A REVIEW OF TEA MANUFACTURE IN 1941

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It is often said that human affairs can never mark time; they either progress or retrogress. Teamaking is still in 1941 a human affair, partly an art and not exclusively a science, although much progress has been made in the matter of scientific control and in mechanisation. Enlarging on this point, it may be said in general terms that science in teamaking is largely a matter of aiding, rationalising, and eventually reducing to a formula, personal judgment.

Without the aid of scientific methods it is scarcely possible to detail a successful method of manufacture. Mechanisation permits the application of scientific methods with precision and reliability, but we have not reached the stage where tea leaf can be delivered to pre adjusted machinery and chests of high quality product turned out without further human intervention.

Nobody will dispute the fact that teamaking is a matter of a good deal of personal judgment and I doubt whether anybody will dispute the folly of trying to mark time which is tantamount to slipping backwards.

At the present moment we are in a position where the temptation to attempt the impossible feat of marking time is very strong. Government contracts and high local prices are tending to stifle the progressive spirit which is stimulated by open competition, and if this state of stagnation persists we shall find that standards of manufacture and quality will inevitably deteriorate.

The theme of this article is an earnest appeal to all concerned to prevent this deterioration gaining impetus. I will not go so far as to say that any deterioration has actually started, but I will say that there are some signs and symptoms if recent circulars on the subject of foreign matter be taken into account.

In present circumstances nobody can reasonably expect the normal rate of progress to be maintained as there are many difficulties to be faced both outside and in the tea factory, not the least of which

is the question of materials which I will enlarge upon later on. I maintain, however, that some rate of progress, however slight, must be aimed at in order to prevent or reduce trouble in the future.

I have expressed my fear of deterioration in the general level of quality of Ceylon tea. Some will deny the fact that the general level of quality has improved in recent years, and will say that Ceylon cannot make the same quality teas that were made fifty years ago. On the evidence available I do not believe any such statement, but apart from this I must explain that in this article I am employing the word "Quality" in a wider sense than it is used in the factory: the sense in which "Quality" is used in general commerce. The quality of a commercial product involves many factors which in the case of tea are perhaps more than usually complicated. Amongst the factors for tea are:—

(1) *Suitability for Some Special Purpose, e.g.*, blending, direct packing, or special demands (O.P's, tippy teas, etc.). Varying combinations of other factors are involved: (a) Appearance, (b) Strength, (c) Colour, (d) Pungency, (e) Flavour, (f) Size of grades and weight per chest (suitability for packing and blending machinery), (g) Keeping quality, (h) reaction to milk, etc.

(2) *Standardisation.*—Marks which are known to be reliable in respect of certain characteristics undoubtedly command a premium in the same way as other trade marks establish a reputation for reliability and are bought by those unwilling to experiment with unknown brands. Even the container has a sales value. In the case of tea chests the chests and the linings have a second-hand value and badly packed teas liable to damage in transit are naturally avoided by buyers. Our experiments with new lining materials forcibly demonstrated the value which buyers place on scrap metal foils. Under peace-time conditions they rejected certain linings solely because they lacked scrap value, unfortunately in spite of superior moisture-proof qualities.

(3) *Foreign Matter.*—Freedom from obvious foreign matter is of the greatest importance to any commercial product and may even involve legal proceedings where the foreign matter is objectionable or deliberately added (see 4.)

(4) *Conformity to Food and Drug Regulations.*—Regulations concerning foods and drugs tend to become more and more stringent and it must be recognised that such regulations are very desirable. In the case of many products, including tea, they protect the *bona fide* producer from competition by substitutes and adulterants and by resale of re-dried spent leaves.

The importance of factors such as (3) and (4) is not generally realised and will be dealt with more fully later in this article.

Research on tea manufacture is concerned with all these factors and is sometimes monopolised for some considerable time by special circumstances such as a Food and Drug Regulation which demands special attention to some particular feature of production.

Research on tea manufacture is not therefore solely a search for the best rolling pressure or firing temperature but a systematic investigation of the whole field of quality with the object of raising the general standard of the industry's products. Likewise progress in the factory is a matter of attention to all the factors involved in the wider conception of quality following, but not necessarily waiting for, the lead given by research.

I have called this article a review because I intend to cover, as far as possible, the whole field of quality and this I shall do in roughly the same order as that in which I have already enumerated the factors concerned. The review is therefore divisible into three parts:—

1. General Manufacture.
2. Foreign Matter.
3. Tea in relation to Food and Drug Regulations.

1. GENERAL MANUFACTURE

Success in tea manufacture is undoubtedly based on attention to detail and the production of teas of uniform quality, possessing the characteristics most desired by the buyers in the particular market in which the teas are sold. There is a good deal of confusion of thought and advice in this matter and to me it appears that the normal channels through which information about buyers' requirements filter through to those concerned with manufacture, leave much to be desired In our reports on various investigations concerned with manufacture we have repeatedly stressed the difference in the requirements between a buyer in London and a buyer in Colombo, and the work with the Clivemeare roller brought out further differences between the various London buyers and, in particular, between the blenders and others.

