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*Jaggery Making in Hospet and Suggestions for its improvemnt.

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Bellary is one of the foremost sugarcane producing districts in the Madras Presidency. It had 9761 acres (the highest in the Presidency) under sugarcane in 1905–6, Coimbatore and Godavari following with 9689 and 8413 acres respectively. Strangely however, the jaggery into which all the cane grown in the District gets converted is the worst type of cane jaggery produced in the Presidency. The cause of this with the best means of improving the quality of the jaggery was taken up for investigation by the Department last year and continued during the present year. It is proposed in the present paper to deal with the results so far obtained.

Local methods of cane cultivation and Jaggery making :- The sugarcane area in the District lies mostly along the right bank of the Tungabhadra and consists mainly of black clay, although the lighter soils situated higher up the basin consisting of red loams are occasionally also brought under cane cultivation. The water supply through the channels is almost perennial. Cane and paddy are taken by rotation, but not infrequently the same crop is grown for several years in succession. Cane is planted during April—May and harvested 9—10 months later in January —March. The manures ordinarily used are 10—12 cartloads of cattle manure and 60 maunds of castor cake per acre. No wrapping or propping of canes is practised. The usual variety of cane grown is a thick white cane known as Javari Kabbu very similar to Coimbatore Poovan in appearance and quality of juice is perhaps identical with the latter. It is said to have been introduced into the District about 1840 when it ousted the local thin cane. The average out-turn of jaggery is about 300 maunds ($3\frac{1}{2}$ tons) per acre.

The usual 3 roller iron mill is used for the crushing and is either owned by the cultivator or land owner or hired for the occasion; but the crushing is done by a set of professional boilers who hail from the North and bring their own working cattle. They come over during the harvesting season usually in batches of eight with four pairs of animals and establish themselves at the

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sional boilers are expected to turn out a certain quantity of jaggery each day for which they are paid partly in kind. The grower usually exercises a certain amount of supervision over the boiling but not being familiar with the technique of the process himself he has no control over the quality of the jaggery produced. The jaggery boiler endeavours to turn out the maximum quantity of jaggery during the day with the minimum amount of trouble and attention. Towards this end he uses huge pans (9 feet in diameter at the top) and does no more than two boilings per day each lasting 8-10 hours. The quantity of juice used for each boiling is four tankfuls, the capacity of the tank (which is sunk into the ground close to the mill and receives the juice) being 80-90 potfuls of 40 lbs each (=3200–3600 lbs). This quantity is transferred to the cooking pan not at once but in four instalments as the tank gets filled and the contents of the pan boil down. Lime is added partly at start and partly during the boiling, but no scum is removed. At the right stage the pan is removed from the fire and the contents transferred onto date mats spread over rectangular shallow pits in the ground. As much as 450 lbs (17 maunds) of jaggery are obtained from each boiling, but the product is low in quality being dark brown to black in colour and and largely admixed with impurities. Not only no attempt is made to keep the jaggery free from the latter, but impurities in the form of sand and cow dung are said to be at times deliberately introduced.

It was evident even on casual observation that the low quality of the jaggery must be due partly at least to the defective methods of preparation. Part of the investigation therefore consisted in carrying out trial boilings with the same juice as was used by the local boiler but under improved conditions, paying due regard to all essential details of manufacture.

Apart from the method of preparation other possible reasons for the unsatisfactory quality of the jaggery were

(i) The variety of cane grown and the quality of the juice obtained therefrom.

(ii) The nature of the soil and of the irrigation water and the treatment given to the former.

These also were investigated.

Trial Boilings. The trial boilings were conducted in flat bottomed pans of Samlkot pattern which are of smaller capacity than the local ones and the furnaces were of "Sindwahi" type, the main features of this type of furnace being that it is provided with a chimney for the escape of smoke and not gases, a grid over which the fuel is burnt and an air-hole under the latter. The boilings conducted last year did not differ from the local method in other ways except that the scum was carefully removed and care was taken to prevent the juice from being contaminated with dirt. The jaggeries thus obtained were decidedly better than the local product both in point of colour and purity and their superior quality was generally acknowledged.

