

FOREWORD

The Tea Research Institute of Tanzania (TRIT) was established in 1996 as an autonomous organization representing the Government of Tanzania and the tea industry. Its duty is to support the continued development of the tea industry, both large and small-scale producers, with appropriate high quality, cost effective research and technology transfer. It is funded by a statutory cess, levied on all producers of tea, and by grant aid from willing donors.

This publication is the first in a series of Occasional Papers published by the Tea Research Institute of Tanzania aimed at disseminating information on various aspects of tea. It describes how knowledge of the growth and development of tea shoots can be utilized to improve plucking productivity and hence enhance profits. It is intended for tea growers and managers, extension workers, researchers, educators and students. We believe that this publication and its accompanying glossary of the definition of common tea harvesting terms will serve as a useful reference to all those in the tea industry. It is available in both English and Kiswahili.

The author, Professor Mike Carr, has been associated with the tea industry in Tanzania for many years. After graduating from the University of Nottingham in 1966 he worked for the Tea Research Institute of East Africa until 1971. The same University awarded him a PhD for his pioneering work on the water relations and irrigation of tea at the Ngwazi Irrigation Unit in Mufindi Tanzania, before transferring to Kericho, Kenya. After returning to the UK he worked at Wye College (University of London), before joining Silsoe College, Cranfield University in 1976. He was promoted to Professor of Agricultural Water Management and Head of Department in 1987 and in 1993 became Dean of the Faculty. He retired from Cranfield University in 1999. He continued his association with the tea industry during his time at Cranfield, through research, training and consultancy in eastern Africa and elsewhere in the World. From 1985 to 1997 he managed the Ngwazi Tea Research Station, and is currently Executive Director of the Tea Research Institute of Tanzania.

Professor Bruno J. Ndunguru
RESEARCH DIRECTOR, TRIT

SHOOT GROWTH plus PLUCKING equals PROFIT*

By
M.K.V. Carr

The purpose of this paper is (a) to present an overview of how tea shoots develop and grow in order (b) to highlight ways in which this knowledge can be utilised to improve the day-to-day management of plucking, so as (c) to enhance profits. As an addition to this paper there is a glossary of common tea harvesting terms used by producers in eastern Africa, where definitions of words and phrases, cited in the text below in italics, can be found.

SHOOT GROWTH

In tea there are three principal *components of yield*. These are:

- 1). The number of shoots harvested (per m²).
- 2). The mean shoot dry mass at harvest (g).
- 3). The time taken for an *axillary* bud to grow into a shoot suitable for harvest (days), also known as the *shoot replacement cycle*.

It is theoretically possible to determine the annual yield of tea by multiplying each of these terms together. Thus:

$$\text{Annual yield} = \text{Number of shoots harvested} \times \text{Mean dry mass per shoot} \times \text{Number of shoot replacement cycles per year}$$

And hence, by substitution, for example:

$$\begin{aligned} \text{Annual yield} &= 500 (/m^2) \times 0.20 (g) \times 5.0 (/y) \\ &= 500 g/m^2, \text{ or} \\ &5000 \text{ kg/ha of dried tea} \end{aligned}$$

Let us now consider each of these components of yield in turn.

Number of Shoots

This is probably the main determinant of yield. It varies with the clone, the season, inputs such as nitrogen, and stage in the *pruning cycle*. We can define the number of *harvested shoots*, the number of so-called *basal shoots*, and the *total shoot population density*. At the Ngwazi Tea Research Station, Tanzania, for example, the mean annual

* This paper is based on a presentation made at the Annual Open Day of the Tea Research Institute of Tanzania, organised in association with CDC (East Africa) Teas, at Njombe, Tanzania, October 5th 1999.

basal shoot density for clone 6/8 increased from 310 to 560 /m² over three years with a peak (high nitrogen and well irrigated) of 850 /m².

We also need to differentiate between shoots with terminal buds that are either actively growing or dormant (*banjhi*). If shoots are allowed to grow freely when, for example, a bush is left for cuttings, the terminal bud will go dormant after a specified number of leaves, up to 12, have unfolded. Regular harvesting prevents most young shoots from going dormant. Shoots that originate from so-called un-plucked origins (c.f. *plucked origins*) deep in the canopy, often known as secondary shoots, are more likely to go dormant when only a few leaves have unfolded. Similarly inherently slow growing shoots within a population are also likely to go dormant sooner than fast growing ones.

