

condition. I should therefore prefer to look at this venture as a rural industry worked by small groups in co-operation. We are now advocating power crushing and boiling of juice into jaggery on a moderate scale to be worked by co-operative concerns and we say that the produce of 150 to 200 acres could be profitably dealt with, although it is regrettable to note that a concern like this started and working for some time very near Coimbatore closed the business for reasons best known to themselves. My suggestion here would be the addition of a device to the power plant mentioned above—a sort of vacuum pan in which the juice can be boiled down at low pressure and temperature? My object in making this suggestion is to find out a simple method by which the evaporation and concentration of the juice may be done in a closed receptacle under regulated temperature and reduced pressure. I am not a technician and I leave it to the Research Engineer to take it up, if he thinks it worth his while. I am sure that with the modern rapid advance with mechanical devices and in simplification of the same, it should be possible to design and instal a plant for milling and boiling on a moderate scale of investment of a few thousands of rupees to enable villagers to take up. We have small scale rice-hullers, decorticators and ginneries. A sugar milling and sugar boiling plant combined in a small rural factory cannot be an impossibility.

19. If this is done, as I hope it will be, in course of time, the problem of the sugar industry in this country will be to a great extent solved, for after all even with the wildest stretch of imagination you cannot expect for a long time to come more than 25 per cent of the population to consume crystallised sugar; the remaining 75 per cent is satisfied with jaggery. The demand from this 25 per cent of the population may therefore be successfully met from the existing area of sugarcane. From the increased production by the introduction of better strains, improved methods of cultivation, and of boiling should certainly leave enough surplus produce to be made into sugar in the rural refineries.

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## SUGARCANE BREEDING—ITS CHIEF CHARACTERISTICS \*

By RAO BAHADUR T. S. VENKATARAMAN

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### I. Introduction

I am grateful to the Working Committee of your Union for the opportunity they have given me to speak to you on the subject of Sugarcane Breeding. The success of the Breeding work attempted at my Station is directly dependent upon the amount of sympathetic interest that the Station is able to evoke from the Agriculturists assembled here and the guidance which the Station is able to get from them as to the kind of cane that is needed in each locality. I feel confident that both my colleague—Mr. Nand Lall Dutt, M. Sc., who is in immediate charge of the breeding of thick canes—and myself will have from this symposium many valuable suggestions that would materially influence our cane breeding programme with particular reference to at least Madras conditions.

As the time at my disposal is rather short—and I would add 'rightly so', as in such meetings the discussions that follow each talk are more valuable than the talks themselves—I shall confine myself to placing before you the

\* Paper read at the M.A.S.U. Conference, July 1930.

salient features connected with cane breeding and incidentally refer to certain factors which appear to have contributed to the quick and satisfactory results that have resulted from it.

## II. Variation in seed-grown sugarcanes

Perhaps the very first feature that would strike the novice to sugarcane breeding is the wide variation among a population of seed grown canes, even when the seed is obtained from 'selfed' flowers. The suggested explanation for this phenomenon is—to put it in the language of the Breeder—the heterozygous nature or the genetic impurity of the parent canes. It is believed that the extant canes must have originated in the remote past from true seed, such seed having resulted from a natural but complicated hybridization in the wild state. In the ordinary vegetative method of propagation (from cuttings) this heterozygous nature does not get a chance to show itself but does so when the sugarcane is reproduced from true seed. Thus visualized, certain of the sugarcane varieties which have been in cultivation over extensive tracts in Northern India and elsewhere may be said to have had practically the same genetic composition all these years and in every one of the millions of plants of each variety.