Chemical Examination of Cane juice, Soil and irrigation water :—With regard to the other possible factors affecting the colour of the jaggery, examination of the juice of the top and bottom halves of the canes according to the method devised in these laboratories showed that the canes were far from being ripe enough for cutting. The juices all showed a high percentage of glucose (1·6–2·9 per cent), high glucose : sucrose ratio (12-20) and low purity co-efficient (75-82) charateristic of immature canes. It was evident that the canes were being cut much too soon. The boiling trials would doubtless have yielded a still better jaggery had the canes been ripe. Except for their high glucose content and low purity owing to the immaturity of the canes the juices were found to be otherwise normal. (Table III). Neither the soil nor the irrigation water were found on analysis to be such as would affect adversely the quality of the jaggery. It thus appeared from a preliminary examination of the the problem that the inferior quality of the jaggery was due in the main to defects in the process of manufacture.

The trial boilings conducted in 1927 showed that by using a smaller pan and an improved furnace, charging the pan only once for each boiling, removing the scum and more careful handling generally, a better quality of jaggery could be obtained. It is probable, however, that in these first trial boilings which were mills, the cultivators utilizing their services in turn for milling their canes and boiling down the juices for them. The profes-

carried out by the Agricultural Demonstrator sufficient attention was not paid to several details in the technique to which a professional boiler might attach particular importance. e.g., liming, regulation of the heat, stirring the massecuite whilst over the fire and after removal from it, timely removal of the pan from the fire etc. It was therefore thought desirable for the proper conduct of the trial boilings which were to be repeated this year, to obtain the services of a professional jaggery boiler thoroughly familiar with the art. They were accordingly entrusted to an an experiencd jaggery boiler from Samalkota. At the time the experiments were taken up this year, the canes were found to be quite ripe. The first boilings were conducted at Hospet in flat bottomed pans, over "Sandwahi" furnaces specially constructed for demonstration purposes and at the hands of the Samalkota man they yielded jaggery of excellent colour and consistency and was superior in point of colour to that obtained last year. Jaggery boilings in large local pans attended to by local jaggery boiler were also conducted close by and the difference in the quality of the jaggery obtained under the two methods was most striking. The Samalkot man's methods did not differ very much from those adopted for the trial boilings last year but careful observation showed that he used much less lime than the local boiler for the same quantity of juice. The Hospet trials thus showed that the colour of the jaggery obtained by using the smaller pan and improved furnace could still further be improved by judicious regulation of the quantity of lime added. The local practice was thus faulty in another important respect viz., excessive liming.

Further experiments which were conducted at Kampli had for their object the study of

(i) The effect of lime on cane juices of varying quality and the best quantity to use in each case.

(ii) The influence of the purity of the juice on that of the jaggery.

(iii) The effect of soil conditions on the quality of the juice.

The boilings were conducted as at Hospet in a flat bottomed pan over a "Sindwahi" furnance and in a local pan over local furnace closeby. The first series of experiments were made with the juice of canes cut from the Demonstration plot at Kampli,

varying the quantity of lime added and in the case of the local pan also the quantity of juice used for one boiling. The capacity of the tank in which the juice was collected was 18 potfuls (18 x 40 lb.) so that the quantity of juice used for one boiling was 4 x 18 x 40 or 2880 lb. added in four instalments. Not more than 1 tankful was used for a boiling with the Samalkota pan.

Proportion of lime used by the Local Boiler;—The quantity of lime ordinarily used in boiling down ripe cane juice at Kampli is about 16 coconut shell cupfuls (about 2·5 litres) for one boiling or 2880 lb. of juice. This quantity is of course, only a rough approximation, since the consistency† of the milk of lime is variable within limits, as also the quantity of juice used for one boiling. Sometimes however juices as those from over-ripe or dieased canes do not yield a firm enough jaggery when boiled down with the above quantity of lime. In such cases the jaggery boiler increases the quantity to 20 or even 22 cupfuls. The jaggery in such cases is proportionately darker in colour.

As will be seen from the results of the analysis of four different samples of milk of lime [Table V], the lime suspensions used by the jaggery boilers are apt to differ rather widely in their strengths. Roughly the proportion oflime used for the boiling down of normal juice may be taken as 0.042 of the juice. It must be remembered however that in liming his juice the jaggery boiler is guided not so much by the quantity of lime (no. of cupfuls) actually added as by the appearance of the limed juice.

Small Scale Boilings :—It seemed desirable before carrying out the trial boilings in the Samalkota pan with reduced quantities of lime to conduct tests on a small scale using only one or two potfuls of juice to see how far the reduction in lime could be carried consistently with the production of jaggery of satisfactory quality. The results of small scale boilings carried out with the aid of a small experimental pan placed over a pit dug out in the ground and provided with fuel and air passages (sketch) are set down in table VI.