Dry Mass of Shoots

The dry mass of a shoot depends not only on its size, or fresh mass, but also on its dry matter content. The fresh mass (or weight) of an individual shoot is linearly related to the number of leaves. Thus for clone 6/8 it ranges from 0.16 to 0.35 g/leaf depending, for example, on the level of nitrogen fertilizer applied. Thus a shoot with 'three leaves and a bud' will weigh up to 50% more than a shoot with 'two leaves and a bud'. The dry matter content of a shoot varies considerably with the season, and also with fertilizer and irrigation (e.g. clone 6/8 from 19 to 30%). The product of fresh mass times dry matter content gives the shoot dry mass. Remember that processed tea leaving the factory has a water content of 2-4%.

Shoot Replacement Cycle

The shoot replacement cycle is a measure of the time taken (days) for an axillary bud, when released from *apical dominance*, to grow into a shoot suitable for harvest. It is mainly influenced by temperature, but also by water stress, nutrition, the dryness of the air and clone.

Shoot growth can be considered as a three-stage process:

Stage 1). A long lag phase as the axillary bud slowly expands and as the leaf *primordia* within it develop. This is followed by:

Stage 2). A period of rapid shoot extension and leaf development, and finally:

Stage 3). The terminal bud becomes dormant (*banjhi*).

Rates of shoot extension and development are functions of temperature. *Base, optimum* and *maximum temperatures* can be specified for tea. The base temperature is in the range 8 to 13 °C depending on the clone, the optimum temperature is about 24°C, and the maximum 35 to 40 °C. The base temperature for shoot development is about 2-3 °C less than for shoot extension. This is why the *internodes* are shorter during the 'winter' months than in the 'summer', and it becomes difficult to harvest tea by hand.

Clones with a low base temperature will continue to produce shoots during the 'winter' or at high altitudes where it is cool. Small differences in the base temperature can have relatively large effects on rates of shoot development and extension at these times and places. Clones 6/8 and SFS150 have low base temperatures for shoot

extension (*ca.* 9 °C); clones 207 and S15/10 are intermediate (*ca.* 10 °C), whilst clones 1 and K35 have high values (*ca.* 11°C).

Water stress will reduce rates of shoot extension and development and, hence, extend the duration of the shoot replacement cycle. It also reduces shoot length at harvest, and increases the dry matter content, but has little effect on the basal shoot population density although peak densities at harvest are delayed until after the rains have started.

Nitrogen fertiliser increases rates of shoot extension and development and reduces the length of the shoot replacement cycle. It also increases (up to 14%) the basal shoot population density and, particularly, the number (300%) of harvested shoots (clone 6/8), but reduces the number of dormant (banjhi) shoots. The length of shoots at harvest is increased with nitrogen fertiliser, but there is little effect on shoot mass. The dry matter content of shoots can be reduced by nitrogen.

Examples of the lengths, measured or estimated, of the shoot replacement cycles at different locations in eastern Africa are given below:

Tanzania

Mufindi: Ngwazi Tea Research Station, altitude 1800 m; winter months, irrigated 90-95 days; rains 60-65 days, an annual total of 3-4 shoot replacement cycles. Unirrigated, unfertilised up to 180 days in dry season, 2-3 SRCs per annum.

Amani: Marikitanda Tea Research Station, alt. 1050 m estimate 50 days, 6-7 SRCs.

Bukoba: alt. 1300 m; estimate 50-60 days, 6 - 7 SRCs.

Luponde: alt. 2200 m; estimate 120-160 days, 2 - 3 SRCs.

Tukuyu: alt. 1200 m; estimate 60-80 days, 5 - 6 SRCs.

Kenya

Kericho: Tea Research Foundation, alt. 2200 m; estimate 120 days, 3 SRCs.

Malawi

Mulanje: Tea Research Foundation, alt. 650 m; main growing season 42 days.

Uganda

Fort Portal: Rwebitaba Tea Research Station, alt. 1450 m; estimate 80 days*, 4 – 5 SRCs.

*Longer than altitude would suggest because of cold air descending from the Rwenzori Mountains.

