Note

Farmers' perceptions of cacao (*Theobroma cacao* L.) planting material and factors affecting the cacao industry in Trinidad and Tobago

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In recognition of the need to revitalize the cacao (*Theobroma cacao* L.) industry in Trinidad and Tobago, a survey of 150 cacao farmers and their estates was conducted in the central, eastern, and southern regions of Trinidad to ascertain the performance and farmers' perception of cacao planting material in their estates and some of the factors responsible for the decline of the cacao industry in Trinidad and Tobago. A questionnaire comprising 38 questions was used for the survey. The results indicated that over 90% of the estates were planted with both clones and seedlings, of which over 70% were supplied by the Ministry of Agriculture. Fifty-seven per cent of farmers showed preference for seedlings as planting material compared to those who preferred clones (32%) or a mixture of both seedlings and clones (11%) and this preference was independent of region ($P > 0.05$). Factors such as labour cost, price of cacao beans, extension service, accessibility to estates (roads and bridges), and cost of inputs such as fertilizers and pesticides were found to play a major role in the declining cacao output. These results are also of value for other cacao-producing countries where production is constrained as well by aging tree populations and the presence of plants susceptible to diseases and pests.

Keywords: *Theobroma cacao* L.; Cacao estates; Clones; Seedlings; Agronomic practices; Farmers' perception

Cacao (*Theobroma cacao* L.) is an important agricultural commodity in many developing countries in West Africa, South-East Asia, Latin America, and the Caribbean. World bean production for 2001–2002 has been valued at U.S. $3.3 billion, of which these countries receive 60–90% of the freight-on-board value (ICCO, 2002). The livelihood of small farmers, who produce 85% of these beans (Becker, 1999), depends on an efficient crop production system. One of the most important inputs is the choice of suitable planting material. This ensures that large-scale replanting can be handled cost-effectively and efficiently in the event of a major disaster such as the devastation in Brazil since 1989 resulting from Witches' Broom disease, caused by *Crinipellis perniciosa* Stahel, which reduced production by 50% within a decade. In cacao, either clones or seedlings could be used as the planting material. The advantage with the use of clones is that single genotypes with particular desirable characteristics such as disease resistance and flavour could be propagated for large-scale use. However, the cost of the infrastructure to produce clones is high and the process is slow. Seedling progenies, on the other hand, are cheaper to produce and large-scale production is relatively easy.

Cacao breeding in Trinidad began by surveying the local cacao population to identify and select trees which produced a minimum of 50 pods per annum at a spacing of 3.6 m^2 and maximum pod index of 16.5. This led to the selection of 100 clones from the Trinitario population by Pound (1932). These were known as the Imperial College Selections (ICS) and were coded ICS 1 to ICS 100. However, with the outbreak of Witches' Broom disease, in Trinidad in the late 1920s, it was found that the local selections lacked adequate

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resistance levels (Toxopeus, 1985; Warren and Kennedy, 1991). A breeding programme was therefore initiated by the Ministry of Agriculture in the 1930s with a few clearly defined objectives: low pod index, resistance to Witches' Broom and Black Pod (*Phytophtora* spp) diseases, and to a lesser extent, resistance to Wilt disease (*Ceratocystis fimbriata*) and maintenance of fine or flavour characteristics (Kennedy *et al.*, 1987). Four parents, one a local Trinitario and three Upper Amazon clones from the germplasm collection expeditions of Pound (1938, 1943) to South America, were extensively used in the programme. These were ICS 1, SCA 6, IMC 67, and POUND 18 (Toxopeus, 1985). The first crosses were made in 1949 and the first selections in 1956 (Montserrin *et al.*, 1957). This programme yielded selections that were prefixed Trinidad Selected Hybrids (TSH) and Trinidad Selected Amazons (TSA). The selections were subjected to generations of interbreeding and selection, and after 3–4 generations, outstanding individual trees were selected, developed as clones, and supplied as planting material (Freeman, 1969; Toxopeus, 1985; Warren and Kennedy, 1991). Over one million plants per annum were supplied to farmers as rooted cuttings in the 1950s (Gonsalves, 1996). Seed belonging to TSH crosses were also distributed as planting material, however, in Trinidad (and the Caribbean generally), the distribution of clonal cacao as rooted cuttings predominates (Kennedy *et al.*, 1987).

Although the planting material was developed from a breeding programme with a narrow genetic base and a few clearly defined objectives, its acceptability to the cacao farmer subsequent to its release has not been fully assessed. This survey was therefore undertaken to ascertain the farmers' perception of the planting material, and the role of the planting material relative to other factors in the decline of the cacao industry in Trinidad and Tobago.

