

The second part of the book deals with the transfer of technology, with particular emphasis on the smallholder as a target group and how to best reach them. Smallholders in Kenya have production levels about 57% of the estate sector, a substantially better performance than those of smallholders in, for instance, Indonesia and Malawi. With the current efforts of TRF's extension service and clonal expansion in the sector, our own smallholders should gradually improve their comparative performance.

The third part is a rather strange mixture, including such topics as consumer demands, auctions, productivity and the impact of malaria, but possibly the most interesting group is that dealing with health aspects, including the question of pesticide residues. There is a very interesting review, from China, of the pharmacological functions of tea; given the fast moving nature and current intensity of research in this field the article is already out of date and could be easily doubled in length simply by including research done since the paper was written in 1996. There is no point of drinking tea for its pharmacological benefits if at the same time you are also consuming unacceptable levels of pesticide residues. Permissible levels are set internationally, particularly by the authorities amongst the main consuming nations, and TRF has long stressed the need for producers to pay very careful attention to this subject. We recently saw a publication from another Tea Research Institute which advocated spraying practically every potential problem as soon as it appears.

The second half of the book (the longer half?) covers two parts dealing with pre-harvest and post-harvest operations. There are three interesting papers on the origin and history of tea germplasm resources in China and genetic dispersal of tea. Of particular interest to TRF, with its highly successful breeding programme, should be a paper on plant improvement but,

for all the advances made by ourselves the most recent reference to TRF work is a paper by Squire in 1985, and that was on physiology; the word "composite" doesn't feature at all. This could be a reflection of lack of access to TRF publications but is more likely to reflect a tendency, of which TRF is also sometimes guilty, to be rather parochial and to rely excessively on local results only. This is perhaps understandable in writing up a trial applicable to local conditions but should not apply to a global review. The same criticism could be made about several other reviews in this part dealing with field practices and crop protection but it must be acknowledged that listing of every region's (or country's) recommended practices would make for tedious reading.

In the final part, on post-harvest processing, there are some useful general reviews of tea chemistry and flavour. In addition to a review of black and green tea manufacturing in various countries there are some interesting sections dealing with products such as speciality, herbal and organic teas, as well as packaging. The last section deals with process control in tea manufacture.

The inner flap of the cover rightly claims that the book serves as "a mine of information", suggesting both tea researchers and planters as target groups. Although some of the general papers on national tea industries, and such topics as organic tea or tea and health, may have wider interest, the book is most likely to be of greater benefit to research staff, particularly for easy reference to past work elsewhere although, as mentioned earlier, some of the reference lists are less than comprehensive. Having said that, the book costs US\$300, so it is far from bedtime reading, but anyone in the industry who wishes to consult it may find it through TRF Library.

6 Improving scion-take in top working

Top-working, or grafting onto tea that is already established in the field, is the most rapid and cost-effective way of multiplying source material for the new clones that are now available (Nyirenda and Mphangwe, 1998a).

Estates adopting the top-working technique will

N.I.K. Mphangwe and H.E. Nyirenda

rapidly become self-sufficient in source material for new clones. This will assist in moving away from using very old clones that are either low yielding such as SFS 204, or of low cup quality such as SFS 150, and therefore allow more rapid exploitation of the latest materials.

The top-working technique involves grafting one type of tea (or clone), usually with desirable agronomic and/or quality attributes, onto the root system of tea bushes that are already established in the field. Cleft grafting is perhaps the most widely used technique of top-working in tea and it involves making a cleft in the stock and then inserting a scion with a wedge-shaped end into the cleft. Moist moss is then put around the graft and an air-tight bag is put over the scions and tied around the stock, just below the graft. This helps to maintain a high level of humidity around the scion, which is necessary to keep it turgid before scion-stock union takes place.

Top-working was first highlighted as the quickest way of multiplying new clonal material at the TRF Annual Field Day in 1997, followed by a practical top-working course for skilled nursery workers (Nyirenda and Mphangwe, 1998b). Since then a number of estates have tried out the technique. Expectedly, results on scion-take have varied between estates, with some achieving very low scion-take whilst others have achieved a very high success rate of >95 %.