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† The jaggery boiler usually judges of the consistency of the milk of lime by plunging his finger into the suspension and withdrawing it. He considers it to be of right strength if the film of lime is just thick enough to prevent the brown of his finger from being seen through.

It will be noticed from a glance at the table and more readily from inspection of the jaggery samples that the best coloured jaggery is obtained when the juice is limed with two cupfuls for 18 pots (or 8 cupfuls for one boiling with the local pan) also that as the proportion is increased the jaggery darkens in colour.

pH values of limed juices.—The proportion of lime to juice which is used in local boilings and that which according to the small scale boiling has been found to yield the best jaggery have so far been given in terms of weight of CaO to a given weight of juice. This however is not a good way of indicating the degree of liming adopted in each case for two reasons: first because all juices are not equally acid; next because even supposing they were, they respond differently in respect of change in reaction, to the addition of acids or alkalis i.e, they differ in their buffer action. Now liming cane juice is one of those cases where the desired effect depends upon the reaction of the solution so that what we really mean by correct liming is liming to the correct reaction or stage of acidity or alkalinity. The latter cannot be correctly defined by the quantity of lime added because of the varying buffer actions of cane juices. Since the best way of defining the reaction of a solution is to state its H-ion-concentration the best way of defining the correct degree of liming (or any degree of liming) is to state what the resulting H-ion concentration of the juice should be.

The H-ion concentration of the juices limed to different degrees in the case of the small scale boiling experiments are given in column 5 of Table VI in terms of pH. In the table which follows are given the pH values of certain bulk juices which had been limed previous to b[illegible]

It will be seen that the [illegible]der usually limes his juice nearly to neutrality, while for [illegible]oduction of jaggery of good colour the juice has to be slightly on the acid side. Juice A used by the Samalkota boiler and limed to 5.5 pH yielded jaggery of very fair colour.

Results of trial boilings:—The results of the trial boilings carried out at Kampli and scheduled in Table II may now be considered. The experiments which had to be carried out under considerable difficulties and limitations which it is unnecessary to recount on the present occasion, point to the following conclusions:—

(1) With ripe juice analysing up to 2·5 per cent glucose content, using the Samalkota pan and Sindwahi furnace and with careful boiling it is possible to reduce the usual quantity of lime to one half of that used locally and obtain jaggery of much lighter colour and equal hardness.

(2) The reduction in the quantity of lime cannot be carried out at any rate to the same extent adopting the local pan and local method of boiling without the risk of impairing the hardness of a jaggery. The reason for this appears to be the large amount of inversion as a result of the protracted boiling and carless firing.

(3) By reducing the total quantity of juice employed at one boiling and the number of charges it is possible with careful boiling to obtain a somewhat better coloured jaggery even with the use of the local pan. The local boiler however appears to be incapable of exercing the necessary care.

It would appear from the above experiments that for the production of jaggery from any given sample of juice satisfactory at once in point of colour and hardness, other conditions being equal the right quantity of lime should be used, an excess of lime tending to make the jaggery dark and deficiency to make it soft and liable to run in moist weather; that the jaggery boilers at Kampli invariably err on the side of exeess to avoid partly the risk of making the jaggery soft and this risk is the greater when large pans and large quantities of juice are used and partly no doubt also the extra care necessary to successfully boil down moderately limed juice into jaggery especially when it is of doubtful quality as when obtained from overripe or diseased canes.

Cane variety and Quality of Jaggery.—Analysis of the juices last year showed the presence of a rather high percentage of glucose in ths Kampli canes, most of the juices examined analysing over 2 per cent glucose. As the canes were then still immature this high glucose content, it was thought, was due to their unripe condition. At the time they were examined this year they were found to be quite ripe but they still showed a high glucose value 2·0 to 2·6 per cent as could be seen from the results shown in Table VIII. As such high figures are not usual in mature canes the possibility suggssted itself of their being due to

defects in the physical condition of the soils or in the method of cultivation. Enquiry elicited the fact that higher up the Tungabhadra the jaggery produced was of better quality. Whilst Kampli jaggery is admittedly the worst produced in the tract, Hospet was credited with producing jaggery of butter quality The cane at Buksager seven miles above Kampli was said to yield a superior jaggery while the report was current that at Kuruvatti in Harpanahalli taluk, excellent jaggery was being produced from juice which required no liming. These reports lent colour to the suspicion that the high glucose content of the Kampli canes was more the result of bad soil conditions or defective cultivation than a characteristic of the variety. It seemed therefore desirable to test the canes and the soil at these places to see how they differed from each other and if the differences observed would justify the suspected connection between soil conditions or soil treatment and the quality of the juice.

