes which from time to time have held the popular favour. Thus the Desavali, Valu, Namala and Keli have succeeded one another and at the time of starting the farm the Mogadi and Yerra were coming into favour. Each cane appears to have reigned for a certain time and then to have become diseased and useless. This appears to account for the large number of canes met with. Not an ancient cultivation, but one struggling against some disadvantage.

6. The local soils have been carefully analysed by the Agricultural Chemist to the Government of India. His verdict is that there is no sufficient cause in the samples for the disease which is raging. A deficiency in sulphur was somewhat marked, and, as usual, there was little nitrogen. The very clayey nature of some of the soils attracted his attention, but this can hardly be regarded as a pre-disposing cause to disease of itself. No analyses were made of the soil on the farm itself as little was likely to be gained thereby in view of the general results of the delta analyses already prepared. (See Appendix I.)

7. The local practice has likewise been carefully studied. It presents sufficient peculiarities for a brief statement regarding it to be necessary in order to understand the chief problems that have presented themselves for solution. Sugarcane alternates with wet paddy in the Gôdâvari delta lands, the usual periods being four or five years of paddy followed by one of sugarcane. The paddy being reaped in the beginning of December, the water is drained off and the land dried. After about 20 days it is ploughed, and this operation is repeated at intervals for a month or more, there being altogether from 6 to 12 ploughings according to the availability of cattle. Ploughing ceases some eight days before planting. The cane plants are obtained by cutting up the whole cane, only rejecting those parts which have dead buds or which have developed roots. The seed is obtained from plant-cane, usually the cultivator's own. When purchased they cost from Rs. 30 to Rs. 50 per acre according to the current price of jaggery. The sets are laid in a heap on the side of the field and the land is flooded. The water

is then drained off, and experienced cultivators run a plough over the mud to mark the place where the future trenches are to be. Then the seed is sown broadcast and trodden in, avoiding only those places marked by the plough. After some four or five days hoeing is done. The instrument, called the lolika, is a short chisel at the end of a long handle, and the work is done by downward strokes, the coolies working forwards for fear of treading on the sets, and covering such as are exposed with earth. As fast as they turn up the soil and break the crust, they tread it down again. Irrigation follows about 15 days after planting. Most of the shoots are through by then and after six or seven days the hoeing operation is repeated. This practice of irrigation followed by hoeing to break up the crust is followed four times. Then the annual flow of water ceases, the water is cut off and the canals are cleaned out. There is no water in the canals from May 1st to June 1st, and the plants are frequently left without irrigation for five or six weeks. This is a serious test for them. At the closing of the canal the young fields are a healthy green with shoots some foot and-a-half high; after the period of enforced drought they are dark gray, are infested with mothborer and the consequent dead hearts, and have generally gone back a good deal in their growth. There should be showers in April and May, but these are frequently absent, as has been the case for three out of the last four years. The ryot regards this as the bunching time and looks with equanimity on the dead hearts, and it is difficult to prove that he is in the wrong. All the same in exceptionally bad years there is the chance of the whole field being lost. Then it is ploughed up and paddy is sown.

8. After the canals are re-opened (or after at least one inch of rain if it occur in May), the trenches are made. These are about 9-12 inches deep and pass along the lines made by the plough at planting time and where no sets were dropped. Water is now coming down the channels in abundance and there is also generally rain. The trenches are undoubtedly primarily for the purpose of drainage although they also serve for the purpose of irrigation. The danger at this time is that of floods, and again the canes are submitted to a very severe test, perhaps a greater one than that experienced in the preceding drought. From observation on the farm, it is considered that this is the time when germs of diseases are spread, any low place which becomes water-logged inevitably dying out before the end.

9. As a general rule no manure whatsoever has been thus far applied. But when the water is flowing freely a good dose of castor cake is given. This is obtained locally from the oil-mills, it is ground up and two table spoons are given to each plant. It is applied when the ground is dry and, two days afterwards, a copious irrigation is given which is followed by another ten days later to cause the oil cake to rot. The cost of cake is Rs. 40 per acre, this being the average cost of 10 bags of 150 lbs. each. The average quantity of nitrogen in the cake is 6-7 per cent. With this generous dressing the manuring is completed.

10. Irrigation now follows, in the absence of rain, once every fifteen days until the time of harvest. It is usual to completely flood

the ground each time, and in only too many cases the water is allowed to lie on the ground for several days. In certain fields it was demonstrated that the land was mud for the whole period between October and January. But in good cultivation the water is drained off after one day's soaking. There is never any lack of water, which, with the water logging thus caused, is perhaps one of the chief reason for the disease in the delta.

11. Now commences the more expensive work on the field. In most sugarcane cultivations, when the canes once cover the ground, they are left to themselves until the time for reaping. In the Gôdâvari delta a series of artificial supports are considered necessary all through the year. About three weeks after manuring the first "wrapping" is performed. The lower, still green leaves of the plants are twisted and tied together and round the base of the plant. At the same time weeding is done, as well as with one subsequent wrapping. There are usually some seven wrappings and these are increasingly costly as the plant increases in height, immense three-legged stools being used towards the close of the season. At the second wrapping bamboos are planted. The leaves are now again tied together, and the canes fastened in groups to bamboos firmly planted in the ground. Later on, at the fifth wrapping, very large and strong bamboos are placed at intervals and groups of plants with their smaller bamboos are fastened to these. It is difficult to get the exact figures of the cost of this operation. The wrappings may be put down as Rs. 37-12-0 in a fairly good crop. The bamboos for a freshly started plantation will cost Rs. 100 per acre and, after that, an annual cost of Rs. 26 should cover the replacements. After three or four years the old bamboos may be sold at from Rs. 6 to Rs. 8 per annum.

12. That this system of wrapping has a meaning will be seen, first of all, from the immense growth in height of the canes and, secondly, from the fact that cyclonic storms occur during the growing period. In one year of the station's existence every single cane was laid flat, and the raising was much facilitated in all these plots which had bamboos.

At or about the fifth wrapping an autumnal hoeing, the kartikah hoeing, is in vogue with careful cultivators. This occurs about November.

13. The crop is reaped during February. Six days before cutting the canes a copious irrigation is given to increase the quantity of juice. There is some incentive to early reaping, for the first few sales of jaggery fetch a very high price, especially such as is ready before the annual feast of Pongul which occurs in the middle of January. After this the prices fall rapidly. The great bulk of the crop is made into common or brown jaggery with insufficient liming, as this fetches a much higher price in the local market than the harder and darker product for export or for the local Sugar Factory.

14. It will be noted from this description that the plants are put in at the driest time of the year when, however, irrigation water is abundant. The young plants then pass through a very severe test when the canals are closed for their annual cleaning. Then follows a period of abundant irrigation frequently added to heavy falls of rain, a time of even greater testing. After the north-east monsoon the ground gradually dries until the time of no rain comes, when, at the beginning of the hot weather, the crop is reaped. At some time during the growing season storms of cyclonic force sweep over the fields, sometimes accompanied by torrential rains. The land is one of the heaviest of clays, the canes get no root support in the soft mud and are laid down in masses, shaken to their roots but easily raised on their supporting bamboos.

15. It has been mentioned that the station has been worked under considerable difficulties. As these will have a marked effect upon the reliability of the result obtained they must be briefly indicated. No suitable subordinates were forthcoming at first and the local labour proved exceedingly unsatisfactory during the first two years. The land, cut up by numerous bunds into small patches at different levels, was excessively uneven, necessitating quite special precautions in equalising and supplying while the crops were still young and allowances being made when the comparative plots were crossed and recrossed by the bunds.

16. More important still was the fact that in each of the first four years, through uncertainty as to the continuance of the farm and to other unavoidable circumstances, fresh paddy land had to be hastily acquired and there was no proper control over its preparation. The much desired aeration of the soil after long continued paddy cultivation was not carried out, the land was rapidly crowded and immediately planted. Each year the fresh land taken up was rented from the ryots and it was difficult to get them to take their crops off in time. No permanent improvements in drainage could be undertaken because the land was not ours. Each year the canes were planted immediately after wet paddy, a practice which cannot be considered good. It is only in this last year, recently commenced, that, the land being our own, we have been able to prepare it according to our wishes and that we have been able to cut the trees, level and drain the blocks and plant the canes where we wished.

17. This it will be at once seen has seriously hampered us in our efforts at improving the ryot's methods of cultivation. At the same time it has made us very fully acquainted with his disadvantages and the defects of his system. But another adverse factor has been the weather, and the results reported in each year can now be seen to stand in fairly close relation with the character of the season. During three of the four years the weather has been exceptionally unfavourable for sugarcane growth. The second year, which was a good one, was taken advantage of fully and may be said to have contributed more than anything else to the success of the farm. The last two years have been very trying, culminating in the failure of both monsoons and a very severe outbreak of disease on the farm and, to a much larger extent, in

the unfortunate uplands where all sources of irrigation entirely failed and it is feared that some thousands of acres of cane have more or less "gone out." A severe cyclone has occurred each year excepting the second and this is now regarded as more or less to be expected on this part of the coast. The acquiring of this experience has been of advantage, but it has not been pleasant in the working of the farm.

18. As the main function of the farm has been the finding and distribution of a healthy cane, and as in the second year such distribution commenced, and the ryots eagerly asked for more canes than were available, most of the experimental plots have been spoiled by the abstraction of the bulk of the cane for this purpose. Rarely has the whole extent of a tenth-acre plot been milled for comparison, more usually a carefully selected average half or quarter has been cut and the rest used for distribution. This must be taken into account in judging the results obtained. On the other hand, most careful month-by-month inspections of the plots have been made, so that the results have been usually fairly accurately predicted. For full reliance to be placed upon the results of comparative trials it will in future be necessary to firmly separate all the experimental plots and allow no canes to be cut from them for other purposes. This is difficult because the land available each year is small, and only a couple of acres can be put aside for mere nursery work.

These are among the chief difficulties under which the farm has been worked, and to them must be added the inexperience both of the Government Botanist and his subordinate staff in farm work generally.

19. As has been pointed out on several occasions the results obtained must not be taken too seriously. The farm was on its trial and several proposals have been made that it should be moved or altered in character. No definite series of experiments has therefore been possible and the character of those inaugurated has altered gradually from year to year. As was pointed out, the work has been of a preliminary character, a series of experiments in experimenting. Only after the decision of Government that the farm should be permanent and the purchase of the land in 1905 has it been possible to lay down a definite line of work, and the study of rotations excepting in the broadest sense was out of the question. These points have, during the planting of the current crop, received very careful attention, but there is still doubt as to the advisability of continuing experiments along certain lines and there are likely to be minor changes in the future as there have been in the past.

20. From what has been stated, it will be seen that the chief work of the farm has been the collection and comparison of as many varieties of sugarcane as possible. At the start the following were planted:—The local Namdu, Keli, Yerra, Seema, Mogali, Valu and Bonta; the Hospot cane (found to be identical with the Keli), the Cumbum striped cane: four canes received through the Inspector-General of Agriculture from Bombay, the Red Mauritius, White Mauritius, Vansia and Sanna Bile. This list was added to as opportunity occurred from North Arcot, Madras, Coimbatore, Tanjore, Vizagapatam, Bengal, Behar and Bombay. The canes were grown together and compared and, as would be expected, it was found that the same cane was being grown in several parts

of India under different names. Thus the Keli, Hospot, Pandia and Poovan hailing from Gôdâvari, Bellary, Bombay and Coimbatore respectively were classed as one variety: the Yerra turned out to be the Kajli of Bengal: and the Samsara of Bengal, Seema of Gôdâvari and Vellai of Coimbatore appeared to be very closely related.

21. In the second year of the farm's existence a find of some importance was recorded. Several years before, the Collector of Vizianagram had it appears introduced a number of Mauritius canes direct. These had had a chequered existence and at one time were to have been destroyed, but were happily grown on although in unsuitable land and conditions. At the instance of the local authorities I visited this plantation and was surprised at the size and beauty of the canes. Of the twenty originally imported, only some eight kinds were left and all records as to their correct names were lost. A few stools of these eight kinds were accordingly added to the Samalkota collection.

22. After several attempts, two of the best West Indian Seedling canes were also obtained and have now become established on the farm, but they do not yet exist in sufficient quantity to determine their value locally. Efforts at raising our own seedling canes will be referred to later on.

A few new kinds were added from time to time which had evidently arisen as Sports on the farm itself. It was noted that the striped canes especially gave rise to isolated canes of one colour. Thus four or five more canes were added to the list, some of them apparently of great value.

23. The full number of canes thus collected together was 45 in the third year. At first each variety was grown on a tenth-acre plot, but this soon became impossible. Afterwards they were divided into two classes. Class I included some eight or ten varieties which appeared to be worthy of extended trial and distribution later on. These were grown on tenth-acre plots and carefully studied and analysed. In Class II were collected such canes as were not regarded as of value but of interest as representative of the canes of certain districts, others about which insufficient information had been collected and lastly such as were of undoubted value but of which there were too few to fill a tenth-acre plot. The canes in these classes have constantly varied during the last few years, canes being shifted from one to the other according to their behaviour. The present Class I varieties are the following:—Red Mauritius, Striped Mauritius, Bonta, Yerra, Ashy Mauritius, Red sports, Green sports, White Mauritius, and it may be noted that each year one or other of the Indian canes has dropped out of the first into the second class and its place has been taken by some exotic form. Next year the Barbados canes will be added to Class I.

24. The canes thus grown, both in the first and second classes, have been subjected to very careful study. Their comparative growth has been noted and recorded in frequent inspection notes, their germinating power, the characters and colouring of the shoot, the rapidity of growth, their tillering power and the botanical characters of the mature canes.

They have been carefully measured according to a uniform scheme, photographs have been taken of all, all have been painted to scale and chemical analyses have been made of the most important. The height of the canes of the different varieties has been carefully recorded as this has considerable bearing on the bamboos and wrappings required. It has been remarked that the canes acquired quite phenomenal stature in the Gôdâvari delta, as will be seen from the following. The Red Mauritius field is about 18 feet high. The Striped, Ashy, Sanna Bile and several others have an average of 20 feet. Certain excessive heights have been recorded. Mogali has been noted 25 feet high. Some striped Mauritius canes, stretched out, exceeded 26 feet when measured on the ground, a quite remarkable height noteworthy when considering the violent winds which result from the "Storms in the Bay" that strike the coast near Cocanada.

25. The number and weight of canes per acre has been calculated in Class I and the outturn of jaggery. These figures are open to doubt because of the smallness of the area tested, but several of the returns show remarkable similarity to the larger tests which have been possible. In the second year a return of 4½ tons of jaggery was recorded in Red Mauritius; in the third year the same cane and the Striped Mauritius produced 5½ tons while in the fourth year two or three of the striped and Red Mauritius plots showed over 7 tons per acre, a truly magnificent return. To this may be added that some Mogali canes sent from the farm to Mysore and some Striped Mauritius in the delta grown by ryots also produced over 7 tons per acre. These heavy returns, while naturally in no way average, indicate that the canes now being grown may with appropriate treatment be made to produce very large returns and that the heavy expenses of cultivation are justified where the variety is fairly disease-resistant. At the same time the cost cannot be borne by the average small cultivator excepting on a very small area. The weight of canes per acre has reached between 60 and 70 tons.

26. The hardness of the rind has been noted as this has an important bearing on the milling properties of the cane and resistance to jackals. The mashing power was at first carefully tested but, later on, it was considered advisable to discontinue this practice because of disease, and it has been given up on the farm. The canes have been analysed by the Chemist at Messrs. Parry & Co.'s factory at Samalkota. From the results, it is evident that some of the canes are of great richness. Tables are appended of some of the results, but these have been rendered of less value by the great falling off all round this last year from the drought and disease. The character of the juice in the different varieties has also been recorded as well as the quality of the jaggery produced.

A series of ripening analyses has been inaugurated, especially in the varietal and manurial plots.

27. It may be noted that the valuable Mauritius canes obtained from Vizianagram were in disorder on discovery and it was impossible to give them their correct names. Full details, including a set of paintings,

analyses, drawings, measurements as well as pieces of the canes themselves have been sent to the Director of Forests, Mauritius, for favour of examination and, if possible, determination, so that our results may be compared with those of other countries. It appears probable that the Striped Mauritius will turn out to be the Striped Tanna and the Red Mauritius the Ischambine, but it is unsafe to give them these names until confirmed. Meantime, the present names are descriptive in a rough and ready way of the chief external characters of the mature canes.