PLUCKING

Crop Distribution

As we all know the distribution of production is not uniform throughout the year. Large peaks in yield occur after a limiting factor, such as low temperature or drought,

'Shoot Growth plus Plucking equals Profit' by M.K.V. Carr, Tea Research Institute of Tanzania, April 2000.

has ended and allowed the accumulated buds of many ages to develop together. This large peak, such as that which follows the start of the rains in Malawi, or the so-called October *flush* in irrigated tea in Mufindi and Njombe in southern Tanzania, can cause major logistical problems in field and factory. Once these shoots have been harvested, and sometimes leaf has to be thrown away if factory capacities are exceeded at these times, there is then a decline in production until the next generation of shoots (*shoot generation*) has developed. There is then a second, usually smaller, peak in production, followed by a third and perhaps fourth until dry weather and/or low temperatures once again reduce growth rates and the cycle is repeated. Each successive peak in production is usually less than the last as the cycles become gradually out of phase.

The initial yield peak followed by the subsequent decline is often referred to as the '*Fordham Effect*' after the scientist who first described the process in Malawi. During the troughs in yield between the peaks the bushes are often wrongly described as being 'banjhi'. Although there may well be more dormant shoots visible at these times than normal, usually slow growing shoots or those from secondary origins, the real cause of the decline in yield is the time delay between one generation of shoots reaching the 'two or three leaves and a bud' stages of growth and the next. The time interval between successive peaks will be close to the shoot replacement cycle. There is little that managers can do to overcome the problem of uneven crop distribution but some *crop distribution management* techniques are recommended in Malawi. Planning ahead is of course essential.

Harvesting Criteria

Managers use many terms to describe the plucking process, including *selective plucking*, *fine/coarse plucking* and *hard plucking*. They are not all mutually exclusive. Selective plucking (c.f. non-selective plucking), in which shoots are carefully chosen on the basis of their length and/or stage of development, is likely to lead to the largest yields of high quality leaf over the longer term. This is a skilled process, harvesting will be slow and expensive, and close supervision is needed.

Fine plucking, in which only shoots with 'two leaves and a bud' together with soft 'banjhi' are removed, should lead to a reputation for high quality, and hopefully high prices, but yields will be reduced, by up to 40 %, compared with 'three leaves and a bud'. Labour productivity will also be reduced.

Hard plucking describes the removal of all shoots above the surface of the *maintenance foliage* (or *plucking table*), regardless of their size or stage of development. This process is also sometimes referred to as *plucking black*. It has the advantage that the labour does not necessarily have to be skilled, large yields and high labour productivity are possible, the rate of increase in height of the table will be reduced compared with less severe forms of harvesting, leading to opportunities to extend the length of the *pruning cycle*. The disadvantages include the risk of reduced yields if the process is taken to the extreme, particularly on tea depleted in nutrients. In addition coarse (*mature*) and broken leaf may lead to low quality.

Yield versus Quality

This is the traditional dilemma faced by managers. The quality of processed tea is judged against many parameters. These include the appearance of the black tea, the colour of the liquor, taste, packing density and cuppage. Their relative importance will depend on the market, which in turn is constantly changing. No wonder it is difficult to plan!

In general quality is inversely proportional to the size of the harvested shoots, and this has led to the development of criteria based on shoot size to judge the quality of the green leaf in the field such as '*pieces per kilogram*'. This is calculated from the sum of shoot number (whole shoots plus broken shoots) divided by the total fresh weight of the sample multiplied by 1000.

The usual target number is 1000-1200 pieces/kg, depending on the stage in the pruning cycle and the clone, and this corresponds to about a 50:50 split between two and three leaves and a bud.

Scheduling Harvests

There are several ways in which plucking is organised and scheduled. The traditional way is by so-called *gang plucking*, in which a group of people, the number depending on labour availability and the size of the crop, move across the field together. *Scheme plucking* by contrast involves individuals or families taking responsibility for harvesting small areas of tea. Deciding when to pluck, preferably well in advance, must be linked to the actual rates of growth and development of shoots. In *programmed plucking* the intervals between harvests are based on the time taken for a generation of shoots to develop to a stage suitable for plucking. For example in Malawi this is taken to be the equivalent of one quarter of the duration of the shoot replacement cycle in the main growing season, that is about 42 days. Hence the recommended interval between harvests is alternatively 10/11 days.