The results of analysis of the juices at Kuruvatti, Hospet and Buksager are set down in Table IX. It will be seen that all the juices except those examined at Kuruvatti which will be discussed separately analyse over 1.4 percent glucose so that the high glucose content of the canes is un-doubtedly a characteristic of the variety. Although all show high glucose values it will be seen that they differ fairly widely amongst themselves the juices varying in quality from plot to plot even in the same locality. This variation could only be due to differences in the soil or its treatment and appears to be worthy of closer study. The samples of soil and jaggery collected at these places taken along with the analyses of the juices are expected to throw some light on the subject.

Kuruvatti Jaggery :—Reference has been made to the superior quality of the cane and jaggery produced at Kuruvatti. The only canes grown here belong to Ayappa Baslingappa Chekki a well-to-do Sowcar or land holder of the place who has been trying sugarcane on part of his land for some years and has installed a plant consisting of a water pump and crushing mill both worked by an oil engine and multiple furnaces for the manufacture of jaggery. He has secured the services of a young man of his community who has had some training at the Manjri station and the plant and method of jaggery boiling adopted here are

on those at Manjiri. The boiling plant consists of two multiple furnaces with four pans each, the last two C. C. which are smaller in size being placed side by side at the same level. In addition there are two single pans DD placed at either end for use when only small quantities of juice are available. When the contents of the pans placed lowest have reached the desired concentrations they are transferred to cooling tanks EE and allowed to cool for about an hour. The massecuite which by this time has turned semi solid is worked by trowels to accelerate crystallization and finally transferred to buckets with perforated bottoms a piece of cloth being interposed between the bucket and the massecuite to enable easy removal of the jaggery. The buckets are then left to drain over night over corrugated iron sheets. When drained sufficiently of the molasses the jaggery is obtained in big blocks by inverting the buckets.

Little or no lime is used during the manufacture, whatever scum rises to the surface during the boiling is thoroughly removed and the boiling juice is splashed about in the pan at intervals, to help the finer suspended impurities to rise to the surface. The unlimed jaggery thus obtained has a clear golden yellow to brown colour, is free from palpable impurities and is crystalline in structure. It is however not as hard as the local jaggery but yields to pressure, crumbles readily and feels moist to the touch.

The Kuruvatti cane it will be seen (Table IX) has rather a low glucose content. This is probably due to the nature of the soil which is a red loam admitting of much better drainage than the stiff clays on which sugarcane is usually grown and also to better cultivation. The jaggery obtained from this juice is in point of colour unapproachable by any prepared elsewhere in the District; but this perhaps is due more to the method of manufacture than to the quality of the juice. For it will be noticed from a glance at Table IX that although the juice as obtained direct from the cane is remarkably pure, that taken from the tank just before being pumped into the boiling pans contains as much as 2.94 per cent glucose, the increase being no doubt due to inversion. Now with regard to the method of manufacture it will be noticed that it differs from the usual method in two important respects viz.,

(i) no lime is added to the juice and

(ii) the massecuite has to be freed from adhering molasses before solid jaggery could be obtained.

The significance of this difference could be best realized from a consideration of the effect of lime on the constituents of cane juice and its use in the manufacture of jaggery and of raw sugar. As it will also serve to explain the reason why the local boiler prefers to err on the side of over liming his juice the subject will be discussed in some detail.

The purpose or at any rate the effect of adding lime to cane juice is three fold viz.,

(i) to neutralize the acidity of the juice and thus prevent inversion which otherwise would occur resulting in loss of sugar on the one hand and increase in uncrystallizable reducing sugars on the other.

(ii) to flocculate or precipitate non-sugars.

(iii) to destroy excess of glucose.

All these three uses are availed of in more or less degree in the usual process of jaggery manufacture. We will consider these three effects separately in the reverse order.

As the destructive action of lime on glucose (iii) is invariably attended with the formation of dark coloured products it is not availed of as a rule except in extreme cases as when much glucose is present. Juices containing only a moderate liming and as in such cases the amounts of glucose and lime present are small, there is not much darkening of the colour produced. Juices richer in glucoe require considerable liming not only to prevent inversion but also to destroy some of the glucose already present. The reacting substances being now present in larger quantities the products of reaction will be in larger amounts also. The jaggery obtained under such conditions will be necessarily dark.