28. It was found, even during the first year of the farm's existence, that we had secured canes of greater value and disease-resisting power than the local ones. Although contrary to all the canons of sugarcane experimental stations some Red Mauritius canes were distributed to ryots in the second year with, however, a stamped agreement that they should make the whole into jaggery if during the year any objectionable character appeared. This method was again adopted during the third year when Striped Mauritius and Sanna Bile were added. The tests outside the farm were thoroughly satisfactory and distribution on a large scale was prepared for. But here a great difficulty was encountered. Very few applicants came forward, namely, those within a few hundred yards of the farm. All the usual Government modes of advertisement were put in action but with no result whatsoever. The time was passing and the fine canes were to all appearance doomed to be crushed and made into jaggery. A special assistant was accordingly sent down from Madras, he was provided with a cart filled with canes of good qualities, and directed to tour through the country holding meetings of the ryots wherever he could get them together. The effect was instantaneous. As many as 19 applications were received from one village and they sent their carts that night to get the canes they had seen. Since this experiment, it has been quite needless to advertise the canes, far more applications being received each season than the station could possibly satisfy.

29. To ensure a wider distribution of the canes the officer in charge was directed to tour through the six taluks of the district and seek out the most influential ryots engaged in cane cultivation, to show them the canes and, on their promise of careful cultivation, to allow them sufficient seed for a tenth-acre plot of each of the varieties being distributed. These taluk plantations were inspected twice during the year and the reports showed that the new canes were vastly superior to the local kinds in every respect. To such of these distant ryots as had cultivated the canes in the methods recommended by the farm, fresh seed was given each year, one or two varieties being added where considered advisable. These were regarded in the light of prizes and the result has been that the canes have got a thorough hold of the delta and there are some half dozen centres from which distribution is taking place. But for the recent unprecedented drought, there would now be some hundreds of acres of the new canes, but this last year has been a serious blow to the upland cultivation, and there has been acute distress in the delta itself. Hardly any jaggery has been as yet made from the canes distributed, the ryots preferring to reserve the seed for extension, most

of the taluks having declared that they intended to replace the local kinds entirely by the farm canes.

30. These applications for seed and the extremely limited area of the farm has had a prejudicial effect on the other experiments to be detailed below. It has been accordingly decided to place a couple of acres aside for a nursery for distribution, and to leave the comparative plots intact. It is necessary that the plots should be untouched in the future, the main canes have been given a start in the district, farms have been started in the South of the Presidency for the local demands there, and, lastly, it is considered doubtful whether the delta itself is a suitable place for a nursery for distribution. There will therefore be less actual distribution from the farm itself in future. Its work has entered on a further stage, accurate results must be obtained from the manurial and methods plots and the advisability for forming an upland nursery will have to be considered immediately.

While the varieties on the farm have thus far been pretty free from disease, the recent year of drought brought it out in almost every kind. It will take some years probably to recover from the effects and before the farm can claim a clean bill of health. This will be dealt with again in considering the general question of disease as relating to the delta conditions.

31. *Manurial Plots.*—The manurial experiments conducted with sugarcane at Samalkota have been of a tentative character.

It was at once observed that to hope for an even piece of ground in irrigated land cut up by irregular bunds into very small pieces was out of the question. Not only did the different banded pieces differ among themselves, but, even within the same bund, the quality of the soil showed most remarkable variations. In judging these, a preliminary growth of *Sourahemp* (*Crotalaria juncea*) was found useful, the difference mentioned being almost entirely in physical constitution. Two alternatives were thus presented, either to postpone all manurial experiments indefinitely or to start at once and by a series of careful observations in the early stages of growth to check the results obtained. The land was only rented and no great levelling operations were permissible, and in fact it was not known how such changes might affect the land itself. The work was therefore started and careful inspection notes taken before the application of the manures. The latter were in general postponed until the reopening of the canals when the plants were some three months old. At this time a specially careful inspection was made in which all inequalities were noted. It is obvious from this that the tables here published for the first time must be read with caution, and do not give the proportionate value of the different manures with any degree of accuracy, but certain conclusions have been drawn from them as detailed below.

32. It will also be noted that the plan of manuring was altered year by year according to experience gained as to the character of the land, the resources of the ryot and the manures locally available. The experiments thus lose in academic value, but, it is hoped, gain in a

corresponding degree in practical worth. What we have learnt more than anything else is the type of manuring most likely to succeed financially in heavy delta lands where wet paddy and sugarcane are grown in rotation. In the first year a series of artificial manures were applied such as are usual in the West Indies. But these artificial manures were found to be largely without effect under the local conditions, and the series has been modified year by year until it has resolved itself into the trial of the different kinds and quantities of local oil cakes, the use of the local "cattle manure" and a "general cane manure." This series it is proposed to continue as mentioned at the end of this section, adding a properly prepared cattle manure as soon as it is available on the farm.

33. The variety of cane used has varied year by year, an attempt being made to deal with the most useful current cane of the district. Thus Keli was planted in the manurials in the first year but afterwards dropped because of its diseased character. Yerra and Bonta were next tried, then Yerra alone. The latter was given up in the fourth year because of the increasing quantity of Red Mauritius being planted and the desirability of learning the way in which manures affected this cane. The Red Mauritius cane has again been planted in the current year.

34. The local manurial practice may be said to be covered entirely by the application of ten bags of castor cake after the reopening of the canals, in June or July, when abundant irrigation is possible, much water being found necessary for the proper disintegration of the cake. Five and twenty years ago, before the establishment of the oil mills in Cocanada, when no castor cake was available in the district, the practice consisted in cattle and sheep folding, the application of village "penta" (ashes, rubbish and cattle manure picked up off the roads), scrapings from the village walls (for saltpetre) and green soiling with wild indigo (*Tephrosia purpurea*) brought from the uplands. Now that the castor cake has taken such a firmhold on the district no manuring of any other kind is usually attempted even before the planting of the canes.

35. The first year's experiments (1902-03) consisted of a trial of penta, castor cake, gingelly cake, lime, ammonium sulphate, superphosphate, saltpetre and bone meal. The proportions applied and the results obtained are appended in the table below and it will be seen that the general results were extremely unfavourable to the artificial manures, which had practically no effect at all upon the weight of canes produced. While by no means satisfied that this result was conclusive, it was decided at once to drop all artificial manures. They were very expensive and not easily obtainable and could only be introduced if they showed marked financial advantages. The general conclusion of the first year's experiments was that the land, after years of paddy cultivation and irrigated after the local manner, was unsuited to the application of artificial manures for sugarcane, but that the ryots' local practice of applying castor cake was justified, and the results

generally appear to show that the yield is proportional to the amount of nitrogen applied in the form of oil cake:—

Five cent plots.	Manure applied.	Quantities per acre.	N.	Weight of canes per acre.	Remarks.
4 & 14	Gingelly cake ...	1,640 lbs.	0.83	67,600	"Penta" is the local cattle manure, ashes, rubbish and sweepings, which are dropped from the carts and are used as a general preparation of the land before all the experiments. The planting of two canes was unsatisfactory, the Bonta being overshadowed by the Yorra and also being much more attacked by jackals.
8 & 12	Castor cake ...	1,640 lbs.	0.27	65,500	
1 & 10	"Penta" ...	60 cart-loads.	0.29	32,200	
2 & 11	1/2 Penta and 1/2 castor cake ...	30 cart-loads.	...	48,500	...
6 & 15	1/2 Penta and 1/2 castor cake ...	30 tons.	...	43,500	
9 & 18	1/2 Penta and 1/2 Bonemeal ...	30 cart-loads.	...	30,500	
5 & 16	1/2 Penta and 1/2 Saltpetre ...	1 cwt.	...	34,240	...
8 & 17	1/2 Penta and 1/2 Super-phosphate ...	1 cwt.	...	21,220	
7 & 13	1/2 Penta and 1/2 Saltpetre ...	1 cwt.	...	17,720	

26. In the second year (1903-04) the manurial experiments were therefore considerably simplified. The number of plots was reduced to ten and each was increased to ten cents. The Keli having proved thoroughly unsatisfactory, the two best local canes, Yorra and Bonta, were planted in alternate rows. It was not considered likely that the problem of the district would be solved by the addition of concentrated artificial fertilisers and only those locally available were applied. Of these castor cake was taken as the standard. A quantity of spent char being discovered in the local sugar-factory, it was added to the series. Lime was continued for a second year as a physical manure. The produce of the weed pits was also tested. There being no cattle in the farm it was found that the nitrogen content in this "compost" was very low. It was therefore added, as the lime, as a physical manure.

Great difficulty was experienced this year because of the unevenness of the plots, one of those devoted to castor cake being particularly bad from the very commencement and being condemned long before the application of the manures. The lime and the compost were added during the preparation of the land and the other manures added at the usual time.

37. The results generally confirmed those of the previous year, as far as castor-cake was concerned. Bone char was apparently beneficial,

probably because of the nitrogen it contained. Lime had a considerable effect on the physical condition of the soil, but there was little effect on the yield. It was considered as too slow acting for a paddy and sugar-cane rotation. The effect of the weed compost was marked, but the low nitrogen content removed it definitely from the range of manures. It was subsequently used as a general preparation of the land before all the experiments. The planting of two canes was unsatisfactory, the Bonta being overshadowed by the Yorra and also being much more attacked by jackals.

Five cent plots.	Manure applied.	Quantity per acre.	N.	Weight of canes per acre.	Weight of jaggery per acre.	Remarks.
5 & 7	Castor cake ...	1,640 lbs.	0.2	32,010 62,560	3,310 6,690	One plot was condemned from the commencement.
1 & 8	Castor cake ... Bone char ...	1,640 lbs. 800 lbs.	0.2 1.3	65,500 55,330	7,370 6,840	
3 & 10	1/2 Castor cake and 1/2 lime.	820 lbs. 2 tons	0.2	43,070 43,990	5,060 4,740	...
4 & 6	Compost from weed pits.	1,000 head loads. 25,000 lbs.	0.25	35,400 35,490	4,150 4,110	
2 & 9	No manure ...		...	26,130 26,110	2,500 3,050	

38. In the third year (1904-05) lime was discontinued for the reasons stated. Compost from the weed pits was also removed and the whole land received a dose of it at the rate of 900 headloads per acre before crowbarring. At the instance of the Inspector-General of Agriculture cattle manure was again added. This substance as we have seen is not available in a proper form in the district but was represented by the local "penta" as before. A mixed cake, made of pongam (*Pongamia glabra*) and margosa (*Melia Azadirachta*, the Neem), having been discovered locally and analysed, it was found that the nitrogen in it was in a cheaper form than in castor and it was added to the series. This was done in the face of the ryots' objection that the jaggery from canes thus manured was bitter and did not keep. The question of cost of manure now forced itself on our attention and it was decided to take 10 bags of castor at Rs. 40 as the standard and to test the efficiency of various kinds of manure obtainable at that price. At the request of a local firm a "general cane manure" was also added to the series. Besides these, it was decided to try the effect of a very large quantity of castor cake. This mode of furnishing nitrogen to the canes appears to be the most useful one in heavy soils in India, and it was desirable

to know whether a larger quantity might not be given with profit than the customary 10 bags per acre.

39. The usual unevenness was noted among the plots. One especially, under 30 bags of castor cake, was a little higher and better drained than the rest and it led throughout, from long before the manure was applied. The piece of land chosen for the manurials during this year was not a good piece, accounting for the generally poor yields, but each side of it was better than the middle which was low-lying. It fortunately happened that each of the duplicate experiments had one plot in the good and one in the bad portion. As compared with the others, excellent results were as usual obtained from the plots under castor 10 bags, but the mixed cake plots (purchased rather dear this first year) were on the whole more satisfactory still. In the 30 bags plots a great mass of canes was produced which were obviously unripe at the time of reaping, twelve months after planting. The net result was that the yield varied according to the nitrogen applied in the form of oil cake, and that, as far as the ripening tests were concerned, the more nitrogen the manure held the longer the cane took to approach maturity.

Ten cent plots.	Manure applied	Quantity per acre.	Cost per acre.	N.	Weight of canes per acre in lbs.	Weight of jaggery per acre in lbs.	Remarks.
		lbs.		Per cent.			
1 & 7	Castor cake 10 bags.	1,640	40	6.2	52,750 45,139	8,000 * 5,420 *	
5 & 8	Castor cake 30 bags.	4,920	120	6.2	85,670 88,590	9,850 10,850	
4 & 9	Penta ...	...	40	0.24	33,870 20,100	3,970 2,310	
3 & 10	Mixed punyam and margosa cake.	3,280	40	4.7	79,920 69,000	9,910 8,450	
2 & 6	General manure groundnut cakes, sulphate of potash bone and spent char.	1,568	60	4.48	43,690 55,970	5,240 5,700	

* These figures appear doubtful, the relative weights of canes and jaggery not bearing one another out. As the two plots were reaped together it is possible that a cake of jaggery was added to the wrong account. There was little difference between the plots.

40. The manurial plots in the fourth year (1905-06) were arranged as in the preceding year. Mixed cake was however much cheaper and as many as 40 bags were obtainable for Rs. 40 and this quantity was applied per acre. The plots were planted entirely with Red Mauritius cane, since that variety was being largely distributed and planted locally and it was desirable to learn as much as possible as to its characters. A uniform

piece of land was secured, the preceding crop being as usual wet paddy. The early stages of growth proved to be excellent in that hardly any supplies were necessary to obtain an even stand, and at the time of manure application there was no appreciable difference to be seen in the different plots. There was thus the prospect of not only a very useful comparative result but also of a bumper crop. As the year wore on however the weather became more and more adverse and towards the end a serious invasion of disease made its way into the block, causing five of the duplicate plots to be rejected as not representative. How far the remainder can be used for our purposes may be left an open question. Certain it is that the yield from them was very large. It was not possible, further, to use the whole of each plot, and so an average piece was selected and the crop experiment carried out on this. It may however be remarked that the results need not of necessity be rejected as giving excessive yield, for similar results were obtained in at least two other tenth-acre plots which were reaped whole during the year. It is especially unfortunate that this disease should have occurred at this time for all the early inspections pointed to a bumper crop all round, partly due to the change of cane but also to the richness of the land, and the evenness of the piece of land in the preliminary tests gave promise of particularly useful results. The results are given in the table below.

1.25 cents chosen from each plot.	Manure applied.	Weight in lbs. per acre.	Cost per acre.	N.	Weight of canes per acre.	Weight of jaggery per acre.	Remarks.
		lbs.	Rs.	Per cent.			
1	Castor cake, 10 bags	1,640	40	6.34	111,440	13,760	*
2	General manure (N.K.P.)	3,120	73	5.81 N 3.18 J 7.60 K	107,200	12,800	
3	Castor cake, 30 bags.	4,920	120	6.31	118,160	14,160	
9	Penta ...	56,000 (2,240 head loads).	50	10.27	78,848	9,488	
10	Mixed cake punyam and margosa, 40 bags.	6,560	40	3.92	122,560	15,920	

* The plots are too small for accurate results, but it would appear that the value of a very large quantity of N in oilcakes is problematical.

† Not analysed, average of previous analyses.

‡ The mixed cake was cheaper than in previous years.

41. As it was suspected that the application of different manures would have a considerable effect upon the rate of ripening of the canes, a series of "ripening tests" was inaugurated in 1904. The canes were

sampled and analysed in each plot once a fortnight from the 7th or 8th month of its growth. In 1904-05, after determining the sucrose, the acidity of the juice was very carefully determined in the hope that this might give an indication of ripeness. But this test proved to be quite worthless because of the great variations. In 1905-06 the glucose was determined in the ordinary way.

It was soon seen that the plot under penta were fast ripening in advance of the rest. The canes seemed to stop growing about the tenth month and might, doubtless, have been reaped then with advantage, although the yield would have been lower even than it was. On the other hand the canes in the plots with 30 bags of castor cake went on growing right through the season and were by no means ripe when reaped at 12 months, indicating that they might with advantage have been left in the ground for a couple of months more. The tables cannot here be given in full although they show a quite remarkable regularity. The analyses are only given after 11 months in the ground. The general net result appears to be that the rate of ripening depends not so much on the quantity of nitrogen in the manure as the quantity presented in the form of oil cake.

1904-05. Manurials—Yerra cane—Planted 13th March 1904—
Tests commenced on 20th November 1904 and analyses given
on 15th February 1905 or after 11 months' growth.

