

# RESEARCH AND THE PRACTICAL MANUFACTURE OF TEA

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During the Commission of Enquiry on the Scientific Department of the Indian Tea Association, witnesses drawn from all branches of the Indian Tea Industry were asked to express views upon the major problems of the industry under the heading of Manufacture. Dealing with the answers received the Report says in paragraph 21: "Ignorance — some of our witnesses have used this word — most truly defines the real problem of the industry in regard to manufacture. The nature and effects of the factors chiefly influencing each process are very imperfectly known. If knowledge of these things can be supplied by research it will help the industry not only to do better in existing circumstances but to meet fresh circumstances in the future whatever they may be."

We, in Ceylon, must also admit the truth of the statement. No criticism of any particular section of the industry is intended by this remark for, as the report goes on to say, no more obscure subject for research on crop products could perhaps be found. They conclude that the needs of the industry justify, and indeed dictate, a substantial outlay and a bold attitude in research on quality. Full knowledge of the chemical and physical changes occurring at every stage is desirable in order to enable us to make manufacture more systematic and subject to rules rather than, as at present, to personal judgment and guessing, or, as I have expressed it before, to change tea manufacture from an art to a science.

An occasion such as the present one affords us an opportunity for discussing outstanding problems, some of which may not have arisen in St. Coombs factory. It is essential that information from all parts of the Island should be available, in order to enable us to take general views on all problems of the Ceylon Tea Industry and not merely confine our ideas to St. Coombs factory. For this purpose accuracy is vital and a comparatively few records of the principal changes daily occurring in the leaf and of the processes whereby these

changes are brought about will provide the essential information. Further to this, if we want to know what we are really doing there must be a well-thought-out system underlying the treatment of the leaf. Hap-hazard manufacture even when carried out by a real artist, a veritable Mrs. Beeton amongst teamakers, will not allow repetition of success with any degree of certainty, and can only serve to confuse the plain cook next door. A tremendous amount of work has already been done in this direction and we shall hear more on the subject of Factory Organisation from Mr. Whitehead. Meanwhile I shall endeavour to give you some idea of the work we are undertaking upon the fundamentals of tea manufacture and some indication of the progress made. Some of the results of recent applied research have been appearing in *The Tea Quarterly*, so today I shall describe some of the less obvious problems whose solution is essential to the rationalisation of teamaking.

The foremost problem in experimental tea manufacture has been to evolve a system for assessing the quality of the teas made, since we obviously cannot get anywhere until we can say with certainty that any particular experiment has resulted in improvement or otherwise. During my first two years' work here I spent a good deal of my time studying means of making the best use of tasters' opinions. A mere valuation in cents does not convey all the information we need. Two teas from an experiment may be worth the same price, one being outstanding in one character and one in another. Thus, prices would not help us in connecting individual causes with individual effects. To obtain more detailed specification of experimental teas I devised a form such as that shown in Table I. Individual bias on the part of the taster is avoided by the expedient of group tasting, under which system the individual tasters first fill in their own forms and then later discuss outstanding disagreements, which are often due to an individual being in the habit of judging for a particular market. All tasting is done before the identity of the samples is disclosed.

The tasting of our teas is carried out by one group in Colombo and another in London, and I should like to take this opportunity of paying a tribute to the keen assistance received from all concerned.

This system has given us consistent and useful information about our experimental teas and has evidently appeared sound to the Indian Tea Association Commission who commented in their report as follows:—

"Shortly after discussing quality specification with London brokers a member of the Commission visited Ceylon. He found there, already working, a system for judging teas from experiments. It proved in all essentials the same as that which had shaped itself in the London discussions. Ceylon, we venture to say, has made a most important advance in bringing quality under critical study. Their initial success is an incentive to other countries and their experience will be a valuable guide."

TABLE I.

*Report on Experimental Teas.*

Name of Taster.....

Firm.....