In the case of the juice in question which contained nearly 3 per cent glucose it would hardly have been possible to prevent the formation of dark products if lime even in moderate quantities had been used. The jaggery could not be as light coloured when prepared with addition of lime as without it. The force of the

argument that the good colour of the Kuruvatti jaggery was probably due more to the method of manufacture than to the quality of the juice will now be apparent.

With regard to the other two effects of lime, the local jaggery boiler has no use for (ii) since he does not care to remove the flocculated impurities forming the scum while it is only partly availed of by jaggery boilers in other parts of the Presidency who remove the scum but leave the coarser suspended impurities behind. Only in the manufacture of raw and white sugar where the impurities are removed both by skimming and by filtration is the clarifying action of lime made use of to the fullest extent.

But for the action of lime in inhibiting inversion (i) it would in most cases not be possible to obtain a solid jaggery from cane juice as the invert sugars not only do not set but also prevent some of the sucrose from crystallizing. When no lime is added as in the method in use at Kuruvatti, it is necessary to remove the molasses either by draining or by centrifuging. The losses due to inversion when lime is not added must be considered‡ but this is set off by the complete absence of any chance of the jaggery blackening. It would for this reason be a much safer method to adopt in all cases where the juices have a high glucose content. The possibility of the introduction of this system more widely in the District in place of the existing one for improving the quality of the jaggery appears therefore worth consideration. The Kuruvatti jaggery could not of course be compared with that produced at Hospet or Kampli their methods of preparation being so essentially different.

In the light of the explanation given above as to the action of lime on cane juice and its use in jaggery making the tendency in the local jaggery boiler to over lime his juice is easily explained. To start with the juice itself contains a large percentage (2-3 per cent) of glucose. Leaving the cut canes out in the sun, an unwashed mill and tank and protracted crushing tend to add to the quantity originally present in the juice owing to fermentative changes induced and the quantity is still further increased in the pan owing to the prolonged boiling and fierce heating. The jaggery boiler has found out by experience that his only chance as against this large quantity of glucose of obtaining a firm jaggery

‡ Dr. Lahmann found these were as high as 30 per cent in the Hadi proess.

s to add lime and if necessary more lime. It is not surprising therefore that he is not able to produce anything better than the vile looking commodity which passes for jaggery in the District.

It has been remarked in the earlier portion of the paper that the local boiler overlimes his juice. The term has been used however in a comparative sense only to denote the fact that he uses more lime than the Samalkota boiler. Compared with the degree of liming practised in the manufacture of raw sugar and of jaggery in other parts of the country which is usually to the point of neutrality, it cannot be said that the local jaggery boiler overlimes his juice for it was found that the local juices are limed no higher than the neutral point. Further it was seen that the proportion of lime ordinarily used in local boiling is about 0·42 per cent of the juice. The quantity used in the manufacture of raw sugar is stated to be nearly 1 lb. per ton of cane which works to ·05 per cent approximately. It would then appear that the low quality of Hospet or Kampli jaggery is to be attributed more correctly to other faults viz. large pan, large quantity of juice etc., in the method of manufacture than those concerned with liming. The former as already pointed out, by impairing the already low quality of the juice render the production of a good coloured jaggery impossible. The use of the Samalkota pan and improved furnace enables a less quantity of lime to be used and a better jaggery to be obtained.

Summary of Results:—To summarise the results of the experiments and the enquiry so far carried out, it has been found that

1. The inferior quality of the jaggery produced in Hospet taluk is due to the following defects in the method of its manufacture.

(i) the use of too large a pan and the large total quantity of juice dealt with at a single boiling.

(ii) the practice of adding more and more fresh juice as the contents of the pan boil down.

(iii) impurities separated by the lime and the heating and rising to the surface on heating not being removed.

(iv) the addition of more lime than the production of a light coloured product demands.

(v) the use of immature and of over-ripe canes and want of care and cleanliness in handling the juice during manufacture.

2. By the use of a smaller pan and improved furnace and avoiding the other existing defects it is possible to obtain jaggery of satisfactory colour and hardness.

3. The optimum quantity of lime for the production of jaggery of satisfactory quality depends upon the purity of the juice. The best proportion for juices containing 2–2.5 per cent glucose as obtained by experiment, is that which would give the juice a reaction of 5.5 P. H. A less quantity is likely to give a soft jaggery and a greater a dark coloured jaggery. Purer juices containing less glucose than 2 per cent may be limed less, but they can stand a fair amount of over liming. Poor juices require considerable liming in order to yield a firm jaggery. As such juices stand liming ill the product is always dark coloured.