Plot and manure.	N in lbs. per acre.	Brix.	Percent- age of sucrose.	G.P.
Penta, plot No. 4	...	20.20	18.76	92.87
Do. " 9	...	19.40	17.92	92.37
General " plot No. 2	...	18.67	16.58	88.80
Manure " 3	70	18.87	16.84	89.24
Castor, 10 bags No. 1	101	20.17	16.73	92.83
Do. " 7	...	20.40	16.79	92.19
Mixed cake, " 3	154	18.50	16.17	87.10
20 bags, " 10	...	18.54	16.09	86.70
Castor, 30 bags, " 5	303	17.09	14.65	85.60
" 6	...	18.14	15.24	84.91

1905-06. Manurials—Red Mauritius cane—Planted 2nd April 1905—
Tests commenced 4th November 1905 and analyses given on
6th March 1906 or after 11 months' growth.

Plot and manure.	N. in lbs. per acre.	Brix.	Percent- age of sucrose.	G.P.	Percentage of glucose.
Penta ...	151	19.78	17.89	90.39	1.26
General manure ...	112	18.51	16.10	88.98	1.78 †
Castor cake, 10 bags ...	104	18.28	15.50	86.48	1.95 †
Mixed cake, 40 bags ...	261	17.53	15.00	85.34	2.18 †
Castor cake, 30 bags ...	312	17.48	14.72	84.78	2.16 †

* Nitrogen not all as oil cake.

† Nitrogen all in oil cake.

42. One of the first things noted in the local agriculture was the marked absence of all vegetable matter in the soil. There was no attempt at supplying this need, although it was one of the chief methods of bringing the land into better physical condition. As we have seen, after the paddy is reaped the land is ploughed as early as possible to aerate it, the usual sowing of a pulse crop after the paddy being given up when sugarcane is to follow. It is not at all clear that a better result is not thus obtained by thorough aeration than by a preliminary green dressing crop. An effort was made to supply this vegetable matter, and, seeing the enormous growth of weeds in the fields, the bands and waste places, it was decided to try and utilize this material. Pits were accordingly dug of a convenient size, and all the weeds, rubbish, with occasional doses of lime and layers of paddy husk were thrown into them with thin layers of earth between. As there were no cattle on the farm, no true compost could be made, but at first cowdung was purchased and added as well. Later on, the nitrogen content proved very low, nothing but weeds was collected, but advantage was taken of the grass growing on the bands to induce the owners of cattle to bring great loads of wild leguminous and other plants in return for grass cut.

The result was that large quantities of this compost have been made each year, reaching finally to 10,000 to 14,000 headloads or 330 to 460 cartloads. The cost of this worked out at something like 1 rs. per cartload, there being no cartage. The whole was added to the soil before ploughing. The only comparative experiment was that recorded in the second year where both the plots treated with "weed-compost" showed a marked improvement over the "no manure" plots. As the nitrogen content proved to be so low, and probably had little effect in this state, the experiment as such was removed from the manurials and as much compost spread each year for the general improvement of the land. This making of weed-compost has become an integral part of the farm's work. Now that cattle have been purchased, it will be supplemented by the formation of a good cattle manure which will be introduced into the manurial series as soon as possible.

43. Another practice, with the same object of adding vegetable matter to the soil, that has become general on the farm without the preliminary accurate testing of its value, is the burying of the trash or dead leaves of the canes after harvest. This matter was early found to be complicated by the fact that this substance was largely utilised in boiling up the juice in the preparation of jaggery. The whole question of fuel was therefore carefully studied. It appears essential that this should be of a highly inflammable nature, should be capable of giving intense heat rapidly and for a short time. As brushwood was found to be too expensive, it is evident that the megass (residue of the cane fibre from the mills) and trash must be used. By a careful calculation it was decided that the ryot could afford to bury half the trash of the fields, and this was found especially easy in the dry-rotation area where red-grass (*Cajanus indicus*) is the usual rotation, the stalks serving the purpose of fuel excellently. Every year an experiment has been tried

with "buried trash," but no definite results have been obtained. As however there can be no doubt as to its ultimate effect, it has now become an integral factor in the best practice of the farm on all the plots. The Varietal plots, for instance, are treated thus each year. It is quite possible that the effect of burying trash may not be measurable in any one year, but the experiment is being steadily continued in the Methods plots.

44. A similar subject, half way between the Manurials and Methods, is the value of green soiling, preferably with a leguminous crop. This crop may be sown and dug in before the sugarcane is planted, when it partakes of the character of a rotation experiment, and may be considered as part of the preparation of the land before planting. Or it may be sown at the same time or after the cane sets and dug in when the latter cover the ground.

Experiments have been only conducted with the latter, the former has been impossible under the conditions of the farm. It may however be stated generally that, while green dressing is of undoubted value for light soils, its effect on heavy lands has not been demonstrated. At any rate the value of the methods has been very much less certain in the West Indies on the heavy lands of Antigua than on the light volcanic soils of St. Kitts.

When the green soiling crop and the canes are grown together the object aimed at is to protect the young plants from the fierce heat of the rainless summer and to afford a mulch to the ground when the canals are closed. Experiments in this direction have been carried on since the commencement of the farm. But the first question to settle was the variety of plant to be grown. Indigo, sunn hemp (*Crotalaria juncea*), green gram (*Phaseolus Mungo*), cowpeas (*Vigna Catjang*) and red gram (*Cajanus indicus*) were tried and compared. Sunn hemp has been chosen as, on the whole, most suitable. But some difficulty was experienced in the fact that this crop is liable to be completely eaten down by insects, this depending on the weather and the time of planting. The present practice is to plant the sunn hemp at the second hoeing, (about twenty days after the cane sets) and turn them in when the canals are closed for their annual cleaning. It was found that great care was necessary to prevent their smothering the cane sets and they are now restricted to a narrow band between each row of canes. Results however are at present contradictory and nothing definite can be stated regarding the value of the method in the delta lands.

45. *Methods plots.*—To describe the results thus far obtained on the farm with regard to the improvement in the local methods of cultivation is no easy matter. The "Methods" plots have not only been much more complicated than the "Manurials," but they have been subject to a much larger number of changes. This is easy to understand when we consider that the guiding ideas at the start were mainly West Indian and that these had to be gradually adapted to the special peculiarities of the Godáviri delta. In the West Indian Islands we have a deep rich soil in excellent "condition" through years of first-class cultivation. There is no irrigation and therefore no paddy, and

the crop depends on timely rains. Every year the greater part, if not the whole, of the dead cane leaves are buried in the soil. The plants are put in from four to six feet apart, tiller freely and quickly cover the ground. Labour is dear, but the soil is very easily worked and, after the canes cover the ground, nothing more is needed until the reaping time. A large sum is spent every year in collecting and applying cattle manure of a superior quality and heavy chemical manuring is the rule. These conditions are exactly reversed in the Godáviri delta.

46. As regards the experiments themselves, there will be few crop returns reported. The results have been largely obtained by observation throughout the growth of the canes. The usual unevenness has appeared early in the different plots, rendering the final yield less instructive, and the "Methods plots" have as a whole been freely indented upon in the efforts to meet the great demand for seed. In many of the succeeding paragraphs the opinions formed will be expressed rather as criticisms of the ryots' practice than as definitely determined experimental results. The latter can only be obtained after years of undisturbed work.

47. As might be expected, the experience gained has led to the general abandonment of the West Indian practice, first in one particular and then in another. It was soon felt to be useless to try and deal with the heavy, refractory clays after wet paddy on these lines at all. This led to the division, from the commencement, of the farm into two very distinct divisions, the wet-rotation area and the dry. This experiment will naturally take some years to complete. The object is to determine if, by the planting of garden and dry crops, instead of wet paddy, in rotation with sugarcane, the Godáviri conditions can be brought more into line with those of other sugarcane growing countries. If this can be done, the application of concentrated chemical manures should produce some notable results. In the wet-rotation, sugarcane will be planted once in three years in alternation with two years of wet paddy, while in the dry it is proposed to plant the sugarcane in alternate years with garden crops such as chillies, yams and turmeric or field crops such as cotton and red gram (*Cajanus indicus*) plus dry paddy. Sugarcane having been now planted on all parts of the farm in turn, this is the first year in which it is again growing on the same land after an interval of other crops. As this is the case on both the "wet" and "dry" areas the results of the next few years will be of no ordinary interest. If it turns out that the dry rotation system is a success, the next problem to be solved is how to apply this to a country where the cane cultivation is subordinate to that of paddy and where it is grown in small patches separated by wide areas under that crop. The only way will be to make some arrangement such as that suggested below by which certain lands are set apart for sugarcane cultivation in each village.

48.—It need not be insisted upon that this experiment, perhaps the most important one being conducted on the farm, has as its main

object the combating of the current disease. There are many reasons for thinking that this disease is a direct consequence of the rotation of wet paddy and sugarcane. There is no doubt that it at once appears in any block or plot or part of a plot which is at all lower than the rest and thus liable to get waterlogged. All the experiments have therefore been directed to ensuring a level field and as perfect and rapid drainage as possible, the latter being considered a *sine qua non* in any healthy cane field in the delta.

49. The choice and preparation of the land for sugarcane cultivation is generally well understood by the ryot, although, in too many cases, he does not act up to his knowledge. In this he has a certain amount of excuse, for it has been noted in some of the fields that the yields with admittedly wrong methods have frequently been as good as those treated to the best advantage. There is always a chance of obtaining a good crop with little expense. What the farm aims at is to obtain a certain although smaller profit rather than the occasional large returns with alternating total loss.

It is necessary that the cane land should have easy irrigation throughout the year, but at the same time it should be as high as possible to ensure perfect and rapid drainage. Owing to the scattered nature of the fields and the small area under each ryot's control, this selection of suitable land is not always carried out, and sometimes cane is grown in very unsuitable places. It is difficult to suggest any remedy for this, unless it be to collect all the sugarcane lands into one block. To get all the double crop lands together instead of having them widely scattered as they are at present should be an object of the department in charge of the distribution of water, for its economy is obvious and the matter might be taken up by the Revenue officials.

50. As regards the drainage of the land, the ryot is very often careless in the extreme. It appears that he was much more careful before the introduction of castor cake as a manure, but that, with its introduction, the habit has grown with him of allowing the water to lie for considerable periods to ensure the thorough rotting of the cake. But the resulting waterlogging is fatal to healthy cane-growing. The best results have been obtained by not allowing the water to lie in the fields for more than 12 hours.

The mode of irrigation is also capable of improvement. The cultivator generally swamps the whole field in paddy-growing and he has extended the practice to the cane fields. It has become the practice on the farm never to allow the water to touch the surface after trenching. The trenches are filled to within about four inches of the surface of the ground, soakage goes on for half a day and then all the channels are completely cleared of all lying water. The saving in mere hoeing is considerable and the finer surface tith is thus conserved for a much longer period.

51. Having selected the piece of land for cane planting with regard to easy irrigation and drainage, the first thing to do is to get it worked up and aerated as soon as possible. Any cultivator will tell you the

exact moment when the ground is dry enough for ploughing or crow-barring and this moment should be seized. To get the land into a suitable condition the first thing is to draw off the water of the previous paddy cultivation. A deep trench should be dug around the entire sugarcane area. This, while intended for the rapid drying of the ground, also serves as a barrier against the seepage water later in the year when the cane fields are surrounded by those under wet paddy.

After various efforts at deep ploughing, it has become the practice on the farm to crowbar, although no series of experiments have been conducted to prove the usefulness of this method, nor indeed are they well possible under the present conditions. The soil is turned up for 9-10 inches in crowbarring and 4-5 inches in ploughing, and the former is regarded as better, not only in giving the cane roots a wider range, but in destroying such weeds as nut grass (*Cyperus rotundifolius*) and *Imperata* grass. If it is necessary to hire, the cost will be about the same for the two, but as most ryots have cattle which must be used ploughing is the rule in the delta.

A certain amount of levelling seems to be essential, although it is rarely attempted by the cultivator. Any low place will be at once detected in the first watering and if not attended to will invariably show a diseased patch later on. The cost of this operation is great, but by constantly doing a little each year, the land can be gradually brought into a very even state. It is most important for obtaining an even stand that there should be no irregularities.

52. The ryot is not too careful, in spite of his protestations, in the selection of his seed, and probably this has had much to do with the spread of this insidious disease from generation to generation. Only too frequently a small patch, where the canes are small and unfit for milling, has been noted as set apart for seed. There is no inherent objection to sowing short-jointed, stunted cane if healthy, but such patches in the delta are usually heavily infected with the red smut.

The cultivator usually obtains his seed from his own fields because of the great cost of purchasing (from Rs. 30 to Rs. 50 per acre). But the practice of occasionally obtaining seed from the lighter, better drained uplands is old and has led to excellent results. This matter has been somewhat carefully studied and there appears to be no doubt that seed obtained from this part gives better and healthier canes than that to be obtained from the delta. This fact has gradually led to the view, to be amplified later, that the Samalkota farm is not perhaps best suited as a nursery for distribution, and unavailing efforts have been made to obtain a suitable piece of land in the uplands for the purpose. It must not be supposed that this view interferes with the usefulness of the farm for experimental work. The latter must be done in the delta, in the heavy land surrounded by wet paddy, and cannot be done elsewhere.

53. A series of experiments have been tried as to the part of the cane best suited for seed purposes. It is probable that this will differ with different canes and in different parts of the country. The local practice is to cut up the cane whole, but, as will be seen below, this

might with advantage be modified. The joints are thrown down horizontally when planting but the tops are thrust in slanting. Most canes show fairly good results when cut up whole, but some cannot be planted thus. The Seema, for instance, has grown far better from tops than from joints on the farm. In one of the plot experiments the whole of the joints failed while every one of the tops grew quite well. Further experiments must be made with the different canes before their individual behaviour is ascertained. It is sufficient for the present to have determined that no general rule can be applied.

Of more practical importance were the experiments with the upper and lower halves of the cane. The general results were that the upper halves had greater germinating power than the lower. This result is not surprising. The lower half has passed to a more permanent stage in growth, has more sugar, has longer joints and therefore fewer buds, many of which are injured, and many of the joints have started their roots. The most economical method is therefore to use the upper parts of the cane for planting and to mill the lower. As perhaps the most striking instance of the superiority of the upper halves in germinating power the following experiment with Yorra may be quoted. Four five-cent plots were planted, in duplicate, with 750 sets a piece, two from the upper halves and two from the lower halves of the same canes. The shoots were counted after six weeks' growth.

Lower ends, 802 and 694 shoots.

Upper ends, 1,732 and 1,489 shoots.

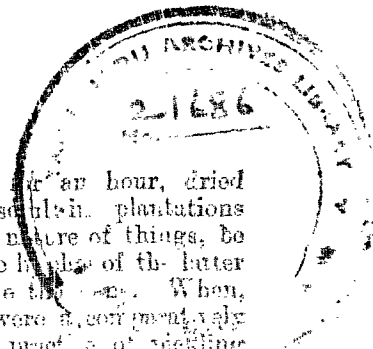
54. This superiority of the upper ends for planting in the delta is of importance in calculating the number of sets required per acre. The ryot cuts up the whole of his canes and plants 20,000 to 30,000 broadcast. By this excessive planting he hopes to get a full stand, but, according to observation, he does not succeed in doing so. No amount of planting will fill up the low, sour places, and if he gets the plants to grow, they are stunted and the first to become diseased in adverse weather. In one cultivator's field observed, sets were replanted twice all over, at a probable rate altogether of 75,000 sets per acre. With greater care in the selection of seed and better preparation and a little levelling, there appears to be no need for more than 10,000 sets per acre. This is the rate adopted on the farm and the yields have sometimes been very heavy. Only in some of the smaller canes such as Bonta has it been found that a larger number is of advantage, and here 15,000 have been considered better. Comparative five-cent plots have been planted each year with 30,000, 20,000 and 10,000 sets per acre, but there is no appreciable difference in the resulting yield, once the precaution is taken to get an even stand. As already hinted, there has been a rather disconcerting equality in yields, suggesting that, with a given cane, the actual outturn on a given piece of land is very much the same within wide limits, whatever plan be adopted. The experiments will be continued. The present feeling is that the ryot's excessive planting is caused by his desire *somehow* to get the land fully planted up, coupled with his neglect of the obvious preliminary preparation.

55. For the first three years an elaborate system of pickling the sets was practised. The newly cut sets were soaked in batches in a

strong mixture of lime-water and carbolic acid for an hour, dried and planted. This operation appears to be useful in plantations infested with mites or borers, but it cannot, in the nature of things, be regarded as a preventive of fungous diseases. The leaves of the latter are inaccessible and pass from cell to cell inside the cane. When, therefore, it became evident that insect pests were a comparatively negligible quantity in the Gôdâvari delta, the practice of pickling was discontinued. But all through the farm's existence the most careful sorting and selection has been practised, every set with any trace of red or borer hole being rigorously rejected. This was done as ostentatiously as possible. It is of course pretty certain that many of the sets thus rejected were perfectly healthy, as there are innumerable causes for the red coloration of the sugarcane tissues, but this red coloration is one of the most tangible proofs of the presence of the disease and it was hoped that an object lesson would thus be afforded to the ryots, besides improving our own plantation. Even here, however, there is room for a considerable amount of investigation, for, as will be seen later, it is not possible by the mere rejection of red marked sets to root out the disease. In spite of all our care, all but two of the local kinds have become gradually worse, until they have had to be replaced by new seed from outside.