These differences are sometimes very striking, judging by comparison of reports on identical samples. Furthermore, they are not due to chance but are very consistent, and we have had every opportunity of proving this since many hundreds of experimental samples have been sent to tasters engaged in all the various markets of the tea trade.

An understanding of buyers' requirements is therefore of great importance, but at the same time it is essential to maintain a uniform level of quality if the buyers' confidence is to be gained and kept. Thus we arrive at the point where we must consider the first and foremost practical step in the factory — organisation.

Some of the best organisation is done before the factory is built, for much ultimately depends on withering space and facilities and the regular supply of adequate batches of withered leaf to the rollers. Again, in the rolling room good accommodation in the rollers is to a large extent invalidated if the roll-breaking accommodation does not match, since rollers are kept waiting for the roll breaker and certain desirable combinations of rollers may be impossible on this account.

Finally, a good consistent output from the rolling room necessitates matched capacity in the drying room or else leaf accumulates on the fermenting tables and the fermentation period has to be longer and longer as the day passes.

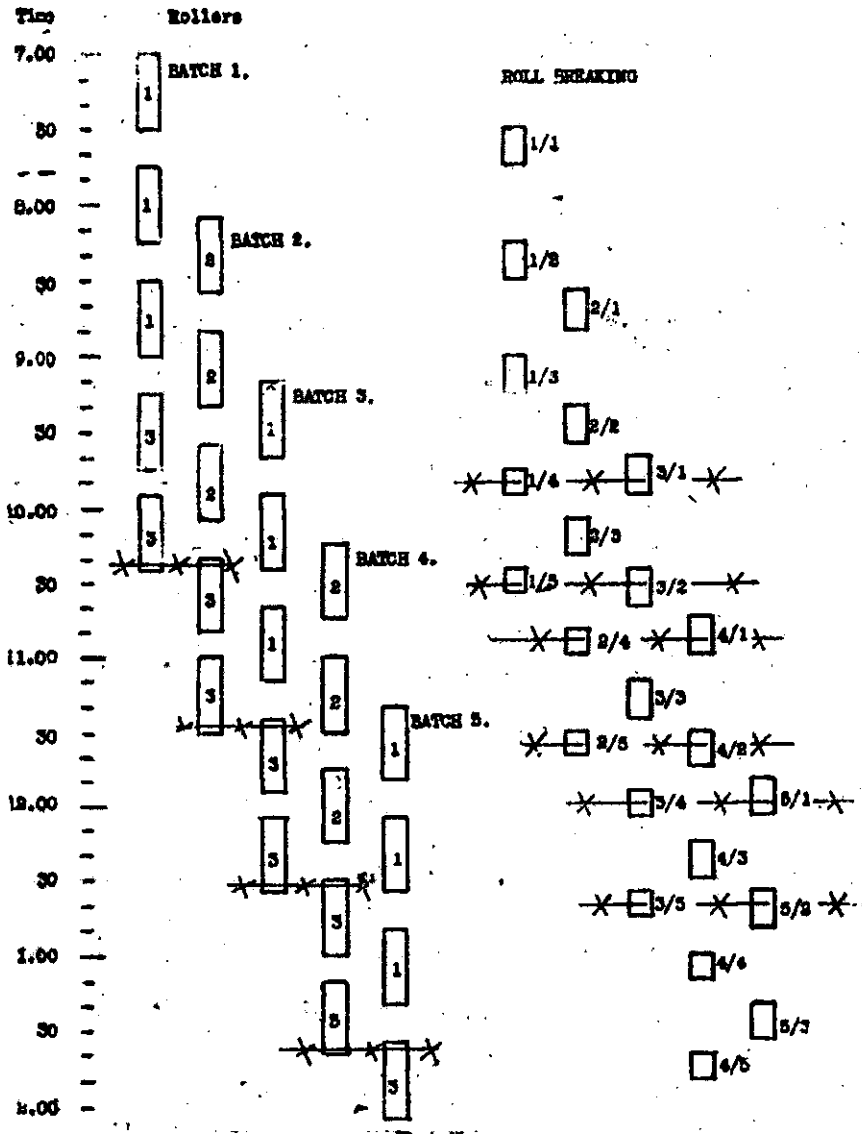
Clearly therefore equipment must in the first place be carefully planned and in the past this has been badly neglected. There has been much improvement in this respect in recent years but it is remarkable how many factories even now have badly matched capacities in the equipment of rolling and firing rooms. Reference to this point was first made several years ago in *The Tea Quarterly* and since that time it has been stressed repeatedly.

In 1937 Mr. F. J. Whitehead gave a paper on organisation at a T. R. I. Conference, a full account of which appeared in *The Tea Quarterly*. At the last Sub-Conference Mr. Whitehead enlarged on the same subject and made very valuable suggestions for certain compensations such as those for rise of temperature in the fermenting room towards mid-day.

Close attention to the matter of organisation has revealed many glaring mistakes which had been overlooked since the industry began. The numerous successive stages make tea manufacture a complicated business and extraordinary mistakes can be overlooked until the whole process is systematised.

