RECENT EXPERIMENTS ON THE BURNING QUALITIES OF TOBACCO *

THE burning quality of tobacco is of special value for all kinds of tobacco used as wrapper. There are of course several other factors, which determine the value of a tobacco leaf as a cigar wrapper, but one of the most important is without doubt its fire-holding capacity.

The Journal of Agricultural Research has published an article on the influence of chlorine on the growth of the tobacco plant and its influence on the quality of the cured leaf. Experiments on light sandy soils and sandy loam soils in North Carolina showed a stimulation of the growth of tobacco by a moderate supply of chlorine in the fertiliser. Under the conditions of the place where the experiment was made a quantity of 22 kg. to 33 kg. per ha. caused the maximum of growth stimulation. It was demonstrated that the presence of chlorine in the soil enables the tobacco plant to make better use of the soil magnesium for nutrition and that a certain amount of chlorine in the leaf improves the resistance to drought. Larger quantities of chlorine however may cause injury to the plant, not by direct toxic effects but by interference with the metabolism of carbohydrates. This injury is more serious on light than on heavier soils. Tobacco leaves from chlorine fertilised plots exposed to various relative humidities after curing, showed that the moisture content was increased. This may influence its elasticity, its combustibility and keeping qualities. Excess of chlorine produced muddy colours in the cured leaf which often showed intermingled colours: green, yellow, brown. The combustibility of the leaf was impaired.

The Tobacco Sub-Station at Windsor (Connecticut Exp. Sta.) in its report for 1929 gives many details on various experiments on tobacco of which those connected with its burning qualities may be shortly reviewed.

Experience showed that dry seasons usually produced a tobacco with poor burning qualities and that the reverse happens when the season has a high rainfall. Analyses of the tobacco of a dry season and of a wet season showed difference in chemical composition, a good burning tobacco having less chlorine, calcium, magnesium, nitrogen, phosphorus, sulphur and manganese and more potash, silica, iron and alumina. A good burning tobacco has a much higher alkalinity than a poor burning one. Even the seconds, usually the best burning leaves, showed a greater alkalinity than the darks from the same plot.

Experiments with potash as a fertiliser showed, that the fire holding capacity of tobacco grown on plots without potash manure diminishes every year. Plots receiving potash however produced a tobacco which did not show any deterioration in this respect. The percentage of potash in the leaf was influenced by the quantity of potash manure, although the soil was very rich in this element. The percentage was increased by applying a larger quantity of potash fertiliser. When the percentage of potash decreased, the same was true in regard to calcium and magnesium in the leaf.

* From *International Review of Agriculture*, Part I, Year XXI, No. 12, December, 1930.

A general relation was observed between fire-holding capacity and the ratio of potash to calcium and magnesium, measured by strip set. A wider ratio was favourable to the fire holding capacity. Differences in this capacity caused by the use of different potash salts, e.g., sulphate, carbonate or nitrate or by the use of tobacco stems, were very small. By applying sulphates to the soil, the percentage of sulphates in the leaves was increased and the burning qualities were weakened.

The Tobacco Experiment Station at Klaten (Java) started experiments on manuring to find a suitable method to apply green manure in relation to the peculiar rotation conditions in accordance with which tobacco has to be carried on. These conditions are only of local interest, but some results may have a more general significance. It has been proved by these experiments: 1. That quality and length were improved by organic manures (dung and green manure); 2. That on phosphorus poor soils length was improved more by dung than by green manure, but that a small amount of P-fertiliser was sufficient to make them equal in this respect; 3. That P-fertiliser had a bad effect on the colour as it hastens the ripening of the leaf, especially in dry years and that not only on P-rich but also on P-poor soils (with only 0·004% cistr. sol. P_2O_5). Dung may therefore also have a bad influence as it contains a considerable quantity of P_2O_5; 4. The fire holding capacity was in general the best after green manuring (*Crotalaria* sp.) because the content of the dung in Cl. is considerably higher than that of the *Crotalaria*. But as the contents of *Crotalaria* augments with age, it should be applied as a green manure not later than after reaching flowering stage. 5. Experiments with fermented green manure showed improvement in length, quality, and colour. The same Station started a very thorough investigation in connection with the fire holding capacity of tobacco leaf, which may be of general interest.