Number	Appearance	Colour	Strength	Flavour	Quality	Pungency	Valuation
1111		TO BE	TAKEN	AS	STANDARD		
1112							
1113							

Please value Standard and use the following terms:—

- (a) *Marking up above the Standard.*
1. Slightly better (S.B.)
  2. Appreciably better (A.B.)
  3. Superior (S.)
  4. Much superior (M.S.)
  5. Very much superior (V.M.S.)
- (b) *Equal.* Symbol (E)
- (c) *Marking down below the Standard.*
1. Slightly worse (S.W.)
  2. Appreciably worse (A.W.)
  3. Inferior (I.)
  4. Much inferior (M.I.)
  5. Very much inferior (V.M.I.)

Special notes or remarks on any, or all, of the samples:—

Such a system is essential before any advance can be made with a subject like rolling, the fundamental principles of which are now being studied. Each of our experimental rollers has been equipped with a  $1\frac{1}{2}$  h.p. motor and an instrument recording the work done. Spring pressure is replaced on these rollers by the addition of weights which apply a constant and known pressure, that is to say, we employ deadweight pressure instead of spring pressure. The dynamic side of rolling is thus maintained constant, thereby facilitating accurate comparison of, for example, batten types. When batten types are exactly similar two of these rollers charged with equal amounts of well-bulked leaf, running at equal speeds with equal pressure applied, give the same dhool out-turn to within an ounce of each other. The power consumed is also the same in both cases. When these teas are fermented and fired the tasters are unable to distinguish them from each other. Furthermore when these dhools are sifted, the weights of the fractions passing through 10-mesh, 7-mesh, and 5-mesh are found to be equal, and if the bulk and dhool are soaked in water, allowed to untwist, and then spread out and examined critically it becomes apparent that the leaf has undergone similar treatment in both rollers. This latter method of dhool analysis has an additional advantage in that the analysed samples may be printed out as blue prints and thus made into permanent records. Human memory as a source of error is then eliminated and the method was worked out in these laboratories for the sake of accurate records and the avoidance of any guesswork. Illustrations of this method appeared in *The Tea Quarterly*, December, 1935. Thus a fundamental principle has been clearly established, namely, that rolling can be accurately controlled and is not a process of chance. Typical of research on tea manufacture, the proof of this elementary point has cost a considerable amount of money and almost two years of time when the work necessary to devise apparatus and method are included.

Ways and means now being available, a considerable scope for investigation of rolling problems has been opened up, and we have been able to compare with considerable accuracy, the performance of our experimental rollers in comparison to commercial rollers. We are now satisfied that our experimental rollers are fully comparable with the commercial size roller, and the tasters have not been able to distinguish the teas made with the experimental rollers from teas made with a commercial roller under similar conditions.

The effect of the form of roller batten upon rolling performance has now been investigated to some extent and so far as we have gone, progress with each particular problem has been marked by the number of other problems raised. As the results obtained have not yet been applied on a commercial scale, I will abstain from connecting the names of the battens employed with these results, and will purposely designate them as batten Types X, Y and Z. Without prejudice to this object I can say that these battens corresponded very closely to the general forms of roller tables associated with the names, Reeves, Jackson's and Lamont Michie. A programme of four rolling periods with gradually increasing pressure was adopted in these experiments and the B.O.P. taken from the first three dhools was sent to the tasters. As shown in Table IIA, one type, namely, X battens proved to be the most efficient from the mechanical point of view, followed by Type Y, and Type Z. That is to say, for a given consumption of power, Type X battens turned out more dhool than Type Y, and Type Y more than Type Z. The Type X battens turned out almost twice as much dhool as Type Z battens per unit of power consumed. When the resultant teas went to the tasters, those from Type Z battens were valued well above those from Type X battens, with Type Y again occupying an intermediate position. Thus there was an inverse relationship between dhool out-turn and price. As shown in Table IIB, differences in valuation sometimes amounted to as much as 3 pence per pound. In every case the B. O. P's. from the teas on the Type Z battens were preferred on appearance to teas made on both the other battens. The colour and strength of Type Z teas were inferior to both Type Y and Type X, but quality, flavour and pungency, if present, were superior.

