ISSN 0040-0378

Tea Research Foundation (Central Africa)

Quarterly Newsletter

April 1993 Number 110

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1 Weather

The following data are taken from the Official Meteorological Stations at Mimosa and Thyolo Tea Research Stations. Figures are the monthly totals and means. 10 year means are in *italics*.

Mimosa TRS		January		February		March		July - March	
Total rainfall	mm	692	*315*	267	*248*	161	*259*	1387	*1417*
Mean max temp	°C	29.0	*29.8*	285	*29.5*	29.1	*29.5*		
Mean min temp	°C	19.2	*19.2*	19.5	*19.0*	18.4	*18.6*		
Mean windrun	km/day	75.2	*70.4*	62.9	*67.3*	70.3	*68.2*		
Mean sunshine	hrs/day	5.4	*6.0*	5.6	*5.9*	6.8	*6.5*		
Pan evapn	mm	25	-	-	-	-	-		
Mean radiation	Langleys	364	-	363	-	377	-		

Thyolo TRS		January		February		March		July-March	
Total rainfall	mm	466	*252*	204	*241*	81	*204*	1046	*1154*
Mean max temp	°C	27.2	*28.1*	27.7	*27.9*	27.0	*27.6*		
Mean min temp	°C	19.1	*19.1*	19.4	*18.8*	18.1	*18.4*		
Mean windrun	km/day	128.1	*106.9*	108.7	*107.8*	100.5	*102.3*		
Mean sunshine	hrs/day	5.4	*5.6*	6.0	*6.4*	7.3	*6.6*		
Pan evapn	mm	103.4	-	95.4	-	102.1	-	1538	
Mean radiation	Langleys	394	*441*	400	*442*	421	*428*		

2 Soil moisture deficit

		Mimosa TRS			Thyolo TRS		
		Jan	Feb	Mar	Jan	Feb	Mar
Total rainfall	mm	692	267	161	466	204	81
Potential evapn (Penman)	E_o	168	142	162	167	153	168
Transpiration factor	E_t/E_o	0.85	0.85	0.85	0.85	0.85	0.85
Evapotransp. (Penman)	E_t	143	120	138	142	130	143
Rainfall - Evapotranspiration		+549	+147	+23	+324	+74	-62

3 Crop yields

Note The experiments which were used for yield recording have been terminated. Fields are being identified for future yield recording.

4 Comment

A.M. Whittle

As is normal at this time of year, staff are preparing for contributions to Field Days with the result that papers for the QNL tend to get held over. Apologies are therefore in order for the late circulation of this newsletter but we hope that with the July edition we will be back on schedule.

We continue to remain short staffed and I must thank staff, both senior and junior, for their forbearance during this past, very busy season. During April we have welcomed Simon Wilkie as the new Assistant Director (Research) and Simon's arrival should now enable us to press on with, and implement, a revised work programme. A new Technical Committee has been established, with industry representatives, to advise on research directions; there seemed little point in commencing the committee before Simon's arrival but it is now expected to meet shortly and to play a crucial role in research planning.

Presumably prompted by the recent drought there has recently been expressed a widespread interest in long-term weather forecasting. One institute with expertise in this field is the Climatology Unit at The University of Witwatersrand. Though their forecasts are based on global data, the detailed forecasts are currently restricted to South Africa; this means that North Transvaal is as close as we can get.

There is active interest in extending forecasts to neighbouring countries but the value will depend on the data supplied. TRF is willing to act as a "clearing house" for meteorological data going to Wits and for dissemination of forecasts if and when they are issued; forecasts are normally not issued monthly but as circumstances dictate. Essentially, the data required are monthly rainfall totals for as long as possible, the longer the better, to establish patterns; for these purposes twenty years is considered virtually useless. Any estate wishing to assist with establishing the data can send me the data either as a hard copy or disc, which will be returned. The value and accuracy of the service will in great part be dependent on the coverage provided, so if estates could dig out their rainfall data it would be much appreciated.

5 Notes and News

Correction

A mistake crept into the typesetting of the article in QNL 109, Table 1, where the headings for Water (kg) and Dry matter (kg) were transposed. Also in Table 2 the heading "70% wither" should have covered the "Total weight" column as well as the following two columns. Apologies for any confusion caused.

