SURVEY OF CANE-FARMING.

1949

by

(A survey report submitted in part qualification for the D.T.A.)

Haeng Ong.

Imperial College of Tropical Agriculture.
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I. OBJECT OF THE SURVEY.

1. The object of the survey is to obtain information on the methods of growing sugar cane as practised by cane farmers. It is hoped that such a survey as this would point out the defects and merits in their methods so that it would be possible to know which of their methods are already efficient and satisfactory, and which are inefficient and require improvement. Then, when that is known, that field investigations could be carried out to discover the means of improvement which would raise the efficiency of cane farming.

2. Attempt has been made to include as much of the information obtained by direct observation rather than that obtained indirectly from the descriptions given by farmers. Nevertheless, the farmers' ideas and theories behind their practice have been included as they may have been based on sound practical experience and so, may prove useful. At least, their views would indicate the extent of their interest in, and their knowledge of, their own work. That in turn would reflect the extent to which they would be receptive to new ideas, which is an important point in the formulation and implementation of an agricultural policy for their benefit.

3. The scope of this survey has been entirely limited to the agricultural practices of the farmers in growing cane and no attempt has been made to describe the sociological conditions under which they work. The object has been purposely limited in scope in order that more attention could be given to details and so, a more specialised type of information could be obtained, which would indicate the lines of field investigations required in the future. At present, there is no such investigation being carried out for the farmers on their soils. It is hoped however, that in the near future this will be a task of the special Cane Farmers' Service, the establishment of which was recommended by the Benham Committee in 1943 and was reiterated by the Soulbury Commission in 1948. The last named Commission has also fully dealt with the organisation and administration of the sugar cane industry which is of great importance but which unfortunately cannot be included through limitation of space, which in turn has further limited the field covered by the Report.
II. Location of the Survey Area.

4. The survey area lies between the 10° 37' 30" on the eastern side and 10° 38' 30" on the western side, and between the latitudes 61° 24' on the southern boundary and 61° 22' 30" on the northern boundary. The furthest distance between the eastern and western sides is 1\frac{1}{2} miles and that between the southern and northern boundaries is one (1) mile.

5. This area is situated in the Tacarigua Ward of the County of St. George of Trinidad and is composed of the cane farmers' land north and south of the Churchill-Roosevelt Highway. It is bounded on the east by the boundary of the Orange Grove Estate and on the west by the southbound government railway. The Southern boundary is within about half a mile distance from the highway and the northern boundary extends to the east-bound government railway.

III. CLIMATE.

6. All the data given below are from the records of the Chemistry Department of the Imperial College of Tropical Agriculture, from the Meteorological Station situated within two miles of the survey area.

(a) Temperature:

7. The average range of shade temperature throughout the year is between 68° F. and 87° F., which are the minimum and maximum mean monthly temperatures, respectively, for an average year. (Average over 18 years.)

The soil temperature data have also been included to give a more complete information of the ecological conditions. (Table I.)

(b) Humidity and Wind Velocity:

8. The average range of minimum monthly figures for relative humidity lies between 47% and 63% and the monthly record of wind velocity varies from 1.46 to 3.08 miles per hour. (Table II.)
### TABLE I - Soil and Air Temperature - Records of Chemistry Department, I.C.T.A. (Figures in degrees Fahrenheit). Copy from L.A. Bridgland.

<table>
<thead>
<tr>
<th>MONTH</th>
<th>Mean Monthly Max.</th>
<th>Mean Monthly Min.</th>
<th>Depth 1&quot;</th>
<th>Depth 1 ft.</th>
<th>Depth 4 ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>84</td>
<td>69</td>
<td>79</td>
<td>67.2</td>
<td>77.8</td>
</tr>
<tr>
<td>February</td>
<td>85</td>
<td>68</td>
<td>80.2</td>
<td>67.3</td>
<td>77.5</td>
</tr>
<tr>
<td>March</td>
<td>86</td>
<td>69</td>
<td>82.3</td>
<td>68.4</td>
<td>78.5</td>
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<tr>
<td>April</td>
<td>87</td>
<td>71</td>
<td>84.3</td>
<td>70.2</td>
<td>80</td>
</tr>
<tr>
<td>May</td>
<td>87</td>
<td>72</td>
<td>83.2</td>
<td>71.4</td>
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<tr>
<td>June</td>
<td>86</td>
<td>73</td>
<td>80.5</td>
<td>70.9</td>
<td>80.7</td>
</tr>
<tr>
<td>July</td>
<td>86</td>
<td>73</td>
<td>81.1</td>
<td>71.1</td>
<td>80.9</td>
</tr>
<tr>
<td>August</td>
<td>87</td>
<td>71</td>
<td>81.8</td>
<td>71.0</td>
<td>81.7</td>
</tr>
<tr>
<td>September</td>
<td>87</td>
<td>72</td>
<td>83.1</td>
<td>71.3</td>
<td>81.8</td>
</tr>
<tr>
<td>October</td>
<td>87</td>
<td>72</td>
<td>82.7</td>
<td>71.1</td>
<td>81.5</td>
</tr>
<tr>
<td>November</td>
<td>86</td>
<td>70</td>
<td>80.8</td>
<td>71.2</td>
<td>80.7</td>
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<tr>
<td>December</td>
<td>85</td>
<td>70</td>
<td>78.7</td>
<td>68.6</td>
<td>79.1</td>
</tr>
</tbody>
</table>

### TABLE II - Humidity and Wind Velocity - Records from Chemistry Department - I.C.T.A. Copy from L.A. Bridgland.

<table>
<thead>
<tr>
<th>MONTH</th>
<th>Min. (16 yrs. Av.)</th>
<th>Av. 14 yrs. at 8 a.m.</th>
<th>Av. 16 yrs. at 8 p.m.</th>
<th>m.p.h.</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>47</td>
<td>85</td>
<td>69</td>
<td>2.01</td>
</tr>
<tr>
<td>February</td>
<td>52</td>
<td>83</td>
<td>66</td>
<td>2.43</td>
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<tr>
<td>March</td>
<td>50</td>
<td>77</td>
<td>63</td>
<td>2.87</td>
</tr>
<tr>
<td>April</td>
<td>52</td>
<td>75</td>
<td>63</td>
<td>3.08</td>
</tr>
<tr>
<td>May</td>
<td>56</td>
<td>77</td>
<td>67</td>
<td>3.07</td>
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<tr>
<td>June</td>
<td>62</td>
<td>81</td>
<td>73</td>
<td>2.48</td>
</tr>
<tr>
<td>July</td>
<td>63</td>
<td>84</td>
<td>75</td>
<td>1.92</td>
</tr>
<tr>
<td>August</td>
<td>63</td>
<td>86</td>
<td>76</td>
<td>1.46</td>
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<tr>
<td>September</td>
<td>62</td>
<td>85</td>
<td>76</td>
<td>1.50</td>
</tr>
<tr>
<td>October</td>
<td>61</td>
<td>84</td>
<td>76</td>
<td>1.52</td>
</tr>
<tr>
<td>November</td>
<td>61</td>
<td>85</td>
<td>77</td>
<td>1.52</td>
</tr>
<tr>
<td>December</td>
<td>61</td>
<td>86</td>
<td>74</td>
<td>1.79</td>
</tr>
</tbody>
</table>
Rainfall and Seasons:

9. The annual rainfall of the area is within the range of 60 to 70 inches. (The I.C.T.A. Meteorological Station, which lies on the north-west of the area, records an average annual rainfall of 66.89 inches.) Therefore this area receives an amount of rain which is about half-way between the extremes of 50 and 100 inches received respectively, by the western and eastern parts of the Island. (Table III).

10. The figure for the total rainfall does not, however, give any indication of its distribution and its "effectiveness" on reaching the soil. For those informations, therefore, the data for the "effective rainfall" based on Mohr's method of rainfall classification is here given. Professor Hardy has stated that - "It is generally recognised that a bald statement of the annual amount of total rainfall, or even of its monthly or daily distribution, is insufficient for the purposes of ecological crop investigations, because in actual fact, only a relatively small part of the total rainfall is "effective" in controlling plant growth. The variable fraction of rain which is stored in the rooting zone may be estimated as the difference between the total rainfall and the sum of the several fractions which evaporate from the vegetation and the soil, which run off the land, and which penetrate deeply beyond the rooting zone". (T.A.1947, Vol.XXIV, pp.45-51.)

11. According to the Effective Rainfall data, this area is classified as belonging to the zone of marked dry season, owing to the fact that the dry season here lasts for at least two months, and in fact up to four, when the monthly rainfall does not exceed 2 - 4 inches. The remaining part of the year receives monthly rainfall exceeding 2 - 4 inches, and perhaps, in four to nine months, exceeding 4.0 inches, when the latter months would be classified as "wet" months and the remaining months as "intermediate". (Table IV.)

12. Therefore, in this area with a marked dry season "the soil can dry out to considerable depth, particularly if there are four dry months with one preceding intermediate month". (Ibid p.46).

13. The rest of the Island experiences, in the eastern half, continuously moist conditions, when there are no dry months but there may be six or even twelve wet months, and in the western part, the other extreme conditions of the zone of strong dry season when there are at least four dry months in the year.
### TABLE III - Rainfall: Average Annual, Average Monthly and Intensity - Records of Chemistry Department, I.C.T.A. Copy from L.A. Bridgland. (Avg. 17 years).

<table>
<thead>
<tr>
<th>Month</th>
<th>Total (ins.)</th>
<th>Total Time rained (hours)</th>
<th>Avg. Rate of Precipitation (ins./hour)</th>
<th>Seasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>2.61</td>
<td>14.8</td>
<td>0.17</td>
<td></td>
</tr>
<tr>
<td>February</td>
<td>1.05</td>
<td>7.1</td>
<td>0.5</td>
<td>DRY</td>
</tr>
<tr>
<td>March</td>
<td>1.43</td>
<td>6.4</td>
<td>0.19</td>
<td>SEASON</td>
</tr>
<tr>
<td>April</td>
<td>1.96</td>
<td>12.6</td>
<td>0.17</td>
<td>Transition month</td>
</tr>
<tr>
<td>May</td>
<td>5.60</td>
<td>24.3</td>
<td>0.23</td>
<td></td>
</tr>
<tr>
<td>June</td>
<td>8.07</td>
<td>37.3</td>
<td>0.22</td>
<td></td>
</tr>
<tr>
<td>July</td>
<td>8.57</td>
<td>33.7</td>
<td>0.26</td>
<td></td>
</tr>
<tr>
<td>August</td>
<td>9.37</td>
<td>32.1</td>
<td>0.29</td>
<td></td>
</tr>
<tr>
<td>September</td>
<td>7.70</td>
<td>22.2</td>
<td>0.35</td>
<td>WET</td>
</tr>
<tr>
<td>October</td>
<td>6.35</td>
<td>21.9</td>
<td>0.29</td>
<td>Short dryer spell or &quot;Petit Careme&quot;</td>
</tr>
<tr>
<td>November</td>
<td>7.82</td>
<td>26.8</td>
<td>0.27</td>
<td></td>
</tr>
<tr>
<td>December</td>
<td>6.26</td>
<td>28.2</td>
<td>0.23</td>
<td></td>
</tr>
</tbody>
</table>

Average Annual = 66.89 inches. Total Time rained = 271.4 hours.

### TABLE IV - Effective Rainfall (from Mohr's Classification).

<table>
<thead>
<tr>
<th>Month</th>
<th>Monthly Rainfall</th>
<th>Number and Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>2.4 to 4.0 inches</td>
<td>1 Intermediate month.</td>
</tr>
<tr>
<td>February - April</td>
<td>2.4 inches or less</td>
<td>3 Dry months.</td>
</tr>
<tr>
<td>May - December</td>
<td>4.0 inches or more</td>
<td>8 Wet months.</td>
</tr>
</tbody>
</table>

GROUP III*: Zone of Marked Dry Season (Evaporation exceeds rainfall during part of year, soil dries out to considerable depth.)

- 2 dry months; 2 - 6 medium; 4 - 8 wet
- 3 dry months; 6 - 5 medium; 4 - 9 wet
- 4 dry months; 0 - 1 medium; 7 - 8 wet

* There are six groups in Mohr's classification, of which four are represented in Trinidad.
To topography and location of soil types:

14. The elevation of the survey area is well under 100 feet but is not lower than 25 feet. The whole area is, broadly speaking, on a slope of approximately 1 in 100, which descends from north to south and which is a continuation of the general fall of the land starting from the foothills of the Northern Range and ending in the lowlands of the Caroni Plain.