A common fault in the past has been to charge more rollers in a given period than the firing machines can deal with. Consequently fermented leaf accumulated as the day progressed and it became impossible to control the fermentation period after the first set. Suppose for instance 400 pounds, approximately, of leaf are charged into the rollers at 7 a.m., 400 pounds at 7-45 a.m., 400 at 8-30 a.m. and so on (*e.g.*, two rollers with 200 lbs. = 400 lbs.; 1st roll of 30 minutes plus 15 minutes for emptying and recharging =

Diagram I.



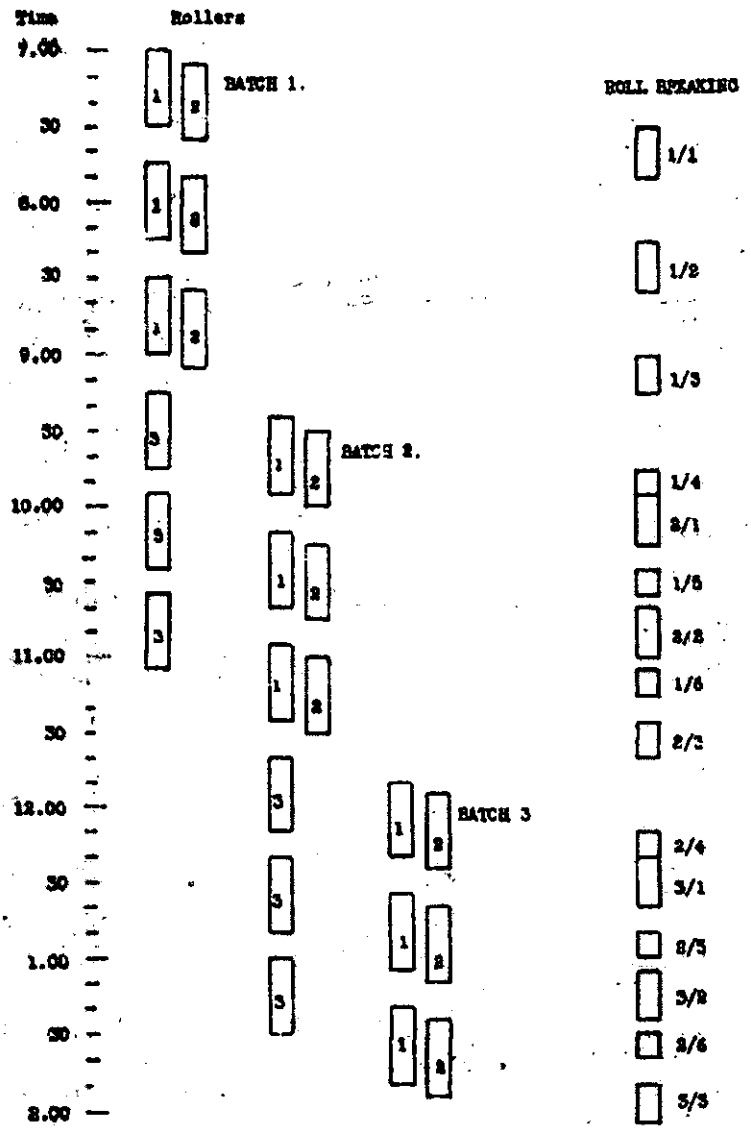
Details.

5 Roll-programme for 3 rollers and 1 roll-breaker.
Charge — 260 lb.
Charging interval — 65 mins.
Out-turn rolled leaf — 3.8 lb. per min.

Comments.

This is a badly arranged programme. There is confusion in the use of rollers, as No. 3 roller is required for fourth and fifth rolls of different sets for recurring periods of five minutes, viz., 10.20 to 10.25, 11.25 to 11.30, etc. In practice the rolls would be cut short or the leaf would have to be kept waiting for the roller. The use of the roll breaker is also badly arranged and if two were available they would probably be employed involving extra labour which could be saved by better organisation.

Diagram II.