4. The defects in the prevailing methods of jaggery jaggery making by increasing the uncrystallizable sugars in the juice make it difficult to lime. Better methods as the use of a smaller pan and improved furnace prevent this undue increase and enable less lime to be used without the risk of making the jaggery soft.

5. Jaggery boiling without the addition of lime as practised at K ruvatti and at the Manjri Station is a method particularly adapted for juices having a high glucose content and its general introduction would serve to solve the jaggery problem in Hospet. Inversion losses are however apt to be high in this method.

The superiority of the jaggeries produced in the smaller pan and with reduced quantities of lime in point of colour was readily admttted by the ryots at Kampli, but they were inclined to doubt their keeping qualities. In order to test the latter point the samples were examined for their moisture absorbing power in the laboratory. The results which are set down in Table IX do not been out this contention.

TABLE I

Analysis of Cane Juices, Kampli Bottoms and Tops.

Date of analysis.	Description of particulars of canes.	Brix.	Brix Top / Brix Bottom.
8–1–1927	Canes from plot near V. Rao's mill Tops.	12·75	·68
,,	do. bottoms.	18·65	
14–1–1927	do. Tops.	13·04	·67
,,	do. bottoms.	19·56	

TABLE II.

Analysis of Cane Juices, Kampli.

Date of analysis	Description and particulars of canes.	Brix corrected.	Sucrose %	Glucose %	Purity Co-efficient.	Glucose Sucrose. Ratio.
10th January 27.	Juice taken direct from mill from on head load of fresh cut canes from plot near V. Rao's mill ...	17·13	13·79	2·08	81·03	15·09
do.	Jnice taken from fulltank canes from same plot ...	17·27	14·01	2·00	81·07	14·28
12th do.	Juice taken from full tank-canes from plot near V. Rao's mill ...	18·01	14·54	2 63	80·74	18·09
do.	Juice from full tank Talavar Lingappa's land ...	16·13	12·64	1·79	78·36	14·16
do.	Tank juice, Fort mill ...	16·37	12·46	2·08	76·11	16·01
14th do.	Tank juice, Canes from V. Rao's mill near Demonstration plots ...	16·67	13·70	1·67	82·18	12·19
do.	Tank juice used for expermental boiling...	17·41	13·89	2·18	79·78	15·69

TABLE III.

Chlorine content of cane juices, Kampli.

Date of analysis.	Description and particulars of juice.	Cl. in 100 cc.	Remarks.
13th January 27	Tank juice from Mukkanna's mill, Fort Kampli.	·098	Clarified with Kieselguhr and alum.
do.	do.	·091	Clarified with Kieselguhr and Formalin.
14th do.	Tank juice used for experimental boiling II.	·049	do.
do.	Tank juice from Bandiachar's mill.	·063	do.

TABLE IV.

Analysis of cane juices-Kampli-Bottoms and Tops.

Date of analysis.	Description and particulars of Canes.		Brix.	Brix Top / Brix bottom
14th Mar. 28.	Demonstration plot canes.	Tops.	17·47	·99
		Bottoms.	17·69	
16th do.	Canes from plot towards east of above.	Tops.	16·87	·9[illegible]
		Bottoms.	17·07	
17th do.	Canes from plot further east reputed to produce best local jaggery.	Tops.	19·76	·9[illegible]
		Bottoms.	20·66	
18th do.	Lingayet Guru's plot near Demonstration plot.	Tops.	18·77	·94
		Bottoms.	19·97	
8th April 28.	V. Rao's plot near Muddapuram.	Tops.	16·2	·95
		Bottoms.	17·1	

TABLE V.

Analysis of Lime Suspensions.

	Sample No. 1	2	3	4		
No. of cc. of 2N (approximate) HNO_3 taken up by 1 cc. of milk of lime ...	2·5	3·5	3·0	3·2	3·05	cc.
CaO in 1 cc. ...	·140	·196	168	1·80	·171	gms.
CaO used for one boiling (local pan) (16 cupfuls=3200cc)	448	627	538	576	547	grams
per cent CaO in juice ...	·0343	·0480	.0412	.0441	.0419	

TABLE VI

Small scale Boilings.