Another approach based on understanding the factors that influence the growth rates of individual shoots is to use the concept of the *phyllochron*. This is a measure of the time taken (day) for successive leaves to unfold. This is influenced by temperature in particular, but is also sensitive to water stress. There are also differences between clones. The reciprocal of phyllochron is *leaf appearance rate* (leaves/day).

On the assumption that after harvest the shoots remaining on the bush have, on average, one unfolded leaf and that the target shoot at the next harvest is 'three leaves and a bud' the interval to the next harvest is two phyllochrons. Using the mean of the daily maximum and minimum temperatures it is possible, using tables, to determine the time to the next harvest and, by so doing, to plan ahead. This is the way harvesting is scheduled at the Ngwazi Tea Research Station in Tanzania.

The criteria to take into account when assessing how best to manage the harvesting process include labour productivity, skill and reliability, the prescribed quality of the green leaf, the importance of a sense of ownership, and ease of day-to-day management. Some system of programmed plucking is essential if managers are to

take the best decisions based on realistic predictions of the future crop. Responding only to events is no longer enough.

Mechanical Harvesting

Although this topic is not central to the theme of this paper, there is increasing interest in some form of mechanical harvesting for tea. Many techniques are now available, ranging from the very simple hand-held aid (e.g. a blade or shears) to a self-propelled machine harvesting three rows at a time. To be effective mechanical systems should be robust, have precise height control of the cutter bar, the speed of which should match the forward speed of the machine, some shoot selectivity, and the operators need to be trained. Mechanisation of harvesting offers some advantages, including increases in labour productivity and associated cost saving. Disadvantages include limited selectivity of shoots, poor reliability and extended periods of downtime during repair, and the poor, perhaps sometimes unwarranted, reputation of mechanically harvested tea in the market place. Too often mechanical harvesting is seen as an instant solution to today's problem. Experience has shown that this is not the case. Forward planning is essential to ensure that the machine is designed to operate in the conditions found in eastern Africa, and that operators are suitably trained. *Leaf handling* after harvest should also not be ignored.

PROFIT

Last but by no means least is the question of profit, the reason that all of you are in business. Profits can be increased by improving the revenue and/or by reducing costs. Raising yields and maintaining, or better increasing, quality and value will improve revenue. Alternatively maintaining the same yields but increasing the value of the processed tea will also benefit the income stream. If yields are reduced then a substantial increase in value is needed if revenue is to be maintained.

Reducing operating costs requires improvements in the productivity of labour and management staff, and/or improvements in the use of expensive inputs such as fertiliser and irrigation, a concept known elsewhere as precision agriculture.

Actions

What actions can you therefore take as a manager to improve profitability through better plucking and leaf handling? I suggest the following:

- Evaluate all your harvesting procedures systematically.
- Look to improve the timeliness of harvests using a knowledge of shoot development rates (phyllochrons); this will allow you to
- Plan ahead.
- Monitor regularly the rate of increase in the height of the table; try to keep it below 100 mm a year; set this as a target for your headman, but remember *breaking-back* is a sin!
- Monitor the quality of the harvested leaf at the leaf shed (pieces /kg).

- Review the handling and storage of the leaf between the bush (yes, the bush) and the factory.
- Train, involve and reward labour. Explain to them, for example, the concept of the shoot replacement cycle and the importance of not removing immature leaf. It is in their personal interests as well as that of the company.
- Determine the potential yields that can be achieved in your locality (ask TRIT) and set these as your target. Remember 1000 kg/ha was, not so long ago, considered to be a large yield. Now it is perhaps 4-5000 kg/ha. What will it be in 20 years time?

Remember that wealth is created in the field; value can be added in the factory (or sometimes lost!).

DEFINITIONS OF TERMS USED IN TEA HARVESTING 1. SHOOT GROWTH, AND 2. HARVESTING AND BUSH MANAGEMENT**

By
M.K.V. Carr

1. SHOOT GROWTH

Apical Dominance: a term that describes the controlling influence of the apical or *terminal bud*, whether active or dormant, over the development of the *axillary buds* lower down the stem.

Assam Type: this term is used to describe cultivars of tea that show vegetative characteristics tending towards those of *Camellia sinensis* var. *assamica* (Masters), namely with large, horizontal, broad, mostly non-serrated and light green leaves (c.f. *China type*).

Axillary Bud: the vegetative bud in the angle between a leaf and the stem.