15. The St. Augustine loam in the eastern part of the area occupies the highest elevation, which is between 50 to 100 feet, and is on a gentle slope of 1 in 100 which descends from the eastbound railway down to the Churchill-Roosevelt Highway. The Maccoya trace runs down the centre of this area.

16. The Streatham Loam, therefore occupies the lower part of the same slope at the elevation of about 50 feet or less. The greater part of the area occupied by the Streatham Loam is of the rolling land and not flat as in the case of St. Augustine loam.

17. The Maloney Sandy Loam lies in the Streatham Loam area and therefore is on the rolling land.

18. The River Estate Fine Sand and the St. Augustine Loam in the western part of the area are on flat land, with the higher portion on the north of the Churchill-Roosevelt Highway and the lower portion on the south of the Highway. The portions, of both these soil types, concerned in the survey area are, however, below 50 feet, though over 25 feet.

(b) Chief Soil Types of the Area:

Brief descriptions (Mainly after E.M. Cheney.)

(i) St. Augustine Loam -

Laboratory data*: "This is a sandy-loam containing over 40 percent silt plus clay. It is markedly acid. The contents of organic matter and nitrogen are medium to medium-low. C/N ratio is relatively low, denoting deterioration or surface erosion. Electrical conductivity is low, denoting poor nutrient status. Available phosphate is medium-low in the top layer and very low in the second. Available potash is very low in the top layer. The theoretical lime requirement is somewhat over 1 ton calcium carbonate per acre in both layers. The degree of saturation by calcium is surprisingly high."

W.R. Mills, P.G. Student, Jan'y. 1949.

* Of peasants' land in the survey area.

(ii) Streatham Lodge Loam - light, implying restricted leaching. Theoretical lime requirement one ton acre of calcium carbonate also from W. R. Mills.

21. Colluvial area of Recent Flood Plains.

Flat land; high lying. Free to partially-impeded drainage.

White to pale grey-brown bleached compact sandy-loam over pale yellow-brown, yellow, orange or red-mottled grey gravelly sandy-clay, containing conspicuous red ferruginous and sepia manganiferous hard concretions (possibly deposited by lateral drainage) over coarsely red-mottled grey detrital quartz-gravel. Perennial water table at 10-14 feet.

Yellow Podzolic (?)

Occurrence: Contiguous on south with, or fringing, St. Augustine Loam.

Vegetation: Deciduous Forest (?), now peasants' gardens.

22. ** Laboratory data: "This is a light sand with less than 30 percent silt plus clay. It is highly acid. The contents of organic matter and nitrogen are medium-low to low, and C/N ratio is medium-high in the top layer but very low in the second. Electrical conductivity is low. Available phosphate is very low and available potash very low.

The theoretical lime requirement is around half a ton calcium carbonate per acre."

also from W.R. Mills.

** Of peasants' land close to survey area.

(iii) River Estate Fine Sand -

23. Colluvial-Alluvial area of Recent Flood Plains.

Flat land; high-lying. Free drainage.

Dark yellow-brown fine sand over bright yellow-brown to orange-brown sand over micaceous schistose sand and variable gravel. Usually nearly concolorous but variable. Developed over fine sandy outwash of St. Joseph Sandy-Loam, originating
in interior valleys. Low but variable perennial water table; prone to drought.

Occurrence: Large area south of Eastern Main Road from Barataria to Tunapuna, including I.O.T.A. New Farm.

Vegetation: Deciduous Forest, now mostly cultivated.

24. ***Laboratory data: "This is a sandy soil with a high proportion of fine sand (over 60 per cent.), Markedly acid. Organic matter and nitrogen contents medium-low to low, and C/N ratio relatively low, denoting deterioration or surface erosion. Electrical conductivity values are low, denoting a low nutrient status. Available phosphate and available potash are both very low. Obviously requires intensive manuring with an NPK mixture.

Lime status is relatively high, implying restricted leaching. Theoretical lime requirement of the surface 6" layer is less than one ton per acre of calcium carbonate, and that of the sub-surface soil (second 6" layer) is nil." - also from W.R. Mills.

*** Of soil near College Farm, not in the survey area.

**TABLE OF LABORATORY DATA**

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Soil Depth</th>
<th>Reaction</th>
<th>pH</th>
<th>O.M. %</th>
<th>C/N ratio</th>
<th>H+ mhos</th>
<th>Available Rate P2O5</th>
<th>Available Rate K2O</th>
</tr>
</thead>
<tbody>
<tr>
<td>River top</td>
<td>6</td>
<td>67.2</td>
<td>16</td>
<td>5.6</td>
<td>4.5</td>
<td>1.48</td>
<td>.099</td>
<td>8.6</td>
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<tr>
<td>Estate sub</td>
<td>12</td>
<td>69.2</td>
<td>14</td>
<td>5.7</td>
<td>4.7</td>
<td>0.84</td>
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<td>7.1</td>
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<tr>
<td>St. Aug- top</td>
<td>6</td>
<td>52.7</td>
<td>21</td>
<td>5.9</td>
<td>4.9</td>
<td>2.35</td>
<td>.165</td>
<td>8.2</td>
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<td>ustine sub</td>
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<td>48.7</td>
<td>22</td>
<td>5.6</td>
<td>4.7</td>
<td>2.00</td>
<td>.119</td>
<td>9.6</td>
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<tr>
<td>Streatham top</td>
<td>6</td>
<td>72.7</td>
<td>8</td>
<td>5.1</td>
<td>4.3</td>
<td>1.66</td>
<td>.101</td>
<td>9.6</td>
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<tr>
<td>&quot; sub</td>
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<td>69.2</td>
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<td>5.0</td>
<td>4.0</td>
<td>0.68</td>
<td>.066</td>
<td>5.9</td>
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</table>

Limits of adequacy arbitrarily accepted for sugar-cane P2O5, 30 p.p.m., and K2O, 150 p.p.m.

(iv) Maloney Sand and Loam

25. Colluvial-Alluvial areas of Old Llanos Terrace.

Rolling to hummocky flat; partially impeded drainage.

Pale brownish-grey compact fine sand over pale grey yellow mottled and speckled sandy clay over yellow and grey sandy kaolinite clay. Prone to waterlogging.
in wet season and drought in dry season.

Planesol.

Occurrence: two small patches in the area.

Vegetation: Marsh Forest, mostly burnt. Cultivated in parts.

26. Laboratory data: as in table below.

<table>
<thead>
<tr>
<th>Colour</th>
<th>Depth</th>
<th>C/N</th>
<th>Elect. Cond.</th>
<th>Available</th>
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<tbody>
<tr>
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<td>Crse.</td>
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<td>Pale</td>
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</tr>
<tr>
<td>Grey</td>
<td>3</td>
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<td>4.4</td>
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<tr>
<td>Speckled</td>
<td>6</td>
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This appears to be a loamy soil but is not as colloidal as the St. Augustine Loam.

38. Agricultural aspects of the soil-types:

(c) Agricultural aspects of the soil-types:

27. The cane soil on the St. Augustine Loam in the east, suffers from severe drought in the dry season. Any young cane growing during that period is almost dried up and seems even to retrogress in growth. At least, growth is almost halted then. During the last dry season the young plant canes dried up to such an extent that a large area of it actually alight from the fire in the mature canes and were completely burnt up. Consequently much re-planting had to be done there.

28. Even in the wet seasons, this soil-type does not hold a great deal of moisture. The fact that it never contains excessive moisture, even in the wet season, is reflected in the absence of many a bed drain between the cane beds in that area. (Section VII, 21) (see photograph a.)

29. This cane be explained from the information given in preceding sections, where it is described as a free draining type of soil occupying a fairly high ground, and in addition, from Professor Hardy’s description that the water-table of this soil lies at 20 to 30 feet below ground level throughout greater part of the year and its material being mostly very porous. (From L.A. Bridgland, Aug. 1948.)

30. Although the soils of the Streatham Loam do not suffer from drought to the same extent, the above description of the St. Augustine Loam holds equally good for them when they are located on the higher ground. Several cane beds are also

--joined--
joined together by the absence of bed-drains between them denoting fairly free drainage of water from the soil. But as Streatham Loam is situated on the lower slopes to the St. Augustine Loam, its drainage is partially impeded in many areas, especially when located on the lower ground. Here the cane-beds are separated by the bed-drain. The water-table has been described as being perennial at 10 - 14 feet, which accounts for its slower drainage than the St. Augustine Loam.

31. The partially impeded drainage of this soil-type is its particular advantage over St. Augustine Loam in regard to cane growth. This soil is generally recognised as the 'cool-land' by the farmers and is expected to yield about 50* tons of cane per acre, as compared with the 'dry-land' of the St. Augustine Loam, whose cane yield is expected to be around 35* tons per acre.

32. The partially impeded drainage of the Maloney Sandy-Loam soils are also indicated by the adoption of the usual practice of digging drains between the cane-beds. The yield here is also expected to be as high as on the Streatham Loam.

33. The River Estate Sand and Loam is a free draining soil-type, which is especially apparent on the north of the Highway but not so obvious on the south side where paddy is being grown and is largely replacing cane, as water is purposely being retained on the land for paddy during the wet season. (See photograph c.)

34. The cane on this soil-type does not, however, suffer from drought to nearly the extent as on the first mentioned soil-type and the yield of over 40* tons of cane per acre is obtainable here. This is perhaps mainly because of its greater moisture content owing to its lower situation and flatter topography, in spite of its free internal drainage.

V. - Scattered Nature of Holdings.

35. It is common for a farmer to hold several parcels of land, each scattered some considerable distance from one another. Sometimes they may be as much as one to two miles apart. If paddy land is included, the distance is increased as it is situated well to the south in the lower lands. This means that the farmer has more trouble to plan out his programme of work, as he must remember what work is required on each parcel of land at any time from the last time he was there, without actually walking over there to check up. Far from being able to check up daily on all his parcels of land, he may not even see some of it for a week or more. This is especially the case when he is working on the paddy land, to which he gives the priority, when he will neglect the work on his cane land, which he may not even visit for a while.

* Approximate yields of plant cane as stated by farmers.
and would not realise the urgency of work to be done there.

36. Another disadvantage of scattered holdings is that the farmer is unable to keep a check on the work of his hired labourers. These disadvantages are accentuated when a farmer lives away from any of his holdings, far away in a village, as most of them do. These divided holdings are definitely less conducive to efficiency than if they were undivided, and in one large unit.

37. The average size of a holding is about three to five acres but it is usually split up into small parcels of land of one acre or less. That means that he may have from three to half a dozen parcels of land and each scattered some distance apart.

38. Therefore not only do the farmers hold small acreages of land but their units of working area is parcels, are very small. Thus the farmer naturally thinks in terms of small working units and would not be too receptive to big ideas in terms of larger working units, even say a five-acre field as a start. This psychological aspect of the farmers deserve full consideration when large scale schemes, such as mechanised agriculture, is advocated for them. The remedy would lie in the re-organising of holdings into larger, undivided units which would help them to re-adjust their outlook, and which is essential for the success of mechanical operations, such as tractor ploughing. (see xv, para 186.)

VI. - Sugar Cane Farming.

(i) Cane beds and bed drains -

39. As a rule cane has always been grown on beds of about 22 to 24 feet in width, both by the estates and by the cane farmers, and the beds are invariably cambered. The beds are usually separated by bed drains which run along the whole length of the beds. Thus, the width of a cane bed is usually measured from the centre of one bed drain to that of the next. Since the bed drains are about 2 feet wide, the actual width of a 22 feet bed, for example, would be only 20 feet.

40. It is therefore rare to see cane being grown on the flat, as opposed to being grown in beds which are separated by bed drains. In this respect this survey area provides interesting examples which are exceptions to the rule. For instance, in the high lying areas it is fairly common to see cane being planted on the flat, without any beds. At least, even when beds are present, there are no bed drains between them and cambering is absent.

(a)
(a) Width of beds, cambering and drains

41. The fields on either side of the Macoya Trace, on the St. Augustine Loam provide interesting examples of the importance of soil-moisture relationship in determining the layout of the fields and the type and width of beds.