SJT

Excerpts from a Tea Planters' Dictionary

Chemical withering - this process involves no chemicals and need not involve any withering (q.v.). It is purely a biological process which occurs after leaf has been removed from the bush but before the cells have been damaged by the LTP, stuffing into sacks and jumping on them, or any other process.

Cooling room - a room through which air is drawn and into which water is sprayed. The air is cooled to exactly the same extent as it would be by passing it trough dhool. A breeding ground for Legionnaires Disease.

Dhool - green mashed up tea leaf, which gradually turns brown. If your wither (q.v.) is too soft or too hard, it will end up looking like green paint or grass clippings. The one consistent quality of dhool is its magnetic attraction for floors.

Fermentation - this is a process which is applied to dhool (q.v.) where it is not fermented, but oxidized by enzymatic reactions. Fermentation is an anaerobic process which produces far more interesting beverages than tea.

Planting - a field activity very rarely carried out by Tea Planters. One year's planting gives thirty to a hundred years' plucking.

Withering - a process which occurs naturally if it is given a chance, once leaf has been removed from the bush. In most withering sheds, the stale air does not have much of a chance to escape to allow further withering to take place. Physical withering involves removal of water (and should perhaps be called wilting), whereas chemical withering does not. Hard withering is when too much moisture has been removed so the leaf is too soft, and soft withering is when too little moisture has been removed so the leaf is too hard (or *vice versa*).

SJT

6 Fluid Bed Dryer monitoring and control

S.J. Temple

Introduction

Perhaps the item in QNL 109 on automatic dryer control was slightly premature. From visiting factories in the region, it appears that although the factory engineers understand the basics of the drying process, the factory managers have little or no idea of what they are looking at with dryer temperature probes.

Hot air supply

In the dryer, the first parameter that is measured is the input temperature. Where steam is used as the heat transfer medium between fire and hot air, control of air temperature should be automatic and simple. At TRF, we have been using the Spirax Sarco type of thermostatic valve. This has a long bulb which is inserted into the delivery air from the heaters, coupled to the valve body by a flexible tube about 2 metres long. We find that the recording of air temperatures delivered by this system is very consistent, but some factories where the same system is installed do not get such good control. This is probably due to bad placement of the sensor tubes (for which the manufacturers give no guidance). If they are fitted too close to the radiator, they will not sense the average air temperature that is supplied to the dryer. They should be as far downstream from the radiators as possible, and it helps if there is something like a bend or a damper between the radiator and the sensor to ensure good mixing of the air.

So if the sensor tubes are installed correctly and the boiler is of adequate size for the load, air input temperature should not vary significantly. Once the reliability of the thermostatic controls has been established, it may not even be necessary to measure the input temperature. Of course, if the heaters or boilers are inadequate, no amount of control will help.

Of course, if a different method of heating the air is used, alternative methods of thermostatic control must be used but there is no reason for these to be complicated or expensive.

We now have a dryer which is supplied with air, variable in flow rate but of controlled temperature. **All the following discussion assumes that we have controlled hot air temperatures.** Let us now look at what happens to the dhool and the moisture in it, to be able to interpret the temperature readings we get from above the dryer bed.

Constant rate drying

When the dhool enters the dryer, there is around 2.5 times as much water as dry matter in it. The surface (and near-surface) moisture will evaporate at a high rate, almost purely dependent on the capacity of the dryer air to take it away and to supply the latent heat of evaporation. The air leaving the dhool at this stage will be fully saturated, so the wet bulb temperature will equal the dry bulb temperature, and this will be determined by the heat absorbed by the moisture from the hot air as the moisture evaporates. This temperature tends to be around 40°C in most dryers. We can use very hot air without risk of burning in this part of the dryer, as the heat goes into latent heat of evaporation rather than heating up the dhool. The limit to air temperature will occur when the outer layer of the dhool particle is dried so rapidly that the surface is sealed, preventing easy movement of the interior moisture to the surface for evaporation. This phenomenon is known as "case hardening", and is most often observed on balls of dhool; with finely divided dhool the surface area is extremely high in relation to the volume so it is unlikely to occur except at ridiculously high drying temperatures (over 160°C).

Falling rate drying

When this highly mobile portion of the dhool moisture has been lost, (at about 40% moisture content wet basis) the rate of drying will start to fall. There is no longer free moisture on the surface of the dhool, and the moisture that is evaporating will come from the inside of the particles. The rate of movement from the inside to the outer surface will gradually fall, as the moisture has further and further to travel to reach the surface where it can be evaporated.