No.	Date of experiment.	Description and particulars of boiling.	Glucose content of juice.	pH. value of juice.	Jaggery obtained
1	21st Mar. 28.	1 pot of Demonstration plot juice boiled down with 15 cc. of milk of lime the proportion corresponding to a little less than 2 cupfuls for 18 potfuls.	...	...	Jaggery of very light colour and fairly hard.
2	22nd do.	2 potfuls boiled down with 30 cc. of milk of lime same proportion as above.	2·63	5·5	Jaggery of fair colour but not so light as above.
3	23rd do.	2 potfuls boiled down with 60 cc. of lime proportion of lime nearly same as local boiling.	1·92	6·3	Jaggery of good colour.
4	23rd do.	2 potfuls boiled down with 90 cc. of lime proportion of lime 1½ tins local boiling.	2·38	6.7	Jaggery of darker colour than above but lighter than local jaggery.

TABLE VII.

pH values of Limed juices.

	Description and particulars of canes.	Glucose content of juice. %	pH value.
A.	Demonstration plot juice limed by Samalkot man for his boiling. 2 cupfuls of milk of lime added to 18 pots of juice. 20—3—28	2·5	5·5
B.	Demonstration plot juice limed by local boiler 4 cupfuls added to 1 tankful. (18 pots.) 20—3—28	2·5	7·0
C.	Juice from Lingayet Guru's plot limed by local boiler. 5 cupfuls of rather dilute milk of lime added to 1 tankful 20—3—28	2·0	6·0

TABLE VIII.

Analysis of cane juices—Kampli.

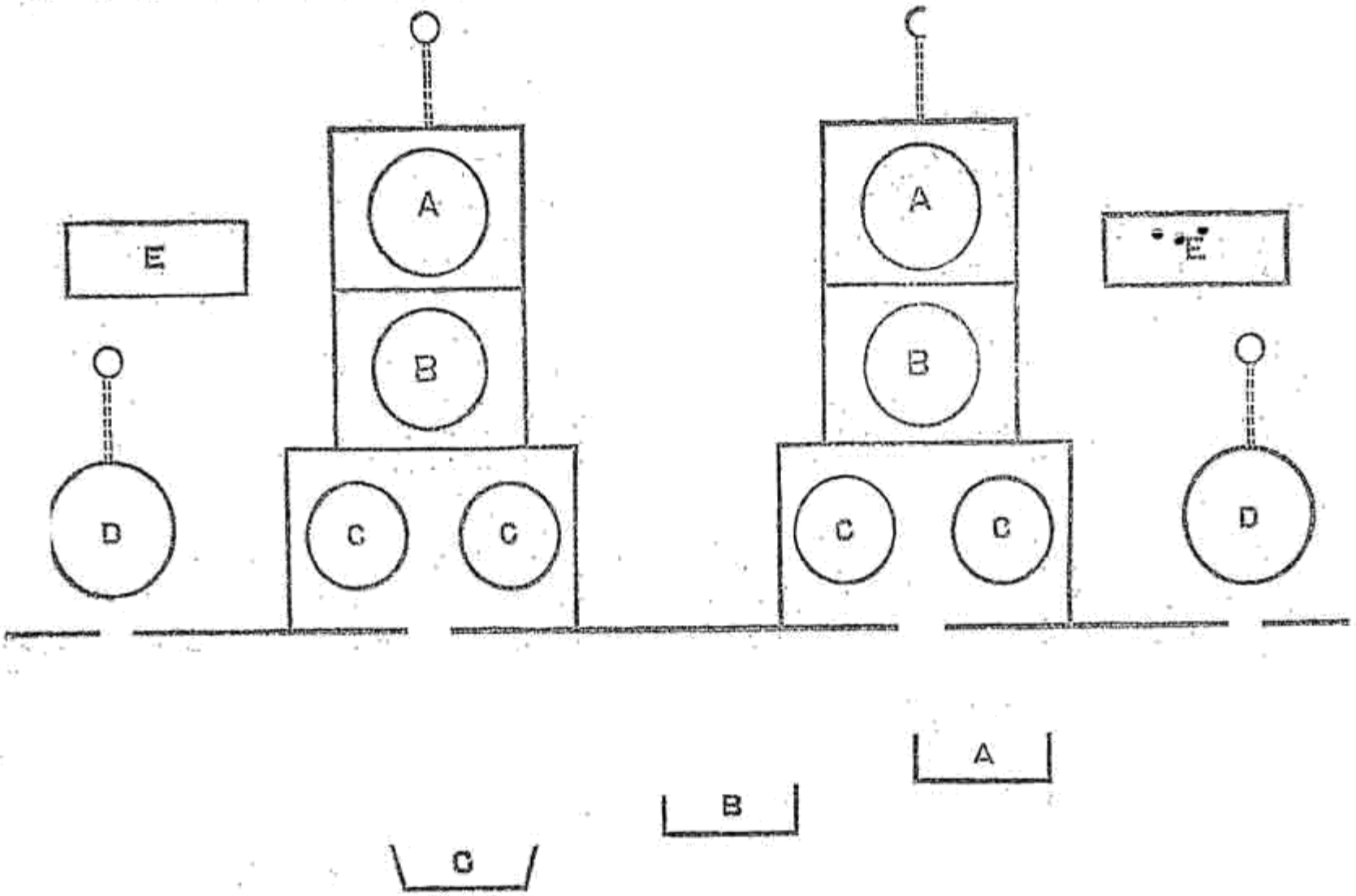
No.	Date of analysis.	Description and particulars of juice.	Brix corrected.	Glucose %	Remarks.
1	16th March 1928.	Demonstration plot canes Fresh juice used for boiling in Samalkot pan ...	17·2	2·08	Canes not quite healthy.
2	do.	Juice from field reputed to produce good jaggery. Mixed juice of tops and bottoms of six canes ...	16·57	1·85	Yields good quality of jaggery.
3	17th do.	Juice from Muslim cultivator's plot reputed to produce best local jaggery. Average of top and bottom values of juice of six canes.	20·21	1·24	Best jaggery produced at Kampli.
4	do.	Fresh juice lrom Lingayet Guru plot ...	16·79	1·85	
5	9th April 1928.	Bulk juice from V. Rao's plot near Muddapuram situated upland under Ramsagar channel ...	...	2·63	Yields poor jaggery.
6	15th do.	Do. do. taken towards end of harvest.	...	2·94	Jaggery obtained from this was soft as well as dark coloured.
7	17th do.	Fresh juice from aonther upland plot, Mudpuram ...	14·83	2·78	Poor jaggery.