42. The fields on the northern high ground have no beds and are absolutely flat. Therefore the question of bed width does not arise. Another such area is on the Streatham Loam on the high ground to the left of the Highway. (See Section IV (c))

43. Further down, in the same area, cane is grown on beds but they are still without camber and without bed drains. The width of the beds are therefore much wider than 24 feet as it is not limited by the consideration of cambering nor of bed drains.

44. A little further down the trace bed drains are instituted, but they are only very shallow, not exceeding 6 inches in depth, and they are not always present, as some of the beds may still be joined together, with only a strip of level ground separating them. The beds are only slightly cambered and are wide, 24 feet or more.

45. Along the bottom of the Macoya Trace, where it joins the Highway, the individual beds are distinctly separated by bed drains which may still be fairly shallow, as a regular practice. Therefore, annual maintenance of drains is greatly needed.

46. South of the Highway, as the region of Maloney Sandy Loam is reached, the beds are very much more cambered and the bed drains are much deeper, about 1 to 1 1/2 feet in depth. The width of the beds have now become standard sizes of between 22 and 24 feet. (Photographs 1 and 2.)

47. The land then begins to fall gently from 50 feet downwards as the trace passes through the region of Streatham Loam, River Estate Loam, Golden Grove Clay Loam and again, River Estate Loam, in that order, until Pasea Clay region is reached at the Tacarigua river. As the land falls, so the drainage conditions become more impeded, especially in the Clay Loam, when the cambering of the beds are the steepest in the whole of the survey area and the bed drains are sometimes 2 feet in depth.

(b) Digging drains

48. So far only bed drains have been mentioned, and not of any other drains, in order to simplify the description of various sizes and cambering of the beds in relation to soil-types and their situation. There must of course be other drains for the collection and disposal of rain water from the bed drains, which in the first place, receives it from the percolating and run-off water of the beds.
49. The drains are firstly dug out by means of a hand fork to the required depth and the earth is thrown onto the bed. This earth, incidentally, helps to heighten the camber of the beds. Then, by means of a long-handled spade, the bottoms of the drains are smoothly levelled down and the sides of the drains are shaped. The depth of drains would depend on the drainage requirements of the soil, and the steepness of the sides, to the texture of the soil.

50. The drains are dug as soon as the fall of the first rains begin to soften the soil when the digging with the fork is not only made easier but also the shaping with the spade then gives a smoother surface to the sides and bottom of the drain, than when they were dug before the rains. On the other hand, digging is completed as soon, and as early as possible in the early part of the rainy season so that the drains are ready to cope with the heavier downpour of rain later in the season.

51. Digging of drains is however a rare operation on the cane lands of the farmers. They are usually dug when the land is first brought in for growing cane, and once dug they remain untouched for as long as they remain to function reasonably well, which means that there is very little maintenance work done on the drains and only the more efficient farmers bother to maintain the drains in their initial condition, as a regular practice. Therefore, annual maintenance of drains is greatly needed and is recommended.

(c) Correct depth of drains

52. From the results of some tillage experiments which were carried out on the estates, the correct depth of drains was found to be at 6 to 10 inches below the ploughing depth, when increased yields were obtained from the plant cane and the following ratoon cane, but there was nothing to be gained from digging drains deeper than that. In fact, deeper drains caused deterioration in crop quality on certain types of soil, such as the loams with a perennial supply of subsoil water. (P.E. Turner, 1943.)

53. Since the ploughing depth in these experiments was one foot, the total depth of/drainage from the surface of the soil was therefore 18 to 22 inches, at the correct depth. Since the bed drains on the farmers' land are at the most 2 feet deep, but mostly at about 18 inches, they are not very far from the correct depth. It is only on certain soils, as mentioned before, that the drains are only 6 to 12 inches deep, which may be the correct depth for those types of soils. For instance, the free draining St. Augustine Loam with a very low water table throughout the year is not likely to need any deep drains, if at all. (Photograph a.)
Forking and cambering beds -

54. Forking and cambering of the beds, as in the case of digging drains, is a rare operation which is only done as an initial preparation of the land when fresh land is brought into cane or when old "ratoon" stools are required to be destroyed before re-planting with cane. The opportunity for forking and cambering or re-cambering of beds therefore only comes when the land is prepared for growing with plant cane. For those who can afford it, hand forking is replaced by bull-ploughing or by contracting the estate to tractor-plough their land.

55. As in digging of drains, forking is commenced in the very early part of the wet season when the first rains have sufficiently softened the land for easier digging with the fork. The centre of the bed is forked first, eventually working outwards to the drain edges, which are also thoroughly forked. The soil is inverted and thrown to the middle of the bed, which therefore becomes round-ridged, i.e. cambered.

56. Therefore, in cambering, the topsoil from the edges of the bed are transferred to the middle. Thus, the subsoil is exposed at the edges of the bed which becomes unfavourable to cane growth. The extent of the subsoil which is exposed depends on the width of the bed, as the wider the bed the greater the amount of topsoil, and perhaps even subsoil, required to be removed from the edges to the middle of the bed to produce the camber. Fortunately, the removal of topsoil from the edges "does not greatly affect the growth of the outer rows of cane with beds 22 feet to 24 feet wide, but it can be serious with wider beds". (P.E. Turner, 1943.) That may be the reason why cambered beds are never wider than 24 feet, while beds with little or no camber can be, and are wider than 24 feet, e.g. St. Augustine Loam around Macoya Trace.

57. Although cambering of the beds is not always necessary, as mentioned above, it is however, recognised as essential on the flat lands and because it is accepted as essential "it has not been deemed necessary to make investigation as to its need", so says Turner. Examples of very pronounced cambering can be found on the lower lands and on soils with partially impeded drainage, e.g. Streatham Loam and Golden Grove Clay, along the Macoya Trace. (photograph 384.)

Building banks:

58. Banks are built across the bed and are generally 4 feet apart from centre to centre. Farmers build the banks across, and not along, the bed because their
cane is usually planted in the wet season. This enables excess rain water to run down the camber of the bed along the furrows between the banks. For wet-season planting, it would be inviting trouble to build the banks along, instead of across, the beds, as the excess rain water would accumulate in the furrows. Then, the only ways that water could escape would be to travel along the length of the bed and out at the ends of the bed. Special outlets would have to be made through the banks to prevent waterlogging. (Photograph 4.)

59. It is only in the cases of dry-season or early wet-season planting that the banks can be built along the beds, when the banks can be broken early, before the onset of heavy rains, because it is made possible by the early establishment of the plants. Incidentally, this is the usual and modern method adopted by the estates, because of their mechanical equipment which enable them to plough* in the dry season, immediately followed by draining and banking units. They are then able to plant as soon as the rains come and the plants are then established early to allow banks to be broken before the onset of heavy rains later on.

(b) Time and method of building banks:

June to December -

60. Banks are built as soon as, and whenever possible after the onset of the rainy season. Then, immediately the sweet potato slips are planted on the top of the ridges or banks. After that cane is planted in the furrows between the banks. Usually, only small areas at a time are worked and planted, thus small portions of the banks are planted at different but successive intervals of time. Generally, the farmer has enough cane land to keep him occupied from the time the first banks are built until the last cane plant is put in, which may be as late as in December. The period of planting is prolonged to this extent especially when the farmer devotes much of his time to planting the paddy. Therefore the actual planting of cane may extend from July until December. When cane is planted early in the wet season, May and June, some farmers do not build any banks at all, which is condemned by some authority as cane demands a good moulding, which is given usually by breaking banks.

* Or, chiselling with heavy duty cultivator, without ploughing.
Fig. 1.

\[ X = \text{width of a forkful of soil.} \]

Fig. 2.
61. Banks are built by means of the fork, and because of that, the width and the distance apart of the banks are mainly related to the width of the fork. It is however because of the standard width of the forks that the banks made by cane farmers are almost of standard size and generally about 4 feet apart from centre to centre. This will be made clearer by the following description of their methods of building banks.

62. As mentioned before, the banks are built across the beds. The first bank is made at one end of the bed and subsequent banks are built after it until the whole bed is completed. In actual fact, each bank is not built as one whole unit but as two half units. The width of each half of the bank being the width of the soil dug by a fork, i.e. of a "forkful" of soil. Thus, the first bank is built by digging a forkful of soil and inverting it on to the undug soil on the right to form one half of the bank. Then, a forkful is taken from the right, and inverted next to the previous forkful to form the other half of the bank, thus completing the bottom half of the bank. (Fig. 1)

63. Usually, each half of two adjacent banks are built at the same time as the farmer digs the whole width of a furrow in working across the bed. He inverts the soil from the left half of the furrow to the left bank and from the right to the right bank. When a furrow is dug and completed, the left bank is completed, but the right bank is only half built. He then digs the next furrow on the right leaving a strip of undug ground the width of a "forkful", next to the first half of the bank and on which the soil would be inverted to form the second half of the bank, (see again Fig. 1) thus completing another bank.

64. Then the furrow is deepened by digging a little deeper and inverting the soil on top of the banks, which are then made higher (Fig. 2). Thus a complete bank is composed of undug topsoil at the bottom half, and the dug topsoil at the top half. Therefore any crops planted on the top of the banks would be entirely in the richer topsoil while those, as cane, planted in the furrows would be in the poorer subsoil. The process of 'breaking the bank' restores the topsoil to the furrow, around the cane plants. (Section VI, 18).

(c) Distance apart of furrows from centre to centre

65. The distance apart of the banks from centre to centre is usually considered as it can be easily measured directly and as it is the same as for the furrows. But of course it is the distance apart of the furrow centres that is
the actual concern as it is in the furrows that cane is planted. On the estates
the distance apart of the furrow centres is set by the distance apart of the
mechanised furrowing bodies, so it is easily and accurately adjustable.

66. The furrows of the cane farmers are two 'forkfuls' of soil in width and
the same for the width of each bank. Therefore the distance between the furrow
centres is the width of a bank plus the width of each half of the furrow on either
side. Thus, it is equal to four times the width of a forkful of soil; the latter
being about one-fourth, the distance apart is therefore approximately 4 feet.

(d) Planting sweet potatoes

67. When sufficient banks have been built, the sweet potato slips are then
planted on top of the banks. Firstly, a slit is made by a short handle hoe,
lengthways along the top of the bank and the potato slip is pushed inside it, leaving
about six inches of vine exposed outside. The soil is then pressed over the slip
in the slit with the back of the hoe. Further slits are then made along the top of
the furrows, planting the slips at about 10 - 12 inches apart.

68. Sweet potato is not the only inter-row crop grown in cane but it has been
chosen because it is the commonest and fits in more closely with the system of
cane farming. Other inter-row crops are thick eye peas (which is sown on bank tops),
pigeon peas, corn, okra, cassava and tomatoes (which are planted on the flat and
moulded up). Beans and eddoes are also grown, and pumpkins or cucumbers are allowed
to grow anywhere between young cane plants and have given remunerative returns.
Most of these crops can only be grown when cane is fairly young, but the taller
crops such as corn and pigeon peas can thrive between older and taller canes.
Ratans are also inter-cropped, especially with corn.

(e) Weeding during building banks

69. A good opportunity for eradication of weeds arises during the building
of banks. The soil is forked and completely inverted over the undug ground on
which a bank is built. If no part of the undug ground is left uncovered by the
inverted soil, the weeds should have little chance of quick re-establishment.
The thoroughness of burying any weed growths then would determine the time when
the next weeding would have to be done. At the same time full advantage can be
taken of digging out such weeds as Para grass* and Bamboo grass by the roots and
dispose of them in a suitable way, such as carrying them away for litter or burnt
when dry. If the above operation had been carried out efficiently, there would
be no need to weed again until just before breaking banks. (See appendix.)

- (iii) -
70. There are two types of planting materials used by cane farmers. One type is called "short plants" or setts and the other is called "long shoots" or "soldier plants". They can both be obtained from the estate as well as from the farmers' own cane.