As the rate of drying is no longer determined by the heat available in the drying air but by the rate of diffusion, not all the heat in the air will be utilised to evaporate moisture so the exhaust air temperature will start to rise, and the temperature of the dhool with it. This limits our air temperature at this stage; too high a temperature will damage the valuable constituents.

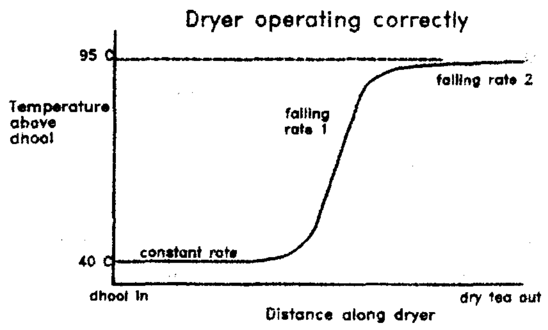
Second falling rate period

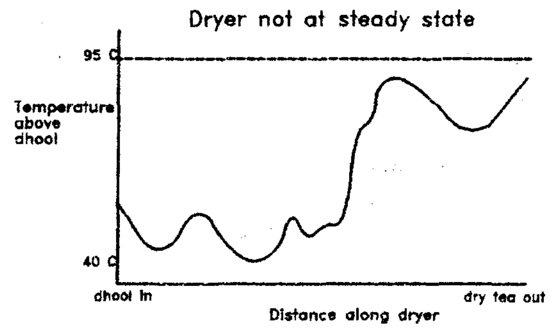
Once all the free moisture in the tea has been evaporated, we still have some further moisture to evaporate. This is the amount of water that the dry tea is capable of picking up from the atmosphere in storage, in a hygroscopic manner. It is quite strongly attached to the organic matter in the tea particle, so is quite difficult to remove; this results in a second falling rate period of drying, but as the rates during this period are very much less than the first falling rate phase, this is considered a separate part of the drying process.

As the heat in the air being fed to the dryer is not being used to evaporate water to a significant extent, the exhaust air temperature will be similar to the inlet temperature. Some of the heat will go to increase the temperature of the dhool, which will be close to the air temperature. Any further drop in air temperature must come from cold air entering the dryer delivery opening, or heat losses through the dryer wall. At this point, too high an air temperature will burn the tea.

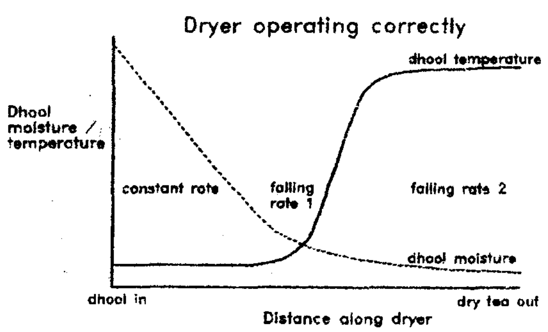
Graphical representation

The best way to look at the conditions in the dryer is to plot graphs with the distance along the dryer as the horizontal (x) axis.





From this graph it is apparent that, for about the first third of the dryer, the temperature does not vary much from 40°C. Again the last third, in which we are getting rid of the remaining small amount of moisture, the temperature does not vary much from 95°C, which in this case is the inlet temperature. It is in the middle third that temperatures are changing rapidly. Adding a line for moisture to the temperature curve shows a better representation of what we mean by constant and falling rates.

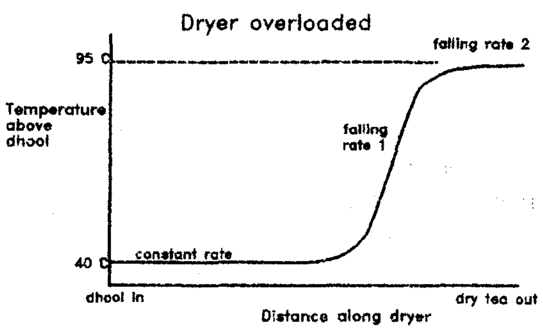


A curve like this is only obtained when a dryer is so operated that there is a steady flow of dhool in, and a steady flow of made tea out, with constant airflow and temperature settings. It takes some time from start-up to reach these steady state conditions and there is always a temptation to alter settings before the steady state is reached, thus disturbing the system again. If the flow of dhool is intermittent, or the weirs, airflow or other variables are altered, the picture will be very different.