The value of detailed specification of teas from an experiment of this sort is demonstrated very clearly when there happens to be a strong market for tip. On these occasions the value of tippy teas appreciates out of all proportion to their superiority in quality and flavour while their colour and strength may be definitely inferior to the less tippy teas. In a series of experiments lasting from June to December there has scarcely been a single exception to the findings I have described. The minimum difference in Colombo values between teas from these experiments was 1 cent and the maximum 9 cents. In London the minimum difference was 3 farthings and the maximum 3 pence. Throughout all these experiments the ratio of the dhool out-turns between battens was practically constant and of the order given in Table IIA.

TABLE II A.

*Showing Out-turn and Valuation of B. O. P. of Dhools 1 to 3 rolled under identical conditions of speed and pressure.*

Date	Battens	% Moisture in withered leaf	% Out-turn of dhools 1-3	Valuation of B.O.P.	
				Colombo	London
3-9-36	Type X	59.3	46.5	78 cts.	15½ pence
	Type Y	59.3	34.0	77 "	16½ "
	Type Z	59.3	27.3	80 "	17 "
15-9-36	Type X	56.4	47.7	78 cts.	17½ pence
	Type Y	56.4	33.0	81 "	19 "
	Type Z	56.4	24.9	87 "	20½ "

TABLE II B.

*Analytical Specification*

*Group Opinion of London Tasters on Characteristics of Teas as given in above Table.*

Date	Number	Appearance	Colour	Strength	Flavour	Quality	Pungency	Valuation
3-9-36	Type X		TO BE	TAKEN	AS	STANDARD		15½d
	Type Y	S.	S.B.	S.B.	E.	S.B.	S.B.	16½d
	Type Z	M.S.	S.W.	S.W.	S.B.	S.	S.	17d
15-9-36	Type X		TO BE	TAKEN	AS	STANDARD		17½d
	Type Y	S.	S.B.	S.B.	S.B.	A.B.	A.B.	19d
	Type Z	V.M.S.	S.W.	S.W.	S.	S.	S.	20½d

Although the Type Z B.O.P.'s. are invariably valued highest they are derived from a lower percentage of the bulk and it is now necessary to get valuations for all the grades and to estimate the price realised by the whole charge of tea rolled on each type of batten.

An interesting question is raised by these experiments and is concerned with the extra power absorbed, per pound of dhool turned out, on Type Z battens as compared to Type X. Is the extra energy needed by these battens just wasted, or is it absorbed in extra rolling of the leaf thereby making better teas? If we pursued the idea of the mechanical efficiency of the Type X battens to an extreme we could devise a knife batten which would give us a very high dhool out-turn for a very small expenditure of energy, in other words, just chop the leaf up. Thus there must be a limit with every type of batten to the amount of dhool it is *desirable* to turn out.

Examination of the leaf taken at the end of the first roll by soaking and untwisting the bulk reveals the type of action which is proceeding in the roller. With Type Z battens only the bud and top portion of the first leaf will be found to be missing from the flush in the majority of pieces picked out. If hard pressure is applied, or if a more severe type of batten is employed, it will be observed that much more breaking up of flush has occurred. Theoretically, at any rate, there is a great deal to be said for division of leaf in the roller by twisting instead of by cutting and tearing. Just how far this ideal is possible even with the best type of batten depends on several factors, and it occurred to us that unevenness in the withered leaf would be an important consideration. We have found that withered leaf brought down from a factory loft does not by any means consist of evenly withered flush. The average of a number of withered pieces of flush may be fairly constant from day to day, or from loft to loft, or even tat to tat, but the *individual* pieces of flush will be found to vary as in the example given in Table III where you will observe a variation in moisture content from 39 to 68 per cent in a handful of flush gathered from the same area of apparently evenly withered leaf.