(a) Short plants or setts -

71. Short plants are the cut up sections of the stem of cane. Each section or sett is composed of two to four nodes and at each node there is a bud. Usually, a three-noded sett, hence with three buds, is the most common. It is about 8–10 inches long, which is the usual length aimed at by the estate labourers when cutting for short plants. (Fig.3)

72. The setts obtained from the estate are not cut haphazard at any point on the internode, nor in the middle of it, but at a certain point. It is cut close to the bottom part of the node, or bloom band, leaving the part with the bud, attached to the upper internode. When planted, the lower end with the node attached would also be the bottom part which will be buried into the soil. The other end which just consists of the cut end of the internode would be the top part to be exposed above the soil. (Fig.4.)

73. This particular method of cutting was adopted by the estate as a result of the experiment in 1940 (Annual Report 1943) when this method gave an increased yield (being statistically significant for the first ratoon though not for plant cane) over the other method of cutting the setts in the middle of the internode.

74. The age of the cane cut up for short plants should not be much older than eight to ten months, as at that age the whole of the stem can be cut up for short plants. In the older or ripe canes the lower part of the stems are undesirable because of their dryness and poor germinating capacity. Thus there would be more wastage from older canes, as only their upper parts could be used.

75. Cutting of planting material requires a gang for that purpose, on the estate.
estate. The material for cutting is selected out of the standing crop of young cane by a couple of labourers. The material is then cut up by several women using straight outlasses. (Cutting 1,000 setts comprises a task, and usually two tasks are accomplished daily by each cutter.) The setts are then collected and tied into bundles of 25 setts, for the convenience of handling. Only the healthy setts are collected, discarding any which are damaged by disease or pests, as shown either by the red discolouration inside or by the small round holes on the rind outside. The latter are the exits of stem borer larvae.

76. Each bundle is dipped, there and then, into a tub of white lime and epsom salt solution. The dipping is only for a brief moment and the bundles are then piled on one side ready for planting. This dipping may kill off any borer larvae that have escaped detection and act as a disinfectant and protection against harmful organisms and other insect pests, but it is not certain what other merits it may have.

77. Some scientific workers have shown that soaking of the planting material in lime solution, and such like, have many other merits. It promotes germination because the setts absorb more water from lime solution than pure water and therefore become fully turgid before planting. This turgidity promotes quick germination which gives a good start and the sprouting of more buds. These lead to the production of more vigorous plants and so higher yields of plant cane and of subsequent ratoons. (Dr. H. Evans 1932 and 1934).

78. But it is not certain whether the quick immersion of the setts, as done in the estate, would allow them to absorb enough water to promote germination.

* Cutting the planting material into short setts enables detection of stem borer damage, etc., which is a point in favour of short setts against the long setts, when in the latter case detection of any damage is more difficult and so requires a more thorough examination which is usually neglected. Long setts are being more favoured by the estates for its many advantages over the short setts. (Section M).

When short plants are available -

79. Short plants from the estate are available throughout the reaping period when they are sometimes given free to the farmers. Unfortunately, the reaping period is in the dry season when very little planting is done, owing to the dryness of the soil which necessitates planting with a crowbar and with the risk of poor germination. The only way of keeping the planting material then is to plant them in the nursery and later use them for planting in the wet season.

80. After the reaping period the estate is busy cutting planting material
for itself and cannot spare any for farmers, who therefore have to wait until about August when the estate has satisfied its own needs. The planting material obtainable then is usually from younger canes, as the older and ripe canes have long been reaped.

(b) Long shoots or soldier plants:

81. A soldier plant is composed of the topmost part of a young cane stem which is cut off at about 1 - 2 feet below the apex. This usually includes about 4 inches of exposed stem below the topmost part, which is entirely enclosed in leaf sheaths. The leaf blades are trimmed off very short before planting. (Photograph 5.)

82. It is important not to cut too low to include the lower "sweet" nodes with high sugar content which will sour and rot in the soil, and hence will destroy the whole plant. Therefore, only the topmost nodes with low sugar content are included in the cutting.

83. The age of cane cut up for soldier plants should be young, so that it includes succulent nodes with low sugar content. The more important consideration is the effect on the standing crop or "mother Cane" from which it is cut; the younger it is cut the more capable it is of replacing the loss by tillering. In addition, if a more mature crop is cut, there is a greater risk of losing the whole remaining stem by fungal rotting. Usually, the cane is cut when it is still fairly small in height so that it is cut fairly close to the ground.

When soldier plants are available -

84. Usually they are obtainable from any young cane which had been planted in the previous rainy season. Thus whenever there are young canes* available the soldier plants will also be obtainable. As they are available throughout the rainy season, both from the estate and from their own canes, the farmers make more use of them than the short plants, which the estate cannot always spare. Besides which, they are more favoured by the farmers.

85. They can be cut in dry season for dry season planting with crowbar as for short plants. They can be cut in the early wet season, when they are used mainly to supply missing plants in the crop which was planted either in the dry season or in the previous wet season; in the latter case, the crop itself can supply its own missing plants. Then, they are cut mostly in the rainy season, from August onwards when the farmers do their main planting.

(iv) Method of planting:

(a) Short plants -

86. Short plants are planted so as to bury all but the topmost node and the
angle of planting may vary from the upright, almost vertical position to a shallow, almost horizontal position. When the soil is likely to be dry for quite a long period, as in the case of dry season planting the upright position is favoured because the lower nodes would then be buried deep enough to be in the moist soil underneath. The soils of low moisture content, such as the St. Augustine Loam in the eastern part, also requires upright position even during the wet season planting.

87. For wet season planting, when the soil is moist or even very wet, the shallower position is favoured since there is no need to bury deeply in order to get to the moist soil. In fact, planting in an upright position would only cause the lower nodes to rot in the waterlogged condition of the soil underneath. For wet season planting it has been suggested not to plant at a greater angle than 45° and in very wet periods to plant at a flatter angle than 45°. (F. E. Turner, 1940.)

(b) Long shoots -

88. Long shoots or soldier plants are planted so as to bury the lower three or four nodes. If the age of the cane is young enough, the lower nodes, being close to the ground, would have already sprouted its roots. (Photograph 5) The nodes are then very close together and each of them is sprouted with roots, which would give quick establishment to the shoot.

89. The angle of planting vary as that for short plants and for similar reasons, although the long shoots or soldier plants are commonly planted at a fairly upright position. This is especially the case when they are planted between the banks of sweet potatoes. In fact, it is because of their tall upright shoots that they perform better than the short plants when they are planted between sweet potatoes.

(c) 90. Supply pick is the instrument used for digging into, and levering up of the soil in order that the planting material can be slipped in. The angle at which the pick is dug into the soil would depend on the angle of planting desired. After slipping in the planting material the soil is well trodden around it to give it a close contact with the soil and to prevent the hole from filling with water which would impair the germination.

91. Thorough stamping of the soil around the planting material is desirable in order to encourage quick and strong development of the roots. This is usually neglected, especially when planting is done in a hurry, with the result that the plants fail to establish, if not actually fail to germinate, leaving gaps in the crop which must be re-planted with supplies.

* Crowbar is used to dig upright holes for the plants.
Furrow (Bed width) 22 ft.

Fig. 5.

In this diagram, furrows and beds are depicted with specific dimensions and spacing. The furrows are 22 feet wide, and the beds are 3 feet wide, with a width of 4 feet between them. The plants are planted at a 6-10 inch interval from the centre of one furrow to the centre of the next.
92. **Recommendation** - It is therefore worthwhile for farmers to pay full attention to this last point which would save them time and labour in re-planting with supplies and also prevent the waste of planting materials.

(v) **Space of planting**

93. Plants, both short plants and soldier plants, are planted in pairs along the furrow, there being a gap of 6 - 10 inches between the plants of a pair. Planting singly along the centre of the furrow is not practised in this area. (Photograph 6.)

(a) **Spacing along the furrow**

94. About six to eight pairs of plants are planted along a furrow of 22 - 24 feet bed. The wider the bed, the more plants it would hold. Therefore, the spacing of paired plants along the furrow would generally be about 3 feet or less. In actual practice the farmers do not of course, measure the spacing for planting. They just put in the plants at roughly 3 feet intervals along the furrow, and they know approximately how many plants can be put in for the width of the bed. On the average there are seven pairs per furrow on a typical bed of 22 ft. width, measured from centre of one bed drain to the next. (Fig.5).

95. For a given size of bed there is a definite and the same number of plants per furrow. Therefore, on looking along the bed, they appear to be planted in rows along the bed rather than across it, as it actually is the case. (Photograph 2.)

96. It has been mentioned before that the width of the beds and the need for bed drains vary with the type of soils. (Section VII, 7(i)). Therefore on the dry soils of St. Augustine Loam in the east, where the soil is a free draining type with a very low water table (Section IV, (a) and (c)) the beds are wider and, in many cases, several beds are joined together without any bed-drain between them. In those cases, the wider beds are joined together an extra one or two may be planted at the junction of the beds where the beddrains are absent. Thus, the furrows may be 42 feet long and there may be fifteen pairs of plants along it.

(b) **Spacing between the furrows from centre to centre**

97. The spacing between the plants of one furrow to those of the next depends on the distance between the furrows from centre to centre. Since the distance between the furrows is about 4 feet, which is the usual distance accomplished by means of the fork (for the reasons given in Section VII, 7(ii)) the spacing between the plants is also of standard distance apart. Therefore, if the plants of a pair are planted 6 inches apart, then the distance between the nearest plants from furrow to furrow would be 3 ft. 6 ins. In actual practice, no measurement
is made by the farmer in planting and the plants would be put in pairs at 6 - 10 inches apart. Thus the spacing between one pair of plants from one furrow and the other pair in the next furrow would vary somewhere between 3 feet and 4 feet. Moreover, if only one plant of a pair should survive then the spacing would accordingly be altered. (Fig. 3).

(c) Quantity of planting material per acre

98. The number of plants, either short plants or soldier plants, required per acre would vary around the region of 5,000 to 7,000 plants per acre, depending on the number of plants per furrow. For example, if there are seven double plants per furrow it would require about 5,600 plants per acre, which would contain about 400 furrows on a 22 ft. bed.

99. In regard to the weight of material required, it is quite easy to estimate that of the short plants. Now, if seven double plants weigh 5 lbs, then there would be 2,400 lbs. of plants per acre, which would be just over one ton per acre. Therefore, when single planting is adopted there would only be about half a ton of planting material required per acre, which is quite a considerable reduction.

(vi) Space of planting: Discussion and suggestions:

100. The problems of planting cane under the agricultural methods and conditions of the cane farmers have not as yet been investigated. Therefore, all the information given here is entirely from the results of the investigations carried out under the agricultural methods and conditions of the estates, and because of that this information cannot strictly be applied, though they can be a guide to the practices of the farmers.

(a) Planting double plants or single plants?

101. The farmers of this area plant double, or paired plants because they are then sure of at least one plant germinating from a pair. This is an important point on some of the dry sandy soils, but where the soil is fairly moist and favours germination of plants, single planting is worth some consideration. Single planting not only demands less labour but it requires only half as much planting material as double planting. Moreover, it has been found that the yield of first ratoon from single planting is as good as that from double planting, even though the yield of plant cane was greater for the latter. (Annual Report, 1943).

102. Therefore, wherever the soil is favourable to germination of plants, single planting may be more economical and profitable. Granted that double planting gives greater yields of plant cane, which is not always the case (Annual Report, 1939-43).
its disadvantages may outweigh the increased yield obtained. In any case, there is some indication that there would be no difference of any significance between the ratoon yield of single planting and that of double planting. As farmers' canes are ratooned several years over, the total yield, both of the plant cane and of the ratoons, must be considered rather than the yield of plant cane alone. In addition, there does not appear to be much difference in the quality (i.e., the number of tons of cane required to produce one ton of sugar) between single and double planting. (Annual Report 1943, p.138).

103. On the other hand, double planting gives a quicker and thicker coverage of ground, which would be a better check on weed growth. This may be one of the contributing factors to its greater yield of plant cane.

104. However, before recommending single planting to farmers, it is first necessary to consider the moisture status of the soil in regard to its favourability to germination, and then the points mentioned above, such as the economy in labour and planting material, the total overall yields and the control of weeds.

(b) Spacing along the furrow-

105. As mentioned before, there are usually about seven pairs of plants in a furrow, giving a spacing of about 3 feet between the pairs, across a bed 22 feet wide. This spacing along the furrow of 3 feet appears to be the best spacing when compared to the results of the experiments. At any rate, there is nothing to be gained by increasing the spacing beyond 3 feet, thereby reducing the number of pairs, or double plants, per furrow. In fact, it would lead to a reduced yield of plant cane.