Basal Population Density: the number of (small) shoots remaining after harvest per unit area of bush, or ground (c.f. *harvested* and *total population density*).

Banjhi: the (Indian) name given to a tea shoot with a dormant terminal bud, recognised by its relatively small size (2-3 mm long). There is '*hard*' *banjhi*, where the upper leaves and stem have become coarse through age, that is unsuitable for manufacture, and '*soft*' *banjhi*, where the subtending leaves and stem are young, that can be successfully manufactured.

China Type: this term is used to describe cultivars of tea that show vegetative characteristics tending towards those of *Camellia sinensis* var. *sinensis* (L.), namely with small, erect, narrow, serrated and dark green leaves (c.f. *Assam type*).

Fordham Effect: the name given (after the scientist who first described the process) to the large peak in production that occurs after a limiting factor, such as low temperatures or drought, has ended and allowed the accumulated buds of many ages to develop together. Once these shoots have been harvested there is then a decline in production until the next *generation of shoots* has developed, followed by a second but smaller peak. The first large peak, such as that which follows the start of the rains in Malawi, can cause large logistical problems in the field, for transport, and in the factory.

** This glossary was prepared in support of a paper entitled '*SHOOT GROWTH plus PLUCKING equals PROFIT*' presented at the Annual Open Day of the Tea Research Institute of Tanzania, organised in association with CDC (East Africa) Teas, at Njombe, Tanzania, October 5th 1999.

Harvested Population Density: the number of harvested shoots per unit area of bush, or ground (c.f. *basal* and *total population density*).

Leaf Appearance Rate: a measure of the rate of unfolding of individual leaves on a tea shoot (leaf/day); the reciprocal of a *phyllochron*.

Leaf Pose: a measure of the inclination of a leaf as indicated by the angle between the leaf petiole, or (better) the leaf tip, and the vertical stem or axis. Tea plants with large, horizontal ($>70^\circ$) leaves are considered to be of the *Assam type*, whilst those with small, vertically inclined ($<50^\circ$) leaves tend towards the *China type* of bush.

Mature Leaf: the name given to leaves that have stopped expanding in area and become hard with aging. They are unsuitable for processing.

Mother Leaf: the name given to the leaf, the bud in the axil of which develops into a shoot or, in the case of a leaf-bud cutting, a plant.

Node: the point of attachment of a leaf to the stem; by comparison the *internode* refers to the length of stem between adjacent nodes.

Phyllochron: the time interval (day) for two successive ‘true’ leaves to unfold from the terminal bud. Harvest intervals can be estimated using the relationships that exist between mean daily air temperature and a *phyllochron*. On the assumption that, after harvest, the shoots remaining on the bush that will form the basis for the next harvest have, on average, one unfolded leaf, and that the target shoot is ‘*three leaves and a bud*’, the interval to the next harvest will be two *phyllochrons*. The reciprocal of a *phyllochron* is known as the *leaf appearance rate* (leaf/day).

Primordia: embryonic leaves (or flowers) that are initiated in buds that subsequently may develop into shoots.

Scale-leaves: two or sometimes three very small, smooth edged, leaves (or catophyls) can be found at the base of a tea shoot. Previously enclosing the bud, they usually fall off as the shoot matures. An upper, much larger, scale leaf is known as the *janum* whilst the term *fish-leaf* is sometimes used to describe a similar leaf, serrated on one

side, situated above the *janum*. These two appendages are not always easy to distinguish, and are of little known practical importance although buds, which can develop into shoots, form in their axes.

Shoot Generation: the term used to describe a population of shoots that develops from (mainly) *axillary buds* following the removal of *apical dominance* by *plucking*.

Shoot Replacement Cycle: the time taken (day) for an *axillary bud*, when released from *apical dominance* after plucking the main shoot, to develop into a shoot suitable for harvesting. In Malawi this is taken to be when the third true leaf has unfolded.

Stage of Shoot Development: a term that signifies the developmental stage that a shoot has reached, for example one having one, two or three unfolded leaves with an ‘*Definitions of Terms used in Tea Harvesting*’ by M.K.V. Carr, Tea Research Institute of Tanzania, April 2000.

expanding terminal bud or with a dormant (*banjhi*) bud. By contrast 'growth' represents an increase in the dry weight of a shoot, and 'size' would commonly be a measure of its length.