While a conventional dryer may be tolerant of changes in dhool feed, because of the positive conveying action of the mechanism, a fluid bed dryer is not. It relies entirely on a steady inflow of dhool to displace the dry tea out of the end. To simplify the discussion, let us only consider the steady state condition of the FBD from now on.

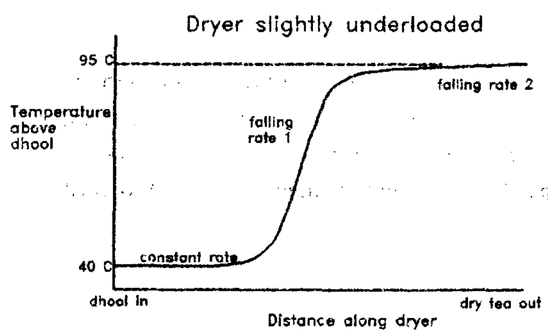
Overloaded dryer

What happens when the dryer is overloaded with dhool? If we look at the graph of temperature again, we find that the constant rate period is extended, because there is more water to evaporate. The first falling rate phase does not occur until further along the dryer, and the second falling rate period is very much shorter. This results in us producing tea at too high a moisture content.



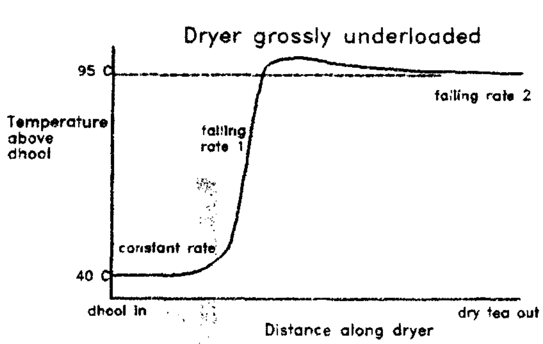
Slightly underloaded dryer

The opposite effect is found in an underloaded dryer. However, as the rate of moisture loss in the second falling rate phase is so small, we will find the tea to be only slightly over dried. The main effect on production here is that heat is wasted, by exhausting more unsaturated hot air to the atmosphere.



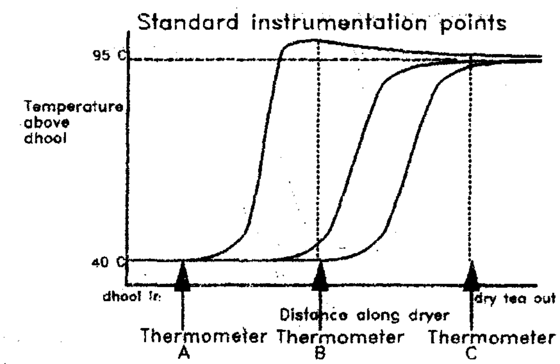
Grossly underloaded dryer

If the dhool load is reduced even further, the constant rate period becomes very short, so the second falling rate section occurs closer to the wet end of the dryer. As there is a lot of very hot air (often around 140°C) here, this will increase the temperature of the made tea and lead to overfiring. When the overheated tea reaches the end of the dryer, its temperature will have fallen back to close to that of the less hot air at the dry end of the dryer.



Standard dryer instrumentation

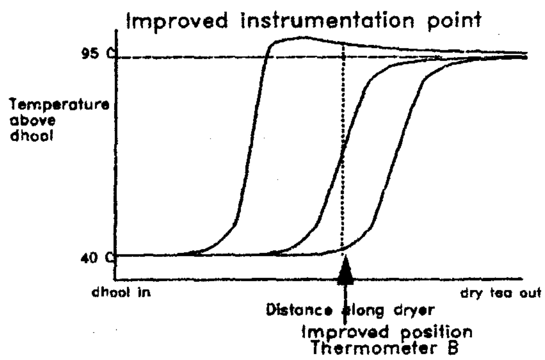
On most dryers, there are at least two or three temperatures measured above the bedplate. Let us call these sensors A, B and C, and note their positions on the distance/temperature graph. On this graph we can see the underloaded, correct and grossly overloaded curves superimposed.