106. For instance, in the experiment on the Orange Grove Silty Loam the yield was greatest (55.48 tons) with eight double plants, per furrow across a bed 24 feet wide, which gives a spacing of about 3 feet. This yield was greater than those with seven and six double plants per furrow by 5.5 tons and 2.85 tons, respectively. The spacings of seven and six double plants per furrow would be about 3 1/3 ft. and 4 ft. which appear to be excessively wide. There is however little difference in the yields of the first ratoons between the different spacings. (Annual Report, 1940 p.197).

107. It must be borne in mind that a closer spacing, of course, means a greater number of plants planted per acre. It seems as though the greater the number of plants used, the greater the yield of plant cane, as in the case of double versus single plantings. (Para.100). But again, the yields of ratoons are not much affected by the various treatments.

-108-
108. The closer planting, here again as in double planting rather than single planting (para. 102) may have a greater smothering effect and a better check on the weeds, and hence would contribute towards a greater yield, however small its contribution may be. Some material used is well compensated by these advantages. The

109. Therefore, the spacing of 3 ft. adopted by the farmers appears to be best as shown by yields of plant cane. In this instance, the farmer is to be commended for having adopted the most efficient method, which should give him a handsome yield providing his other cultural methods have been equally efficient and his land reasonably fertile.

110. There is however, one suggestion to be made. That is, why have any space between the plants within a furrow at all? In other words, 'continuous-row' planting might be adopted with benefit by the farmers. This would mean the planting of short plants, or larger setts if possible, in a single continuous row along the centre of the furrow. This would demand a greater number, or quantity of plants than the ordinary double planting about 3 feet apart, but the greater yield obtained would compensate for it. For instance, where only seven double plants were required before, this would require about thirty short plants of 8 inches in length - over double the original requirement.

111. The advantages of continuous-row planting is well recognised by the estates. They have not only found it to give greater yields than the ordinary method of say, as close as 1 ft. spacing between plants, but also to reduce the work of supplying missing plants. Apparently there are much less missing plants with this method because almost every bud on the plants germinates, since the plants are laid horizontally and covered with a thin layer of soil.

112. This type of horizontal and shallow planting could only be adopted on the soils with ample supply of moisture, and because of that many soils in the area would be quite unsuitable to this method. Nevertheless, the soils on the low lying areas could adopt it with benefit. The planting would just consist of laying the plants in a small continuous groove made by a hoe along the centre of the furrow and then covering the soil, fairly thinly. (Photographs 7 and 8).

113. The planting material used for this need not be as short as the usual short plants but longer setts may be used with advantage. In fact, the estates plant long setts of about 3 feet in length upwards for continuous-row planting. (Photograph 9).

114. The great advantage of continuous planting as now recognised by the -estates-
estates is that it lessens the work of supplying missing plants, if any at all, it gives them a greater yield and it produces straight continuous-rows of plants which land themselves to mechanical hoeing or cultivation between the rows. The greater quantity of planting material used is well compensated by these advantages. The only disadvantage seems to be in that of using long sets of over 3 feet, which makes detection of any damage or injury in the cane more difficult and so more supervision is required. Without this supervision many useless sets will be planted and gaps as long as the length of a sett will often appear, which would be far worse than if short sets have been planted at the usual 18 inches apart in the row. If, on the other hand, more supervision is given then this disadvantage can be eliminated. (Section xi (a).

115. If continuous-row planting is adopted by the farmers, they would enjoy the advantages of greater yields and less work to do in supplying missing plants, but they would not as yet enjoy the greater facilities for mechanical operations. Nevertheless this may be one of the steps towards the mechanisation of their sugar cane agriculture, if such is the desirable future for them. In any case, there would be no more need to hoe between the plants where cane would grow instead of weeds.

116. It must be noted that when mechanised hoeing or cultivation is done on the estates, it is done between the rows of plants which run along the beds and not across the beds, and the rows are in addition 6 feet. Therefore, before these facilities can be enjoyed by the farmers, they would have to alter the direction of their plant rows by building banks along the length of the bed and not across it. (photographs 7, 8 and 9).

(c) Spacing between furrows, centre to centre -

117. Again, the spacing between furrows adopted by the farmers is beyond reproach and provides good and adequate space for the best growth and yield of cane.

118. The spacing between furrows from centre to centre is usually 4 feet as mentioned before. (Section VI§, \( \frac{6}{4} \) and \( \frac{3}{4} \)). The estate experiments have shown that there is nothing to be gained from adopting narrower or wider spacing than that. For instance, on the Orange Grove series it was shown to be immaterial in regard to yields, whether the furrow centres were \( \frac{3}{2} \) ft., 4 ft., or \( \frac{4}{3} \) ft., apart on 22 feet beds with six double plants per furrow across the bed. (Annual Report 1942 p.149).

119. P.E. Turner* has however stated that the "drills (i.e. furrows) and banks

* Proc. Ag. Society, 1940 p.73.
should each be about 2½ ft. wide"; which meant that the furrow centres should be 5 feet apart. This is however unlikely to be adopted by the farmers who work with their forks and who find 4 feet apart the most convenient for them. (Section VII, pages 41-42 and 5). There would have to be a definite advantage in favour of 5 ft. spacing before they would change over from their 4 ft. spacing.

(Vii) Weeding after planting:

120. The next operation after planting is weeding. This is usually carried out by the more efficient farmers, when the weeds are chopped out by brush-cutlass and the roots dug out by the long-handled hoe. The cut weeds are then either left as mulch in the furrow around the cane plants, or carried away to be made into pen manure. (Photographs 10 and 11).

121. Generally, weeding is done when the tops of sweet potatoes are cut for the first time to feed the livestock of the farmers. This can be done a few months after planting sweet potatoes, which will then have produced an abundant growth of tops.

122. Sweet potato tops can be cut several times after the first cutting is made, provided its growth is rapid and vigorous after each cut is taken. This is one of the advantages of growing sweet potatoes in conjunction with cane as its tops provide a ready source of fodder for stock. The other advantage is that it acts as an effective smother crop against weeds during the early stages of cane growth. Some estates used to grow sweet potatoes mainly for the control of weeds but have now abandoned it because of the damage caused to the young cane plants when harvesting sweet potatoes by the labourers.

123. On the other hand the smothering effect of sweet potato tops is so great that it may even check the growth of young cane shoots, especially those from the short plants. In fact, this is one of the main reasons why soldier plants with their tall upright stems and so in a better position to compete with weeds as well as sweet potatoes, are preferred by farmers to short plants.

124. When weeding is done at the same time as topping of the sweet potatoes, the resultant effect is to leave nothing else growing except the cane plants. The furrows and the sides of the banks are thoroughly scraped bare of weeds and the top of the banks are stripped clean of sweet potato tops. (Photograph 10.)

125. On the estates, the weeding called "clearing the furrow" is performed, when the weeds growing in the furrows are cut with a brush cutlass and laid on the banks to wither away.

-(viii)-
Application of Fertilisers:

126. There are three kinds of fertilisers available to farmers from the estate. Ammonium sulphate is sold to them for the use on ratoons and is known to them as "ratoon salt" (which is about $2.00 cheaper than 'plant salt'). The two fertilisers which are used on plant cane are: "Sul-Pot" which is the most popular and which contains 1 part of muriate of potash to 3 parts of ammonium sulphate; and "Magic" which contains 1 part of double superphosphate, 2 parts of muriate of potash and 5 parts of ammonium sulphate and which in turn is dearer than Sul-Pot, hence is less popular. (The estate uses Magic and ammonium sulphate on plant canes, while Sul-Pot is used on ratoons.)

127. The rate of application is at one bag per acre (1 bag = 100 lbs.), therefore when only one application is given only 100 lbs. is applied, while two applications would mean 200 lbs. is the total given. The better farmers usually give two applications to their plant canes and therefore obtain much higher yields (Section VI, x\(\text{v} \)). Ratoons are given only one application, but again the more enterprising farmers use Sul-Pot instead of ammonium sulphate and have found it profitable to buy the dearer fertiliser.

128. The first application of fertiliser is given to the plant cane just at the break of rain, about May to June. The second application, if given at all, is about three months later, i.e. August to October when there is a slightly drier spell. As far as possible applications are given when dry weather is ensured and are withheld during periods with heavy rainfall. Sometimes therefore, the farmers apply their fertilisers during the dry season after the banks are broken, when the occasional showers of rain are ideal for incorporation of the fertilisers into the soil. That is about January and February.

129. Farmers do not usually apply fertilisers at this early stage of growth, i.e. just after weeding, which has been recommended. Instead they wait until much later, the earliest application being about 4 to 5 months after planting, about January, although usually they give their first application 8 to 10 months after planting, about May to June. The second application if given, is in three months time.

130. Compared to the estate, the farmers make very little use of fertilisers. The total quantity given by the farmers is at the most, only 25% of the estate per acre. In terms of ammonium sulphate they give only 20% and muriate of potash about 30% of the quantity given per acre, by the estate. Besides, many do not use any
of the fertiliser mixture with phosphate, i.e. "Magic". (The total quantities used by the estate is 5 cwt. ammonium sulphate and 2 cwt. muriate of potash on plant canes per acre.)

131. Since the soils of the farmers are rather poor to begin with (Section IV, paras.19, 21, 23 and 25), it is not surprising that the inadequate quantities of fertilisers used by them can only produce low yields. The optimum quantities of balanced fertilisers for the particular needs of their soils require investigation, and subsequently recommendation accordingly. The extent of improvement which is possible is indicated by the work of J.A. Potter who has obtained 40% higher yields than those obtained by routine estate manural treatment on soils extremely deficient in available nitrogen and phosphate, by the application of high dosages of super-phosphate and ammonium phosphate. (J.A. Potter, T.A. 1947, pp. 97 and 107).

(ix) Application of pen manure:

132. Pen manure is applied just before the banks are broken. Generally, the banks are not broken until the sweet potatoes are harvested by digging them out of the banks. In fact, breaking the banks and harvesting sweet potatoes is but one operation. Therefore the time for breaking banks is when the sweet potatoes are ready for harvesting, which is from about December until well into the dry season, as late as March. The banks are broken even as early as November on the sandy soils of higher elevation, e.g. Maloney Sandy Loam south of the junction of Macoya Trace and the Highway. Therefore, pen manure is applied within that period and from three to five months after cane is planted.

133. Pen manure is applied at the rate of from 10 to 20 tons per acre. More commonly, it is applied at the lower rates of 10 to 12 tons per acre. These figures are however quite arbitrary as the farmers do not work in terms of tonnage per acre, but only in terms of the number of cart loads per field, which is commonly a fraction of an acre. The farmers commonly speak of applying 20 loads per acre and some may even say 30 loads, but probably one load would not weigh a ton, especially if it has been bought outside. However when the farmers who make their own manure speak of so many loads, one load would probably weigh almost a ton. On the other extreme, some apply only about 10 loads per acre, but each load may weigh a ton in this case.

134. At any rate, a farmer can give a better idea of the amounts of manure, he gives to each plant. From that, the rate of application can be calculated and checked. The method of application is to carry the manure in a round basket, which is commonly
used both by the farmers and by the estates, from the cart or a dump, and distribute its contents around the plants. A full basket of manure would be evenly distributed among half a dozen plants, or among fewer plants for heavier applications. Since a full basket of manure would weigh about 20 lbs, the rate of application per acre, which contains say, 7,000 plants, would be about 10 tons. If a basketful is given to fewer plants, then the rate would be higher.

135. On the estates, one round basket of manure is divided between two plants, about 5,000 of which are contained in an acre, the rate is therefore about 20 tons per acre, which is the usual quantity stated by them. This is slightly more than the optimum dosage of 15 tons per acre recommended for the maximum financial gain, based on the costings in 1934. (P.E. Turner, Emp. Jour. Exptl. Ag. 1934.)