## III. Emasculation inapplicable to cane breeding

The second peculiarity associated with cane breeding is the impracticability of carrying out, with anything like satisfactory results, emasculation of the flowers prior to cross-pollination. The flowers in the sugarcane are so minute—and in certain instances this minuteness is associated with such an extreme delicacy of the floral structure—that the current methods of the Breeder are inapplicable to the cane. As a result of this handicap, the cane-breeder's choice in the matter of parents is limited, as he has perforce to select as mothers only such varieties as have no fertile pollen of their own. The usual method has been to isolate such varieties and shower on their stigmas pollen of the male parent with which it is desired to cross. When such a pollination is done, it results, however, in quite a large number of crossed seeds from two or three such operations, as the cane inflorescence contains sometimes as many as 40,000 flowers, every one of which can develop a seed.

## IV. Newly bred improved canes easy to propagate in cultivation

A third characteristic of sugarcane breeding which separates it rather widely from the breeding of most other crops, is the fact that, when a good sugarcane seedling is obtained by the processes above described, it is comparatively easy to keep it pure and multiply it in cultivation without serious risk of losing the good characteristics for which the new seedling was selected in the first instance. This is rendered possible by the vegetative method of multiplication which is possible in this crop. This is the method usually adopted in the cultivation of this crop, a method which, as already mentioned, ensures almost a genetic identity in the resultant plants.

## V. Sugarcane breeding largely a work in the dark

There is, however, one very serious disadvantage associated with cane breeding, which needs to be brought to the prominent notice of the audience here. You all know how, with most agricultural crops, definite laws are being

discovered in the matter of inheritance of characters ; and, with certain of them at any rate, it is becoming increasingly possible to predict the characteristics of a particular hybrid population with considerable amount of certainty. With the cane such laws about the inheritance of characters are yet to be discovered, though it needs to be mentioned that Breeding Stations with some experience are just beginning to see indications of these. In the present state of our knowledge, therefore, the cane breeder may be said to have to work largely in the dark as to the results to expect from a combination. This necessitates his raising as large a number of seedlings as possible—to increase his chances of securing the desired types—and laboriously working through this large number to pick out the types desired. In recent years as many as over 200,000 hybrid seedlings are being raised each year at Coimbatore and about 40,000 of these grown to maturity. When it is remembered that the cane is a comparatively long duration crop—twelve to fourteen months in this Presidency—and the bulk of the 40,000 seedlings need to be studied for their botanical, chemical and agricultural characters at various stages, it will be realized that the labour involved is considerable.

#### VI. Quick and satisfactory results

In spite of certain difficulties above mentioned the Breeding of Sugarcanes compares favourably with that of other crops in the field of practical achievements. The comparative rapidity of the results from sugarcane breeding would appear to be largely attributable to two factors already mentioned, viz., (1) the very wide variations in the seed population, which greatly increase the chances of the desired types appearing and (2) the ease with which the improved canes could be introduced into cultivation and kept pure. There would appear, however, to be yet a third and not unimportant reason which has suggested itself to me within recent times and which is likely to be not without interest to the other Breeders.

#### VII. Wide range of parents employed in sugarcane breeding

Consciously, or unconsciously the Sugarcane Breeder would appear to have used in his breeding programme a wider range of parents than Breeders of most other crops. It is now widely accepted that the work of Java experts offers perhaps the most striking example of practical achievements in the realm of sugarcane breeding. Their first successes in cane breeding, as is now well known, are associated with their memorable fight against 'sereh'. For breeding a cane resistant to this disease they crossed one of the canes they had in cultivation with an Indian cane which was specially imported into Java with considerable labour on account of its resistance to the 'sereh' disease. It has since been found that this Indian cane is of a different species from the other parent and the successful canes were therefore interspecific hybrids. Again, the cane 'Kassoer' which has entered a great deal into the parentage of the later Java seedlings, is itself a natural hybrid between two species of *Saccharums*, viz., *Saccharum officinarum* and *Saccharum spontaneum*.