It is clear that thermometer A tells us that the constant rate section is working correctly, and thermometer C will show that the dry end air temperature is about right, only showing a very slight rise if the dryer is overfiring the tea. They are not really giving us any information on whether to expect the tea to be dried correctly or not.

Thermometer B is of more use to us, but notice that the difference in reading between correct and overloaded is very small. It shows clearly the difference between correct and underloaded. If it were to be moved only slightly further from the inlet, it would discriminate much better between correct and overloaded.

We can see from this that the temperature measured at three fixed points can be very misleading. What would really be of most use would be to indicate the position at which the temperature goes through 65°C. In the MRF dryers we find this by measuring at 15 points along the dryer, but this is impractically expensive for commercial use. If finances restrict us to three measurement points, then we should find out the position under correct conditions where the temperature is 65°C. Placing the other thermometers quite close to this one will give us useful information.



Positions A and C are not really of much help, providing that we can rely on the thermostatic control valves (in our experience, quite a fair assumption).

If we can afford to measure more points, then we can get a very good picture of what is happening in the dryer, and by displaying it on a bar-graph display this can give the operator a good idea of what he is achieving.

7 The drought: a review

B. Mkwaila

In 1992, the entire tea growing area of Southern Africa experienced what growers called the worst drought in living memory. But there have been worse droughts before, as many estates' weather records will affirm. For instance, one estate in Thyolo which normally receives 1200 mm annually received 760 mm in 1992, but the records also show that the rainfall for 1965 was 729 mm. What is lacking about these past droughts is documentation as to what effect they generally had on crop and other factors.

This review is meant to look at what happened last year and how it affected us. The Concise Oxford Dictionary defines drought as *the continuous absence of rain.* Figure 1 shows the monthly rain distribution at Mimosa in Mulanje (Fig 1a) and at Thyolo station (Fig 1b) for 1992, compared to the previous year and the ten year mean.

Figure 1a Rainfall figures (mm) for Mimosa

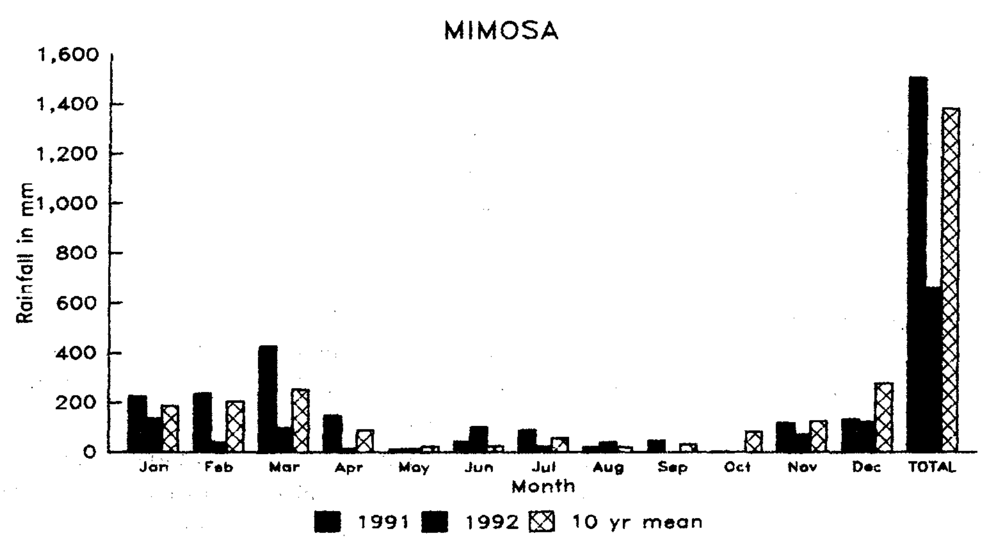
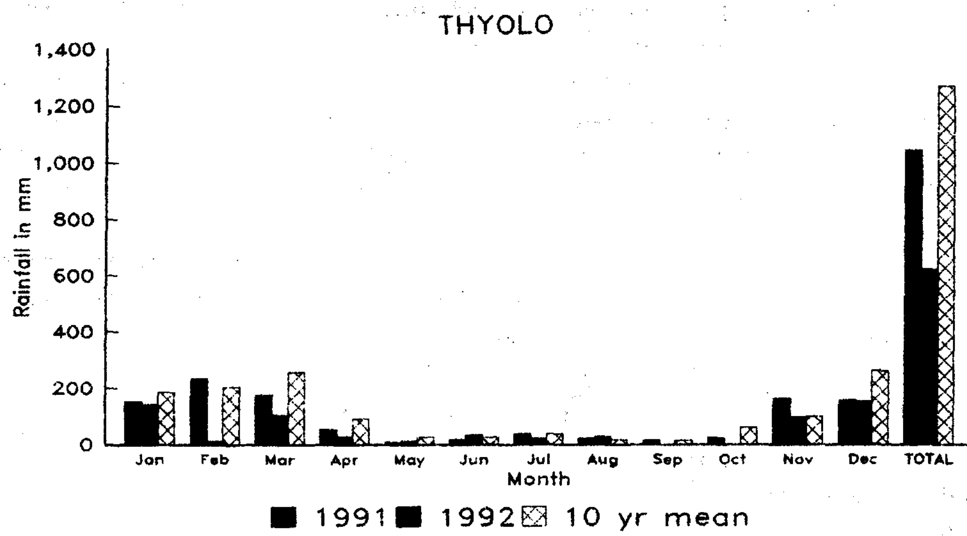