136. The quantity of pen manure applied would of course depend on the quantity obtainable. The farmer who has a few livestock, say two bullocks, a cow and a donkey, can make all the pen manure he requires and so can apply it at a higher rate. While, those who do not possess any livestock must purchase the manure from outside when the cost of it would limit the quantity applied. There is however a limit to the quantity obtainable and because of that there is a real need to supplement the pen manure with artificial fertilisers. Pen manure is highly valued by the farmers because "it lasts longer", i.e. of its greater residual effect than artificial fertilisers, but its yield value of nitrogen in a normal dose (say, 15 tons) is only equivalent to 1 cwt. of ammonium sulphate and it is an inadequate source of potash. (P.E. Turner, Emp. Jour. Exptl. Ag. 1934.)

(x) Breaking banks:

137. The banks are broken immediately, if possible, after the application of manure which, as mentioned in the previous section, takes place from about November, in the rainy season, to as late as March, in the dry season. That is, when the sweet potatoes are ready for harvesting.

138. This process of breaking the bank transfers the soil from the bank back to the furrows, covering the pen manure which surrounds the plants. Breaking the banks is the reverse of building banks in that each half of a bank is broken and returned to the same furrow from which it was taken. Thus, by means of a fork, the left half of the bank is dug and inverted over the left furrow and the right half, over the right furrow. The sweet potato tubers are easily dislodged by a shake of the fork before inverting the soil, which is fairly dry by this time. (Photograph 12.) When all the banks are broken, the surface of the soil becomes level again as before
the building of banks. (Photograph 13.)

139. Banks may be broken either by breaking all the banks at the same time or by breaking every other bank and then the rest after a certain interval of time. The second method is called "half-moulding" and is also still practised by some estates. Therefore both methods are practised by the farmers as well as by the estates.

140. Half-moulding is desirable when the cane plants are at a very young stage, say about 6 weeks old, because a complete moulding would retard their growth considerably. When only every other bank was broken the plants would be moulded up only into half a bank of soils, while if a complete moulding was given, the soils from a whole bank would surround it. The half-moulding allows for an interval of time for the plants to advance further in growth before the final moulding, i.e. breaking the remaining banks, is given. About one month is allowed to elapse between the first moulding and the final moulding.

141. Half-moulding is however, unnecessary when the cane plants are fairly advanced in growth, which they are about three months old when the banks are usually broken. At that stage the plants would not be much affected by being given a complete moulding in one operation.

142. Since most of the farmers do not break the banks until the sweet potatoes are ready for harvesting, about three months after planting both crops, half-moulding is not necessary for them. If cane was planted much later than sweet potatoes, then it would still be fairly young when the banks are broken and so, half-moulding is necessary in order not to retard its growth. On the estates, half-moulding is adopted because the first moulding, i.e. breaking every other bank first, is given early when the plants are as young as 6 weeks, and the final moulding is given one month afterwards.

143. It is recognised that sugar cane cannot be grown without moulding. The botanical explanation is that new roots (shoot roots) must be continually formed as they function for a limited time, and moulding helps this by covering more nodes of the cane stem from which new roots can be developed. (H. Evans, Ph.D.)

(xi) Last operation before harvest

144. At the same time as breaking banks, when the plants have begun to bunch i.e. to tiller, any missing plants are supplied with fresh planting material. The plants may be missing because of the failure of short plants to send up any shoots or because of the failure of soldier plants to establish themselves, as the case may be.
may be, depending on which type of plants are used. The fresh planting material, i.e. the "supplies", used for supplying missing plants are normally the soldier plants. These can be obtained from the other plants which have bunched more than others or from any young canes suitable to cut for soldier plants. These are obtainable at any time when banks are broken, and so they are always available when supplies are required.

145. In addition, cane grown from soldier plants will need to have their terminal or "mother" shoots cut off at this stage, and these shoots together with the new shoots which are more advanced than the rest will be used as supplies. (The estates mainly use shoted short plants, grown in nurseries which are scattered at convenient distances apart in the field for this purpose, as supplies.)

(b) Cutting terminal shoots of soldier plants

146. When cane is planted from soldier plants this operation becomes necessary. Although, in comparison with planting from short plants, this may appear to be a disadvantage it fulfils several useful purposes and is actually an advantage.

147. When a soldier plant was planted, its terminal shoot continued to function and so kept the lower nodes alive. Soon, the lower nodes begin to send out shoots from their buds. Tillers of various orders are developed and eventually, a stool is formed. But as soon as the tillering or bunching, begins the original shoots are no longer required and are better cut off. It is not certain to what extent their continued growth would harm the rest of the stool, but at any rate, they can serve further useful purposes when cut off, as they can then be used as supplies for missing plants and also as stock feed. The latter use is quite important for live-stock owners, who will be running short of fodder for their animals at this period, i.e. the beginning of the dry season.

(c) Forking between the plants and the rows

148. The next digging work to be done after breaking banks is the forking of soil between the plant rows and also between plants within the row. "Floor forking" is the term given to forking between plant rows.

The need for this is realised when the process of building banks is remembered. The soil between plant rows is where the bank was built on, and so, it is the undug soil whose surface had only been scraped by the fork in breaking bank. This strip of soil had not only been undug but it had in addition been compressed into a compact mass by the weight of the bank built on it. (Photograph 15). Thus, forking between plant rows is essential to loosen this soil for better aeration, increased absorption
of rain water and for the improvement in tilth of the soil. In addition forking would destroy weeds, especially those growing between the plants.

149. The forking is done as soon after breaking banks as possible while the soil is still fairly moist and so digging is easier. If it is left too long the soil will dry out and become harder as the dry season advances.

150. Alternatively, the soil is not forked until the first rains have softened the soil. This applies mostly to the drier and higher lands where the soil is very much more compact and harder during the dry season than those on the low-lying areas, e.g. St. Augustine Loam in the east. (Photograph 16). The forking at this time not only loosens the soil but it also buries weeds which have begun to grow with the onset of rain. For the forking to be really efficient each forkful should be completely inverted to bury the weeds and expose the unweathered soil on its underside.

151. Some farmers do not manage to do forking until about July, as they give priority to the ploughing of paddy fields during the early part of the rainy season and to the planting of paddy soon afterwards. By that time the weeds have been well established and competing with cane plants. Although the cane plants are well established by the, the growth of its tillers and the formation of further tillers will be greatly hampered by the thick weed growth.

(d) Weeding and trash ing:

152. The weeding this time, which will be about June to July, is done by hand, to pull out the weeds by the roots which is possible now that the rainy season had set in since May. One of the worst weeds at this time is the sweet potato itself, with its trailing and thick covering vines, but it is however fairly easy to pull out by the roots and easily gathered. It is not strictly a weed as the farmer uses some of the vines for planting on banks for the next crop and the surplus, together with the weeds, are fed to the stock. Therefore the farmer lets it grow voluntarily from the odd tubers that have remained behind after harvesting of sweet potatoes. Although it is desirable for these purposes, it can be a bad weed if left to grow unchecked. (Photograph 18).

153. The worst weed at this time is definitely Commelina diffusa, a grass which takes root at every node and breaks easily into pieces when it is pulled. Therefore it is hard to gather and hard to eliminate as it can propagate itself from any small broken pieces which are left behind. A list of the main weeds are included in the appendix.

154. At the same time as hand weeding, trash ing is also done. This consists of
removing the dead lower leaves from the base of the young canes. The farmers do
trashing mainly because the factory requires clean canes for grinding, and by
trashing the cane at early stages the trimming of canes free of trash is made much
easier at reaping time. There appear to be no other reason for trashing, although
it has been said that trashing prevented the accumulation of water in the sheath of
the dead or dying leaves which would have encouraged rooting or shooting of the
enclosed nodes. This is not considered harmful by farmers. (C.A. Barber.)

155. Field experiments have also failed to discover any real benefits from
trashing in regard to yields. Experiments at Ste. Madeleine estate have shown that
trashing has very little influence on the yield of plant canes although it may
exert a greater effect on the yield of first ratoon. (Annual Report, 1941, p.109
and 1942 p.148).

(xi) Harvesting of cane:

156. In Trinidad, there is a definite period in the year when cane is reaped
and this period commences with the dry season but ends sometimes after the end of the
dry season. This is because cane ripens in the dry season and is ready for reaping
even at the beginning of the season. The aim of the sugar factories is to finish
grinding by the end of the dry season as the quality of cane starts deteriorating
then. But sometimes, if the factory had started grinding late, it may not finish
grinding until the second week in June, which actually happened to one factory this
year. Therefore the period of reaping does not necessarily terminate with the dry
season, but in fact, it is prolonged beyond it in accordance with the grinding
capacity of the factory.

157. The times of reaping of farmers' cane is arranged by the estate who
prepares a schedule of reaping for both farmers' and estate cane, to fit in with the
rate of grinding of the factory. The Orange Grove factory commences grinding about
January and the farmers' canes are accepted about a fortnight after (16 days in 1948)
because "breakdowns are liable to occur in the factories during the first week or so
of the season. When this happens the harvesting of estate cane can be abruptly
terminated without great inconvenience, but it would be impossible to get quickly in
touch with a large number of scattered farmers. The farmers, in any case, would
suffer financial loss which they can ill afford if they were required to cancel
the arrangements they had made to reap and deliver cane" - from Report of the
Commission, 1948, Chap.IV, 93.
158. Normally, cutting and carting of cane is done entirely by the members of the family themselves, the numbers being adequate for the amount of cane they grow and reap. Sometimes they may hire a labourer if their numbers are inadequate. A family of three or more commonly manages to reap their cane without outside help.

159. Farmers' canes are not burnt normally, before they are cut, as burnt canes are paid 60 cents less per ton than the official price for unburnt canes. Even then burnt canes must be delivered not more than three days after burning or else the factory may refuse to accept them altogether, since burnt canes deteriorate quickly. However, burnt canes are given priority of delivery by the factory, and because of that some farmers find it more expedient to burn their canes and receive less for them in order to be allowed to deliver earlier than would originally be permitted.

160. One great disadvantage in burning cane is that the whole burnt area has to be reaped and delivered within three days, which means that a family labour force is no longer adequate for such a task. Then, the help of other families and hired labour is required, which increases the cost of reaping considerably, apart from the reduced price received for burnt canes. This may not affect the bigger farmers who normally hire labour for reaping, to the same extent as the small farmer who normally manages without hired labour. To the latter, accidental fires are more of a disaster than a gain.

161. The canes are cut by cutlass which is used by one hand while the other holds the cane stem. The stem is first cut about knee high, its leafy top cut off, then thrown into a row on the ground. (Photographs 19 and 20). The lower, remaining part is then cut off very close to the soil surface. The cut must be with the ground in order to promote good ratoons, all springing from below soil level.

162. Cut cane is heaped into rows which allow a cart to pass between them. (Photographs 21 and 22). Cane tops are gathered, usually by the womenfolk, and tied into bundles to be carried home for feeding livestock. (Photograph 23). Trash is trimmed from the canes as they are cut and is left on the ground for the meantime. (Section 41 (a)).

163. A cart is drawn between the rows of cut canes and it is carefully loaded and packed and finally tied up with a rope for safe transport. Canes are usually cut into such lengths, about 3 - 4 feet, that they are loaded in two lots, one in front -
front half and the other in the back half of the cart. The canes lie along the
length of the cart, sticking out in the front as well as the back and dovetailing
into each other in the middle of the cart.

164. A draught animal of all types pulls a cart - a mule, donkey, bullock or
bison. (Bisons are commonly used to pull estate carts.) A mule or a donkey is much
quicker and so can take more loads to the factory than the bullock during the season.
Quick transport is a help when permit is given for delivery of say, three cart loads
a day, even in spite of the same delay and waiting at the factory.

165. The farmers who do not own carts, they have to hire them from other farmers
who charge at the rate of $1.00 or more per ton of canes carted. The farmers who own
carts not only hire them to fellow farmers but also do carting of the estate canes,
as the estate is not entirely self-sufficient in transport facilities.

166. At the factory, there is invariably a long queue of carts waiting their turn
to unload their canes onto the receiving conveyor-belt which leads direct to the mills.
This delay and waiting is therefore entirely caused by the greater rate of delivery
of canes than the rate at which the factory can take in and grind. This delay is no
doubt a "waste of man and animal power", besides being a cause of grievance among
farmers in their relationship with the estate. The remedy lies in a better organisa-
tion of delivery, in which the full cooperation of the farmers and the sympathetic
assistance of the estate are both essential. This is not an easy matter but nevertheless,
it is a worthy objective which will be of mutual benefit to the estate and the
farmers as any improvement in industrial relationship is bound to be beneficial.
(The question of cane deliveries and industrial relationship has been given consider-
ation and its importance fully appreciated by the 1948 Commission.)