56. One of the most fruitful sources of loss in the local cane cultivation is the irregularity of the fields. While bits here and there show a great growth of tall canes, they are separated by low and weak places where the canes lead a struggling existence. These are as a rule low and ill-drained parts although not always so, and all sorts of experiments have been made in order to obtain an even stand. To do so in the local conditions requires unremitting care from the very commencement. When the land is flooded before planting a certain amount of levelling must be done, carrying baskets of mud from the higher places to those where water lies. After germination, the piece is steadily gone through and the young plants are lifted from dense parts to the bare patches, at the same time earthing up the latter if at all low. The amount of labour required to do this is sometimes considerable, especially at first, but the cost is not so great as would appear, and the improvement is lasting.

57. But it is not always possible to plant up the bare spaces from the plot itself. Then supplies must be obtained from outside. Various trials have been made as to the best way to do this supplying. In the first place it has been found that the plants moved must be at least as old as those already in the plot. All attempts to sow the bare places with fresh seed have failed, partly because the treatment of the sets should be different from that of young growing plants, but also because the newly planted ones are left behind and overshadowed by the main growth. Then it has been found that on the farm the supplying should be done not later than six weeks after planting and of course if possible in dull weather. Small strips have been planted at the time of sowing outside the main field, but perhaps the best plan is regularly to throw a few extra sets at the end of each row between it and the next, planting the whole ground here instead of merely the row. Supplying



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ratoned fields is more difficult and it has been found best here to put stools in the vacant places, supplying with sets having always failed.

The even stand, although so important from a crop point of view, is peculiarly necessary in all comparative plots, and special efforts have been made each year to obtain it in the Manurials before the application of the manures. On the whole the results have been satisfactory, and we have been able by this preliminary work, coupled with careful inspection notes at intervals, to fairly easily decide the effect of the different manures even before harvest time.

58. The depth and mode of planting has received a certain amount of attention. At first the sets were thrust down into crowbarred holes at the bottom of depressions, after the West Indian plan, but this was given up because the plants took such a long time to come up. Planting in trenches a foot deep was then tried but there seemed to be no great advantage in this, and the labour was excessive. Thus far deep-planting does not appear to be of special value in these lands, although the matter is by no means settled. One fact may be mentioned in passing and that is that the deep-planted plots have invariably had far less dead hearts from moth-borer than the others during the closure of the canals, arising a stronger plant. Shallow furrows were tried, but this was not possible unless the sets were planted dry and there were difficulties in the way, although dry-planting has been successfully introduced in some plots. Lastly, the ordinary, local plan of throwing the sets on the puddled ground and treading them in has given quite good results as far as growth is concerned. The resources of the station are not at present equal to extended experiments under this head, but the subject assumes some importance when we consider the very poor tillering of the canes thus planted, their enormous growth in height and the poor foothold they seem to obtain in the muddy ground. If we could by any means get a bunch of medium sized canes instead of two to four enormous ones, the whole question of wrapping and bamboos would be settled. The only apparent solution is deep-planting, therefore it should be held in view and made the subject of future trials. Very large returns can be obtained by the present method, but if a shorter growth could be successfully introduced there is no reason why the same could not be obtained with far less expense.

59. Experiments conducted with planting the sets in rows and broadcasting have shown that there is practically nothing to choose between them as far as the yield obtained is concerned. But there are so many particulars in which row-planting is preferable that it has been unhesitatingly recommended and is always adopted on the farm.

From planting to reaping, all the operations are rendered easier, and this applies especially to the maintenance of surface tilth. The hoeing in the Gódávári delta is done by *tolika* as already described. But with seed sown broadcast the cultivator must move forwards for fear of treading upon the brittle shoots. After the local fields are hoed they are well trodden down by the advancing line of coolies and much of the stirring of the soil is lost, worked backwards there is not a foot-mark and the field presents a peculiarly well tilled appearance. By

planting in rows it is easier to place the sets at their proper distances, while broadcasting requires to be done by an experienced ryot and, judging by observation, the distances apart are anything but regular. Trenches are not dug between all the rows on the farm but beds are formed with two or more rows to each. No coolie is allowed to walk on these beds, whereas in the irregular trenching in broadcast fields this is not well possible. When it is remembered that field operations continue in the Gódávári delta throughout the life of the canes, right up to the reaping, the advantage of maintaining this surface tilth will be at once recognised.

All the operations of weeding, wrapping planting bamboos and cutting the canes are easier and, in fact, frequently less costly. Where 20 men will wrap a field planted broadcast, only 15 are needed if the canes are in rows. There is, lastly, the greater ease with which fallen canes or lurking jackals are detected, one glance in passing along the ends of the rows showing the whole block. The advantage of row-planting where the canes are ratoned will be mentioned later.

It is needless to say anything more as to the advantage of this mode of planting which, indeed, is almost universally followed in other parts of the country. The only difficulty lies in the act of planting and this is easily overcome. A couple of strings are stretched across the puddled land at the required distance apart, the sets are dropped along these and the strings are moved one over the other as planting proceeds.

The distances of the rows apart, the distances of the sets in the row and the number of rows to a bed have not yet been determined, but there is a tendency on the farm to widen the beds. Experiments are being tried with two, three and even four rows to the bed, it being of advantage to increase the available rooting area for the canes. It has not however been determined how far the water in the channels can be expected to soak laterally.

60. Besides the ordinary planting of joints and tops, experiments have been tried in other methods, two of which appear to have some points of interest, "stool-planting" and "nursery seed-beds."

In stool-planting, the old 'root' of a cane is split to two or three and replanted. The method has been chiefly introduced for the rapid multiplication of valuable kinds, where it seemed a pity to throw away the old roots, but it appears that the method is not uneconomical in some other cases. The old roots must be got out of the ground for the succeeding paddy planting, and they may as well be made use of. It has been found moreover that a perfectly full stand may be obtained by planting them at the rate of 5,000 to the acre. There was little difference in the plots planted at the rate of 10,000, 7,500 and 5,000. One acre's roots will therefore plant up five acres of fresh land. No supplying is needed as all the plants grow readily. Curiously enough, plants thus lifted and divided appear not to suffer so much from disease as ratons. The yield has yet to be worked out, but to all appearance it will be found behind that of plant canes. The plants raised from stools seem to have characters half way between plant canes

and ratoons, maturing earlier than the former but not growing so tall. But these points have still to be decided by further experiments.

61. The use of a seed-bed is a much more important departure. It may be compared with that used for paddy. Where there are water difficulties, especially where irrigation does not extend throughout the whole year, the nursery seed-bed has been found useful. Its applicability to different classes of soil has not been worked out yet, but it is being tried in various parts of the Presidency. The sets are planted quite close, in fact almost touching one another. It has been found convenient to plant them in rows and for two of these rows to form a bed with irrigation channel between. From eight to ten cents of these seedlings will plant up an acre, and the seed-bed may be raised near a pond or be irrigated by a well until the irrigation channels are full. In the Ganjam district this method is, so to speak, duplicated. There the seed-bed is used to plant up an acre or two of canes and these, when half ripe, are cut up for the main planting. It has been found convenient on the farm to transplant the young plants after about six weeks, but this is a matter of convenience. A perfectly even stand is at once obtained, there being no failures. In the lighter lands in the south of the Presidency the lifting of the young plants is easily done with an ordinary fork and the cost is found to be small. Ripening tests have been applied to the nursery-planted canes but the results as yet are not conclusive.

62. Closely connected with the nursery system and stool-planting is the production of an early-maturing cane, a shortening of the time required in the field before harvest. This latter is of course especially intended for places where there is abundant irrigation for only part of the year. The maturing effects of the sparing application of nitrogenous manure in the form of oilcake has been noted already. From ripening tests in Class II Varieties it appears that the canes do differ in the time required for maturing, although there is probably a general tendency in any climate for all the varieties to approximate in this respect. An unconfirmed experiment with Yerra shows that by stripping this cane of its old, dead leaves the maturing has been accelerated by one month. But the latter method cannot be applied where jackals are prevalent and the cane is soft. Lastly, there is the question of the restriction of irrigation. There has been no opportunity of trying this on the farm at present, but it seems probable that it will have an effect on the time required for ripening. From the results obtained thus far in all these directions, there would seem to be no reason, for instance, why in the Kistna Delta, with 200,000 acres of rich land under paddy and sunn hemp (*Orotalaria pumcea*) and a nine months' water-supply, successful sugarcane cultivation may not be introduced.

63. One of the most difficult problems to be solved in the Gódvári delta is that of the customary wrapping of the canes and their support by bamboos. As has been noted, this is an extremely expensive operation, and various modifications have been attempted. The reason for the adoption of this curious custom seems undoubtedly to be the enormous height to which the canes grow and the insecure foothold

they have in the saturated heavy clay. This is of great significance when we recall the cyclonic storms which are experienced in this tract. The wrapping also incidentally protects the canes from the attacks of wild cats and jackals, but it appears probable that this very action, by using up the leaves not yet withered, tends to the formation of new ones and the lengthening of the whole plant. It is probable that the matter must be approached indirectly by deeper and wider planting, restricted watering and the encouragement of tillering, but a number of direct experimental modifications have been introduced on the farm. Wrapping and bamboos have been altogether discarded, a system of "loose-boxes" has been arranged where the bamboos form railings against which the canes can lean, or the canes have been made to lean against one another in rows or cocks and more or less tied together. Thus far no definite result has been obtained. As to the crops obtained in the experiments it is merely worth recording that in one year, when the whole of the canes on the farm were laid low by a sudden squall, the plot with railings was considered a hopeless failure, yet at the harvest it produced the thickest canes and these, although few in number, yielded the greatest amount of jaggery of any on the farm. The matter is extremely complicated and must be the subject of continued observation and experiment. The burden imposed by the present expensive method upon the cultivators is well nigh intolerable and there surely must be some means of reducing this heavy annual outlay.

64. Experiments have been made in mulching the ground when the canes are young, the ground bare and the sun at its full strength. But the results are not at present decisive. The method adopted has been to spread the dead leaves over the ground on the beds and to dig them in when the trenching is done. Certainly hoeing and weeding are done away with by the method and thus the cost of working reduced, but there are difficulties regarding the germination of the canes which have not at present been got over.

65. The time of planting and reaping the canes has received some attention. This is usually done about February in the delta, but the severe check experienced by the young canes when the canals are closed in May has suggested the possibility of planting in June and reaping in May. The plots planted in June have been fairly successful, and it may be noted that the canes then, available have been eagerly bought up at high prices for eating. But the question is complicated by the labour available. The delta cultivation is dominated by wet paddy, and this is the season of greatest activity in the paddy field. It has also to be determined whether the yield of jaggery would be so great if the canes had to pass their last few months without rain. The experience thus far gained seems to indicate that mere irrigation is not enough to keep the canes healthy but that they must be occasionally washed by copious rains.

In the Coimbatore district there are two cane seasons, January-February and July-August. September planting has been tried on the farm. The growth of the canes was quite successful but it is doubtful whether jaggery making can be carried out at this time of year. The operation as carried out requires perfectly dry weather and any rain at once stops all work and sometimes leads to heavy loss.

66. As to ratoons, the experience on the farm, as in all countries where the red smut has made its mark, is that the practice should be discontinued. A fair crop of Bonda was kept growing for three years on the same land, but it was cut out because, being sown broadcast, the irrigation channels became so big and deep. A "permanent" plot was then laid down with the best varieties. But unfortunately the year was a very bad one as regards weather and disease appeared even in the plant canes. It was accordingly decided to abandon the experiment for the present. When the condition of the soil is somewhat improved it may be tried again for there appears to be no reason why canes should not be grown on the same land continuously or in short rotation if proper care is taken to keep the soil in tilth and supply the necessary manures.

A notable improvement was introduced in the cultivation of ratoons by having two rows planted in each bed and remaking the beds each year. At the end of the first year the trash was thrown in the trenches; fresh trenches were made down the middle of the beds and the earth from these was thrown on the trash in the last year's trenches. By continuing this operation year by year it was intended to give the roots a thorough stirring each season besides new, well aerated soil to grow in. The experiment is a particularly attractive one and is capable of various modifications. For instance, by having three rows to the bed and digging fresh trenches each year the old trenches would be used only every three years.

67. Now that the station land has been purchased and other crops have been introduced besides wet paddy, a series of short rotations has been inaugurated on the dry area. Acre blocks have been set apart for two-three and four-year rotations. The other crops are at present red gram (*Cajanus indicus*) plus dry paddy sown together, chillies, turmeric and cotton. The first of these has especially approved itself in the past three years, the ground at the end having a surprisingly thick mulch of dried leaves upon it while the crops obtained have been quite as profitable as with wet paddy. Turmeric on the other hand has proved most remunerative and the digging of the roots is an excellent preparation of the soil. Chillies will also yield heavy crops but as yet the seasons have been against them. Cotton has not yet been tried but is being sown this year. It was intended to place these three blocks in line with the permanent sugarcane block which would be a sort of one year rotation, but this plan has had to be given up for the present.

68. A determined attempt has been made to grow seedling canes. The resources of the farm did not suggest carrying out the ambitious projects of the West Indies or Java, but it was desired to determine whether seedling canes could be raised in India. Some 75 boxes of arrows have been laid down altogether and this last year a parallel series of trials were made by the Curator of the Nilgiri Gardens under glass. But the total results were only two seedlings raised from the White Mauritius cane on the farm and these died in early infancy. Although many of the canes are accustomed to arrow freely, the hot, dry air of Indian plains appears to take away any likelihood of the successful prosecution of this line of work. For anything of value to be attained, it is necessary that a vast number of seedlings should be raised every year.

As has been mentioned, a series of ripening tests has been started. For these it is sufficient that the sucrose and glucose should be determined at fortnightly intervals. The results have been extremely interesting, but, with the exception of the Manurials (already referred to, it is not proposed at present to publish any results. The observations were chiefly made on the Manurials, Varieties of Class I, and plots devoted to stool-planting, nursery seed-bed, June and September planting, and will be continued year by year.

69. Although really outside the limited scope of the farm's work, some time has been devoted to experiments in jaggery making. The general results are as follows. By appropriate treatment, cleanliness, quick treatment after crushing, rapid boiling and sufficient liming, a good hard jaggery is easily obtainable in the local pans. The ryot is well aware of the effect of adding lime and, in fact, is accustomed to alter the quantity according as the product is intended for export or for local market. The harder jaggery made on the farm was of considerably better quality in almost all the varieties than the local underlined stuff (some 6-8° p. c. in the 80 cakes sampled), but it was found to be unsaleable in the local market while the price received for export was unremunerative. The subject was left at that point. As long as the local demand takes up all the jaggery made, it is useless to try and introduce improvements on the lines mentioned. A careful weekly list has been maintained for the past two years as to the price in the local market and an experiment has been introduced of keeping the jaggery for a rise in price. The peculiar native custom of smoking the jaggery thus kept is being tried in a special jaggery house.

70. The questions as to the origin of the prevailing disease and the best mode of combating it have been kept prominently before the farm staff. Many specimens were examined under the microscope but, once the actual naming of the fungus causing the disease was confirmed, no further purely scientific work has been attempted. The disease is a well-known one both in the West Indies and in Java and the farm is not equipped in any way for its further examination. A careful record has been kept of those parts of the farm where the disease has shown itself and each year it has been attempted to trace its course of development. The general conclusion from a study of these "disease maps" is that the fungus is present practically in all parts of the farm and in all of its canes. Although some varieties are much less liable to its inroads than others, it makes its appearance in any of them when the ground is at all waterlogged, either by insufficient aeration by the collection of water from higher parts or by mere seepage from adjoining channels. The matter is however difficult and the observations will be continued.

Other pests of various kinds have been noticed and carefully collected wherever seen, but as none of them appears to be of prime importance they need not be mentioned here.