So far as our rolling experiments are concerned where withers have varied to the extent of 4 per cent from mean, such variations in the average wither do not appear to have affected dhool out-turn to any marked extent. Whether, or not, variations in the moisture contents of the individual pieces of withered flush affects the twisting and dividing of some of them, thus preventing effective separation of fine parts from coarse parts during the rolling, remains to be worked out in detail, but I would say at the present moment that the behaviour of the various pieces of flush, in so far as being twisted and divided into dhools is concerned, is fairly uniform.

TABLE III.

*Moisture Content of the Constituents of a handful of leaf from the same area of apparently evenly withered leaf.*

	Per cent Moisture
1	43
2	67
3	62
4	39
5	64
6	62
7	68
8	57
9	47
10	43
11	53
12	61
Average	55.5

Variation in the moisture contents of individual pieces of withered flush has led us to investigate the effect of various conditions on the rate of wither of such individual pieces of flush. This is a fundamental problem which has been rather overlooked in the past since we know very little about the actual mechanism of withering. The variations of which I spoke just now are not those due to uneven conditions in the withering loft or to bruising of leaf, but are inherent in the leaf before it is plucked. We have studied the rate of wither of individual pieces of flush under carefully controlled conditions in the laboratory. The effect of high and low humidity, high and low air flow, upon large and small flush and banji, from bushes of high and low jât, different ages from pruning, and so on, have been investigated, and have been found to have relatively minor effects compared to the large variations which are found between pieces of flush picked from the same bush. These variations appear to be due to internal factors. The variation becomes more pronounced when the wither is carried below 65 per cent moisture content, unless very small hygrometric differences are employed. From the latter condition it would appear that slow withering is a means of increasing the uniformity of the wither.

Thus, under present conditions, whilst leaf is withered down to 50 to 55 per cent moisture content, it seems that unevenness in normal short and medium withers is inevitable. We have yet to discover why certain pieces of flush wither so much more easily than other pieces picked from the same bush. It may be that the cell sap is less concentrated in some pieces of flush than in others and that we are withering down to constant concentration of sap contents. Moisture content may not be the dominant factor in withering and although possibly incurring the risk of persecution for heresy I would say that I believe that percentage wither or moisture content within reasonable limits is of less importance in regard to the effect of *withering alone* upon the made tea than is generally supposed.

Nevertheless, in practice, measurement of the percentage moisture in withered leaf is highly desirable because one must, at least, be certain of reasonably uniform material being fed to the driers whose capacity depend on the amount of moisture in the leaf fed to them. I do not wish to decry the importance of measuring the moisture content of withered leaf; far from this I have been to considerable trouble to devise means of rapid practical measurement, and a satisfactory laboratory apparatus was described in my Annual Report for 1934. Since then further developments have taken place and there is now every prospect that similar apparatus in suitable form, will shortly appear on the market. With this apparatus it will be possible to determine the moisture content of three samples of withered leaf in 15 minutes, and also, the time taken for the determination of the moisture content of fired tea will be reduced from 4 hours to 10 minutes.

The rate of wither is not the only variable feature of flush from the tea bush. I indicated at the last conference that I proposed to study the behaviour of the ferments, or enzymes, in tea leaf during manufacture and am now able to report considerable progress along these lines. We have obtained definite indications of variability of the fermentative activity of different pieces of flush before withering. During the withering process the activity of the ferments shows a marked increase. This increase in activity of ferments during withering appears to be partly dependent on length of wither as well as on degree of wither. We have just constructed, in the other section of this loft, an air-conditioned withering chamber capable of withering a charge for one of our experimental rollers, which will enable the effects of these differences in enzyme activity to be

accurately studied. Possibly the most important aspect of this biochemical investigation is the study of the inactivation or destruction of ferments during firing. It must be remembered that the activity of ferments during manufacture will persist until either the moisture content necessary for fermentation is dried out of the leaf or the ferments are destroyed. If ferments are not all destroyed during firing and the fired tea becomes damp, the fermentation will start up again and the tea becomes soft, just as over-fermented teas become soft. After considerable thought, a specification was drawn up last year for a small-scale experimental drier and this has just been installed. This machine is steam-heated and permits of very accurate temperature control. The drying chamber was constructed for us by the Colombo Commercial Co., Ltd., and we are much indebted to Mr. Salmon for the assistance he gave us in giving practical form to our suggestions. The heating units were imported from England on specifications kindly prepared for us by Mr. Ridler of Messrs. Marshall's Tea Machinery Co.