(a) *Method of Examining Fire Holding Capacity.*—In order to examine the influence of various cultural practices on the fire holding capacity of the leaf, the average glowing duration was ascertained by noting, how many seconds each leaf continued to burn, when lit by means of a glowing carbon-point at the bottom of the leaf on the right side between two veins. In order to get sufficient reliability 800 leaves were burnt per test. Owing to the possibility of obtaining an average from a very large amount of experiments, this method was preferred to the "cigar-test".

Of the various burning qualities only the most important, namely the fire holding capacity, has been examined.

The figures thus obtained showed three types of frequency-distribution. The first with leaves of good fire holding capacity showed two summits; one not far removed from the arithmetic mean, the other as a result of leaves showing abnormal burning capacity. This made it impossible to apply the theory of probability and, as the investigation was started to find the causes of low-burning capacity, it was not necessary to spend time on it. The second type appeared by examining leaves with a very short glowing duration; it showed a flowing curve, of which the summit, as compared to the arithmetic mean, had largely shifted towards the side of the short glowing period. Provided that the frequency was expressed not in the time of glowing but in the logarithm of it, it was possible to employ the theory of probability to this case. The third type lay between the other two. The flowing curve did not deviate much from the binomial frequency-distribution and the theory of probability could be applied to observations of the glowing-time.

As the tests proved that the glowing duration was directly proportional to the logarithm of the percentage of moisture, it was possible to apply a correction for differences caused by moisture difference. It was proved that: $\log A - \log B = k \times (a-b)$ in which A represents the corrected glowing duration by a percentage of moisture, and b the moisture—percentage at the determined glowing duration B.

(b) *Chemical Composition of Good and Bad Burning Leaf.*—A chemical investigation of the leaf confirmed the previous observations that a bad burning leaf contained more chlorine and less potash than a good burning one. Although in most cases the percentage of chlorine in the ash was sufficient in itself to settle the matter, it was found that exceptions did occur and that besides the contents in potash, the contents in lime and magnesia were also of influence. The correlation coefficient between average glowing duration per leaf per plant and the amount of chlorine, sulphate, potash, calcium + magnesium expressed by the quotient

$$\frac{K_2O}{Cl \times (CaO + MgO)}$$

were calculated from the average glowing duration, computed for some nineteen separately harvested plants growing side by side in one test field and where thus the influence of different soil conditions was eliminated.

The correlation coefficients between the period of combustion and the proportion of the different mineral elements in the ashes of the leaves are shown in the following table:

	Mineral elements in the ash				
	Cl	CaO + MgO	K_2O	SO_3	$\frac{K_2O}{Cl \times (CaO + MgO)}$
Correlation coefficients	−0·7	−0·2	+0·4	0·0	+0·8

(c) *Influence of Manuring on Fire Holding Capacity.*—It has been proved, that the glowing period does not improve by fertilising. Among the organic fertilisers it was found that straw manure (fermented rice straw) and dung most seriously harmed the glowing capacity of the leaf. Oilcakes (kapok seed, coconut, groundnut, etc.) and *Crotalaria* choppings used as green manure had little or no injurious effect. The injurious effect was closely associated with the amount of chlorine in the organic fertilisers.

Also the usual inorganic fertiliser, sulphate of ammonia, if necessary supplemented with double superhosphate, is detrimental, although to a less degree than dung. Contrary to what was expected after the chemical examination of the tobacco, no improvement was recorded after the use of potash fertiliser.

(d) *Influence of Soil Conditions.*—The occurrence of non-burning tobacco was found to be most prevalent in places where quantities of chlorine existed in the soil moisture. It is therefore probable that all measures to soil-capillaries will be of value, whereas those precautions that tend to increase these soil capillaries will prove disadvantageous. In fact the early inundation of the soil, by which the soil particles are able to coalesce more closely, has disastrous results on the fire holding capacity.