This article aims to highlight some of the ways that scion-take in top working may be improved.

1. Training and choice of grafters:

Top-working is a skilled operation; as such, grafters need to be adequately trained before they are deployed in an extensive top-working programme. Training will improve the grafters' competence regarding the choice of branches onto which to graft, selection of scion material,

correct alignment of the scion-stock cambia and also in deciding how moist the moss should be and how tightly it is tied around the graft. All these aspects, trivial as they may sound, will have a significant effect on scion-take in top-working. These aspects have been covered in detail at TRF top-working courses conducted in Malawi and Zimbabwe. Even after training, the level of success will vary with different grafters. This means that for the best results, it will be important to assess the grafters and only use those most competent. To further highlight the importance of this, let us look at results on scion-take achieved at one estate in Malawi that embarked on a large-scale top-working programme. By using all the 13 grafters available at the estate, an average scion-take of 54% was achieved (Table 1a). The range of scion-take among grafters seems to suggest that there was no adequate assessment and selection of grafters before the operation started. If the estate had chosen the four best grafters, for example, it would have achieved an average scion-take of 82% (Table 1b). The level of success can be disappointing if all available grafters are not highly competent. For instance, using the four grafters who had achieved the worst scion take from those listed in Table 1a, the estate would have achieved an average scion-take of only 39% (Table 1b).

Another estate, also in Malawi, started with fourteen grafters and achieved very low success rate. After assessing the grafters, the estate chose the two most competent grafters who are now continuously doing the grafting work and the success rate has increased to over 95%. The selected, trained staff must continue grafting so that they do not lose the skills they have acquired.

Table 1a *Percentage scion-take for thirteen grafters used by an estate in Malawi in its top-working programme*

Grafter	Scions grafted	Successful scions	% scion-take
1	750	230	31
2	360	150	42
3	635	477	75
4	2100	985	47
5	730	306	42
6	1810	909	50
7	550	240	44
8	800	509	64
9	750	580	77
10	550	510	93
11	250	119	48
12	189	174	92
13	2650	1297	49
Total	12124	6486	54

Table 1b *Scion-take results for the four best and four worst grafters from the pool of thirteen grafters listed in Table 1a*

Four best grafters				Four worst grafters			
Grafter	Scions grafted	Successful scions	% scion-take	Grafter	Scions grafted	Successful scions	% scion-take
3	635	477	75	1	750	230	31
9	750	580	77	2	360	150	42
10	550	510	93	5	730	306	42
12	189	174	92	7	550	240	44
Total	2124	1741	82	Total	2390	926	39

Choice of top-working method:

There are two basic methods of top-working, one where an artificial shade is erected over the area to be grafted and the other where bush canopy is used to provide shade to the grafted scions. The advantages of the artificial shade method include easy supervision of the grafters and easier identification of the grafting bags that are drying out (showing no condensation inside). In addition, more than two branches may be grafted onto one bush. Advantages of the bush canopy method include continuity of plucking from the un-grafted branches and a better opportunity for re-grafting in case of union failure. The cost of erecting shade is also avoided.

From the grafting results achieved on some estates, it appears a high success rate is possible with the artificial shade method. High scion-take may also be obtained with the bush canopy method as long as there is close supervision of grafters and regular checking. Where such supervision cannot be guaranteed, it is advisable to adopt the artificial shade method; in such a case the initial higher cost will be justified by improved scion-take.

Number of scions per branch :

In the past, grafters have always been advised to graft two scions onto one branch where it is large enough to accommodate them, the main reason being to increase the chance of scion-take. It has been observed, however, that most grafters find it difficult to insert the second scion without disturbing the scion-stock cambial alignment of the first scion. If the branch is relatively small, the cambial of both scions may eventually become badly aligned with that of the stock branch, and this usually results in scion-stock union failure. If your grafters have this problem, it would be wise to graft only one scion

on each branch, ensure proper cambial alignment and increase the chance of scion-take by grafting on more than two branches per bush wherever possible. A preliminary study carried out at TRF suggests that the results of grafting one scion per branch are superior to those where two scions have been grafted.