The ferments of the tea leaf are relatively highly resistant to heating, and we have found that, in normally fired teas, there is a considerable residue of potentially active ferments. Roughly three quarters of the enzyme content of the leaf is destroyed by firing, the remaining quarter being merely inactivated by dryness. In passing it may be mentioned that other methods of inactivating the leaf are under investigation, particularly the effect of light of certain wave lengths. Meanwhile it is essential that the tea should be kept dry until it is consumed. In an article in *The Tea Quarterly* some time ago I explained how fired tea will gain or lose moisture, according to the atmosphere to which it is exposed, and since air-conditioned storage of tea is not practised, and is probably impracticable, we must therefore resort to airtight, moisture-proof packages. Metal foils as used at the present moment are moisture-proof when intact and properly sealed but unfortunately they generally lack the mechanical strength necessary to resist puncturing and tearing under the conditions involved. On this account there is little to choose between the ordinary metal foils now in general use, whether folded or sealed, in momi or patent chests. Recently, after a large number of tests with different packing materials, some very promising results have been obtained with a thick strong paper having a very thin facing of metal foil and which may be effectively sealed. In this combination the paper has the requisite mechanical strength and the metal foil renders it moisture-proof. The metal foil, being extremely thin,

is very pliable and is therefore less liable to break along bends or creases.

A lining of this type, in both momi and patent chests, has been tested in a specially constructed chamber maintained at 90 per cent relative humidity. After a month's storage there was not any rise in the moisture content of the teas packed in these chests and although they had been packed on a mechanical packer and roughly handled there were not any signs of punctures or tears in the linings. A few trial shipments have been made with satisfactory results and we are waiting for confirmatory reports from London before recommending this material as a most suitable form of lining for tea chests. The use of rubber and cellulose films which may be heat-sealed is also being investigated. This work provides an example of the close connexion between fundamental problems and practical methods, although at first sight the connexion between enzymes and packing materials might not be apparent.

To sum up, we have proved that rolling conditions may be standardised, and that bulked leaf rolled under identical conditions, except for batten type, may yield teas varying in value 3d. per pound. This has opened up fresh problems because dhool out-turn is involved, the smaller dhools from the same bulk yielding the superior teas. The mechanism of dhool formation by the twisting of the leaf in the roller has led to further experiments which have shown that an apparently even wither only expresses an average result; wide fluctuations remain in the moisture content of different pieces of flush. Following up this observation, the fact became evident that individual pieces of flush from the same bush exhibit widely different behaviour during manufacture. A purely biochemical investigation has revealed the main reason for the liability of fired tea to deteriorate when moisture is absorbed, and a purely physical investigation has revealed the nature and behaviour of fired tea exposed to the atmosphere. Equipped with such knowledge we are able to specify the requirements for packing materials and it is fortunate that a suitable material is now likely to be available to meet these requirements.

Progress in research on tea, as with other natural products, is governed by the complexity of natural laws as well as by the intensity of effort which can be applied to their elucidation. Unfortunately in the case of tea manufacture the facts involved are unusually complicated and on this account the fullest co-operation is necessary

between all those concerned. Provided this is forthcoming there is little doubt that science can assist tea manufacture as it has served other industries.

## DISCUSSION

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The Chairman said that before commencing discussion on this very important paper which he was sure the meeting would agree had been most interesting, he would like to mention that linings of the metallised paper described in the lecture might be seen in the room below.

Mr. O'Brien asked Mr. Lamb whether any further tests had been made with a material called Pliofilm. He said that he understood some initial tests with this material had been made which were fairly satisfactory. He was rather interested because it was said to contain an element of rubber in it.