(e) *Breeding Good Burning Varieties.*—A large number of plants grown side by side or close together under identical circumstances and harvested separately, showed that great differences are to be found with regard to the average glowing period per plant.

The hereditary character of these differences was also proved.

Among the chief practical measures for the improvement of fire holding capacity the following may be mentioned:

1. Improvement of drainage and system of tillage. 2. Replacing dung by green manure. 3. Avoidance of all not strictly necessary flooding. 4. Careful adaptation of sowing and transplanting dates to weather-forecasts. 5. Some reduction in planting distance. 6. Avoidance of excessive heating in the drying sheds.

(f) *Influence of Climate.*—Burning capacity however does not depend only on soil factors as climate also plays an important part. The Experiment Station of Scafati (Italy) started in 1929 an experiment to prove the influence of climate on combustibility of Kentucky tobacco. In the community of Bibbiena second class tobacco is produced and in the Valle di Chiana only a fourth class. Four wooden cases, each about $\frac{1}{2}$ m^3 were filled with earth, two of them with soil from Bibbiena and two with soil from Chiana. The two containing Bibbiena soil were transported to Chiana and placed in a field at Chiana and with the other two the process was reversed. It was possible in this way to cultivate tobacco in Chiana soil at Bibbiena and vice versa at the same time with the surrounding tobacco plants growing in untouched soil.

The result has been that the tobacco cultivated in Chiana soil at Bibbiena has not been influenced by the climatic conditions of that place; in regard to its combustiblity it belonged also to the fourth class, as that grown at Chiana itself. The tobacco cultivated in Bibbiena soil at Chiana however was influenced by the climatic conditions: it belonged also to the fourth class while at the same time the same tobacco grown at Bibbiena produced a second class product.

THE CLOVE INDUSTRY IN ZANZIBAR *

(*A*) *Production.*—It is impossible to deal with the industry of paramount importance to Zanzibar—clove growing—in a report confined to events falling within the calendar year. That report, written in October last, carried the review of the industry up to end of June, 1929, and indeed it was possible to remark upon the commencement of the 1929-30 harvest.

In this report we are, therefore, concerned with the season commencing in July, 1929 and terminating for statistical purposes at the end of June, 1930.

The previous season—1928-1929—having been an unusually poor one, cloves brought to town during July to June having amounted to only a trifle over two lakhs of fraslas (say 3,100 tons), it was only to be expected that the 1929-30 season would be unusually good. Expectations were realised and the season established a record.

Exactitude in statements of the measure of crops is an impossibility. Even when all cloves produced in the country had to pass through the Customs on entering town for the purpose of excise it was not necessarily the case that all the cloves picked between July and February, the normal limits of the harvesting period, were brought to market between July and the end of June, nor that all the cloves brought in during that period belonged to that particular harvest. I have known four-year-old cloves brought into town from the plantations, though this is very unusual.

Estimates have to be made of stocks from previous years brought in and hold-overs carried by the producers. Although old stocks coming in can be distinguished from new season's produce it frequently happens that, being drier, they are mixed with the new to enable the bulk to pass the standard required by the Produce Export Decree. As an estimate of the season's crop is fundamentally based upon the deliveries at the Customs, and such was not obligatory during the past two seasons, excise having been taken at the time of export only, even the fundamental data have been lacking in the accuracy of former years. The clove deliveries we may characterise as the raw figures to distinguish them from those which the Comptroller of Customs prepares to represent so far as can be ascertained by the quantity produced during the season.

In the season 1928-29 the deliveries were given as 200,568 fraslas, and during 1929-30 as 928,943. The latter raw figure requires various adjustments to allow for hold-over and parcels brought to town but not passing through the Customs House for weighing, and the Comptroller of Customs is of opinion that the season's production must have reached at least 10 lakhs of fraslas (over 15,500 tons) and therefore have beaten the previous record of 9·8 lakhs in the season 1922-23. Early in 1930 it was realised that the succeeding crop would be an almost complete failure.