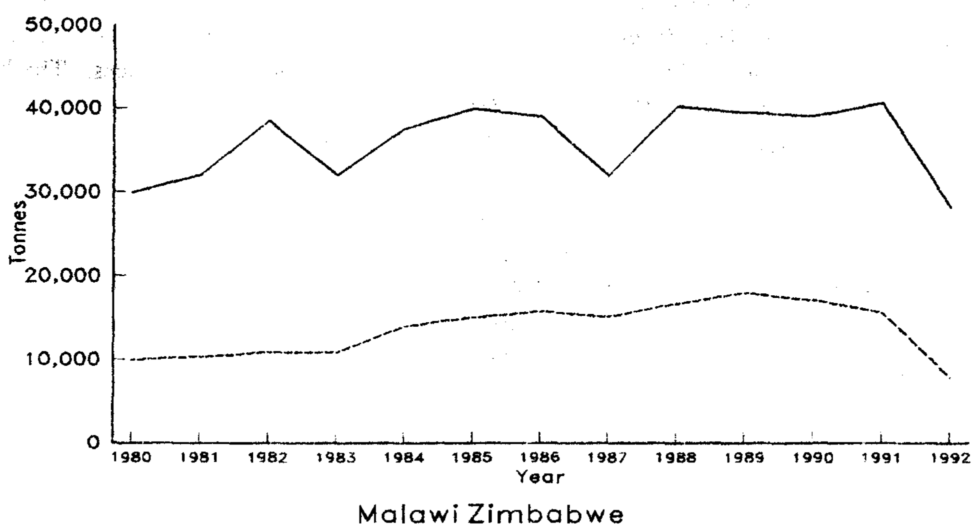
Figure 1b Rainfall figures (mm) for Thyolo



At Mimosa, Mulanje, the first indication of drought was the low December 1991 precipitation of just over 130 mm as compared to the ten year mean of 270 mm. January 1992 was only slightly better and was followed by the driest February on record with only 40 mm. March, often the wettest month of the year, received less than 100 mm compared to over 400 mm the previous year. The main cropping season of November to April received a total of 420 mm. This was quite a drastic shortfall, as the previous season's total rainfall had amounted to 1440 mm.

Similarly at Thyolo station, December 1991 rainfall figures were much lower than the 10 year mean. Thereafter the rainfall was declining considerably compared to the ten year mean and February with only 9.4 mm was the driest on record.

Figure 2 Total production figures (tonnes) for Malawi and Zimbabwe, 1980 - 1992



The effect of this shortfall on crop was very severe. The graph in Figure 2 shows that the 1992 total crop for Malawi fell to below the pre 1980's figure to 28 thousand tonnes. The graph also shows that Zimbabwe suffered a similar fate in their 1992 production, falling to below the pre 1980's production; 7.8 thousand tonnes as compared to 10 thousand tonnes in 1980.

There are two other important points brought to light by Figure 2. The first is that there had been other droughts in 1983 and 1987. These two droughts had a similar effect on crop, reducing it by 18% from the previous season in each case. While the 1983 drought also had a slight residual effect in the following season, the 1987 drought did not have the slightest residual effect in 1988, crop that year attaining a record of 40 thousand tonnes.