Terminal Bud: the name of the vegetative bud found at the apex of a shoot from which new leaves unfold when it is actively developing but, if left to grow, becomes dormant (or *banjhi*) after a certain number of leaves have unfolded. Later the cycle is repeated.

Total (Shoot) Population Density: the total number of shoots (*basal* and *harvest*) per unit area of bush, or ground. This is a major determinant of yield in tea. Values can range from 100-200 to 1000-1200 /m²

Two/three Leaves and a Bud: a shoot with two or three unfolded 'true' leaves (ignoring any *scale-leaves*) and an actively growing, >10 mm in length, *terminal bud*. These are shoots at *stages of development* considered to be suitable for processing.

2. HARVESTING and BUSH MANAGEMENT

Acceptable Leaf: a term used to describe whether the relative proportions of shoots at different stages of development and size within a freshly harvested sample meet the factory specifications.

Breaking-back: the process in which old leaves unsuitable for processing are removed and discarded in order to maintain a level *plucking table*.

Crop Distribution Management: the term used in Malawi for techniques recommended to mitigate the problems of managing large crop peaks, particularly those that follow the start of the rains. These include 1) removing 30-40 mm from the top of bushes (*skiffing*) 17-27 days after the start of the rains or 2) *tipping* pruned tea 50 mm lower than the recommended height, then *plucking* normally until the peak occurs when one round of *plucking* is missed. Both practices are claimed to reduce the size of the crop peak without any loss of crop.

Flush: the word used to describe the state of the crop when there is a large number of visible, actively growing tea shoots per unit area of the bush surface.

Gang Plucking: the number of *pluckers* needed to harvest a given area of tea is decided on a daily basis by management depending on the availability of crop and labour; the *pluckers* then move across the field in a group or gang.

Green Leaf: a collective name commonly used to describe the harvested leaf before processing begins in the factory.

Immature Leaf: a term used to describe shoots that are less developed than those specified for harvest, typically those with one unfolded leaf, or with a partially open second leaf, and an active *terminal bud*.

Leaf Handling: this term covers the movement of *green leaf* within the field, weighing and storage, and transport from the field to the factory. The positioning of weighing points, and ease of access from the field, affects the productivity of the *pluckers*. Similarly bad handling of the *green leaf* in the plucking basket and poor storage conditions after weighing and during transport can have adverse effects on the condition and tea making quality of the leaf entering the factory. Since leaf handling extends from the time that an individual shoot is plucked in the field to the onset of the formal withering process in the factory, it is often the neglected part of the total tea production process, being the full responsibility of neither the field nor the factory manager.

Maintenance Foliage: the name given to the canopy of leaves below the level at which the tea shoots are harvested. These are the leaves that intercept sunlight and, through the process of photosynthesis, manufacture carbohydrates that contribute to the growth of the tea bush. For large yields it is essential to ensure that the leaf canopy completely covers the ground surface for as large a proportion of the *pruning cycle* as possible.

Origin: see *plucked origin*.

Pieces per Kilogram: this index can be used as a measure of both the ‘quality’ of *green leaf* after plucking, and also of *plucker* productivity. In Malawi shoots taken from about five, 300-500 g samples of known fresh weight, selected at the weighing point, are divided into the following categories and then counted. **Whole shoots:** 1) immature (shoots with one leaf and a bud, and very small two leaves and a bud); 2) shoots with two leaves and a bud; 3) shoots with three leaves and a bud; 4) soft banjhi; and 5) coarse (shoots with more than three leaves and a bud, and hard banjhi). **Broken shoots:** shoots with leaves missing. **Broken bits:** torn leaves and buds without stems. The number of *pieces per kilogram* is then calculated as follows: **divide** the **sum** of the number of whole shoots and broken shoots by the total fresh weight of the sample and then **multiply** by 1000. (A more detailed analysis is also possible.) The target number of *pieces per kilogram* varies with stage in the pruning cycle, and the type of tea plant or clone. The higher the number the more small shoots in the sample. In Kenya the target is about 1000 pieces/kg for seedling tea in the second and third years after pruning. This is considered to represent a 50:50 split between shoots with ‘two and three leaves and a bud’.

Plucked Origin: a tea shoot that has developed from the *axillary bud* of the leaf immediately below the point of abscission of a harvested shoot, following the removal of *apical dominance*. By comparison a shoot that has developed from a bud without the removal of apical dominance is said to have come from an *unplucked origin*.