71. An interesting experiment was introduced in the third year when a "diseased plot" was laid down. This was carefully segregated and had its own irrigation and drainage channels. It was purposely and copiously treated with diseased matter and planted with rows of diseased sets. The plan of operations is quite easy to understand. Into this diseased area were introduced canes whose immunity it was

desired to test. It was also attempted to raise in it immune strains of the diseased varieties. Whenever in any badly diseased place some bunches were seen to stand out among the rest with the appearance of general healthiness, these were marked and sown in rows between the diseased ones. It was assumed that some of these healthier plants might be ones less liable to the disease. It was intended to select again from among their offspring the most healthy canes and replant these in the same plot. In a few years it was suggested as possible that immune strains could be thus raised. The results after two years, have proved quite conclusive regarding the plants selected, in that no more healthy sets are available to continue the experiment. The whole have gone out, including the sets of the "immune" varieties tested. From this it would appear that the parasite is more adaptable in its parasitism than the cane is in its resistance. The experiment is held in abeyance for the present and the land put under red gram (*Cajanus indicus*) and dry paddy. From this experiment it seems probable that any cane placed under a disadvantage may be destroyed by the fungus and that there is little hope of raising immune varieties after this plan.

72. Another fact tending in the same direction is worth drawing attention to. When the farm was started, a full set of the local canes was got together. There was no opportunity of exercising any selection, because of the lateness of receiving orders. These canes proved many of them to be heavily diseased. Each year the greatest care (short of microscopic examination) was taken to reject all which showed a suspicion of the disease. This has now been done for four years, with the result that during this last trying season every one of the local canes with the exception of the Bonta and Yerra varieties, has been swept out of the farm. In none of them could a sufficiency of healthy sets be got to make up a row in the Class II Varietal plots. The mere selection of sound sets as it is possible for the cultivator to do it will not therefore eradicate the disease. The line of work on the farm is thus temporarily narrowed to the collection of hardy canes from various parts of the world and introducing them into the local cultivation. By the constant infusion of new blood the industry may be saved, and the results obtained in this direction thus far have been very satisfactory. But it would appear to be of advantage to the district if all the old canes disappear as soon as possible, as otherwise they will assuredly pass the disease on sooner or later to the new arrivals. And the question again comes up as to whether the farm, while perfectly adapted to testing the new kinds, is a suitable distributing centre for the delta. Considering the history of the local kinds, and the sudden increase of disease during this past trying year, it would appear desirable that some place near, but in the upland, should be sought out for this purpose.

73. In concluding this report it may be well to refer briefly to certain facts regarding the sugarcane industry in Java, which have recently come to our knowledge. There appear to be many points of similarity between the conditions prevailing in Java and the Gôdâvari delta. In Java the sugarcane alternates with wet paddy, there being usually two years of paddy to one of sugarcane. The land does not belong to the factory, but is rented each year for sugarcane growing from the ryots. The greatest difficulty is therefore experienced in

aerating the soil after reaping the paddy and, unless this is done carefully for six weeks at least before planting, a good cane crop cannot be expected. It has, furthermore, been found impossible to raise healthy sets continuously on this land so frequently under wet paddy, and special nurseries have been instituted in the uplands at great cost for the supply of seed-cane. The canes are planted in the middle of the driest part of the year and frequently undergo considerable trials in the first few months because of drought. The ordinary chemical manures with potash and phosphoric acid have been discarded in favour of nitrogenous manures in the form of oil cake. Ammonium sulphate alone of the artificial chemical manures is used, and that more as a stimulating than a feeding manure.

The result obtained after many years' fight with the disease practically amounts to the necessity of constantly introducing new varieties which are hardier than the local kinds. It has been found that this must be done for each locality separately, the new cane found valuable in one tract proving useless elsewhere. Efforts appear to have been made to evolve immune varieties by a method similar to that adopted in the disease plot at Samalkota. This consisted in picking out a few healthy plants from among canes heavily diseased. But the result was the same as that obtained at Samalkota, and it is now considered that this mode of selection leads to no useful result.

These facts in many respects throw additional light upon the difficulties experienced at Samalkota, and it is satisfactory to note that, in the main, the Samalkota results are in accordance with those obtained from the much more careful and long-continued experiments and observations in Java.

APPENDIX I.

Analysis of Gôdâvari soils by Dr. Leather.

Laboratory number.	Taluk.	Serial number.	Description.	Total lime, CaO.	Carbonic acid.	Equivalent of Carbonic acid as		Phosphoric acid.		Nitrogen (Total).
						CaO.	Ca CO ₃ .	Total.	Available.	
347 1900 348 1900 350 1900 352 1900 361 1900 362 1900 369 1900 363 1900	Râmachandrapuram.	1	Surface } Regur loam from Biccayel village.	1.47	.42	.53	.95	.035	.016	.068
		2	Subsoil }	.23	...	...	...	.015	.003	.018
		3	Regur clay from Kulapalli village.	.98	.050	.078	.008	.053	.003	.053
		4	Regur clay from Tossipudi village.	1.53	.236	.300	.536	.131	.014	.058
		5	Regur clay from Tapeswaram village.	1.32	.671	.090	.161	.052	.010	.165
		6	Regur loam from Mandapeta village.	.597	.032	.040	.072	.056	.031	.041
		7	Regur clay from Mandapeta village.	1.31	.104	.132	.236	.067	.011	.031
		8	Subsoil stratum from Mandapeta village.	1.45	.200	.254	.454	.058	.015	.027

Table of Analyses of the more important Canees at Santa Fé de Bogotá.

Name of cane.	Year of analysis.	Cane.			Juice extracted.					Megass.	
		Percentage of sucrose.	Percentage extracted in crushing (to 100 parts of cane).	Brix.	Percentage of sucrose.	Coefficient of purity.	Percentage of Brix.	Glucose ratio.	Pounds of sucrose per gallon juice.	Percentage obtained in crushing (to 100 parts of cane).	Percentage of sucrose in megass.
Bonta	1903	14.75	62.60	19.47	17.56	90.19	0.75	4.27	1.89	...	10.05
...	1901	14.36	61.79	18.95	17.48	92.24	0.46	2.63	1.87	38.21	9.33
...	1905	14.46	60.67	19.03	17.49	91.90	0.53	3.03	1.83	39.33	9.81
...	1906	15.35	68.38	19.59	17.64	90.04	0.93	5.27	1.80	21.62	10.40
Red Mauritius	1903	13.47	63.90	17.86	15.22	85.21	1.03	12.68	1.63	...	10.39
...	1901	13.01	62.30	17.76	15.29	86.09	1.77	11.57	1.63	...	9.26
Red Mauritius retanned	1903	15.05	61.91	20.77	19.08	91.80	0.75	3.93	2.06	...	8.53
...	1904	12.85	62.24	17.91	15.62	87.21	1.73	11.07	1.67	37.76	8.99
...	1905	13.13	62.46	18.39	16.76	88.12	1.15	7.19	1.66	37.54	8.71
Red Mauritius	1906	10.20	64.28	16.95	13.30	78.47	2.88	20.15	1.12	25.72	4.67
...	1903	13.07	69.26	16.29	13.37	82.07	1.73	12.93	1.11	...	12.43
Secoma (varipe probably)	1904	14.40	62.19	19.28	17.97	93.20	0.59	3.28	1.03	37.81	8.55
...	1905	10.23	63.26	20.55	16.88	87.31	0.50	2.65	2.19	38.74	10.91
...	1906	14.61	65.81	19.84	17.62	86.91	1.13	6.41	1.90	34.14	8.54
...	1903	15.55	68.22	20.73	19.03	91.79	...	...	2.03	...	...
...	1904	15.55	68.22	19.99	17.73	92.39	0.50	2.82	1.91	31.78	10.88
...	1904	15.35	63.15	20.05	18.42	91.87	0.43	2.33	1.98	36.53	10.10
Striped Mauritius	1904	15.09	62.40	19.81	16.10	91.37	0.52	3.26	1.95	37.60	10.10
...	1905	15.02	62.77	20.44	19.33	94.57	0.30	1.55	2.02	37.23	10.17
...	1906	16.26	62.47	21.31	19.94	93.57	0.67	3.60	2.17	37.53	13.02

White Mauritius	1905	11.02	61.79	17.21	15.77	87.11	1.39	9.48	1.67	...	6.77
...	1904	12.96	61.88	17.93	15.60	86.20	1.62	19.11	1.66	35.12	9.33
...	1905	13.03	62.73	17.61	17.34	85.43	1.09	6.32	1.86	30.23	8.57
...	1906	13.03	62.24	17.91	15.27	85.71	2.08	13.62	1.61	33.72	8.92
...	1903	12.91	60.54	17.26	14.74	79.84	1.99	13.81	1.51	...	8.95
...	1904	9.02	62.70	16.71	11.32	67.34	3.46	13.35	1.20	41.30	6.22
...	1905	8.83	55.40	16.79	10.34	77.62	1.69	15.44	1.20	44.79	6.66
...	1906	9.24	61.56	16.37	11.37	79.49	2.28	20.05	1.21	38.02	5.80
...	1903	13.12	62.37	17.22	14.07	84.47	0.72	1.12	2.13	37.44	10.22
...	1904	13.14	62.56	17.07	14.07	94.89	0.59	1.56	2.13	40.41	13.43
...	1905	15.02	63.83	18.61	17.61	90.86	0.91	0.03	1.93	34.02	12.23
...	1906	15.03	62.95	17.76	13.34	86.03	1.30	3.74	1.43	33.11	7.71
...	1903	15.12	62.05	18.63	13.34	81.90	1.70	12.47	1.15	34.02	8.66
...	1904	15.03	61.00	18.63	10.17	74.90	1.95	13.65	1.08	24.00	5.74
...	1905	15.02	62.76	17.13	10.12	74.46	0.30	1.16	2.20	39.97	10.01
...	1906	15.10	62.62	20.13	16.34	83.05	0.87	3.53	2.04	34.19	10.33
...	1903	16.03	65.62	19.75	10.83	85.20	...	...	1.75	...	...
...	1904	16.04	62.51	20.99	18.60	93.07	0.42	2.22	2.04	30.45	11.55
...	1905	16.10	61.06	17.54	15.18	91.01	0.36	1.08	1.96	35.11	10.10
...	1906	16.08	62.77	19.01	19.33	90.74	0.51	1.33	2.11	36.27	12.51
...	1903	15.02	62.47	20.12	13.51	80.45	0.59	3.22	1.93	35.73	15.27

Note.—The lower results obtained in 1906 were probably due to the bad season.

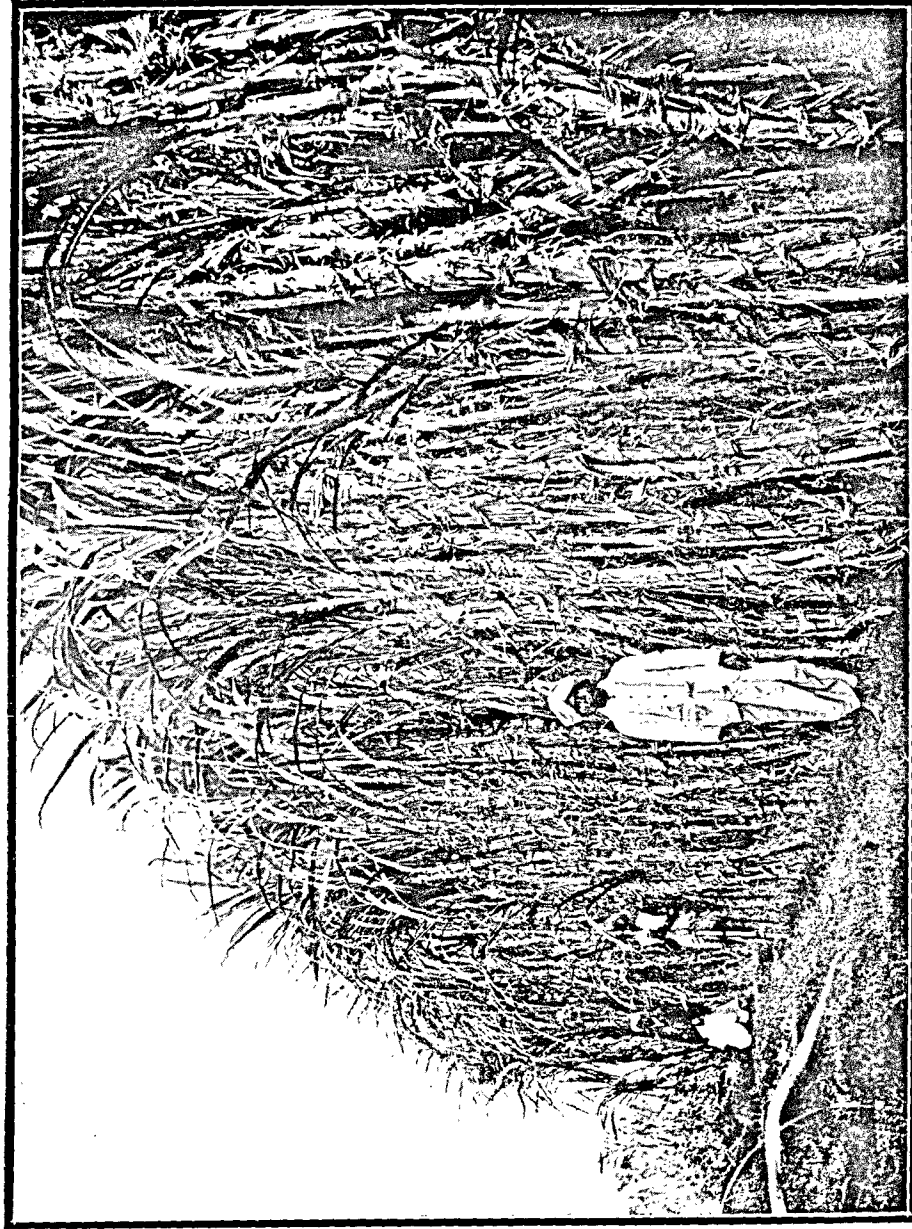


Photo. Etching.

FULL STAND OF RED MAURITIUS CANES (10 MONTHS.)

Roonker College.

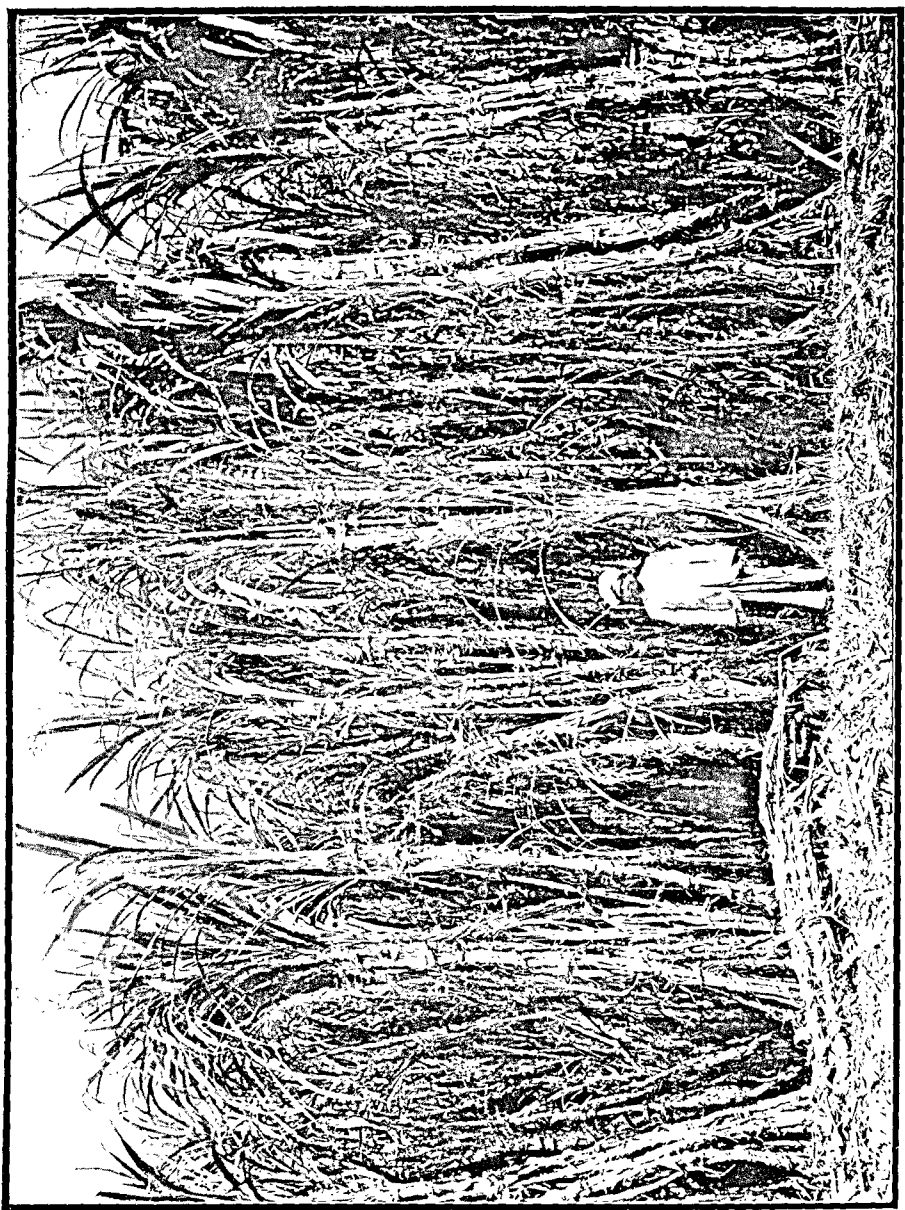


Photo. Ex. 111.