Frequent checking:

For successful union, the scion must be kept moist and turgid to prevent wilting and fast drying of the cut surfaces. This is achieved by ensuring that the grafting bags remain airtight and that the moss inside is moist enough. In the first 3-4 weeks after grafting, it would be advisable to check the grafted bushes at least once a week. Any torn bags must be replaced and drying moss should be lightly sprinkled with water to maintain high levels of humidity inside the bag. Low levels of humidity in the grafting bags, resulting from either a torn bag or drying moss, can easily kill a scion within 12 hours, until such time as complete scion-stock union has taken place.

Hardening-off the successful scions:

For good results, it is advisable to adopt a gradual hardening-off process for all successful scions. This begins with the loosening of the bag (leave it hanging over the scion), and a day or two later checking for any wilting scions on the bushes that are being hardened-off. Such scions should have their grafting bags re-fastened and, if necessary, the moss moistened with a light sprinkle of water. It is advisable to treat each grafted branch independently in deciding when to start hardening-off, since scion-stock union time may vary between branches and bushes. When it is time to start reducing shade, avoid sudden exposure to direct sunlight as this may result in scorching and eventual death of the scion.

Provision of incentives:

Giving a monetary reward for every successful scion that an individual grafter achieves will motivate the grafters to achieve a high number of successful scions. For best results each grafter must be made fully responsible for all of the bushes that he/she has grafted up until the time of final hardening-off.

Summary:

Paying attention to detail in the above factors will greatly improve scion-take and this will in turn motivate growers to continue using the technique. Ignoring the points considered above will, on the other hand, result in a very poor grafting success rate that may discourage the use of top-working.

If you intend to embark on top-working this year, this is the time to start planning the training and assessment of your potential

grafters so that those selected will be available in July/August when you start your main top-working programme. Even experienced grafters may need a few practical sessions to refresh and further sharpen their grafting skills.

Also, remember to send your orders to TRF for scions of the new clones that you want to multiply if you do not have source bushes for such clones.

References

Nyirenda, H.E. and Mphangwe, N.I.K. (1998a) Rapid multiplication of new clonal material. *Tea Research Foundation (CA) Quarterly Newsletter* 131, 8-9.

Nyirenda, H.E. and Mphangwe, N.I.K. (1998b). A short note on TRF's top-working course. *Tea Research Foundation (CA) Quarterly Newsletter* 132, 9-10.

7. Replanting For Maximum Total Value: Which are the ideal clones possessing high quality and high yielding potential?

Introduction

In QNL 125 factors that would lead to quick establishment and early production with the view to shortening the payback period and maximising benefits from a replanting programme were highlighted and discussed. Although the question of choosing elite plant material with a high degree of drought tolerance and sustainable high yields (in addition to quality and other attributes) was highlighted, some estates are still ignoring this as one of the most important factors. In order to realise the shortest possible payback period, quality and early sustainable high production attributes of the plant material to be used must be considered as a package when deciding which clones to use.

SFS 150 and SFS 204 are both very popular clones in Central and Southern Africa. SFS 150 is a high yielding clone with very good cool season growth but only makes an average quality tea, whereas SFS 204 makes a very high quality tea but is low yielding (except under high N rates). This implies that neither of these clones would produce maximum total value. Although some of the new clones from the breeding programme have been shown to

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produce higher yields of tea similar in quality to SFS 204, (and consequently more total value) some estates are still planting out SFS 204 because they believe that it makes the best quality tea.

This article attempts to fill the gap in current thinking by examining the biochemical and organoleptic (total score and valuation) assessments of SFS 150 and SFS 204 against some of the new clones from PC 81 to PC 168. The clones have been put in four different groups because they occur in different trials at Mimoso and Nsuwadzi Research Stations and have been sampled in different seasons between 1992 and 1998. Total score is the sum of the taster's score on various quality attributes which include colour of infusion and liquor, strength of liquor, colour of liquor with milk, briskness and brightness. Each attribute is scored on a 0 - 10 point scale. Total value is a product of the crop produced and the professional taster's valuation per kilogram of made tea for each clone. A comparison of the parameters has been made relative to SFS 204 by assigning this clone with a value of 100. Where SFS 204 was not available, relative comparisons have been made with SFS 150, PC 81 and PC 108.