(xii) Ratoons:

(a) Hauling of trash

167. The trash which was trimmed off when canes were cut is left lying all over
the beds. The trash forms a thick covering 'mat', especially abundant after a crop
of plant cane. This 'mat' will smother the ratoon shoots and prevent them from
emerging as rapidly as they should, so it has to be removed as soon as possible.

168. When there is any sign of ratoons shooting up sufficiently to show up the
rows, trash is hauled into every other row. This is done so that the bare rows can
be forked later on as soon as the rainy season sets in. Hauling the trash therefore
achieves two purposes: the uncovering of ratoon shoots for their proper growth and
the uncovering of the alternate rows in readiness for forking as soon as possible.
The merits of forking are discussed later. (Note that the term "row" here means the space between the rows of cane stools.

169. When this ratoon crop is reaped, trash from it will be hauled into the rows which were bare last year and the rows with trash last year will be bared and forked this year. (Photographs 25 and 26.)

170. Sometimes much of the trash is removed from the land to be used as mulch for growing yam. This of course removes much of the organic matter in the form of trash which is usually put back to the soil and therefore it is not a sound practice in the long run. The cane crops already take away much of the ingredients of organic matter, especially potash and a lesser and similar quantity of phosphates and nitrogen without this further loss by removal of trash. (Noel Deere, 1921.) Trash being a source of humus, is valuable as such and therefore, also as a potential source of plant nutrients.

171. Fortunately, a great deal of trash which is removed is often for the purpose of litter and is made into pen manure which is returned to the soil later in the year.

(b) Forking or not forking:

172. Many farmers do not fork their ratoons. When asked about it they just say that they have forked their plant canes but no forking will be given to the ratoons. That may either mean that one forking is sufficient to last several years or that ratoons do not repay forking. Explanations are not readily given, although one experienced old farmer said that it was harmful because the forked soil provided hiding places for "blight", i.e. the nymphs of froghoppers, and so the ratoons suffer severely from blight attack. This may be one reason for the unpopularity of forking. Exceptions do occur, as some fork their ratoons and have sometimes received gains in yield.

173. P.E. Turner has revealed that forking (or mechanical tillage) of ratoons does not even give a cumulative beneficial effect but it even deteriorates the quality of canes on soils of poor internal drainage. It can cause loss in yields which may be damaging of the root system and to formation of irregularities on the soil surface leading to waterlogging. Moreover, it can adversely affect the benefits of sulphate of ammonia. Therefore forking is not only unnecessary but it is harmful.

(c) Weeding and application of fertilisers:

174. From the beginning of the rainy season weeds grow very rapidly and establish themselves within a month. If weeding is not done before then or soon afterwards, the canes, both plant cane and ratoon, receive a very severe check from the smothering effect of the weeds. Ratoons, being given the least attention and so are weeded last, especially...
especially suffer and some of the shoots fail to emerge at all, resulting in a very patchy crop with plenty of caneless gaps. It is most probable that the low yields of farmers' ratoons are largely due to late weeding, if that is done at all in some cases.

175. Weeding should really be done twice. The first time should be when the first growth of weeds begins to appear with the onset of rain. The best tool for weeding then is a hoe which can work deep enough to bring up the young weeds complete with their roots. The common practice is to weed with a brush-cutlass when the weeds are full grown. This is much to be depreciated, as only the weed tops are cut leaving behind the greater portion of the root system and rhizomes in the soil, and these soon give rise to a fresh growth of weeds.

176. Soon after the weeding, the fertiliser is applied to the ratoon stools at the rate of 1–1½ bags of sulphate of ammonia (1 bag = 200 lbs.). Although sulphate of ammonia is the usual 'salt' or fertiliser given, the fertiliser mixture for plant cane is given to the ratoons by some farmers who find it profitable to pay the extra cost of it. (S.A. @ $9.50 and Mixture @ $11.50 per bag.)

(xiv) Varieties of cane:

177. The most common variety of cane grown by the farmers is B.H.10(12), which serves their purpose in that it drops its trash readily and so enables the farmers to deliver clean cane without much effort. The other varieties which are now grown by farmers are 3.37161 and 3.37172, which were only introduced into the estates only as recently as 1946. However, these two varieties are too abundant in trash for the purpose of the farmers, as they really require to be burnt before reaping, which is done by the estate but which is a disadvantage to farmers. The cane farmers' department of the estate stated that the farmers prefer 3.37172 if they cannot get B.H.10(12), the latter being always preferred and only when it is unavailable that they can be given the other varieties. Another variety which was grown but is not now given to them is B.3337 which is a high yielder but unfortunately possesses a trash of "firmer texture than B.34104, which adds to the difficulties of weeding, and unless the cane is burnt, of reaping". (Annual Report, 1943, p.199). B.34104 is not grown by farmers.

178. With regard to the comparative yields of these varieties, in the varietal trials (Annual Report, 1946) on "soils with a moisture supply dependent on overhead precipitation and on which cane growth falls off appreciably during the dry season", (c.f. St. Augustine Loam around Macoya trace), B.H.10(12) had given significantly lower yields of plant and ratoon cane than 3.37161, 3.37172, B.3337 and some others in the experiments. Plant cane yields of B.H.10(12) were 9–33 tons per acre, of
B.37161 were 38 - 51 tons, B.37172 were 35 - 43 tons, and B.3337 were 31 - 52 tons per acre. Similar results were obtained on "soils with perennial supply of water" (c.f. Streatham Loam along Macoya trace south of the highway), when the highest yields obtained from B.H.10(12), B.37172, B.37161 and B.3337, in that order, were, 31, 52, 56 and 59 tons per acre.

179. Quality of the cane from different varieties varies, but on the whole B.3337 and B.H.10(12) were poorer than the rest, requiring about 9 - 9.5 tons of cane per ton of sugar. Corresponding figures for B.37161 and B.37172 were 8 - 8.4. (These were results from neighbouring estates, since Orange Grove Estate did not make any juice analysis, except one.) The quality of cane would be of importance to farmers when the new scheme for the calculation of the price paid for their cane, should become operative.

180. But these experiments were carried out on the estate soils which are generally more fertile than farmers'. Therefore the following conclusion from 1944 Report is relevant; "that on the soils of low fertility there is no evidence to suggest that marked improvement in yields will be obtained by the planting of the newer varieties" and that the solution would lie in the soil regeneration in these areas, such as "improved agricultural practices by way of better cultivation, drainage and tilling". (Annual Report, 1944, p.52.) Therefore on the poorer soils of the farmers, investigations are necessary before any new varieties are greatly extended. In addition, Professor Hardy's warning should not be overlooked; that, "where the planter can obtain largely increased yields from lands of diminishing fertility by the simple procedure of replacing an old variety by a newer, more vigorous strain, without necessarily having to maintain a high standard of cultivation, he naturally tends more and more to overlook the need for soil maintenance". (T.A.XXI, 1944 p.182.)

(xv) Yield of cane:

181. There is great variation in the yields of farmers' cane which is largely determined by the efficiency of individual farmers and to some extent by the soil-type and its water relations. (In regard to the latter it has been referred to in Section IV, 3. An efficient farmer can produce 32 tons per acre on the same soil type (St. Augustine Loam on Macoya trace) and in the next field to an inefficient farmer who can produce only 14 tons. A farmer whose livelihood is entirely by farming is usually efficient, while he who has other jobs beside farming, tend to be inefficient. Another factor in variation of yields is the mixture of plant and ratoon cane often grown in the same parcel of land, and even the gaps in the ratoon are supplied with -plants-
plants which mixes the crop even more.

182. The average yield for the area reaped on the Macoya estate (land around the whole length of Macoya trace) is about 20 tons per acre including plant and rattoon cane and their mixtures. However, plant yields of 30 tons is possible in the north and 60 tons in the south on the Streatham Loam. Rattoon yields are also low in the north (≈ 5 - 10 tons) compared to the south (≈ 25 tons) but the latter is subject to 'blight' which can bring rattoon yields down as low as in the north. Froghopper attack is serious in the south where the soil is 'cool' i.e. soil moisture is fairly abundant especially in the rainy season when the froghoppers are more prevalent. The land in the north is 'hard land' which is not troubled by froghoppers. Plant canes are fortunately not attacked as long as there are some standing crops of rattoon cane, which are preferred by froghoppers. Therefore froghopper attack is an important factor in the yield of rattoons on the moist soil with partially impeded drainage.

183. The yields from Streatham Lodge area are higher than from Macoya estate. As high as 80 tons/plant cane have been obtained per acre, while rattoon yield of 30 tons are common. The soils here are mostly well supplied with moisture and in fact, unless the drains are looked after, there is tendency for water, to stand in the drains in the wet season.

184. Therefore, when the individual yields are examined from each parcel of land, which is more or less than an acre, the yields of farmers' cane can be as good as the estate. It is only in the aggregate that their average yield is much inferior to the estates' because of the less efficient farmers producing lower yields than they are capable of, and because their soils on the whole are poorer. A great deal can be achieved alone by raising the standard of farming of those who are inefficient to that of those who are efficient, besides providing better facilities to maintain the standard, when once it is raised. The practice of mixing plant and rattoon cane, the neglect to weed in time and even the neglect to break banks, are a few inefficient habits which can lower the yield considerably, probably getting only about 10 tons of plant cane per acre.

185. This information on yield has been obtained entirely from the cane farmers' department of the estate, whose staff has given both the opportunity to study their office data and the opportunity to accompany and learn their field work. This department has a difficult and a varied function when it is realised that every individual of the 3,000 farmers have to be given attention. Not only that, when estimating their crop, each holding, each parcel of land, each bed and each portion of the bed has to be inspected and estimated for the probable yield of cane. These estimations are necessary.
necessary both for the information of the Company and for the advancement of loans and the sale of fertilisers to the farmers by the department.

186. The allocation and renting of estate land to the cane farmers is also the responsibility of this department, who have purposely divided each holding into scattered parcels in order to safeguard the interest of the farmers in the event of cane fires. The scattered nature of holding has been discussed in Section V, but this last point had been overlooked and so it is here included. Therefore, the rented holdings will remain scattered into parcels so long as uncontrolled cane fires continue to be prevalent, as the farmer with an undivided, compact holding would stand to lose all his cane in the event of accidental fires. That being the case, although the re-organising of holdings is directly in the hands of the estate, the farmers themselves are also indirectly responsible and must as far as possible prevent the uncontrolled burning of cane. This matter is however not as simple as it appears.

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In addition, even though space does not allow the mention of everyone by name, I am indebted to the staff of the Orange Grove estate, especially of the cane farmers department, of Woodford Lodge, Brechin Castle and of other estates, for imparting to me the practical knowledge in sugar cane agriculture. Last but not least, I am very thankful to the cane farmers who have given all possible help and information on their daily job of hard work.
VII - CONCLUSIONS:

187. The following are the major conclusions arising from the report:

(1) The yields of cane stated by farmers seem roughly to correspond with the moisture status of the particular soils as determined by topography and soil-type. (para. 27-34.)

(2) The cane soils of farmers are very poor; lacking in organic matter, mostly worn out or eroded, being very low in phosphate and potash, and require liming. (para. 20, 22 & 24.)

(3) The division of holding into parcels of land is agriculturally undesirable but is necessary to safeguard against uncontrolled cane fires. (para. 35-38 & 186.)

(4) The width and camber of beds, depth of and the need for bed-drains; are all determined by the drainage of the soil concerned and topography. (para 39-47.)

(5) Banks are built across the beds because cane is planted in the wet season, and they are about 4 ft. apart from centre to centre because they are built by fork. (para. 56-66.)

(6) Cane is planted in the subsoil but is moulded with the topsoil which was used to build the banks. (para. 61-64.)

(7) Soldier plants are more popular than short plants because they compete better against weeds and sweet potatoes which will smother the cane as well as weeds. (para. 89, I22 & I23.) Soldier plants are also more available. (para. 84.)

(8) Terminal shoots of soldier plants are cut when the stools are formed and can be fed to the stock or, used as supplies, which can be a great advantage in favour of soldier plants over short plants. (para. 144-7.)