Mr. Lamb replied that the preliminary tests with Pliofilm were extremely successful, but since then there had been a big delay in the work owing to the fact that the material was not available in sufficient quantities for export from America. He believed that in America, at the time of speaking, milk was sold in paper bags lined with Pliofilm.

Since those tests a tendency for the Pliofilm to age and become brittle had been noticed in the used lining. The first samples of Pliofilm received was one of the early batches made by the Research Department of the Goodyear Company, and it was most probable that this defect has been noticed and overcome. He had, however, taken the matter up with the Goodyear Company. A week or so ago he received material for further experiments; this appeared to be more pliable than the previous sample even when first received.

Mr. D. W. Finley, referring to Mr. Lamb's statement that there was a big difference between individual specimens of apparently evenly withered leaf, but that this with regard to wither alone did not appear to affect the final result, said that additional evidence on this point was brought forward by considering the behaviour of fermented dhools in a pressure drier. The leaf entered the drier at approximately 55 per cent. moisture content. By the time it had reached the end of the third tray it was approximately 8 per cent. It leaves the drier with a moisture content of 2 to 3 per cent. If, therefore, some parts of the fermented leaf entered the drier at 60 per cent., and other parts at 50 per cent., was it not to be expected that this difference would not be apparent in the made tea, because there was bound to be a levelling effect over the last three trays? This confirms Mr. Lamb's suggestion.

Mr. Finley also asked Mr. Lamb whether he considered that difference in wither between the individual specimens in the withered leaf affected the rate or evenness of fermentation or the final infusions.

Also in a recent *Tea Quarterly* it was stated that different types of withering materials had little or no effect on the rate of wither. He would like to ask Mr. Lamb whether he considered that the two sides of each piece of leaf

on the tats withered at different rates? If so, was there any appreciable advantage to be obtained by turning leaf on the tats, especially if the leaf was thickly spread?

Mr. Lamb said that he would take Mr. Finley's second question first. The effect of a number of materials of more open weave than ordinary hessian had been examined and the results were described in his Annual Report for 1935. In brief, it might be said that these materials gave only 1 per cent. harder wither than ordinary hessian under the same conditions. Any differences in the average quality of teas made from the leaf withered on the various materials had not been detected over a period of more than a year.

He had gone into the question of whether the surface of the leaf exposed to the air flow had any effect on the rate of wither, and he had exposed leaf both with the under surface and the top surface to the air flow, but no difference could be detected.

The practice of turning leaf during withering did not receive much support from these observations, but he pointed out that turning leaf particularly when the spread was thick would expose leaf which otherwise would not be exposed to the air flow at all during withering.

Mr. Lamb taking Mr. Finley's first question went on to say that it was not possible, at the time of speaking, to say what effect the variations in the moisture contents of individual pieces of flush had on the evenness of fermentation. He pointed out that he was referring specifically to variations inherent in the leaf brought to the factory. He mentioned in his paper that these variations did not appear to affect behaviour during rolling, and that he had advanced a possible explanation that the leaf tended in fact to wither down to a constant concentration of sap contents. He had also mentioned that differences in the fermentative activity of individual pieces of flush had been observed. From the somewhat meagre evidence in hand, at the time of speaking, he thought it probable that the evenness of fermentation was not affected by the variations in moisture contents of individual pieces of flush.

Further to Mr. Finley's remarks about the behaviour of heterogeneous material during firing, Mr. Lamb pointed out that during rolling, the individual pieces of flush were thoroughly broken up and bulked so that the drier had at least well bulked material to work with. The high-drying potential on the bottom rows would tend to even out any differences which might exist between the fragments of leaf.

Mr. D. T. Richards asked Mr. Lamb whether he could give any idea of the cost of this new material, Kraft Paper.

Mr. Lamb in reply said the Institute had received a few details which led them to believe that the cost of Kraft Paper would be less than most of the present packing materials. The difficulty, at the time of speaking, was for the Customs authorities to make up their minds whether Kraft Paper was in fact a paper or whether it was a metal foil. He believed that paper carried a duty of 15 per cent., and metal foil 2½ per cent.