Materials and Methods

The survey

Cacao is grown in three main regions in Trinidad involving more than 5000 farmers. The regions are classifed as eastern (2800 farmers), central (1700 farmers), and southern (910 farmers). Out of these, a total of 150 farmers were interviewed in the three regions, divided as follows: eastern (78), central (47), and southern (25).

A survey was conducted in these three regions from 7 October to 30 November 1998, using a questionnaire composed of 38 questions. The questions were divided into four categories.

Category 1: The farmer and the estate

In the first section of this category, the farmer was requested to give his or her name and age, how long he or she had been a cacao farmer, the location and size of estate, the type and source of material planted, the age of trees and spacing between them, the number of trees, and the annual yield in terms of dry beans sold.

The second queried problems related to the establishment of the crop, diseases and pests, small, unmarketable beans, and fermentation. Information was sought on the persistence of these problems and their impact on the farmer.

The third part dealt with agronomic practices such as weeding, pruning, application of insecticides, fungicides, and fertilizers, and removal of moss and other epiphytes.

Category 2: The farmer and planting material

In the second category, the farmer was first asked about his or her perception of planting material released by the Ministry of Agriculture and whether he or she would accept similar material for future expansion of the estate or replacing dead plants.

The next category concerned the farmer's preference for planting material and whether he or she would prefer clones, seedlings, or both and why.

Category 3: Factors affecting cacao production

In this category, the farmer was asked the extent to which the following factors affected cacao production in Trinidad: weather, labour availability, labour cost, price of produce, access to credit and mode of payment for crop, extension service, access to estates (roads and bridges), and cost of inputs (fertilizers, pesticides, and planting material).

Category 4: Qualities of ideal planting material

In this category, the farmer was asked to give his or her views about the qualities of ideal planting material.

Data analysis

Data collected on farmers' age and the size and yield of the estates were analyzed by one-way ANOVA using Minitab (Version 7.2). The Chi-squared test was used to determine statistical differences between the three regions in the sources and types of planting materials in estates, age of trees, farmers' preference for planting material, adoption of agronomic practices, as well as factors affecting cacao production.

Results and Discussion

The study showed that males dominated cacao farming with females being only 4.3% (central), 5.1% (eastern), and 4.0% (southern). A similar study conducted in Ghana (MASDAR, 1998) also showed that males dominated cacao farming (84%). Regarding age, most of the farmers were over 50 years, with a range of 32–82 years (central), 21–83 years (eastern), and 27–75 years (southern). This finding was similar to studies conducted in Ghana where the cacao farming population was over 50 years old (Anon, 1995; MASDAR, 1998).

The mean size of the estates was not significantly ($P > 0.05$) different among the three regions (Table 1), but the yields in the eastern region were significantly ($P < 0.05$) different (370 kg ha^{-1}) from the yields in the central (178 kg ha^{-1}) and the southern (170 kg ha^{-1}) region. The lower yields in the latter two regions agreed with the findings of Griffith (1987) who found that the national average yield was 150 kg ha^{-1}. The differential increased yield in the eastern region was due to one large high-impact cacao estate planted in an orchard system. In Ghana, the national average yield was 289 kg ha^{-1} (MASDAR, 1998).

The southern region contained significantly ($P < 0.05$) more young and mature cacao trees compared to the other two regions (Table 2). The eastern region, on the other hand, contained significantly ($P < 0.05$) more trees in the old and aging category.

The results of the survey indicated that over the last seven years, no new estates had been established in the southern and central regions, although both regions showed evidence of 32 and 14.9%, respectively, of replanting (data not shown). In the eastern region, however, three new estates had been established over the past seven years and the existing estates (47.5%) showed evidence of replanting (data not shown). The results of the survey also showed that mature cacao trees in all three regions were more than 15 years old (data not shown). In Ghana, more than 55% of the cacao trees were over 15 years old (MASDAR, 1998). Thus, within a few years, the mature trees would be classified as old and the rate at which new estates were being established and old estates replanted would not be sufficient to replace the number of old and often unproductive trees. Under these present circumstances, it is going to be extremely difficult to increase cacao production in Trinidad.

Although all three regions used planting material supplied by the Ministry of Agriculture, the farmers in the southern region also used material obtained from other sources such as abandoned estates, other farmers, and from their own estates (data not shown). The southern farmers indicated that they did not wholly depend on the Government as a source of planting material because they perceived a persistent problem of small, unmarketable beans. Farmers still tend to use seeds from hybrid trees as planting material. However, it is generally not recommended, because the most valuable characteristic of a hybrid is early vigour, attributed to heterosis. But this is almost lost after the first generation and in most cases, yield is negatively affected.