(9) The very close spacing of farmers' cane is correct. Any wider spacing would only reduce the yield and increase work in weeding. (para. 103-119.)

(10) The quantity of artificial fertilisers used by farmers per acre is only 25% of that used by the estate. Very little potassic and generally no phosphatic fertilisers are used. (para. 126-131.)

(11) The quantity of pen manure applied depends on the amount available. About 10-15 tons per acre is applied by farmers who make their own pen manure, while others apply only 5-10 tons per acre through
Conclusion (II) continued:

financial limitation being bought from outside. (One load costs $2.) Artificial fertilisers are necessary to supplement the pen manure, the quality and quantity of which being lacking. (para. 132-6.)

(I2) Keeping livestock is complementary to cane farming as they can produce the valuable pen manure economically by consuming cane-tops, soldier plant shoots, sweet potato tops, para grass and other weeds, and by using trash and weeds as litter. (para. 152, 171 and appendix.) Moreover, a draught animal is essential for carting cane, pen manure, etc., and for ploughing the cane land as well as rice land. (para. 54 & 164.)

(I3) Moulding is required for the best growth of cane and this is achieved by breaking banks, which is the same operation as harvesting sweet potatoes. (para. 137-143.)

(I4) Forking between the rows is required because the soil there has never been dug over, besides being compacted by the weight of the banks built on it. (para. 148-151.)

(I5) Trashing is done to give clean cane to the factory, rather than for the doubtful benefit to cane yield. (para. 154-155.)

(I6) In Trinidad, cane ripens in the dry season when the factories commence grinding and aim to finish by the end of the season. This required careful planning of cropping schedule, both for farmers' and estate's cane, the difficulty of which is manifested by the long waiting queues at the factory. (para. 156 & 166.)

(I7) Trash must be hauled to expose the emerging ratoon shoots and for forking. The benefit of forking is however doubtful. (para. 167-173.)

(I8) Weeding and application of fertilisers to ratoon is essential and is profitable. (Estate does not advance loans to farmers unless they weed their canes, which is a commendable policy of the estate.) (para. 174-6.)

(I9) Varieties of cane; B.H.10(I2) is preferred to other new varieties as it drops its trash readily. The question of quality of cane and of new varieties will be important in the future. (para. 177-180.)

-(20)-
Conclusions continued:-

(20) The yields of farmers’ cane can equal that of the estate, if they avoid mixing ratoon and plant cane, weed and break banks in time, and if more use is made of fertilisers; such are the practices which mark off the efficient from the inefficient farmers and account for the disparity in their cane yields. (para.181-184.)

(21) Cane farmers’ department of the estate has a difficult and a varied function, and is helpful to farmers. (para.185 & 186.)

(22) Great improvements can be obtained alone by raising the standard of farming of those who are inefficient to that of the efficient farmers, as a start. Then better facilities can be provided to maintain that standard and if possible, to improve on it in the future.

(23) Mechanisation; facilities for tractor-ploughing of farmers’ fields is available at a charge of $16 per acre from the estate. Further mechanism would require the alteration in the direction of banks, which would have to run along the length of the bed and not across it, as now. Which in turn would mean that planting must be done in the early wet season and no later, in order that banks could be broken early before the onset of heavy rains. In fact, further mechanisation of cane farming would mean the wholesale adoption of estate methods by farmers. (para.110-119.)

(24) Froghopper attack is a great controlling factor in the yield of ratoon cane (plant cane being less affected). (para.182.) Although there are a few other pests of major importance on sugar cane in Trinidad, such as the Catinia and Diatraea moth borers, there are now no diseases of importance, either fungal or of virus, and under the estate the cane are good. The control measures and methods of application should be intensified and recommaned accordingly. Mechanised and tractor facilities require special consideration. (para.120-121 & 126.)

(25) Farmers should make their own bee-keepers in order that they are not limited by the amount they can afford to buy. This should become, as herding livestock is supplementary in cane farming, the initial cost in purchasing freestock is the only difficulty; farmers should be encouraged to buy either from the estate or from dealers.
The following are the main recommendations arising from the report:

1. **Drains:** Annual maintenance of drains on the soils which normally require drainage, should be carried out and not left until they ceased to function through silting up and weed growth. (para. 51.)

2. **Planting:** Thorough stamping and pressing in of the soil in planting is necessary, especially for soldier plants, in order to give a better establishment of plants, which would save time and labour in supplying missing plants and also prevent the waste of planting materials (which are very scarce this year, for example). (para. 90-92.)

3. **Continuous-row planting:** Might be adopted on the soils with ample supply of moisture, as it gives greatly increased yields, avoids the need to supply missing plants which saves material and labour in the long run, even though a greater quantity of material would be needed per acre in planting than in ordinary method. Planting a greater quantity of material is economical, as it ensures a good and thick establishment of cane which can dominate weeds in the early stages and eventually which give a high yield commensurate with the greater quantity planted. Continuous-row planting would not only give a greater output per acre but it would also eliminate the need to do weeding with the row where cane would grow instead of weeds. (para. 110-116.) This would also be a step in the direction of mechanisation.

4. **Artificial fertilisers:** A greater use of fertilisers is required to supplement pen manure. The need for fertilisers is greater where pen manure is scarce and the soils are poor. The optimum quantities and times of application should be investigated and recommended accordingly. Phosphatic and potassic fertilisers require special consideration. (para. 126-131 & 136.)

5. **Pen manure:** Farmers should make their own pen manure in order that they are not limited by the amount they can afford to buy. This should be easy, as keeping livestock is complementary to cane farming. The initial cost in purchasing livestock is the only difficulty, which should be overcome by loans either from the estate or from credit.
RECOMMENDATIONS (continued):

(5) continued:
credit societies which are functioning so well now. (para. I36.)

(6) Early forking after breaking banks is desired to improve soil-
tilth and to control weed growth. (para. I48-I51.)

(7) Ratoon; early and twice weeding, and application of fertilisers
to ratoon cane is essential and profitable. (para. I74-6.)

(8) Efficient farming; Planting of pure plant cane and avoid mixing
it almost stool tree to stool with ratoon cane; timely and frequent
weeding; and timely breaking of banks to mould cane; are all essent-
ial for better yields and hence of efficient farming. (para. I84.)

(9) Control of froghoppers is required on soils which suffer from
their attack, as they reduce ratoon yields considerably. This would
require the assistance of either the estate or the Department of
Agriculture. (para. I83.)

(10) Varietal trials to investigate the quality of cane as well as
the yield of cane varietied grown by farmers would be important in
the future and therefore would be required. (para. I77-I80.)
2. W.H. Mills - practical work at Chemistry Department, Imperial College of Tropical Agriculture, 1949.
5. Annual Reports, Field Experiments on Sugar Cane in Trinidad, Sugar Cane Investigation Committee publications, 1939 - 44.
6. P.E. Turner - Proceedings of the Agricultural Society of Trinidad and Tobago, 1940, p.73.
11. Noel Deere, 1921, - Cane Sugar: a textbook.
12. Professor F. Hardy - Tropical Agriculture, XXI, 1944, p.182.
APPENDIX:

THE following is a list of some of the major weeds of caneland:

1. Bidens pilosa.
2. Cornelia diffusa. (para. 153.)
3. Ipomoea spp. (see also para. 152.)
5. Croton lobatus.
6. Ageratum conyzoides.
8. Euphorbia haeasipifolia.
9. Leonotis nepetaphylla.
12. Mimosa pudica.

N.B. Para grass is regarded by farmers as the best fodder grass for stock and is allowed to grow in the cane, sometimes attaining a few yards in length through their creeping growth habit. They are periodically gathered for feeding the stock. (It is different on the estate, where it is regarded as the most pernicious weed and a para grass gang is especially employed to dig them out with special tools called duchets.)

But for farmers who have no para grass, it is recommended in paragraph 69 (page 17)
ST. AUGUSTINE LOAM: along Maccoby trace. This ditch is very deep, being deepened yearly by the water itself, and the level of water is at least 10ft. down even in the rainy season. The soil drains out freely and excessively into it. (29th. July)

STREATHAM LOAM: taken from the Highway. Rolling land is clearly shown by the sweet potato banks which are being planted. (29th. July)
RIVER ESTATE LOAM: near the Highway.
Low-lying land enables water to be retained for growing
paddy during the wet season. A cane field is seen behind
the rice nursery. Note the water standing in the trace.
(29th July)
Photograph 1.

CANE BED AND BED DRAIN. An oblique view of a bed, with a bed drain running between it and the next bed on the left.

Photograph 2.

CANE BED, a view along the centre of the bed (At the mark X.)
CAMBERING is steep on the soils of partially impeded drainage. Note the bed drain on the right edge of the bed, cowpeas grown along it and tomatoes in the centre of the bed. (Streatham Loam along Mecoya trace.)

Photograph 4.

Pronounced camber on this bed is shown by the descending curve of the banks. (This young cane is grown from short plants in July.)
SOLDIER PLANTS. Note the closeness of the exposed nodes and the little protrusions of roots from each node. (Compare size with hat.)
Photograph 7.

Planting materials are laid along the grooves which run along the bed, making four continuous rows. (Woodford Lodge estate.)

Photograph 8.

Planting materials are then covered over with soil by a hoe. (Woodford Lodge estate.)

Photograph 9.

Long cane of 3-4 ft are used as planting materials. (Woodford Lodge estate.)
Photograph IO.

6 MONTHS OLD CANE IN JANUARY.
The banks are cleared of sweet potato tops and of weeds, former is fed to the stock and latter is left as mulch in the furrow around the young cane plants. (Note the pigeon pea Y plant.)

Photograph II.

THE SAME CANE, before weeding and clearing sweet potato tops.

THE SAME CANE, II MONTHS OLD IN JUNE.
Small shooting tillers are seen on the left side of the stool. Another weeding is to be given soon.
Photograph 12.

BREAKING BANKS: 3 months old cane. Farmer stands on the broken half of the bank, soil from which has been inverted around the plants on the right. He holds a sweet potato tuber which has been dug out in the process.

Photograph 15.

AFTER BREAKING BANKS: 6 months old. The next operation is to fork between the plant rows, the need for which is seen by the hard and compact appearance of the soil on which the man is standing.
Photograph 13.

AFTER FORKING BETWEEN ROWS IN SEPTEMBER: 4 months old. Soil between rows and between plants has been forked. (From short plants.)

Photograph 14.

TWO MONTHS LATER: clods have weathered down to crumb structure. Note the weeds beginning to appear.
Photograph 16.

Forking between rows in July: 12 months old. Trash has already been stripped and is lying between the stools on the right.

Photograph 17.

The same, showing trash lying between the stools.
Photograph 18.

10 MONTHS OLD CANE IN JULY: getting very weedy and is about to be weeded. (From short plants.)
A cutlass is used to cut cane.

Cane tops is held and the main stem is chopped off on to the ground. (Note the cleanliness of stem through being burnt previously.)

The cut cane is then heaped into rows which allow a cart to pass between them.

A bullock-cart is then driven between two rows of cut cane ready to be loaded and taken to the factory.
BY-PRODUCTS IN REAPING SUGAR CANE:

Photograph 23.

CANE TOPS are bundled together and carried home to feed livestock. Or, they can be cut up into short plants for planting.

Photograph 24.

CANE TRASH is abundant from cane which has not been burnt. A cartload is being taken away for yam mulch and for litter in the pen.
Photograph 25.

RATOOD CANE: 3 months old. Trash is hauled into the alternate space between the rows of cane. (seen across the rows).

Photograph 26.

RATOOD CANE: the same. Trash in the left row but none in the right row (seen along the rows).
THE IMPLEMENTS USED ON ONE HOLDING:

LONG HANDLE HOE: Used mainly for moulding up (corn, okro, etc.) and for weeding.

A CUTLASS in the right hand and a SHORT HANDLE HOE in the left hand.
CORN AND OKROES are planted before cane, either on banks or on the flat and moulded up later.

BLACK EYE PEAS are grown on the banks, as with SWEET POTATOES.
TOMATOES are sometimes planted in the hollows dug out between the rows of cane in January, after breaking banks.

PIGEON PEAS still remaining in the rows of cane up to June.

PUMPKIN AND SWEET POTATOES: pumpkin are allowed to mature in situ, while the potato tops are later cut up into slips for planting on the banks. Seen in July, long after breaking banks.