To come nearer home, the Sugarcane Breeding Station at Coimbatore has been indulging in species hybridization within the genus *Saccharum* from its very inception in the year 1912 ; and to Dr. C. A. Barber, C.I.E., belongs the credit for having deliberately used for the first time *Saccharum spontaneum* in the breeding of sugarcanes. To-day most of the Coimbatore seedlings which are giving such good accounts of themselves under North Indian conditions—and in recent years in foreign countries as well—are all rather

complicated interspecific hybrids within the genus *Saccharum*, at least three new distinct species being involved, viz., *Saccharum officinarum*, *Saccharum Barberii*, and *Saccharum spontaneum*. If the breeding of sugarcane has any suggestions to offer to breeders of other crops, one such would therefore be the desirability of employing as wide a range of parents as might be possible.

### VIII. Sugarcane X Sorghum hybrids

We succeeded last season in effecting at Coimbatore intergeneric hybrids between the sugarcane (P.O.J. 2725) and *Andropogon Sorghum* (Periamanjil of Coimbatore), apparently the first recorded intergeneric hybrid with the sugarcane. These hybrids are quite an interesting lot and certain of them show characters obviously derived from the cholam parent. This cross was attempted with the definite object of breeding short duration sugarcanes and certain of the hybrids have ripened off after a period of but five months growth, their juices at maturity proving almost as rich as that of the standard sugarcanes at harvest. These are being multiplied from cuttings at the Coimbatore Station. One of the obstacles to an extension of sugarcane cultivation has been its long duration on the land; and it now seems not unlikely that the new hybrids might yield sugarcanes that could be cultivated like certain of our cereals.

### IX. Use of wild types as parents

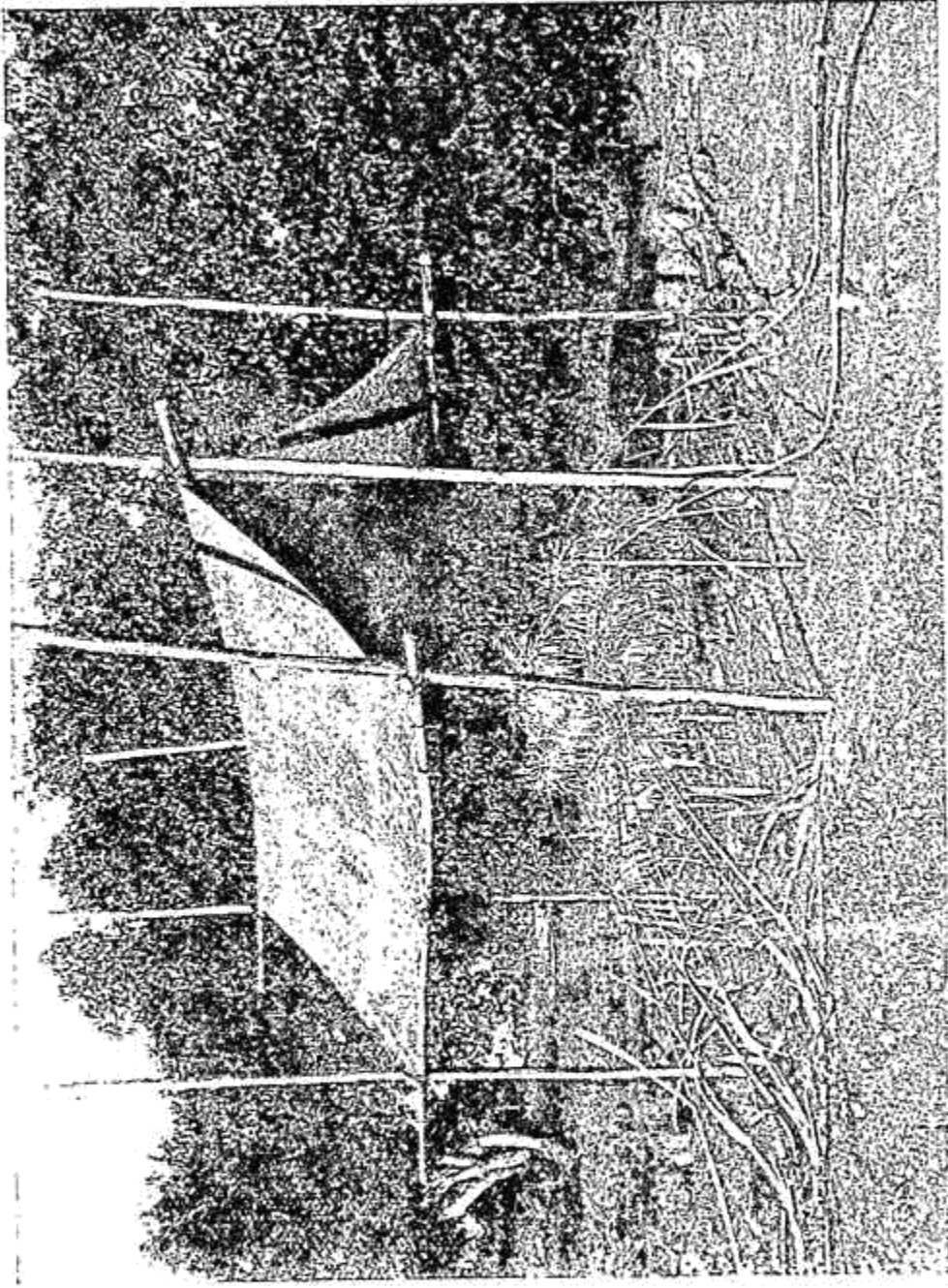
Secondly, the bulk of both the Java and the Coimbatore seedlings, which have proved successes in recent years, have the blood of the wild sugarcane, *Saccharum spontaneum*, diluted to varying degrees. It appears to me more than likely that this wild blood has definitely contributed to the greater vigour and the comparative disease resistance and hence the success of the recent productions. If my assumption is correct, an attempt to employ the wild types in the breeding of other crops is definitely suggested.