The second point is that while we know that the 1983 and 1987 droughts were worse in Zimbabwe than in Malawi, tea production in Zimbabwe was hardly affected in those two years. The reason for this was that a large proportion of the tea in Zimbabwe depends heavily on irrigation and that during those two drought years the growers never ran out of water in their reservoirs and were therefore able to ride the droughts.

The question is: Why did the 1992 drought have such a drastic effect on Zimbabwe tea production then? Reason for this is that the 1992 drought in Zimbabwe actually started in 1990, getting progressively worse each year and by 1992, at the height of it all, the water reservoirs were completely empty.

Whether or not a particular drought will have a residual effect in its wake is open to speculation. The phenomenon, by its nature an Act of God, is not amenable to programming and experimentation. My observation of the recent drought suggests that a drought will not have a significant residual effect, provided it has not devastated tea bushes as to cause severe die-back on a significant proportion of the area under tea. Whether die-back occurs or not will depend on other factors prevailing during the drought.

Figures 3a and b show maximum temperatures for October for Mimosa and Thyolo research stations from 1989 to 1992. The reason for highlighting these temperatures is that while tea bushes were not productive during the drought due to severe moisture deficit, they somehow maintained their structural integrity. Although they were in a stressed state, they did not have much sunscorch, defoliation or die-back until the last week of October. Then, seemingly overnight, the bottom fell out.

The temperature figures show that although the general pattern of most temperature fluctuations is similar at Mimosa and Thyolo, the temperatures are generally higher at Mimosa. Also the 1989 to 1991 figures show that when the temperature reached a high of above 35 °C, it never stayed there for more than two days before taking a dip. At no time would maximum temperatures be the same for several days long enough to give a horizontal line. This is where the 1992 figures depart from the general pattern. From about the middle of the month, the temperatures are close enough to more or less form a horizontal line at both places. The big difference between Mimosa and Thyolo is that from the 16th onwards, the maximum temperature at Mimosa has been above 35 °C and from the 24th it stayed above 37 °C to the end of the month. At Thyolo on the other hand, while horizontality was maintained, the temperature generally stayed below 35 °C except for three days when it went just above.

Figure 3a October temperatures (°C) at Mimosa

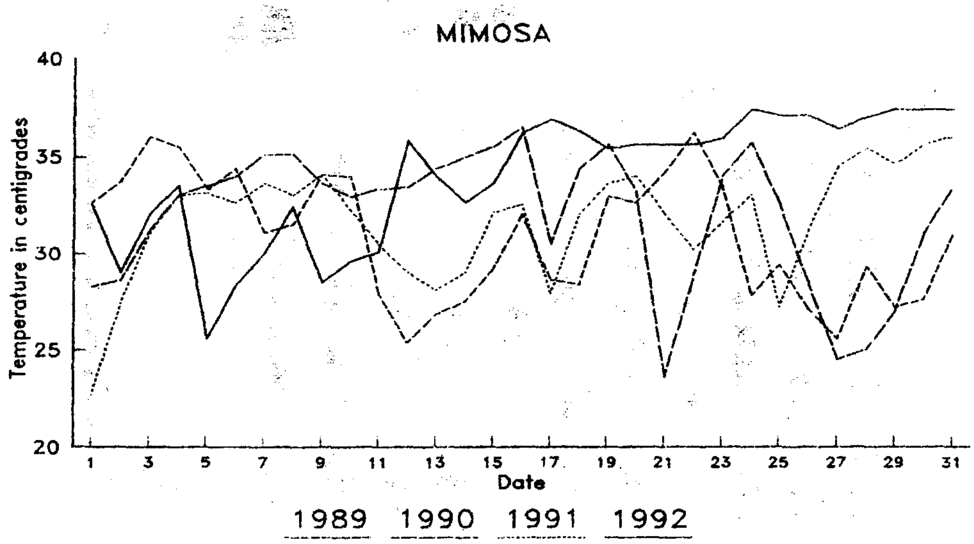
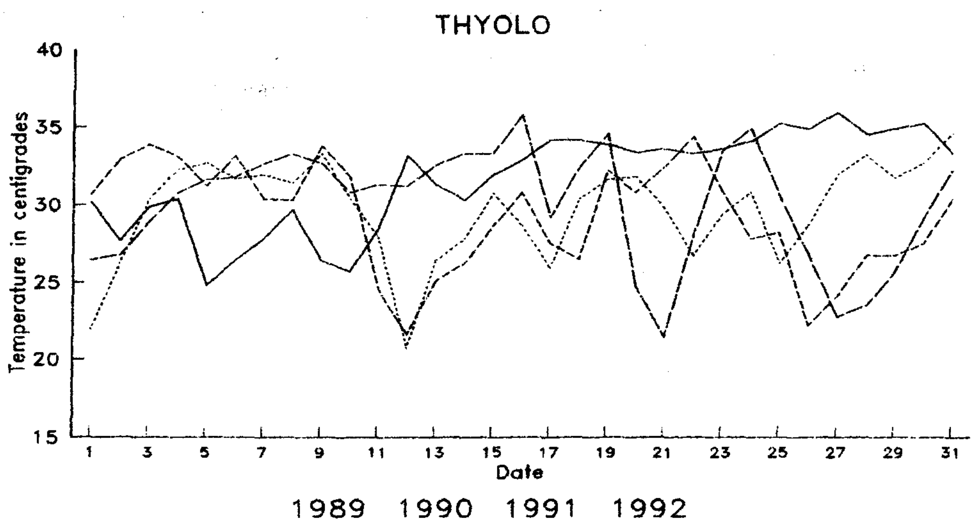