Pluckers: the name commonly used to describe people who harvest (pluck) shoots by hand from a tea bush growing in the field.

Plucking: the skilful process of removing targeted tea shoots by hand. Various terms are used to differentiate types or intensities of plucking. For example, in *selective plucking* the *pluckers* are encouraged to harvest only shoots of a specified maximum length and *stage of development*. Thus *fine plucking* refers to the selective removal of

two leaves and a bud and soft banjhi only. By contrast, in *non-selective plucking* the *pluckers* are expected to remove all the shoots above the level of the table regardless of size or *stage of development*. This is also sometimes referred to locally as *plucking black*, a reference to the dark colour of the *maintenance foliage* when all the young shoots have been removed, or *hard plucking*. Shoots unsuitable for manufacture should always be discarded.

Plucking Round: the interval (day) between one harvest and the next.

Plucking Table: the level surface of the leaf canopy which *pluckers* are charged to maintain after *tipping*, or allowed to increase in height at a certain rate. A bamboo *wand* facilitates this process. The faster the *table* rises the shorter the interval between one pruning and the next. One important role of management is to ensure that the rate of increase in the height of the table, above ground level or the last prune, is kept to an acceptable minimum. This should be measured on a regular basis. Shoots left on the bush represent lost crop.

Plucking Wand: a length (2.5 to 3.5 m) of bamboo, with a diameter of 10 to 20 mm, used by *pluckers* as an aid for maintaining a level surface on the top of tea bushes.

Programmed Plucking: the term used to describe a system of management in which the harvest interval is determined on the basis of the time taken a *generation of shoots* to develop to a stage suitable for plucking. In Malawi this is taken to be equivalent to one quarter of the duration of the *shoot replacement cycle* that, in the main growing season, is about 42 days. The recommended harvest interval is therefore alternatively 10 or 11 days.

Pruning Cycle: the time interval between one pruning of a tea bush (once the formative prunes have been completed) and the next. In eastern Africa commercial practice is usually to prune every three or four years but this can be extended if the height and level of the *plucking table* allow the *pluckers* to continue to harvest efficiently. The terms *first, second, third and fourth year after pruning* refer to the successive twelve-month periods following the prune. In Malawi the three years in the pruning cycle are referred to as *pruned (P)*, *un-pruned one (UPI)* and *un-pruned two (UP2)*.

Scheme Plucking: a management system developed in Malawi in which each plucker (or a family) is given an area of tea for which he or she is responsible throughout the season. The area of each plot, representing the number of bushes that can be harvested comfortably in one day is, commonly, about 0.05 – 0.1 ha depending on the yield and the harvesting interval. Sometimes two (half-size) plots are allocated each day so that it is easier to accommodate a five and a half day working week, and to introduce flexibility in the system. Plots are demarcated by stakes at each corner or by allowing a shoot of tea to grow to a length of about 0.5 m. The responsibility for applying fertilizer, weeding and pruning to each plot can also be delegated to individual pluckers. Systems that suit local practices need to be developed to suit individual estates. *Programmed scheme plucking* is the term used to describe the combination of *programmed plucking* with *scheme plucking*.

Skiffing: a very light prune intended to level the *plucking surface* if it has become uneven, or sometimes to extend the length of the *pruning cycle* in a mature crop; usually a sign that management has failed to control the harvesting process.

Tipping: the name given to the first and second harvests after pruning when a new *leaf canopy* is being established and a level *plucking surface* is being formed at a specified height above the ground or prune.

ACKNOWLEDGEMENTS

The contribution of CDC (East African) Teas to the preparation of the paper is gratefully acknowledged.

In compiling this list of definitions reference has been made to a number of sources including the Tea Growers Handbook (4th Edition), published by the Tea Research Foundation of Kenya (1986), and the Tea Planter's Handbook, published by the Tea Research Foundation of Central Africa (1990). All errors however are mine alone. Please forward any comments, amendments and additions to Mike Carr at the address below. All communications are welcome.

Professor Mike Carr

*Research, Training and Consultancy Services,
Crop and Water Management Systems (International) Ltd.,
29 Bedford Road,
Clonhill,
Bedford MK45 4AE, UK.*

Tel/Fax +44 1525 861185;
E-mail mikecarr.rtcs@freeUK.com