The tremendous variation in size of crop from season to season has not so far received an explanation. Precisely what effect it would have upon the market if future crop could be foretold it would be difficult to say. Speculation quickens interest, and the uncertainty of the future position must necessarily lead to competition in buying stocks. There is probably hardly another crop in which it is such a gamble to deal. Growers and

* From the Annual Report of the Agricultural Department of Zanzibar Protectorate for 1929.

merchants alike must speculate on the probability of the next crop and it is in vain that we look through the records of the past to give us a clue to the future.

An apparently safe system for the producer to adopt is to hold a proportion of his crop in years of great plenty; to hold very little when the crop is average and to sell that at the first sign of a large succeeding crop; to sell hold-over gradually and not expect to get the top price of the year for the whole of it.

Before attempting to peep into the future it is well to consider this question of variation in size of crop critically.

When I visited Singapore in 1924, the Director of Botanic Gardens there drew my attention to some clove trees which, though quite well developed, practically never produced a bud, whereas at Penang, about 380 miles way, clove production is an important industry which leads the world as regards quality. Mr. Birkill expressed the view that the difference in behaviour of the trees in the two islands was capable of a simple explanation, viz., that in Singapore the climate is uniformly moist whereas in Penang there are distinct dry periods, as in Zanzibar, and that this stimulus is necessary to cause the trees to flower.

Now were flowering a simple reaction to a climatic stimulus there would be no difficulty in correlating crops with meteorological observations, but so far a correlation has not been found. The Dutch botanists who have studied the tree in its native habitat state that the clove only flowers twice in three years and will bear heavily once in from four to seven years. Periodicity in flowering is a general phenomenon, that it to say that flowering plants have a tendency to flower at certain periods apart from any external stimulus. The coconut palm flowers every 26 to 30 days, many plants flower twice a year, some annually, others only once in their existence. The clove tree appears to have an obscure periodicity so that the effect of the external stimulus—climate—is obscured. The same stimulus will only produce the same reaction if the tree is in the same phase. There is also a clear indication that when the external stimulus acts upon the trees when in a phase preparatory to flowering an abnormally large crop results, but a reaction follows, presumably due to temporary exhaustion, and the trees will completely miss flowering for a season. There is a kind of oscillation produced and the pendulum does not come to rest at once, large and small crops alternating for perhaps four seasons.

We have probably three factors to take into consideration:

(1) The nature of the climatic stimulus.
(2) The phase in the periodicity of the trees.
(3) The reactions from a previous stimulation.

Obviously unless these factors are known and measured the resultant—the future crop—cannot be predicted.

During the first half of 1930 the trees certainly received a stimulus in the way of a dry period, and some of them will unfortunately never flower again. The dry period—May to August—was, however, not altogether seasonable, and it does not appear to have produced any tendency on the part of the trees to produce buds for the December-January portion of the crop. How many weeks or months pass before the effect of a stimulus is visible to the eye is not known, so that were we more certain even of its nature we should still be unable without further knowledge to gauge the effect upon a forthcoming crop whose size may be affected by the conditions obtaining only during a particular and short interval of time.

Our peep into the future—the season 1931-32—cannot therefore be made with anything approaching safety. We do not know how the past, present, or future climatic conditions will modify the trees' inherent tendency. There has been a violent oscillation, two lakhs, ten lakhs, the present (1930-31) crop of less than two lakhs. The oscillation would tend to carry the future crop upwards, but it is obvious that we are too near the last phase of the heavy bearing period for it to appear again, and a rather above average, say 6½ lakhs, crop would appear to be the most probable event.