A TALL FIELD : 7 TONS OF JAGGERY TO THE ACRE (12 MONTHS.)

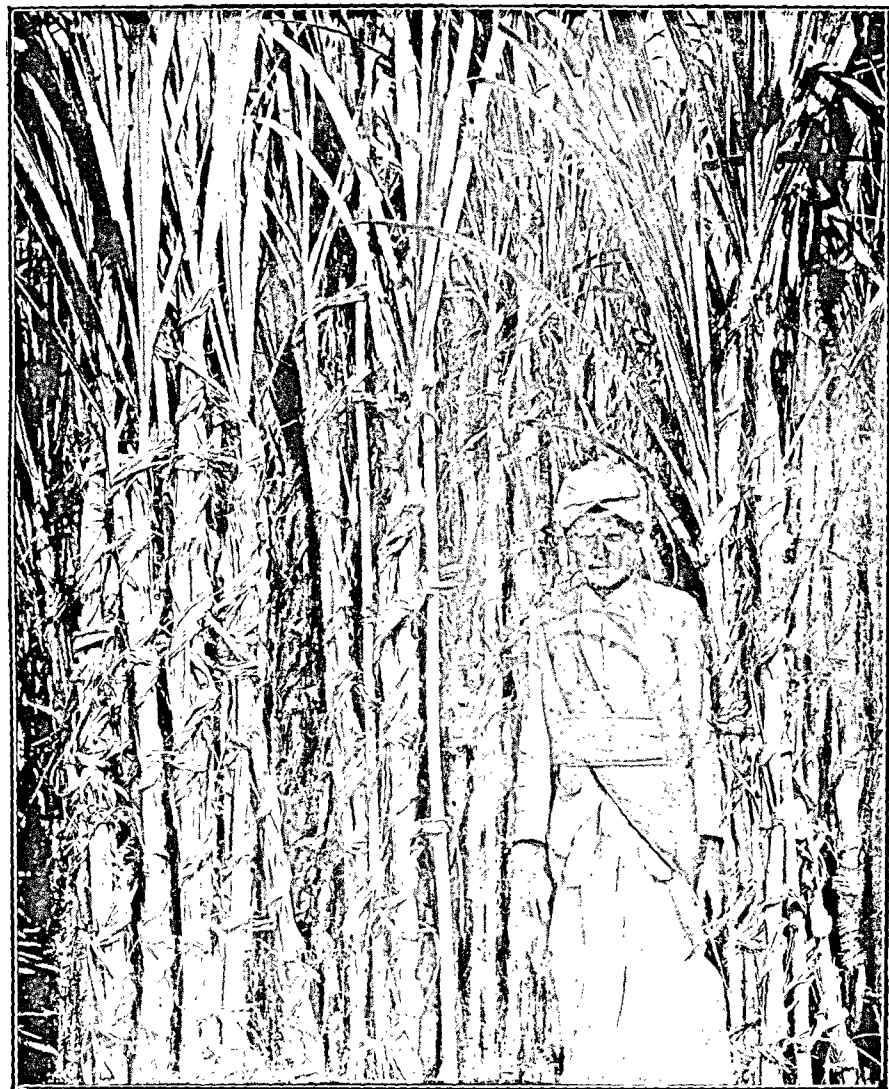


Photo Etching.

Roorkee College.

WRAPPED CANES.



Photo, Fiching.

Roorkee College, re.

WRAPPED CANES.



Photo, Etching.

STRIPPED CANES.

Roorkee College.

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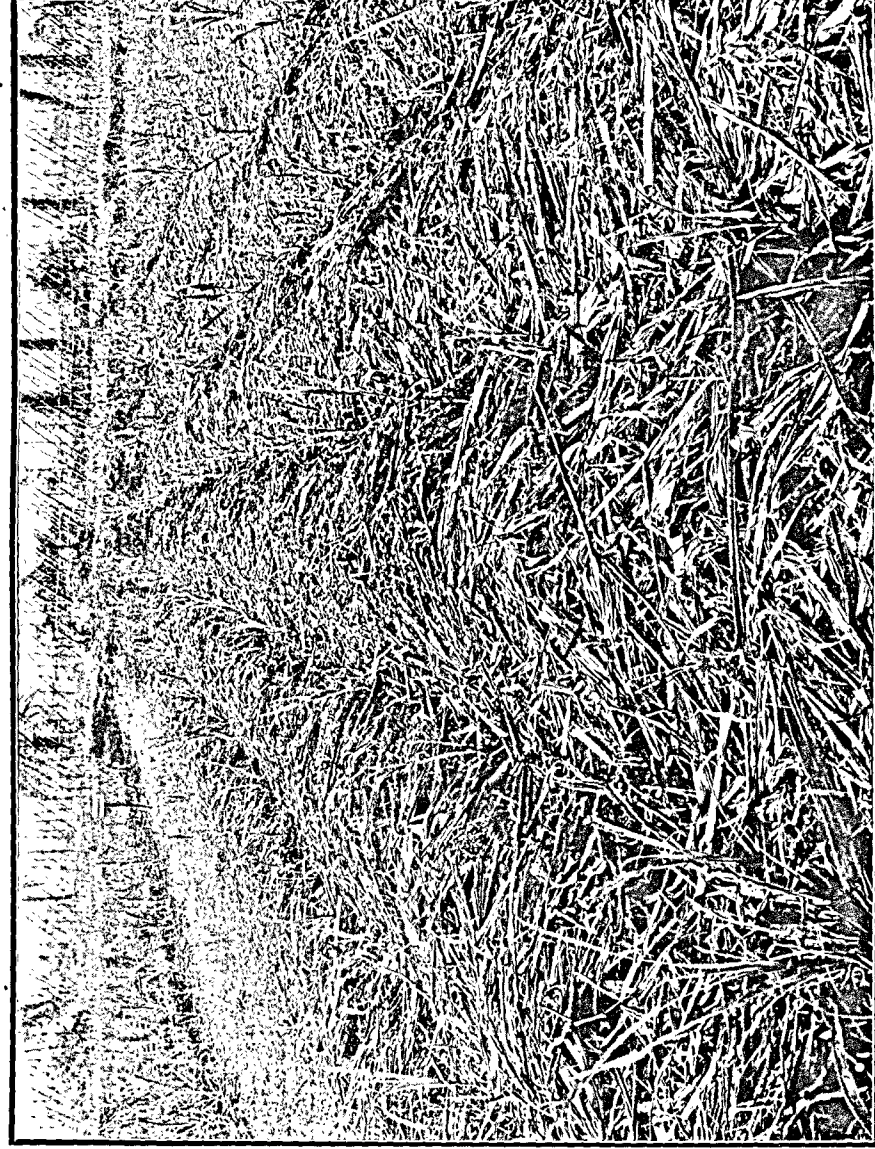


Photo. Etching.

SURFACE MULCH OF TRASH.

Roorkee College.

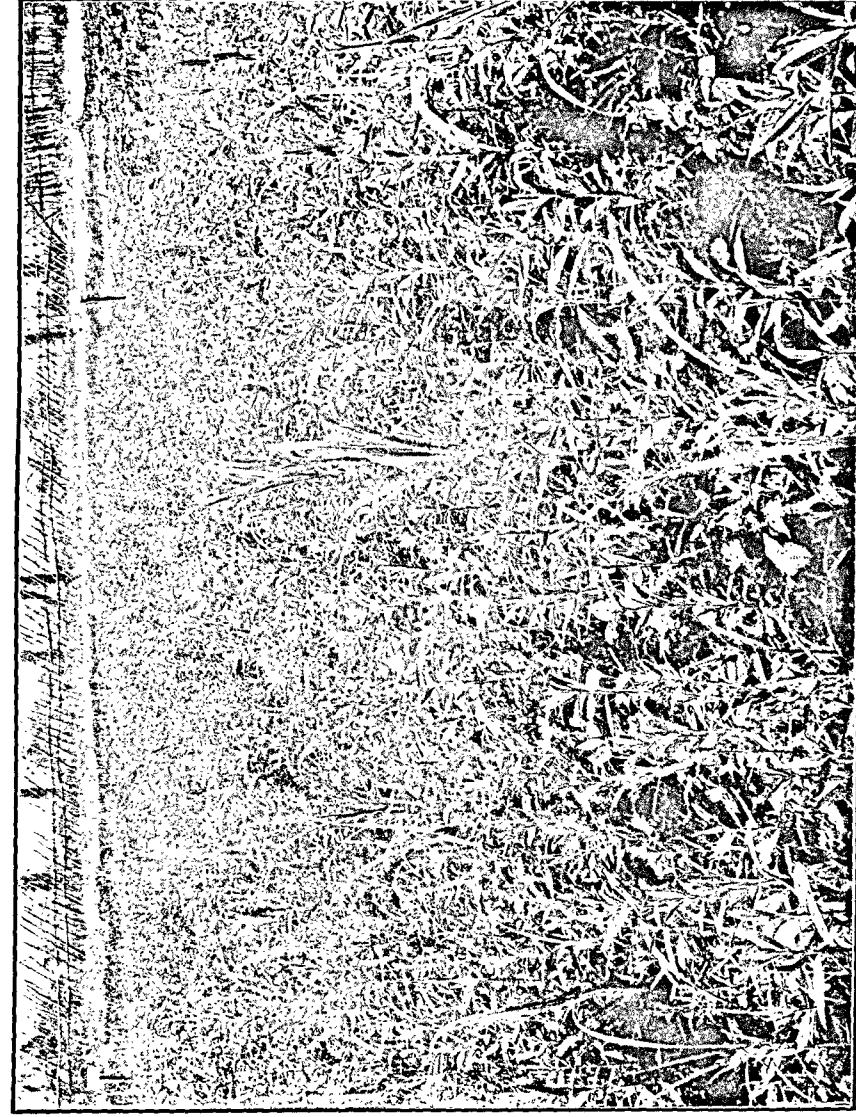


Photo. Etching.

GREEN DRESSING WITH SANN-HEMP AND COW-PEAS.

Rourke College.

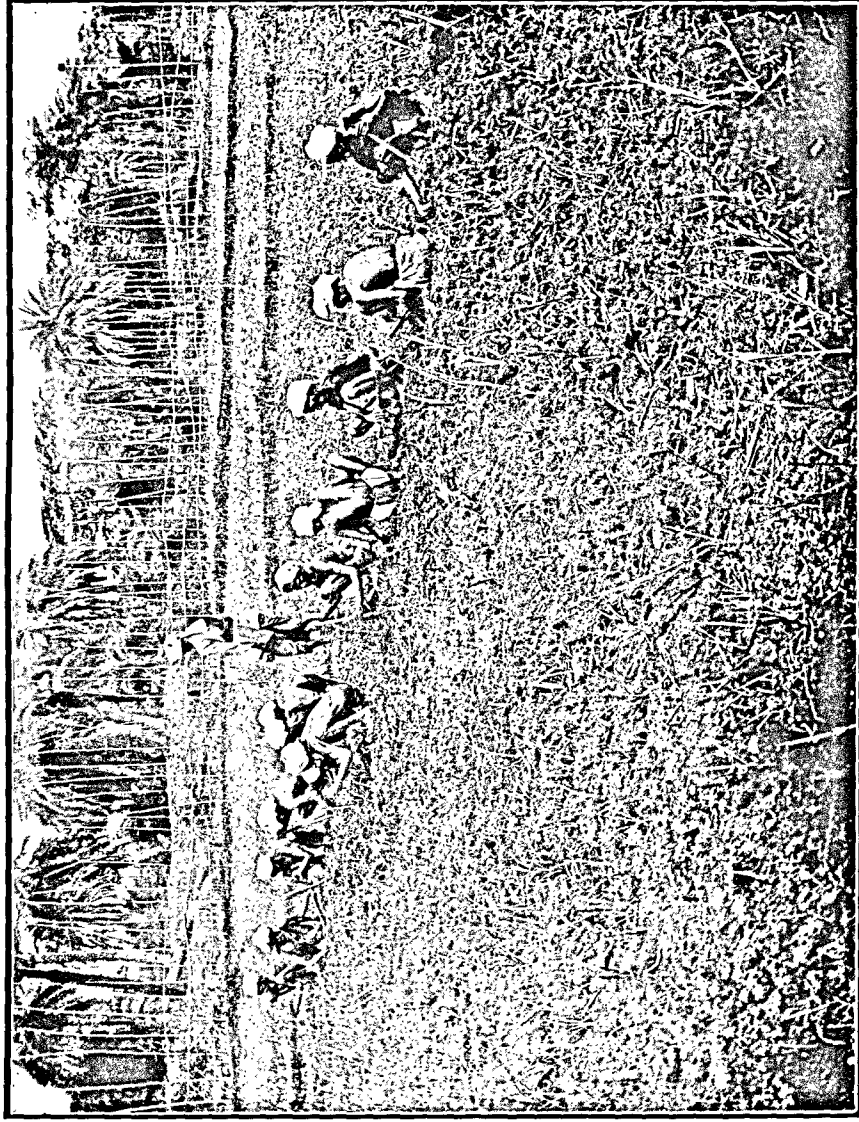
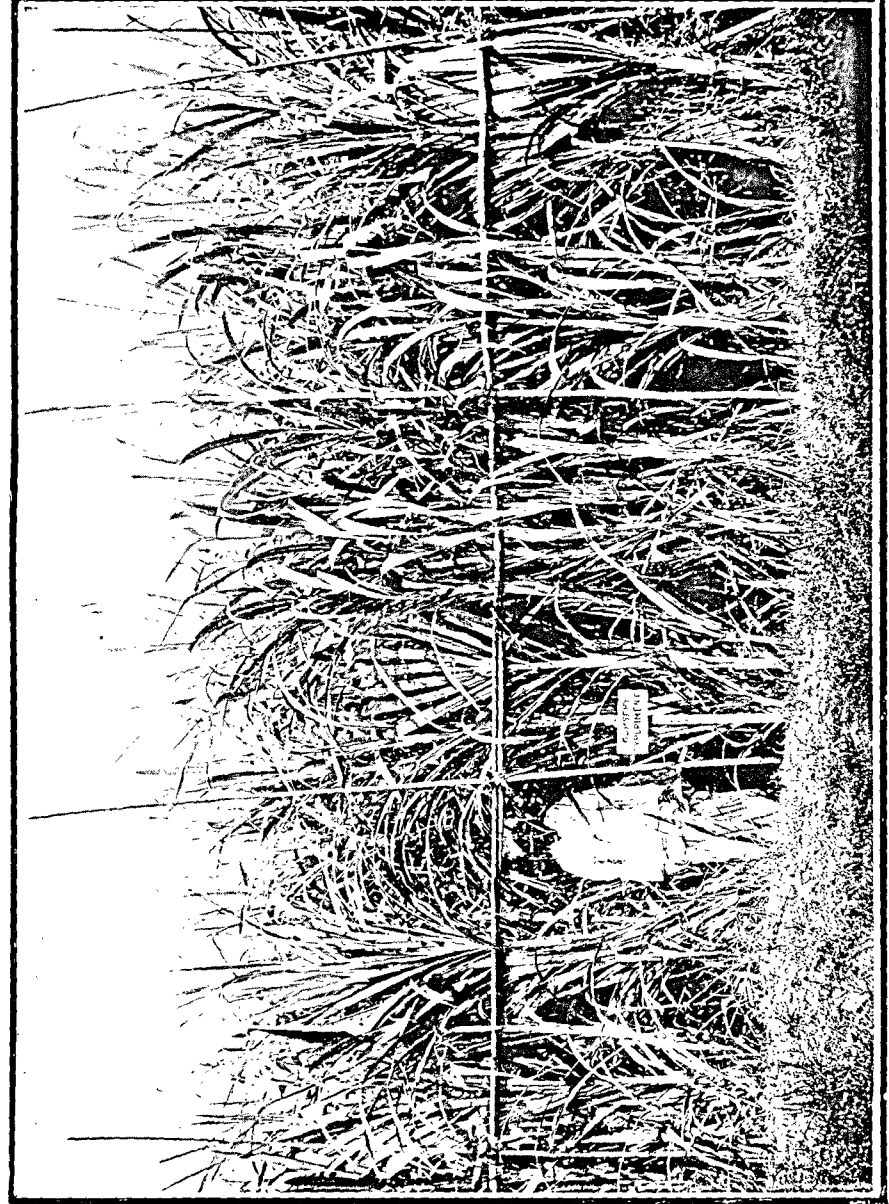


Photo. Etching.