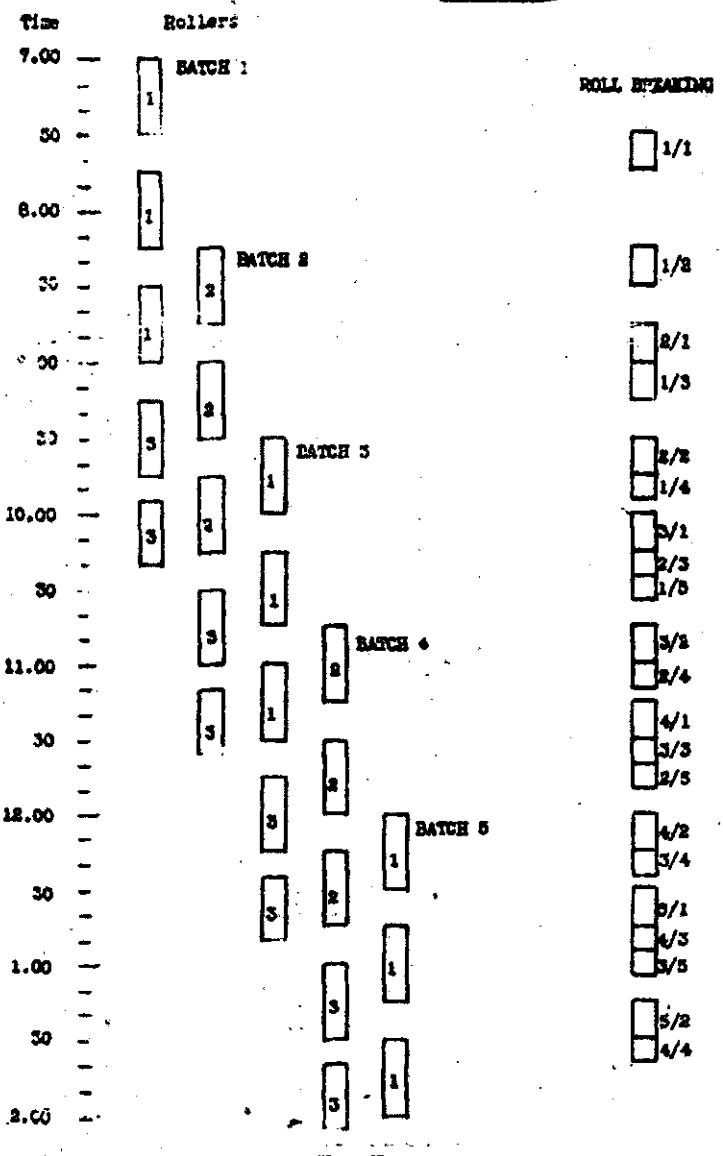
Details.

6 Roll programme for 3 rollers and 1 roll-breaker.
Charge — 580 lb.
Charging interval — 145 mins.
Out-turn rolled leaf — 3.8 lb. per min.

Comments.

This programme is well arranged, but charging two rollers and the consequently large charge gives the drier 145 minutes work assuming need of the same drier as in Diagram I which has a capacity of 3.8 lb. per minute. There is a very long interval between the first and last leaf fired and danger of over-fermentation of some dhools.

Diagram III.



Details.

5 Roll programme for 3 rollers and 1 roll-breaker.
Charge — 300 lb.
Charging interval — 75 mins.
Out-turn rolled leaf — 3.8 lb. per min.

Comments.

A well arranged programme using rollers and roll breaker with maximum efficiency. Fifteen minutes are allowed for roll breaking first and second rolls and 10 minutes for later rolls. The drier will fire the whole of each batch in 75 minutes.

45 minutes). This corresponds to 9.0 lbs. of leaf per minute being produced in the rolling room. Now if the drier can only deal with 8.0 lbs. per minute, fermented leaf begins to accumulate because each batch of leaf takes 50 minutes to fire whereas the rolling room is dealing with it in 45 minutes. Thus if it is decided to start firing at, say, 2 hours 30 minutes it will not be possible to start the second batch until 2.35, and by the time a sixth batch is fired the time becomes 3 hours. Such mistakes are common and are particularly liable to occur when there is a rush of leaf and the teamaker is anxious to speed up manufacture as much as possible.

The order in which rollers are used also requires careful planning, otherwise one roller may be required for say the fifth roll of the first set and the fourth roll of the second set, (see Diagram I) with the result that one roll of leaf has to wait until a roller is ready or else it is combined with another batch of leaf. Unless programmes are carefully mapped out such pitfalls are abundant and indeed it is practically impossible to foresee snags unless the rolling programme is set out in the form of a diagram.

The first thing to do when planning a programme of manufacture is, therefore, to find the exact capacity of the firing machine at the temperature at which it is to be run. A firing machine should be run slightly under capacity, *i.e.*, spreading a little thinner than the maximum to allow a margin for adjustment when the wither is softer than usual or when a charge slightly larger than planned has to be used.

This capacity in pounds per minute is the capacity which the rolling room must work at and the rate at which withered leaf must be prepared for rolling.

The interval at which the rollers are to be charged must next be decided and this interval in minutes multiplied by the capacity (in pounds per minute) of the driers gives the charge for the rollers.

It is usually necessary to ponder over these figures for some time as there are several other things to be fitted in The rollers must be capable of dealing with the charge at the decided intervals and must be charged and discharged at specified times. Arrangements must also be made for roll breakers to be free when required. Diagrams 1, 2 and 3 illustrate these points. Normally it is desirable to charge at intervals of the order of sixty minutes or else the difference in time between the longest and shortest fermentation is too much and the later fired dhools become over-fermented. This interval is a matter for much experiment according to conditions, and some estates have found intervals as short as 40 minutes give good results.

The roll breaking intervals for the first rolls can usually be reckoned at 15 minutes and the later ones at 10 minutes but there again if roller charges are small shorter intervals may suffice. Further details are given in Mr. Whitehead's articles already quoted and these articles should be studied when planning programmes.