### X. An appeal for help and Co-operation

Before I bring this little talk to a close there is one very important aspect of sugarcane breeding which I wish to bring prominently to the notice of the audience assembled here. I consider it most appropriate that I should mention it here and now.

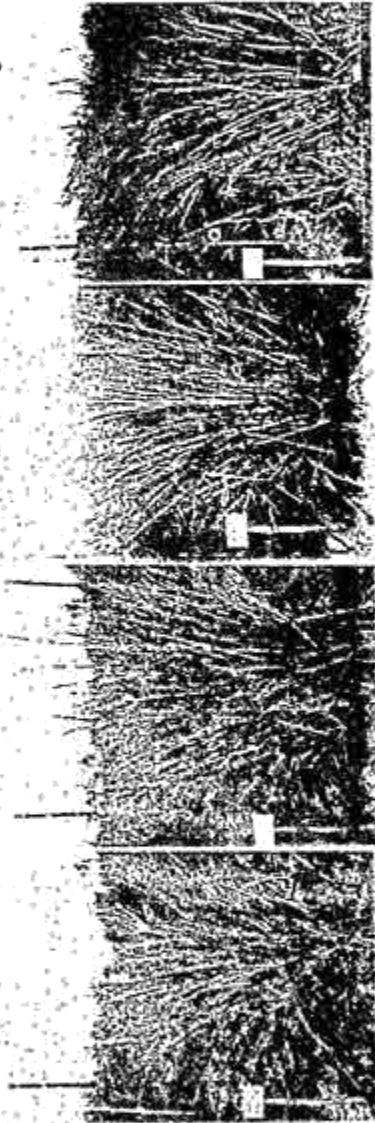
The cane breeding work both in India and elsewhere is rapidly reaching a stage when the actual raising of the seedlings—and in as large a number as desired—would cease to be a problem. It is true that it has not yet been possible to employ as parents any and every cane variety one would desire; but it can reasonably be assumed from the trend of current events that considerable progress will ere long be made even in this direction.