TOLIKA-HOEING IN YOUNG CANES.

Roorkee College.



Photo, H. L. Jung,

NO WRAPPING — BAMBOOS AS RAILINGS.

Koonkee College.



Photo. Eiching.

THE EFFECT OF CYCLONE.

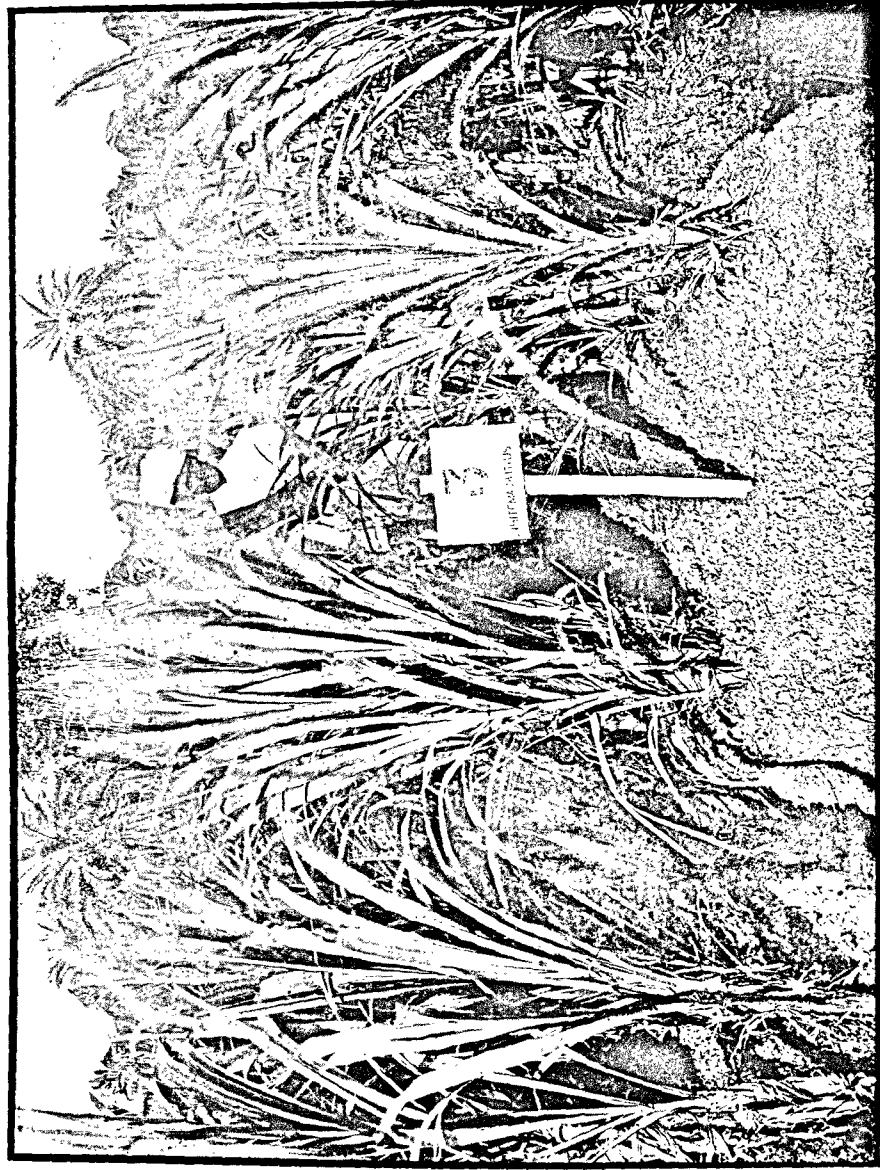
Roorkee College.



Photo. Exchange.

DIGGING FRESH TRENCHES IN RATOONS.

Roorkee College.



Photo, Echling,

RATONS. FRESH BEDS COMPLETED.

Keweenaw College.

31

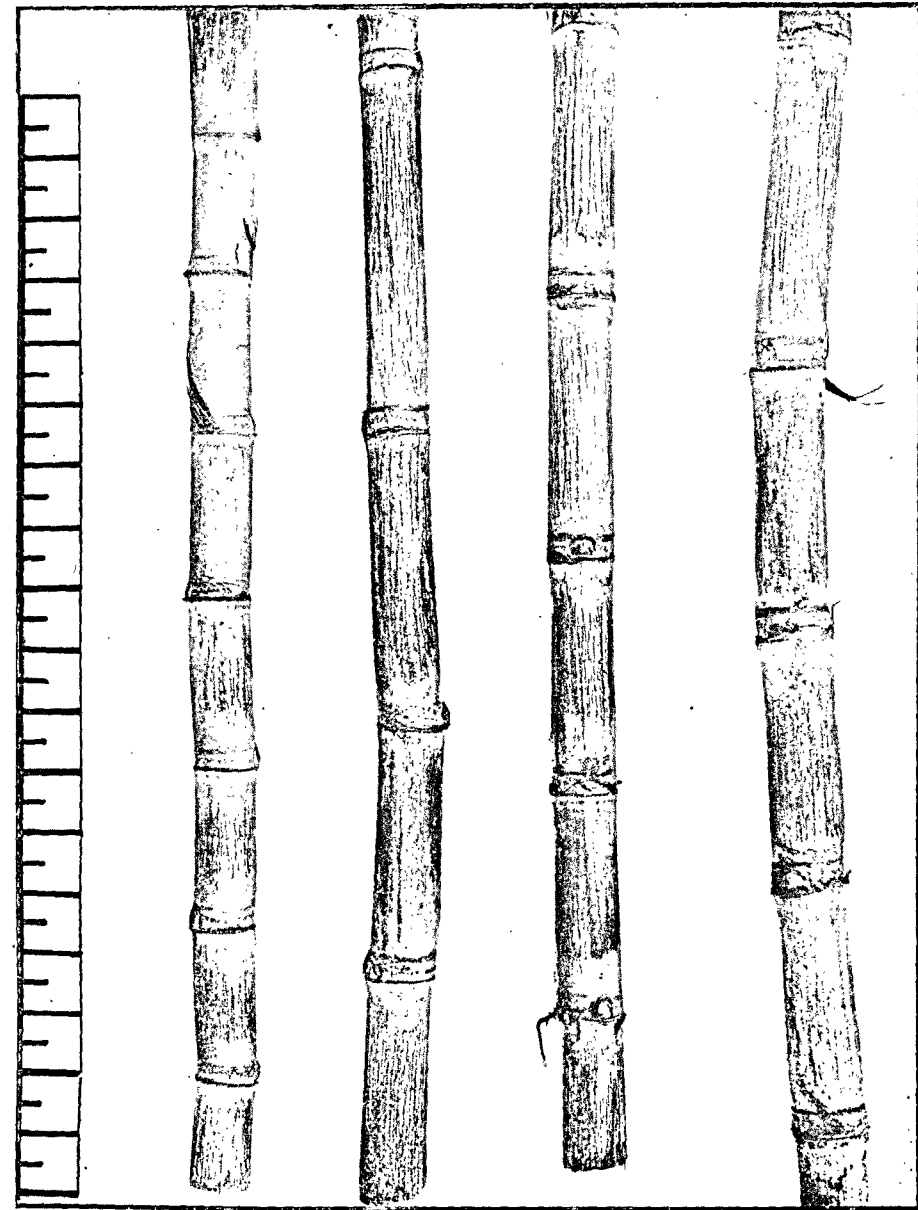


Photo. E. C. Long.

Roorkee College.

CANES PHOTOGRAPHED TO SCALE.

32

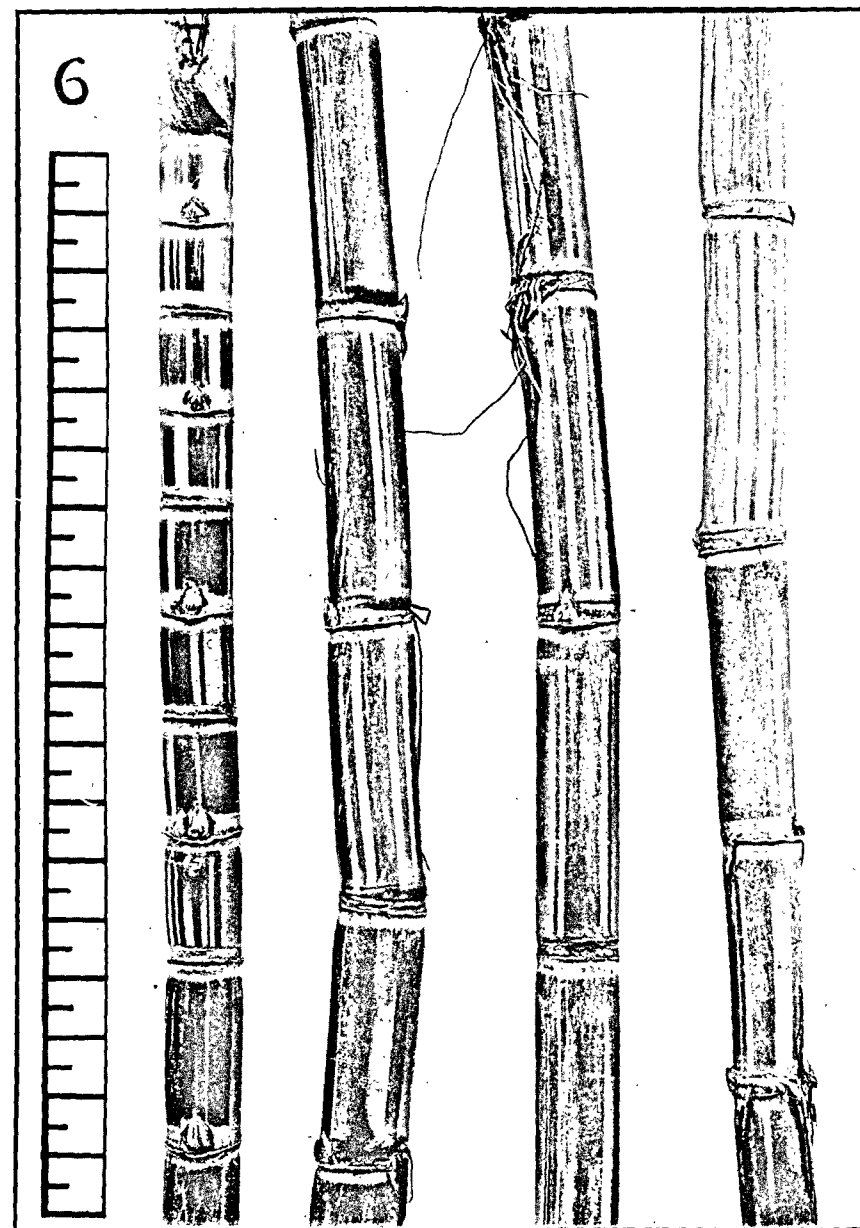


Photo. Eichung,

Roorkee College.

CANES PHOTOGRAPHED TO SCALE.

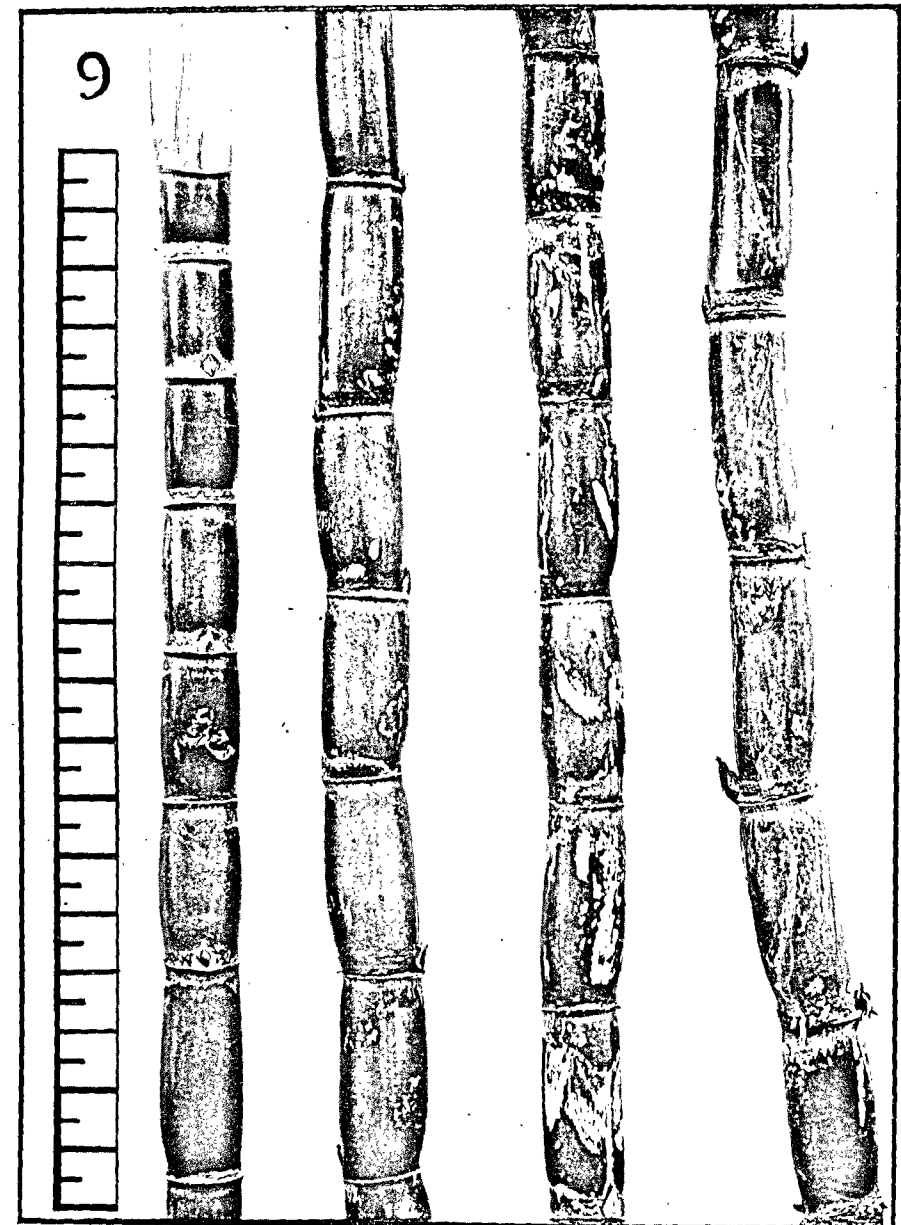


Photo. Etching,

Roorkee College.

CANES PHOTOGRAPHED TO SCALE.