Without carefully planned organisation it is impossible to obtain consistent results or to apply with best effects the results of research on other aspects of manufacture. For instance, it has recently been proved that firing temperatures above 190°F. are injurious to quality. If a factory formerly employing an inlet temperature of 200°F. drops to 190°F, the capacity of the firing machine would be reduced with the result that unless the programme is modified fermentation times would increase owing to accumulation of fermented leaf and thus results, instead of improving, might easily deteriorate. Again, it is still not uncommon to find firing capacity greatly in excess of rolling room output. Here there is no danger of accumulation of fermented leaf and lengthening fermentation periods, but the drier runs empty between batches. In this case firing cannot be uniform since the leaf first passing through an empty drier is dried out much too rapidly and the bulk of the day's work is a mixture of leaf fired under a wide range of varying conditions. Gaps in firing programmes also mean waste of heat and high firing costs.

Organisation, even if it fails to bring about immediate improvement, enables new methods to be given a fair trial and when the best methods are found it enables the level of quality to be maintained. Apart from this, however, power, fuel and labour costs may often be reduced by attention to detail and choice of the most economic methods. For instance, three or four labourers may be employed on a roll breaker which can be dispensed with if the rolling programme is slightly altered (see Diagrams I and II) or, again, planned programmes may reduce the length of the working day and reduce overtime pay expenses.

The examples I have given all refer to small factories; the larger the factory the more vital becomes the question of organisation and, in general, large factories are much better organised than small ones. Once thorough organisation has been achieved all subsequent modifications are much simplified, record keeping is reduced to a minimum since there is no point in recording the same figures day by day, and the whole process of manufacture becomes infinitely easier to supervise.

Rolling appears to offer scope for considerable improvement and our experiments are now beginning to show promise of practical results. The experiments with the Clivemeare roller reported in

previous publications indicated that considerably improved liquors and infusions could be obtained by drastic methods applied over a comparatively short space of time and London blenders shewed great interest in the Clivemeare teas. Unfortunately, the Government contract specifications requiring grade percentages at the average figure for the previous three years, and the general state of uncertainty, ruled out a wider application of Clivemeare methods in general practice. From all but the blenders point of view, the appearance of Clivemeare teas was also too unorthodox to gain popularity in present circumstances. I feel certain that the Clivemeare roller, perhaps modified, will eventually establish itself but in the meantime it has undoubtedly opened up new lines of research.

The latest series of experiments has demonstrated the necessity for the employment of two different types of battens in normal rolling procedure, one for twisting without producing much dhool, and the other for cutting up the bulk when the twisting has been completed.

Cutting battens alone do not produce the best results, the reason being that the ordinary roller is too clumsy a contrivance to produce any effect on minute fractions of leaf of the size of ordinary dhools.

Upon the twisting action depends the satisfactory expression of juice and the rate and extent of fermentation. Unless leaf is thoroughly crushed, which is no easy task, unfermented tannin remains in the leaf when it is taken to the drier with resultant loss of strength and quality, and the formation of undesirable products when the fermented tannin is heated in the drier.

Our work on the biochemistry of tea is beginning to throw light on these processes and affords a useful guide to the solution of factory problems.

A number of commercial types of battens have been tested and information is now available to anyone interested. It is not desirable to publish comparative tests between battens marketed by different firms as each individual rolling problem should be considered on its merits. We have suggested, however, that commercial types should be offered as twisting or cutting battens and a distinction drawn between the various alternative centre battens usually available with each type. The reason for this latter caution is that we have found, by starting from a plain wooden table, that the greater part of the batten action takes place at the centre of the table and we have obtained 40 per cent of dhool in a single roll from a simple device screwed on the door of an otherwise plain table.

A shallow plain cone gave good results on a twisting table, but when two circular grooves were cut on the cone the table became a quite satisfactory cutting arrangement. The problems now being studied are how to get the maximum twisting action in the minimum of time and how quickly to reduce the bulk with cutting battens without making too much fannings, dust, and flaky leaf. Generally, it appears that the present tendency in general practice is towards over rolling. If a given type of batten has not achieved the desired result in two or three rolls it seems unlikely that it will do much better in four or five. Long rolling programmes mean a long interval between the first and the last dhools fired and the juice expressed in the first roll becomes over-fermented. (*Note.*— This expressed juice is not necessarily in the first dhool — it may be in the Big Bulk).

Certainly the gradual expression of juice stage by stage is most undesirable because, once exposed to the air, fermentation of juice is a rapid process and part may get badly over-fermented with consequent dull liquors and infusions.

The whole idea of five and six rolls appears therefore to be a faulty one; the juice should be expressed as quickly as possible so that it will all ferment over the same period. High dhool percentages do not, however, mean complete expression of juice, the reverse is often the case. Leaf could be cut into small pieces with scissors without exposing but a small fraction of the total content of juice.

The main rolling problem in a nutshell is, therefore, to express juice completely and quickly without loss and without spoiling appearance and making too much dust, flaky leaf, and fannings. It offers much scope for ingenuity and is a problem which can be tackled on estates as well as at the Institute.

This may seem an obvious problem, nevertheless it has taken some considerable time to prove that these are the lines on which future work must concentrate.