In my last annual report attention was drawn to what appeared to be the repetition of a previous cycle, and the following figures will be found of interest :

Season	Fraslas	Season	Fraslas
1913-14	7,83,680	1924-25	7,61,412
1914-15	5,26,309	1925-26	6,11,814
1915-16	7,96,757	1926-27	7,33,209
1916-17	5,11,635	1927-28	6,90,752
1917-18	2,98,197	1928-29	2,00,568
1918-19	8,24,502	1929-30	10,00,000
1919-20	2,62,550	1930-31	1,75,000
1920-21	5,48,277	1931-32	6,50,000
1921-22	2,66,802	1932-33	?
1922-23	9,81,915	1933-34	?
1923-24	3,11,794	1934-35	?

The chief object in discussing the apparently fortuitous variations in the clove crop is to draw attention to the nature of the problem in the hope that observers in this and other countries will give some attention to the matter. It is possible that experience elsewhere with fruit or forest trees may put us in possession of the means to unravel the knot, and suggestions would be most gratefully received.

(*B*) *Finance.*—It is inevitable that violent fluctuations in production should be accompanied by corresponding fluctuations in price. Some idea of these fluctuations will be gathered from the following figures of the average price of Zanzibar cloves for the month, with duty added.

Date	Duty paid price Rs. per frasla Rs. Cts.
1929	
January	30 98
March	33 91
June	31 95
September	16 50
1930	
January	14 74
March	18 65
June	19 84
September	22 21

There has during the past two or three years been a movement on foot in many parts of the world to stabilise production with the object of steadying prices. The general principle of making the supply fit the demand; of managing that the production is economically carried out; and of arranging that the consumer is supplied regularly at a price satisfactory to all parties, has been called "Rationalization."

To what extent this principle can be applied to the Clove Industry has been the subject of much thought by many minds. In the early part of the year under review a Committee was appointed to consider the matter generally. That Committee did not reach any agreement but the views which were expressed by members, in many cases very divergent, were subsequently published with the object of stimulating thought upon the matter.

Possibly the word "Rationalization" is unfortunate. It cannot be translated into Arabic or Kiswahili in thought or word. The general impression gathered by the producers was that cloves should be "rationed" like food to soldiers, and the idea left them wondering. It was generally considered that we were dealing with a very difficult and abstruse matter, and the more the subject was discussed the further we appeared to get from understanding it. A speck of dust under the microscope becomes a boulder, and the smoothest pavement a land of impenetrable mountains.

Laying aside the rationalizer's microscope this simple issue appears:

Production of cloves cannot be stabilised. If the producers find it inconvenient to have a good income one year and practically none another they must not sell all their cloves at one time. If the consumers find it inconvenient to pay 1s. 6d. per lb. for cloves one season and 9d. per lb. another they must buy more freely when cloves are plentiful. One or the other must hold stocks. Whoever complains has the remedy in his own hands.

If the producers and consumers were rational the question of rationalizing the industry would not arise. It would not seem unreasonable to put our own house in order before attempting to dictate to people overseas how much and when they should buy.

Comparing the two seasons 1928-29 and 1929-30, the former a two lakh crop and the latter in the region of a ten lakh crop, the average selling prices per frasla duty paid during the twelve months of each season were in the former Rs. 28-15 for Zanzibar and Rs. 27-98 for Pemba, and in the latter Rs. 18-29 for Zanzibar and Rs. 17-55 for Pemba. Considering the size of the 1929-30 crop the prices were very satisfactory and could not have been maintained had there not been a very distinct effort at internal "rationalization" in the shape of holding over stocks. It is estimated that something like 2½ lakhs of fraslas (3,900 tons)—more than twice the maximum production of Madagascar (our only serious competitor)—were held from the market. This indicates the strength of our position in the producing world.

During the twelve months ending June, 1929, Zanzibar had exported 7·48 lakhs (11,700 tons) and Madagascar ·54 lakhs (850 tons) of cloves. Neglecting the smaller contributions from other countries (perhaps 400 tons) it is evident that at least 12,550 tons of cloves were bought during the period in which the Zanzibar price was about Rs. 18 per frasla duty paid.

Overseas stocks do not appear to have increased and there is every appearance of this quantity having been actually consumed.