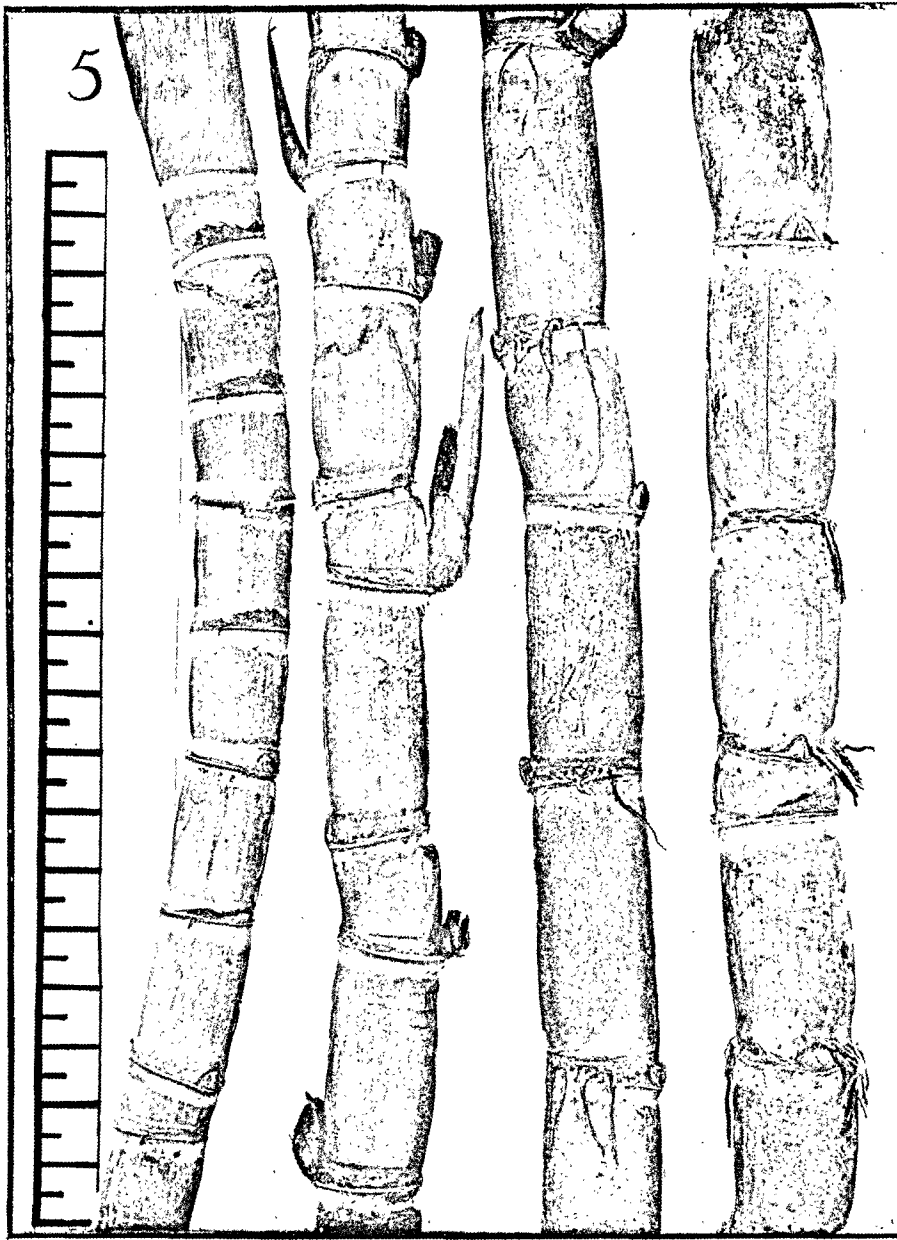
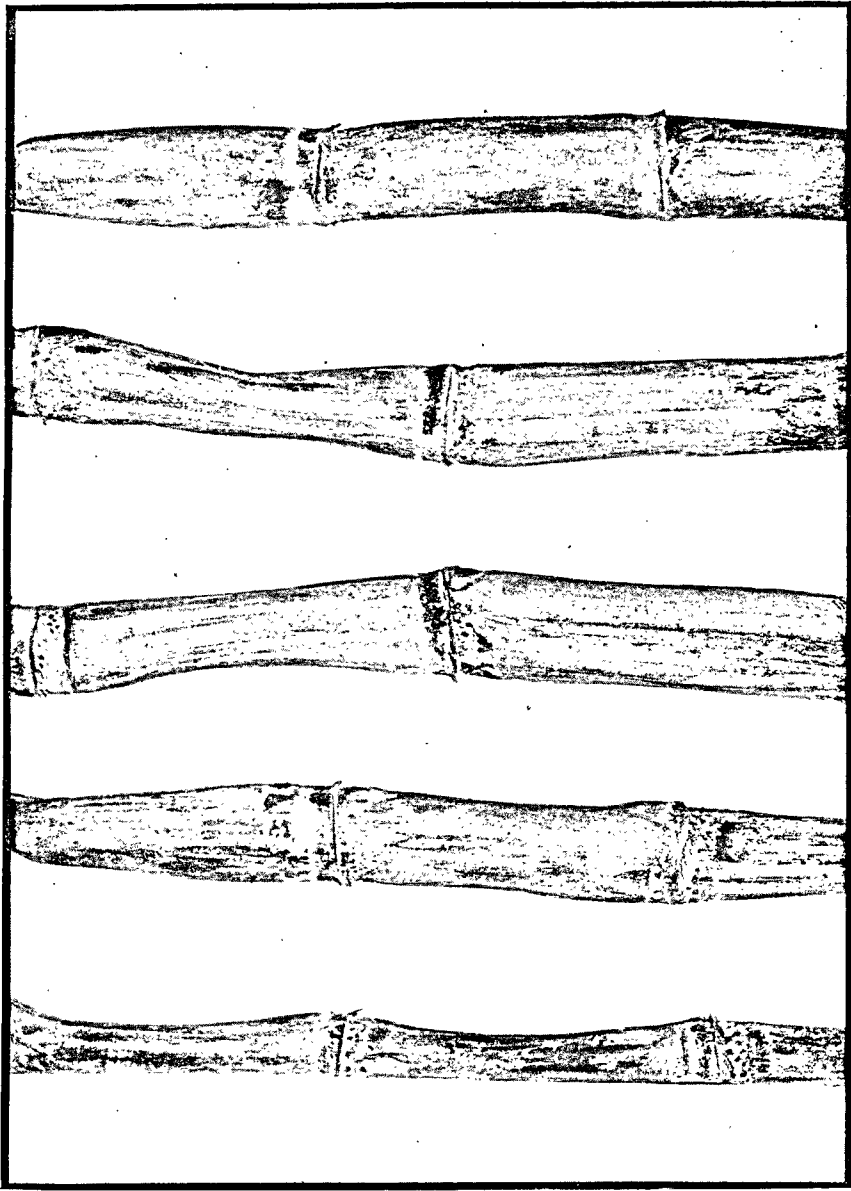


Photo. Titching,

Roorkee College.

CANES PHOTOGRAPHED TO SCALE.

35



Ph. C. Fickling,

RED SMUT—BLACK EMPIONS ON DRY CANES.

Roukee College,

mk

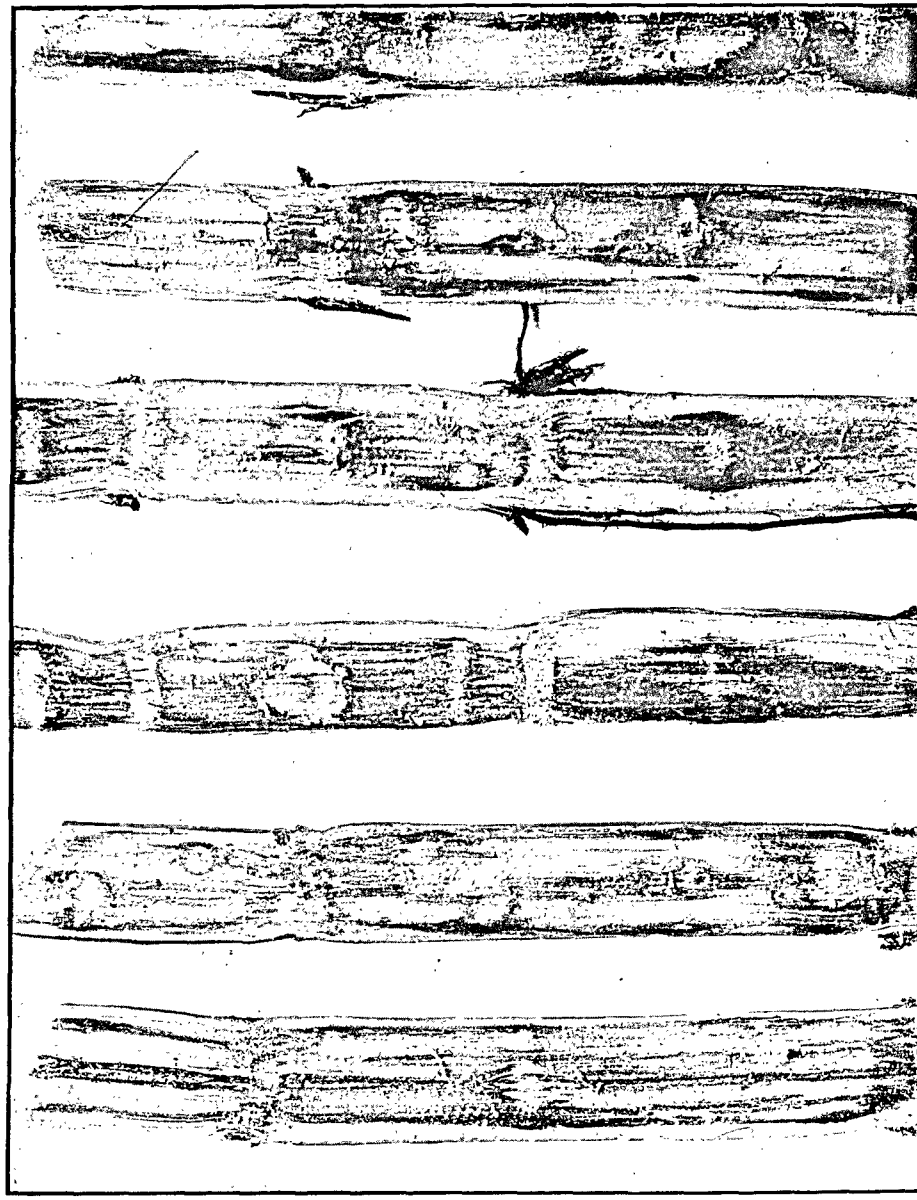


Photo. Fiching.

RED SMUT. CANES CUT OPEN.

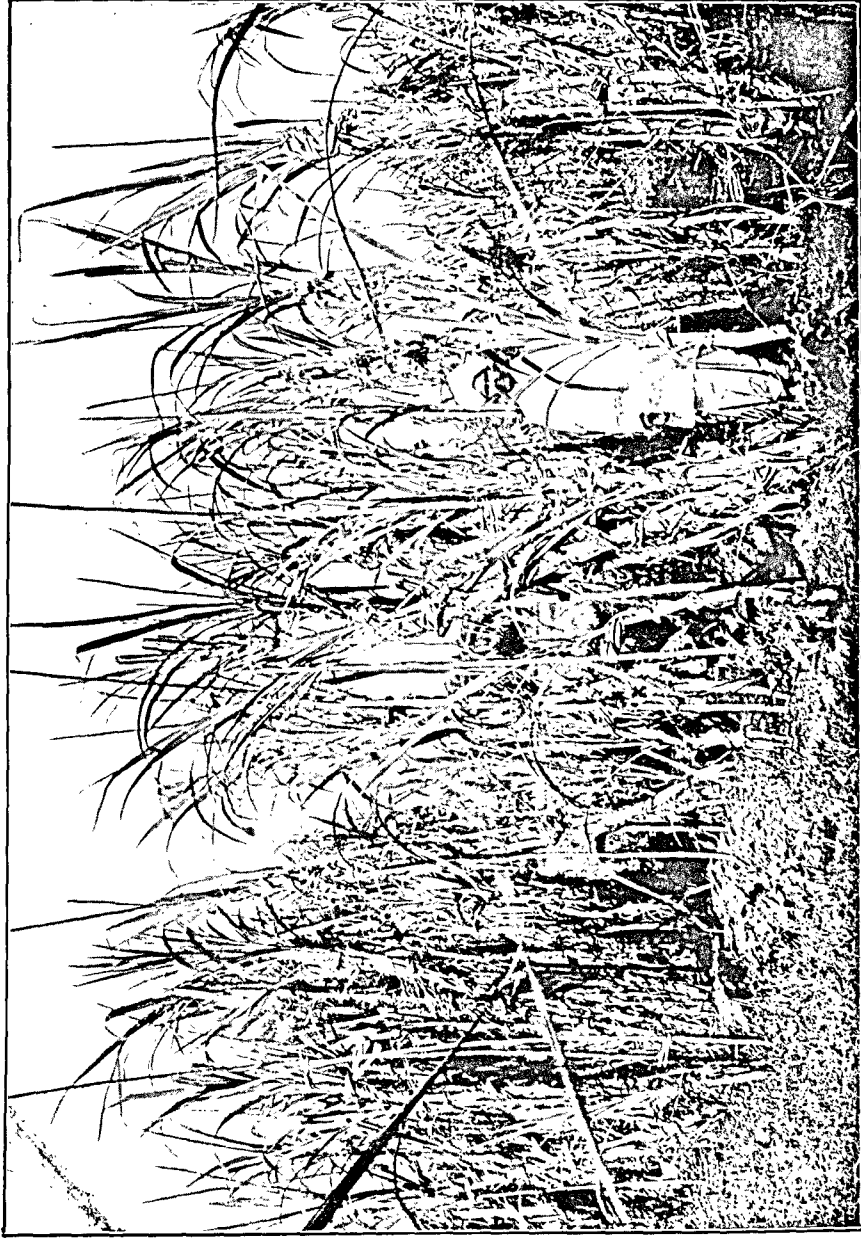
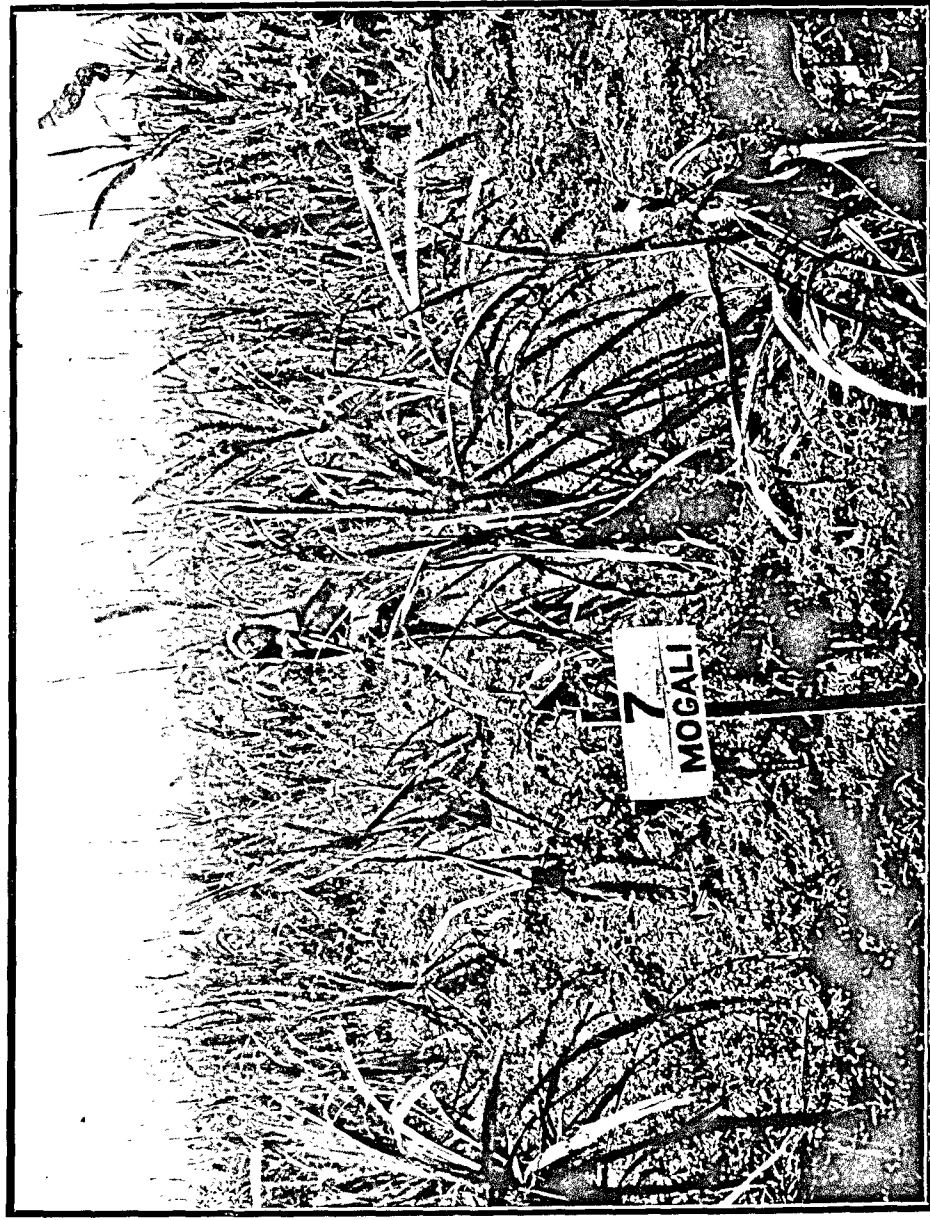


Photo E. J. Jang.

THE EFFECT OF THE DISEASE.

Roorkee College.



Photo, Echling.

DISEASED PLOT. END OF SECOND YEAR.

Roorkee College.