In firing there has been an enormous improvement in the past few years. The improvement is not the result of any very fundamental changes in drier designs although drying machines have undoubtedly been improved, but is due to attention to detail. The Institute has a fair claim to some of the credit for these improvements. Firstly the moisture balance was introduced for the control of moisture content, then attention was drawn to exhaust temperatures as an index of firing conditions, while at the same time the closest co-operation with engineers has been maintained. Whereas six or seven years ago even new machines were frequently run badly

out of adjustment, very little interest being taken in technical adjustment so long as mechanical performance was satisfactory, drying engineers now carry sets of sensitive thermometers, anemometers, pressure gauges, CO_2 recorders and all the equipment necessary for fine adjustment and service. Consequently driers are adjusted to give even spread, air flow is even, output is satisfactory, thermometers are checked and fuel consumption is usually much reduced. Drying is becoming a precision operation and it is rarely that the Institute's officers discover serious faults in any but the very oldest machines.

Recently it has been proved conclusively that in a single firing operation, firing above 190°F. is injurious to quality, and that while firing at 160°F. produces teas of better quality when fresh, these teas are uncertain in keeping properties even when stored at low moisture contents. Whatever the inlet temperature the exhaust temperature must not be allowed to fall below 120°F. because below this temperature undesirable conditions are set up on the top row of trays. Similarly the exhaust temperature should never go above 135-140°F. A modern drier can be run between 125 and 130°F. without difficulty, and under these conditions will produce brisk teas for an economical consumption of fuel.

At the present moment work is in progress, and is nearing completion, on the question of the most suitable moisture content to which tea should be fired. The results of these experiments appear to be a foregone conclusion as 3-4 per cent has given consistently better results with both fresh and stored teas than 1-2 or 4-6 per cent.

These conclusions are drawn from the results of hundreds of experiments carried on throughout the various seasons and, although they have not indicated the necessity for any wide deviation from existing practices, they do define the best firing conditions and settle points which have been the subject of controversy.

Before completing this section on general manufacture, the results of the experiments on individual high-yielding bushes must be briefly mentioned. That individual bushes have been found to vary widely in the quality of the leaf they produce is an important fact and indicates the improvements in quality which may take place when clones are proved and vegetative propagation becomes a practical possibility, a hope which is quite likely to be realised.

2. FOREIGN MATTER

Whatever the rights and wrongs of the case are, the demand for hygienic methods of food manufacture is a very real one and,

furthermore, it is permanent and will become more insistent in the future. There has been a marked tendency in Ceylon to avoid the issue in this matter. Weighing up the impurities which have come to light in the form of complaints and expressing that weight as a percentage of total exports is useless. Even though this percentage may be an exceedingly small figure, the presence of *any* adventitious matter is greatly resented by buyers and brings the particular mark concerned into disrepute.

Each single impurity must be regarded as a potential complaint in which case an ounce of odds and ends, representing some minute percentage by weight, may represent fifty potential complaints.

Another excuse put forward is that impurities find their way into tea during bulking and blending and other operations subsequent to departure of the tea from the factory. This may be so, but it does not behove us to accuse other people until our own case is indisputable. I have even heard the whole question attributed to propaganda designed to sell machinery. It is no use trying to fool ourselves ; impurities can find their way into tea as they do into every other foodstuff and this is because of breakdowns or omissions in the hygiene of manufacture. I repeat that the public demand for hygienic methods in the manufacture of foodstuffs is a very real and insistent one and, even if only because "The customer is always right," we must conform to those demands. That the demand is strongest in America where we are trying to enlarge our markets, and where we shall have to sell in exchange for munitions of war is a fact which makes the matter even more important.

In recent years there has been a big development in hygienic methods of manufacture and the Tea Research Institute of Ceylon has taken the lead in the matter though, for obvious reasons, considerable restraint has been exercised in reference to this work in our publications. The subject has, however, been discussed in conference and at St. Coombs factory many devices to promote hygienic manufacture can be seen. We have also kept in close touch with engineering firms on this subject and there is really little excuse for lack of progress anywhere. A great deal of time, trouble and money has been spent in many factories all over the Island in improving hygienic conditions, and those who do not endeavour to keep up with the average are doing a great disservice to the tea industry of Ceylon which should not be permitted to continue.

So far as foreign matter is concerned, the essential part of hygienic manufacture is the elimination of the floor as a harbour for leaf once it has been sifted after withering. Although efforts may

be made to keep the floor clean it is the inevitable harbour of everything that falls, and mixing of leaf and foreign matter is almost unpreventable if the leaf is allowed to come in contact with it.

Fermentation, even when concrete is preferred as a surface, (and it has many advantages) must be carried out on raised platforms or tables and not on the floor as it is quite impossible to guarantee otherwise that the most carefully planned schemes will not allow the accidental inclusion of foreign matter.