The study indicated that generally farmers preferred seedlings ($P < 0.05$) to clones or a mixture of the two (Figure 1). Farmers in the central region significantly ($P < 0.05$) preferred seedling material compared to the eastern and southern regions. Farmers were requested to

Table 1 Estate size and yield in the three cacao-growing regions of Trinidad

Region	Estate size (ha)		Mean yield[1] (kg ha^{-1})
	Mean[1]	Range	
Central	5.2 a	1.6–16.2	178 a
Eastern	6.1 a	1.0–30.4	370 b
Southern	5.3 a	0.8–16.2	170 a
SED	1.4		7.7

[1]Same letter within a column denotes lack of significant difference
SED, Standard Error of the Difference between Means

Table 2 Age of trees (%) in the three cacao-growing regions of Trinidad

Region	Age category[1]						
	Young	Mature	Old	Y&M	Y&O	M&O	Y,M,&O
Central	0.0	0.4	23.4	0.0	6.4	55.3	8.5
Eastern	3.9	14.1	17.9	5.1	28.2	20.5	10.3
Southern	0.0	20.0	20.0	20.0	4.0	28.0	8.0
χ^2	6.9 ns	5.0 ns	0.7 ns	21.5*	24.5*	16.5 ns	0.3 ns

ns, No significant difference between regions at 0.05 probability level
*, Significant difference between regions at 0.05 probability level
[1]Young (Y), ≤7 years; Mature (M), 7–25 years; Old (O), ≥25 years

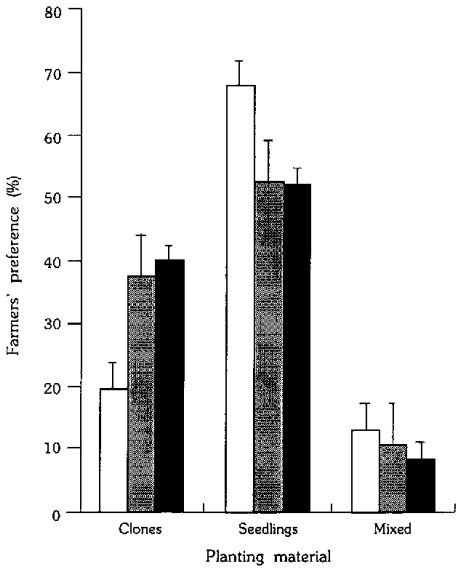

Figure 1 Farmers' preferences for planting material in the three cacao-growing regions of Trinidad. Error bars represent standard errors □, Central region; ▨, Eastern region; and ■, Southern region

indicate their preferences for the two types of planting materials and they indicated the following.

Clones

Although clones bear earlier and produce bigger pods and larger beans, they have a shallow root system which leads to lodging and hence clones cannot be grown on slopes. In addition, although the plants when young produce large pods, they become smaller as the trees age. Clones produce pods only in the branches. They also suffer higher mortality during drought conditions and are more costly to manage due to their plagiotrophic growth habit which necessitates continuous pruning over time.

Seedlings

Seedlings contain a tap root system that enables the plant to be established on both sloping and on flat lands. Seedlings eventually produce higher yields because pods are borne on both the trunks and on the branches. Seedlings generally withstand drought conditions far better than clones. They also have the advantage in that they are less costly to manage and do not hinder movement of farmers in the field. Another advantage is that their pod sizes do not decrease in size with the increasing age of the tree. However, two disadvantages in selecting seedlings as planting material is that they take longer to begin to produce pods and some trees grow very tall making it difficult for the farmers to harvest the pods.

In addition to the farmers' preference for seedling materials, seedlings have the advantage over clones in that they are less expensive, are easier to produce, and are easier to transport compared to clones. Seedlings are easier to establish, particularly under exposed conditions, the canopy closes more rapidly leading to less maintenance, and they have fewer insect problems and are more precocious. However, a disadvantage with seedlings could be segregation among individuals within progenies. This could be overcome to some extent by the use of controlled pollination in seed gardens.

Although seedlings have more advantages than clones, it is a traditional practice in Trinidad, Grenada, and other Caribbean islands where the Trinitario genotypes are grown, that clonal material is distributed as planting material (Wood, 1985a). This practice is, however, less common in other cacao-growing countries, where seedlings are used especially for Amelonado cacao since the seed is uniform. Amazon hybrids are also widely distributed in these countries (Wood, 1985a).

Although only seedling and clonal materials have been discussed here, cacao can be propagated via budding, which is being done on a large scale in Malaysia, and top-grafting, currently being practised on a large scale in Bahia, Brazil, to propagate clones with resistance to Witches' Broom disease. One advantage of grafted and budded trees is that seedling root stocks would have strong tap roots which would facilitate more rapid and successful establishment of the field. The distribution of grafted plants for commercial cacao production has not been practised in Trinidad, but could provide an interesting alternative to clones or seedlings.

Based on Category 3 of the questionnaire, farmers were requested to indicate their agronomic practices. In all three regions, almost all the farmers controlled weeds manually, with only a few farmers in the central region using chemical weed control (data not shown). Almost all the farmers also pruned their trees.