The twelve months July 1930 to June 1931, will have available some

3,900 tons Zanzibar hold-over
3,000 tons Zanzibar new crop
1,500 tons Madagascar

8,400

This estimate shows that world supplies are 33 per cent less than the previous twelve months' consumption. At the moment of writing the duty paid price of Zanzibar cloves is about Rs. 24 per frasla. It would undoubtedly have been much higher had not the very important Indian market been dull owing to the general trade disturbance.

(*C*) *Inspection of Cloves.*—The Agricultural Produce (Export) Decree, 1929, came into force on August 17th. The object of this Decree is the same as that of the Agricultural Produce (Adulteration) Decree, 1927, which it revoked. The new legislation was necessary as experience had shown that the earlier decree was faulty, particularly in regard to fixation of responsibility as between owners, agents, shoppers, etc. Under the first decree it was an offence to deal in cloves which did not comply with the standards of quality laid down. Control could be exercised from the plantation to the wharf. The present decree limits control to the wharf, and therefore greatly reduces the amount of work involved in inspection. Refusal to permit exportation is the only punishment in the case of produce unfit for export being offered, but that this is a sufficient deterrent from attempts to ship such produce will appear from the following:

	August 17th to December 31st, 1929.		
	Examined	Passed	Failed
Consignments	1,139	1,115	24
Bales	91,955	89,320	2,635
	January 1st to June 30th, 1930.		
	Examined	Passed	Failed
Consignments	857	848	9
Bales	60,624	60,127	497

Of the 1,52,579 bales of cloves, representing 1,996 consignments, examined between 17th August, 1929, and 30th June, 1930, 97·9 per cent passed, these representing 98·3 per cent of the consignments.

The rapidity with which merchants adapted themselves to the new conditions imposed upon them by the decree is remarkable, but it must be remembered that the previous Adulteration Decree had already effected a tremendous improvement in the quality of produce coming into the market.

The members of a Committee advising upon the nature of the new decree were divided in opinion as to the desirability of retaining powers of control before the actual time of export, some fearing that the producers would not respond to the law unless pressure were applied directly to them with the result that the onus of conditioning cloves would fall upon the exporter and that he would necessarily give a very low price for produce desirously below or suspiciously near the standards prescribed. Particularly was this fear felt in regard to Pemba cloves as the producers were further away from the point of export and their produce would have changed hands many times before it was subject to examination.

How far these fears were justified will appear from the following figures supplied by the Comptroller of Customs:

(a) Before the Export Decree came into force

	Rupees per frasla		
Period	Zanzibar	Pemba	Difference
	Rs. Cts.	Rs. Cts.	Rs. Cts.
1925-26	16 83	16 86	0 03
1926-27	13 77	13 71	0 06
1927-28	12 85	12 64	0 21
1928-29	28 15	27 98	0 17
(b) Decree published 1929			
July	20 07	19 07	1 00

(c) Decree in force

	Rs. Cts.	Rs. Cts	Rs. Cts.
August	16 00	13 02	2 98
September	13 20	12 20	1 00
October	14 51	13 57	0 94
November	12 96	12 16	0 80
December	12 26	11 64	0 62
1930			
January	11 44	10 90	0 54
February	12 20	11 82	0 38
March	15 42	15 35	0 07
April	18 61	18 53	0 08
May	17 66	17 38	0 28
June	16 71	16 54	0 17

(July 1929—June 1930, Excise Duty Rs. 3-30 to be added).

These figures do not represent the extreme fluctuations caused by the decree, but they enable a measure to be taken of the loss to Pemba through its failure to meet requirements. On the quantities changing hands the loss during the year must be in the neighbourhood of four lakhs of rupees.

The plantation owners undoubtedly prefer to lose money than to be subject to direct pressure and the above figures whilst indicating how severely they have punished themselves also show that after about six months they recovered their position.