Taken in order, the following points have all proved their worth:—

1. Withered leaf sifters.
2. Chutes with canvas extensions to allow withered leaf to be fed direct to the roller.
3. Designing or, in the case of existing machines, raising the rollers to allow of trolleys of ample capacity to receive discharged leaf.
4. Basins or Scoops for feeding leaf to roll breakers.
5. Design or, where possible with existing machines, adaptation of roll breakers to feed into trays or basins.
6. Raised fermentation tables or fermentation trays.
7. Trays for the reception of leaf discharged from the drier.
8. Rejection of all leaf falling on the floor.
9. Careful binding of boxes for storing dhools to prevent splinters of wood or nails, arising from wear or accidental damage, finding their way into the leaf. Trolleys should also be lined with sheet metal to exclude splinters. In the case of roller trolleys the door when allowed to fall unchecked often splinters the trolleys.
10. Raised platforms for picking over.
11. Magnetic cleaners and travelling inspection belts attached as feeding mechanism to packers.
12. Inspection of chests immediately before packing.
13. Uniforms for all factory labour and insistence on rules and regulations with regard to bangles and jewellery. The uniforms should have the minimum of pockets and the remaining pockets should be deep to prevent accidental loss of articles from them.

14. Adequate provision for washing or wiping feet or shoes at the entrance to factories and exclusion of all animals.

15. Regular inspection of brushes, and brooms and rejection of worn equipment. Prompt attention to wear in concrete areas.

16. Exclusion of all unauthorised persons from the factory.

Many other points will doubtless suggest themselves but most of the above have arisen in practice.

Hygiene is not merely a matter of reluctantly giving way to demands, for it has many advantages. Scrupulous cleanliness avoids dangers from taints and Benton in North East India has shewn that certain specialised bacteria which may proliferate in stale tea juice will give rise to products causing taints and initiate certain fermentation processes giving rise to dull infusions and soft liquors. The normal fermentation process is due to enzymes (ferments) contained in the leaf itself and fermentation caused by micro-organisms is unnecessary and so far as we know wholly undesirable.

We are carrying out experiments on these aspects of hygiene and, although it appears that dangers to quality from this cause are small in a normal hygienic up-country factory, there is evidence to suggest that sterilisation of machinery in low-country factories, by means of blow lamps at the commencement of each day's work, may have beneficial results. Whatever the elevation, however, taints will arise from lack of attention to hygiene.

3. TEA IN RELATION TO FOOD AND DRUG REGULATIONS

The necessity for Food and Drug Regulations is obvious, and the general public of most civilized countries are safeguarded by legal enactments. Such acts protect not only the consumer but the producers as well since wholesale adulteration is contrary to their interests.

Tea adulteration was formerly a common practice in England, many leaves such as those of Plum, Poplar, Willow, Sloe, Elm, and others having been used fraudulently to increase the bulk of genuine tea. Thus in 1872, thirty-six out of forty-one tea samples in Birmingham were found to be adulterated.

The sale of Food and Drugs Act of 1875 although mainly repealed and replaced by such acts as the Food and Drugs (adulteration) Act of 1928 still stands in respect of those sections relating to tea.

In America acts "To prevent the importation of impure and unwholesome tea" date back to 1897 with amendments in 1908, and 1920. Canada, Australia, New Zealand, South Africa, Iraq are amongst other countries which have enactments regulating the importation and sale of tea.

In recent years the enforcement of these acts has been increasingly rigid and, although it is not necessary for the individual Planter to study these rules and regulations in detail, it is imperative that he should be aware of their existence and appreciate the necessity for ensuring that all Ceylon Teas exported from the Island conform to all Food and Drug Regulations.

Later investigations became necessary in regard to the occurrence of traces of lead in tea in excess of the limits imposed by the Food and Drug Regulations. A very thorough investigation of this question by the Tea Research Institute indicated that this was due mainly to the use of unprotected lead foil in packing or of lead coated machinery. The matter was easily put right and a subsequent analytical survery of Ceylon teas showed that such contamination had been, for all practical purposes, eliminated.

The object of regulations governing the sale of food and drugs are mainly:—

1. To prevent the consumer from injury to health.
2. To protect the consumer from fraud.
3. To protect the producer from unfair competition.

Injury to health may result from the use of poisonous facings, dyes and preservatives or from accidental inclusion of poisonous metals. Thus in 1923 difficulties arose from what was then a common practice, the facing of green tea with potassium ferrocyanide. This practice was stopped and is of academic interest only now since green tea is no longer made in Ceylon.

There has been a tendency when any complains of contamination or foreign matter have been received to attribute these to propaganda by rival traders in other beverages and stimulants. There is, however, not the slightest basis to support such an explanation. A brief appreciation of the general situation will show that not only tea but all beverages and stimulants are subject to examination by Public Health Authorities. The more frequent references now made to such regulations merely indicate the growing and very proper insistence on more rigorous standards of purity in all materials used as foods or beverages.

Fraud is now uncommon and adulteration by foreign leaves rare. Spent tea leaves may be re-dried and in some cases coated with gum or starch and rolled into small balls with sand and grit.