For quick and satisfactory—and I might even add any—results, an efficient and quick means of testing the new productions in the localities for which they are intended is vital. Owing to certain difficulties both in the matter of flowering and the fertility of the flowers in the sugarcane, the cane breeding activities for the whole of India is at present carried on in one place at Coimbatore. The breeding done at Coimbatore is only half the problem and all that the breeder can do at Coimbatore is to make a preliminary selection of probable useful types. To facilitate this the standard canes of the various localities are grown at the Station and the new productions compared with these at almost every stage in their growth. But it is obvious that this



Isolated Sugarcane 'Mother' arrows waiting to be cross-pollinated.

# Saccharum Spontaneums

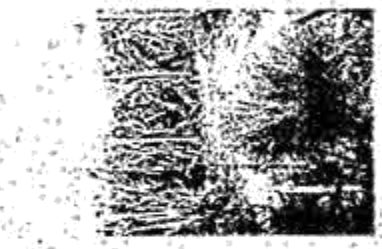


Gough's Java

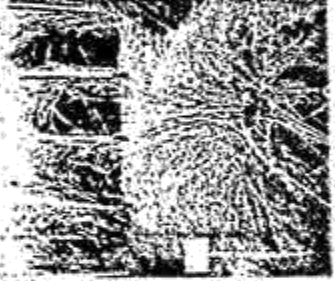
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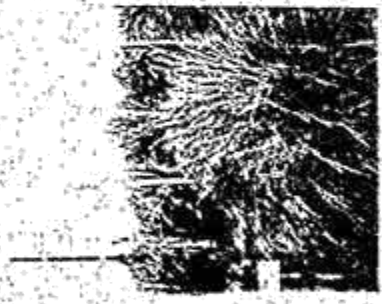
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Certain of the 'Wild Sugarcanes' for use as parents at the Imperial Sugarcane Station, Coimbatore.

can never take the place of the testing of the productions in the locality itself and under local conditions. To state the problem in a concise manner, the breeding of suitable improved canes for the various parts of India with its wide variation in soil and climatic conditions, is essentially a team work composed of the Breeder at Coimbatore and the officers in charge of the local testing stations. The Sugarcane Breeding Station at Coimbatore feels confident that, in the efficient testing of the new productions, it can count on the help of the audience here in a joint endeavour to place on a satisfactory footing the raw material for such a *Vital Food* industry as that of the *Indian Gur* and *Sugar Industry*.

## THE MANURING OF SUGARCANE \*

By B. VISWA NATH, F.I.C.,

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A crop of 30 tons of sugarcane per acre removes 80 lbs. of nitrogen, 50 lbs. of phosphoric acid and 180 lbs. of potash from the soil. An examination of the results of field experiments for 25 years at all the experiment stations in the Presidency, chiefly at Samalkot, Anakapalle and Palur, reveals that the problem of nitrogen nutrition of the sugarcane is of greater importance than that of either phosphoric acid or potash. In the manurial programme of the Experiment stations, the application of oil cakes is the chief item and the soundness of the scheme is reflected in its wide adoption in the sugarcane tracts.

An analysis of the results of work at the different experiment stations in the Presidency is attempted in this paper with a view to obtain information on the requirement of the sugarcane plant in regard to the three principal manurial constituents, Nitrogen, Phosphoric acid and Potash.

The economics of the different systems of manuring are not discussed here, as that would vary widely with the locality, and the ruling prices of the manures and the crop. Attention is confined to a discussion of the relative merits of different manures and the combinations in which they are beneficial to sugarcane. The subject matter is divided into three broad divisions :

- (1) manuring as affecting the yield,
- (2) manuring as affecting the quality of the juice and the jaggery and
- (3) manuring as affecting the vegetative and reproductive quality of the resulting seed material.

### (1) Manuring as affecting yield

*Evaluation of results :* There are two ways of evaluating yields in sugarcane experiments.

- (i) as weight of cane
- (ii) as weight of jaggery.

The latter is doubtless important from the ryot's point of view but to an experimenter, it is open to certain objections. The yields of jaggery on weight of cane and on weight of juice vary up to 5 per cent. These differences are due to variations in mill efficiency, and to differences in the methods of

\* Paper read at the M.A.S.U. Conference, July 1930.