From time to time the question of grading cloves has been raised. It is perhaps not fully understood in the overseas markets what is the precise nature of the Government control in Zanzibar. Formerly cloves were frequently shipped quite wet, due either to careless preparation, deliberate adulteration, or accidental damage by rain or sea-water. Also large proportions of stems and other foreign matter were frequently present, again due either to careless preparation or deliberate adulteration. The inspection at present is directed exclusively towards preventing the exportation of cloves containing more than 16 per cent moisture or 5 per cent foreign matter. Although the decree provides for rules being made for prescribing grades of quality such rules have not been laid down. It must clearly be understood, therefore, that a certificate of quality under the decree only takes account of these two factors and does not purport to reflect upon the quality of the produce from any other point of view. Weather-beaten wind-fall cloves, the colour of ashes, swept up from the ground at the end of the harvest will, if they contain less than 16 per cent moisture and 5 per cent foreign matter, pass the test.

The Zanzibar Chamber of Commerce has recently given careful consideration to the advisability prescribing a limit to the proportion of withered cloves (locally called Khoker) which shall be permissible in cloves. At first sight this appears to be a sound and simple proposition. If ordinary or normal cloves were of a regular and definite appearance the addition of khoker could be detected and its amount determined. Unfortunately the appearance of normal cloves varies very greatly depending upon the precise stage of ripeness when gathered from the tree and upon the climatic conditions and methods of handling obtaining during the dry period.

If there is wet weather during a heavy harvest the producer is unable to protect his cloves. Heaped in sheds they degenerate and if left spread out in the rain the colour is washed out of them. Under these circumstances a large proportion of the crop becomes wrinkled and discoloured and, in fact, indistinguishable from the khoker obtained from plantation sweepings.

When the bulk of a sample is bold and bright, with a proportion of dull, wrinkled and discoloured cloves, it is obvious that the material has not been wholly prepared under the same conditions and is therefore a deliberate blending. The proportion of each quality present can easily be determined. When, however, the bulk is dull and discoloured it is impracticable to make any definite separation on an appearance basis.

The quality of a sample should be gauged by

1. Dryness.
2. Freedom from foreign matter.
3. Colour (reddish-brown, dark-brown, black, dull or bright).
4. Form (with or without crown, smooth or wrinkled, etc.).
5. Size (weight per 100 cloves).
6. Oil content.

The present inspection guarantees a product satisfactory as regards 1 and 2. If grading were established 3, 4, and 5 would have to be taken into consideration and the grades determined in relation to these factors. Item 6, perhaps the most important one of all—it is the oil in the clove which alone gives it any value whatsoever could not be undertaken as part of any general inspection, but the oil content of any sample can be obtained on payment of a fee.

In the grocery trade, including in that term the supply of cloves for all culinary and chewing purposes, colour, form and size, are important factors. The oil distiller can have no real interest in anything beyond the oil content, though he may perhaps, mistakenly regard the general appearance as a good guide to that point. The spice grinder is more interested in the oil content than in anything else as it is this which gives strength to the spice. Colour, however, may be some consideration to him.

Government is quite willing to undertake any grading which can be shown to be in the best interests of the industry and of this country. It is obvious that the consumers should indicate their requirements and to what extent they are prepared to pay a premium for the particular quality of produce which best meets their need. The producer would be prepared to offer fair-average-quality and premium cloves, the buyers would doubtless prefer fair-average-quality and discount cloves!

I have frequently observed very small differences in price between samples at the opposite ends of the scale. At the present moment with cloves at Rs. 24 per frasla duty paid, half a rupee is only 2 per cent of the price but represents buyers' opinion of the difference in value between the best cloves obtainable and some quite inferior produce.

Is grading therefore really required?

For the present at any rate the consumers must rely upon their agents or shippers to select for them the quality which they require. The best cloves are bought for the best price. If the consumer pays that price but gets "Khoker" he should change his agent. There are many firms in Zanzibar with long experience in shipping cloves to all the markets of the world and the Chamber of Commerce would always provide a list of such merchants on application.