**Mr. I. L. Cameron** asked **Mr. Lamb** whether he had been given to understand that not only experimental rollers but that a large scale ordinary commercial roller could be absolutely standardised.

**Mr. Lamb** explained that he had compared the experimental rollers with a commercial sized roller under standardised conditions. In this case the commercial roller was equipped with an independent motor and kilowatt recorder, but it was not found to be possible to apply deadweight pressure because of the labour involved in lifting 200-300 lbs. of weights on to the roller cap when pressure was required.

In this case he had resorted to spring pressure applied by a calibrated spring and was assisted by a device (Messrs. Marshall, Son & Co.) on the market, at the time of speaking, which included a dial on which pressure was registered in lbs. weight.

**Mr. Lamb** also referred to another device (Colombo Commercial Co., Ltd.) which applies pressure by means of a motor which cuts out as soon as it is overloaded. The overload trip is therefore, set to produce the required pressure. By means of a time switch the pressure can be applied at any desired interval for any desired period.

**Mr. William Coombe** said that a good deal of trouble had arisen in recent years about linings for tea chests. He would like to ask **Mr. Lamb** whether Kraft Paper would conform to regulations, and whether it would require paper lining. He also enquired whether Kraft Paper would stand up to actual wetting.

**Mr. Lamb** replied that the Food and Drug Regulations with regard to tea chest linings applied only to metals which appear in the schedule of poisonous metals. Provided the metal employed in Kraft Paper or similar paper did not belong to that category, paper linings were not necessary.

He did not think the paper would stand up to wetting for a prolonged period because the metal was in the form of a very thin foil which was rolled on to the paper and fixed by an adhesive. If Kraft Paper was soaked for any length of time the metal foil separated from the paper. If it was only a question of a few splashes as would normally occur during transport in wet weather he thought the paper would most certainly prove quite suitable.

The paper used in Kraft Paper was very tough and non-absorbent and did not become sodden when immersed in water.

**Mr. Stromgren** said that the fine leaves or buds were the most valuable portion of the shoot. The rolling being mainly a process of separation, one might thus conclude that the finer the leaf separated the higher the value of the separated product. If, therefore, the same result of separation as shown in Table II could be obtained by other means, should not then the value of the fine leaf thus obtained be the same, irrespective of the method employed. In other words, must one conclude from Table II that the high valuations for Type Z was due to the design of the table battens?

**Mr. Lamb** replied that he thought the batten was of prime importance. The design of the batten appeared to govern the amount of separation of the finer

parts of the leaf from the coarser parts. When tippy leaf came into the factory and two rollers with battens of the Type X and Z were charged with the same well bulked leaf the separation of tip by batten Z was most marked. More power was consumed in rolling by this type of batten and presumably must have some effect upon the leaf.

**Mr. W. H. Brymer** asked Mr. Lamb whether pressure was not the governing factor in dhool out-turn.

Mr. Lamb replied that that was the case. If hard pressure was used with one of the battens which gave a small dhool out-turn then of course the dhool out-turn was raised; but his point was that the three types of battens given in Table II were being considered under exactly the same conditions of pressure and speed and in this case it must have been the batten which caused the higher dhool out-turn. As a matter of fact he had caused types X and Z battens to give similar dhool out-turn by varying the pressures. Unfortunately there were not any reports available on the resultant teas as they had not come in at the time of speaking. The reports on these teas should answer questions as to whether the batten has any intrinsic effect on quality.

**Mr. J. P. Blackmore** asked Mr. Lamb if he could give any idea of the percentage of the various grades turned out by battens X and Z.

Mr. Lamb replied that he was sorry he had not the actual grade percentages to hand, but they could be given afterwards.

**Mr. Blackmore** enquired if the reports and valuations for the other grades as well were available.

Mr. Lamb replied that the teas had been sent for valuations but that the reports had not yet been received.

The Chairman then called upon Mr. Whitehead to read his paper.