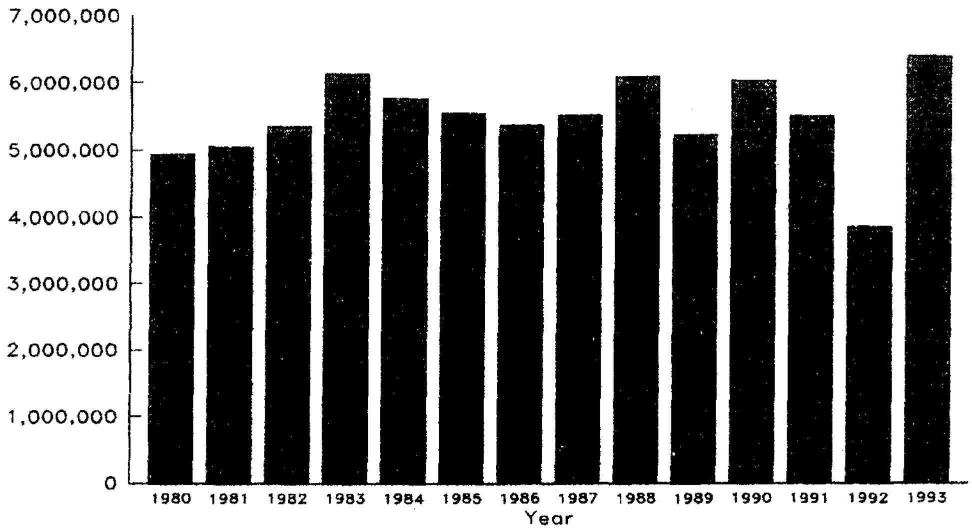
Figure 3b October temperatures (°C) at Thyolo



This difference in the maximum temperatures resulted in severe sun scorch, defoliation and substantial die-back in Mulanje, while central Thyolo was not similarly affected. I believe that had the rains broken at the normal time, Thyolo would have proceeded to respond normally and would have had no residual effect from the drought, whereas Mulanje would have had to recover from the die-back first, thereby manifesting residual drought effects.

As it were, the rains were late. Consequently, the December, January and February crops were below normal, albeit improving with each month. The January rains were much higher than normal, resulting in a very heavy crop in March. Figure 4 shows that the 1993 March crop was an all time record for that month: 6.4 thousand tonnes, an indication that the tea had fully recovered from the drought. Given adequate rains from then on, production should be normal for the rest of the year.

Figure 4 Total Malawi tea production in tonnes for the month of March, 1980 - 1992



In conclusion it must be said that the tea came through it all a lot better than had been expected. There were no large scale deaths. Deaths occurred only in patches where there was a definite inherent soil problem such as rocky outcrop, dambo soil, gravel or laterite, or proximity to a Eucalyptus plantation.

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