(*D*) *Artificial Drying of Cloves.*—Rumphius, the 17th Century Dutch botanist, states that in his day cloves were covered with leaves and for some days subjected to a smoky fire. That was in Amboyna, the home of the clove. Nowhere in the world does fire-drying of cloves appear to be practised at the present day.

The question of artificial drying of cloves has been considered in this country from time to time, the first recorded experiments having been carried out by Mr. Lyne some twenty-seven years ago, though at a much earlier date hot-plates had been advocated but, so far as I know, not tried in practice. The 1903 experiments were more particularly tests on drying under glass, which process Mr. Withycombe is again exploring.

The Department of Agriculture experimented with fire-drying during the 1927-28 and 1928-29 seasons, reference to which was made in the previous annual report. During the 1929-30 season the crops on the Government Plantations were leased and there was no opportunity of carrying out field experiments on the subject; laboratory tests were, however, made to ascertain safe temperatures for drying so that loss of oil should not ensue. With the coming into force of the decree prohibiting the exportation of cloves containing more than 16 per cent moisture it was anticipated that some form of conditioning plant in the town would become necessary.

The merchants were quite convinced that it would be impossible for them to bring the cloves into condition for export—they then proceeded to do it! For a month or two Zanzibar was transformed into a drying ground. Public and private open spaces, school playgrounds, roofs of houses, even roads and foot-paths, were covered with drying mats and cloves. The merchants certainly made the careless producers pay for the trouble involved, but their enterprise in carrying out the conditioning was admirable. During the period from the commencement of the decree, 17th August until 31st December, there was a normal amount of rain and a lot of wet cloves were brought into town (as witness the variation in price referred to) and yet of the 91,955 bales examined, only 2,435 were rejected on the score of moisture. Of these 1,328 were removed from the Customs, dried and replaced, in time to catch the ships by which they were intended to be shipped. Only 1,107 bales (1·2 per cent) of all the cloves brought to the wharf during this period actually missed shipment on account of excessive moisture.

The producers have, since August 1929, learned something of their lesson and it now seems doubtful whether money spent on a mechanical drier would be a good investment.

The department invoked the aid of the Imperial Institute in ascertaining the probable outlay necessary to provide drying machinery for conditioning cloves. The proposals of a number of firms have been received but of their suitability for clove drying there is, of course, no experience.

It was intended to make further experiments to test the applicability of the different systems of drying to our produce, but the clove harvest ended so abruptly that green cloves became unobtainable before much could be accomplished.

The conclusions arrived at were:

1. Hot air drying by natural draught is unsuitable. Quick drying is essential to obtain a good colour and air must be either at too high a temperature or else be under forced draught to remove the moisture at a satisfactory rate.

2. Drying on mats over a sand-bath type of kiln such as is used on Government plantations for preparing copra is very successful if the green cloves are spread at the rate of 1½ lb. per square foot, turned over at intervals, and the temperature not allowed to rise above 60° Centigrade. Under these circumstances the cloves dry out to a moisture content of 10 per cent (drier than required by the decree) by the end of the second day—actually only being hot for about 12-15 hours—and present a very good appearance, better in fact than the sun-dried article.

   Analysis of material thus produced shows that there is no material loss in oil our material yielded 19 per cent essential oil with slightly less than 10 per cent moisture.

It is proposed next season to utilise the copra kilns on Government plantations whenever the weather interferes with sun-drying. It is worthy of note that after the first few days of careful attention by Mr. Raymond or myself the kilns were left entirely in the hands of the native plantation staff and not a single clove was damaged. The remarks on this subject in my last annual report were too pessimistic though it must be remembered that our native staff is perhaps more disciplined than that found on plantations generally.

The natives themselves were enthusiastic over the matter and consider that we need no longer trouble about the weather in clove harvest time. The produce commands a premium on the market.

(*E*) *Regeneration of Clove Plantations.*

(*F*) *Local Distillation of Clove Oil.*—Attention has continued to be paid to these important matters and it is confidently hoped that before the end of another year definite knowledge of the economic position in relation thereto will have been acquired.