In the central and southern regions, no farmer used insecticides, but in the eastern region, there were some farmers who applied insecticides to control insect pests, especially thrips. Less than a quarter of the farmers in each of the regions applied fungicides to control Black Pod disease and less than a fifth in each region applied fertilizer. The farmers indicated that they could not afford to purchase chemicals. Most farmers especially those in the central and eastern regions removed moss from their cacao trees, however, there were no

significant ($P > 0.05$) differences between the regions (data not shown).

The situation in Trinidad is similar to what pertains in Ghana where, although studies have shown that using chemicals to control weeds in cacao estates reduces cost of production by over 30% compared to manual weeding (Oppong *et al.*, 1999), most farmers have not embraced the technology probably due to the high initial capital outlay needed to purchase the chemicals and spray equipment.

All the farmers rated adaptability or ease of establishment, vigour, yield, bean size, and resistance to diseases as important attributes of any acceptable planting material. These factors have often been among the major considerations in cacao-breeding programmes worldwide, although with different emphases in different regions.

The yield potential of the TSH material is >2 t ha^{-1} in Trinidad and the pod index is typically 8–9 pods kg^{-1} of dry cacao (Kennedy *et al.*, 1987), similar to modern hybrid varieties elsewhere (Glendinning, 1966; Atanda and Jacob, 1974). The very low yields being recorded from estates in Trinidad clearly demonstrate the commercial under-exploitation of the true genetic potential of the TSH material. It was observed that most of the estates had many spaces resulting from dead plants. Although many of the farmers were not able to provide information on the total number of cacao trees they had in their estates, from those who did, it could be estimated that the mean number of trees per hectare was approximately 500. Where spaces were being filled, in most cases the cacao trees were replaced with other crops such as citrus (*Citrus* spp) or breadfruit (*Artocarpus altilis*). Moreover, it was found during the survey that most of the estates were overshaded, in places by permanent shade trees, but most often by other crops of economic value to the farmer.

Contrary to the perception of some cacao farmers in Trinidad, the widely-used commercial TSH varieties have large beans. Recently recorded dry bean weights of a selection of these varieties ranged from 1.1 to 1.6 g. The perceived problem of small beans that is causing these farmers to use material from their own estates could be attributed to a combination of factors. Since many trees on farms are old, they could predate the distribution of TSH varieties by the Ministry of Agriculture. The old trees could belong to the ICS plants that were distributed to farmers from the 1930s to the 1950s. The TSH plants were distributed from the 1960s to the present. These old trees would also have passed their maximum bearing potential, and would require extensive application of fertilizers to make them productive. It may also be possible that small beans are produced from TSH varieties if trees are badly neglected, so their full genetic potential is not realized. The problem of small beans may also be linked to reports of unauthorized distribution of non-commercial TSH varieties in the 1980s, some of which may still be grown on farms. If such trees were replaced by currently recommended TSH varieties, this should dispel the negative perception found in the survey.

Factors affecting cacao production

There were no significant ($P > 0.05$) differences between regions in farmers' ratings of the nine factors that they perceived affected the cacao industry in Trinidad. In order of importance, the farmers indicated that the most serious constraints to production were cost of inputs, cost of labour, price of cacao beans, roads and bridges, and the extension service. The cost per man-day of labour was U.S. $16.00 while the price paid for cacao beans was U.S. $1.92 kg^{-1}. The factors identified in this study were similar to those identified in other cacao-growing countries. According to Gordon (1976), in Ghana, the sharecropper type of labour was difficult to obtain since wages were significantly higher in the urban areas. In addition, family members were concentrating more on obtaining a formal education and thus family labour was also scarce (Gordon, 1976). Wood (1985b) indicated that in Nigeria, cacao production was constrained by high wages and shortage of labour. One alternative may be the introduction of mechanization on cacao farms such as brushcutters to control weeds and mechanical pod breakers. However, a feasibility study would have to be conducted to determine the economic and agronomic implications.

From the results of the survey it appeared that generally there was not much contact between the extension services offered by the Ministry of Agriculture and the farmers. Although there were no significant ($P > 0.05$) differences between regions, generally, the southern region reported a relatively active relationship between its farmers and the extension services. However, the extension services are invaluable when introducing new planting material to farmers and also in the technical support required when assessing the commercial value of existing planting material.

This study has shown that although the TSH material was distributed to all the cacao-growing regions of Trinidad, many farmers still retained their ICS cacao plants in almost all the farms surveyed in the study (data not shown). This may be one of the reasons for the low yields realized from these farms. Only three farms contained TSH material alone and these farms showed significantly ($P < 0.05$) greater yields compared to the mixed planting material (data not shown). However, further studies would have to be conducted before any firm conclusion could be obtained.

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