During the 1914-18 War a product called "Roka" was the subject of prosecutions. This was a compound of cereals, fruits and nuts rolled into small cylinders and used for adulteration up to 20 per cent. Lime or whitewash is sometimes added to increase colour or fine sand and grit to make up weight. Also shipments may be damaged by rain or sea water and subsequently re-dried.

Adulteration and fraud of this nature are detected by determination of ash contents and the percentages of soluble matter.

It occasionally happens that genuine tea may be questioned if accidental sand or grit raises the ash content to a suspicious level, or owing to some unusual growth conditions the ash content of genuine leaf is above or below the usual figures. Analytical investigations are carried out at the Tea Research Institute from time to time to discover the ranges of ash content, etc. in genuine tea. The elimination of fine sand from dust grades is of importance on this account.

Apart from these factors the inclusion, accidentally or otherwise, of any offensive foreign matter may involve legal proceedings.

For any of these complications to affect estates in Ceylon is very rare but every now and again events such as metallic contamination arise and it is necessary for such complaints to be fully understood. The final question to be reviewed is therefore the question of materials.

MATERIALS

War time conditions have raised a number of problems which may affect the aspects of quality concerned with Foreign Matter and Food and Drug Regulations unless the position is fully appreciated. Lead from lead coatings or metals containing even traces of lead very easily contaminate tea owing to the acidic nature of tea juice and the apparent affinity of tannin for lead. Stainless steel and aluminium have consequently been extensively employed in modern tea machinery, and immediately prior to the War materials such as monel metal were giving promising results from tests. The metals most suitable in tea manufacture are, unfortunately, those in great demand for munitions of war. Consequently we must expect, as replacements and repairs become necessary, to have to improvise and temporise until supplies of suitable materials are again available. Wood will fortunately meet all our needs for roller tables, and concrete (or glass) can be

used for fermenting tables. Roller jackets are a problem as stainless steel is the only material, so far employed, which is quite satisfactory. Where wood cannot be used brass will have to suffice but it should be limited to employment where stainless steel or wood cannot be obtained or applied and should be of high quality. Actually *pure* brass is a very satisfactory material but many of these alloys appear to contain lead originating as an impurity in the zinc. Chemical analyses can however decide any doubtful cases. Galvanised mesh will meet all our needs in roll breakers and green leaf sifters.

With regard to driers lead-coated trays are absolutely out of the question. Tin coated trays are very suitable but trays galvanised with *good* quality zinc are almost equally satisfactory. Galvanised ware may be employed to a limited extent *so long as it is of good quality*, but poor material, apart from any lead content, may contribute a small amount of zinc to leaf manufactured on it and this should not be allowed to proceed unchecked. Where stamped aluminium sheets cannot be obtained for sifting dry tea brass weave will suffice but it is most important that it should not be repaired with lead solder as this rapidly wears and causes marked contamination.

The question of linings is a difficult one. Lead is, however, quite satisfactory provided paper interleaving is used *between the lead and the tea* to protect the metal from abrasion. Experiments at the Tea Research Institute shewed that tissue paper interleaving eliminated lead contamination from this source.

Pure lead foil is not suitable for very long periods of storage as it tends to oxidize and form soluble compounds. Normally, lead foil is rolled out between sheets of tin and is thus tin coated.

Lacquers may find useful employment for coating metallic linings for tea and could be applied not only to lead but to zinc alloys. Certain zinc alloys of high tensile strength are now being offered for packing tea. Lacquers have solved many problems in the canning industry where the problems of metallic contamination of foodstuffs have been much more difficult than in the case of tea where the danger is only a limited one.

However much relaxation of Food and Drug Regulations there may be in war time, the requirements in regard to impurities which may pass into the infusion and thus prove injurious to consumers will stand. Tea must conform to these regulations and there is no difficulty about them which cannot easily be overcome.

Poisonous insecticidal sprays on tea in plucking are not used by the tea industry, so problems arising from this source do not affect us as they affect many, almost all, fruit industries.

Lastly, it should be pointed out that liability to metallic contamination and choice of materials are subjects in which the Tea Research Institute can give speedy and complete advice and this should be sought before any risk is taken.

SUMMARY

Tea Planting is becoming a complex subject and at the present moment subject to harassing difficulties. On this account it is hoped that a review of one aspect, namely manufacture, may prove helpful in providing a perspective and contributing to a sense of awareness of certain factors which may not have been studied in detail.

The wider implications of tea quality are discussed and a plea is made for endeavours to maintain some degree of progress with the idea of preventing deterioration in the general level of quality produced under war-time conditions.

It may be noted that the review deals with questions concerning all parts of the Island and indeed shews that by far the greater part of the Institute's research activities on quality concern the low-country as much as up-country. Thus, the sections of the review mentioning organisation, the principles of rolling, firing conditions, quality aspects of selection, hygiene, Food and Drug Regulations, and materials, affect low-country factories as much and in some cases more than their counterparts in Dimbula.

The review will also be of value if it gives some insight into the scope of the activities which have to be undertaken by a research organisation, such as the Tea Research Institute, responsible for all the technical problems arising out of a process of food manufacture, such as tea manufacture, under modern conditions.