TABLE IX.

Analysis of cane juices—Kuruvatti, Hospet, and Buksagar.

No.	Date of analysis.	Description and particulars of juice.	Brix corrected.	Glucose %	Remarks.
		Kuruvatti Juices.			
1.	31st March 28.	Juice from six average canes which had grown erect ...	21.6	·96	Soil loamy and well drained: canes planted first week of February 1927. Excellent jaggery produced by Poona method.
2.	do.	do. do. lodged canes ...	18·8	1·25	
3.	do.	do. do. arrowed canes ...	19·6	·81	
4.	do.	Bulk juice from tank ...	19·6	2·94	
		Hospet Juice.			
5.	3rd April 28	Juice from Lingappa's plot from six average canes. Mixed juice of top and bottoms ...	18·3	1·61	Black cla,.
6.	do.	Juice from Rasul Sahib's plot at Chickwadgi from six average canes. Mixed juice of tops and bottoms. ...	17·2	2·5	Black clay. Jaggery produced, of poor quality
7.	5th do.	Juice from plot north of Railway line from six average canes. Mixed juice of tops and bottoms.	18·1	1·47	Black clay liable to be water-logged. Canes stunted in growth.
		Buksagar Juice.			
8.	17th do.	Juice from Prahlada Rao's plot from six whole canes. ...	19·3	1·39	Black clay yields very good jaggery.

Multiple furnaces at Kuruvatti



A, B, C, C, Battery of four pans, CC the lowest ones being placed at the same level.
D Single pan. E Cooling tank.

TABLE X

Moisture Absorbing Powers of different samples of jaggery.

No.	Description of Sample.	Moisture absorbed during 26 hours. per cent on dry matter.
1.	Hospet jaggery, prepared in Samalkot pan and over Sindwahi furnace ...	14·58
2.	Do. Local pan and furnace ...	13·70
3.	Kampli jaggery prepared in Samalkot pan and over Sindwahi furnace ...	18·21
4.	Do. Local pan and furnace ...	20·18
5.	Kurnvatti jaggery prepared according to Poona method.	15·25

Four Years' Experience of a Farm Tractor.

By Amanat Ali Habibullah, Dip : Agri.

I have about 800 acres of land under direct cultivation. A "McCormick Deering" or commonly called an International Tractor (15-30 H. P.) has been working on my farm for the last 4 years. It is being used for the following jobs :—

1. From the beginning of December till the end of March every year, for running a small ginning factory consisting of 8 gins. (The actual working days are about 75 days.)

2. From the first week of April till the break of the monsoon for ploughing.

3. In certain years, rrom the end of rainy season say from middle of September for a month or so, for Discing land prior to