Growing Plantain at High Densities

S. Belalcázar, M. I. Arcila,
J.A. Valencia, D.G. Cayon
and G. Franco*

Introduction

In Colombia at present more than 400 000 hectares are under plantain cultivation, 280 600 of which are in the central coffee plantation zone. The production volume is 1.7 million tonnes per annum and the average yield 6 tonnes per hectare. These yields are considered low since it is possible to reach a level of 50 tonnes per hectare using new technologies.

The increase in population growth, together with rising food consumption, requires solutions which, while avoiding the destruction of the environment, contribute to greater productivity. Various possibilities include cropping system with species combinations, intercropping or high density planting (Figure 1a & 1b).

High density planting of banana, cocoa and coffee, for instance, results in higher yields per area without the quality of the harvest being affected, which is to the advantage of the farmer whose plantation profits and income are improved (Franco and Vega, 1987; Israeli and Nameri, 1967; Jaramillo de G., 1984; Uribe and Mestre, 1980 and 1988).

In the case of coffee, increases of 71 % over 5 harvest periods have been observed, for densities of 10 000 plants per hectare, compared to plantations of 2 500 plants per hectare (Uribe and Mestre, 1980).

For cocoa, increases of 60 % have been noted, with 1 333 plants per hectare, compared to normal densities of 625 plants per hectare (Franco and Vega, 1987).

For plantain, Belalcázar *et al.* (1990) and Cardona *et al.* (1991) have observed production increases from 270 % to 345 % with densities of 3 000 and 5 000 plants respectively per hectare, compared to the conventional 1 000 plants per hectare.

Other effects of high density production include an increase in times to flowering and harvesting for banana and plantain along with a lower incidence of black Sigatoka (Israeli and Nameri, 1967; Marcelino and Quintero, 1987).

The weight of bunches per plant is lower, but this factor is offset by the presence of a greater number of bunches per area. This effect has also been observed for coffee (Uribe and Mestre, 1980 and 1988) and for cocoa (Franco and Vega, 1987).

The findings which are presented here evaluate the effect of high density planting on the parameters of growth, development and production on a commercial scale. The work was carried out by ICA and by CORPOICA in co-operation with the Comité Departamental de Cafeteros del Quindío (Coffee Producers' Departmental Committee), and supported by the International Development Research Centre (IDRC) of Canada and by the International Network for the Improvement of Banana and Plantain (INIBAP).

Figure 1a & 1b: *High planting densities of Plantain results in optimal land use and higher yields per area without the quality of the harvest being affected.*

* *Instituto Colombiano Agropecuario ICA and CORPOICA, Banana and Plantain Programme, Apartado Aéreo 1069, Armenia, Quindio, Colombia*

Table 1: *Effect of planting at 3 x 2m on growth and production factors.*

		Growth Factors			Production Factors		
Corms/hole	Number of plants/ha	Height (m)	Circumference of the pseudostem* (cm)	Duration of the veg. cycle (months)	Average weight of bunch (kg)	Yields (tonne/ha)	% of plants harvested
1	1 666	3.5	49	15.5	15.0	23.1	92.6
2	3 332	4.2	50	18.0	14.3	40.5	85.0
3	5 000	4.3	51	20.0	13.3	51.9	78.0

** At one metre from the ground.*
Source: Cardona. Franco. Belalcázar. Giraldo. Validación y ajuste de tecnología sobre prácticas de siembra y manejo de plantaciones de plátano. 1991.

A new option

The high density technology generated for plantain constitutes a profitable alternative for the producer. Traditionally, the crop has been managed on a perennial basis, with different plantation layouts according to the agroecological zones and the producers objectives. The new method requires treating the plant as an annual, since once the crop has been harvested the plantation is eliminated.

In studies carried out at a semi-commercial level, results obtained agree with those of previous research (Belalcázar *et al.*, 1990): the increase in the number of plants per hectare has a direct influence on growth factors and on overall production, with an inverse effect on output per unit and on the percentage of plants harvested (Cardona *et al.*, 1991).

The analysis of results shows that the increase in the length of the vegetative cycle is compensated for by higher yields. This, therefore, warrants the farmer waiting an extra 3 to 5 months with densities of 3 332 and 5 000 per hectare, rather than densities of 1 666 plants per hectare. (Table 1)

The same table shows that the reduction in yield is in inverse proportion to density increases. Generally speaking, this is due to pest attacks, diseases and abiotic factors such as storms, or to plants with growth problems. These plants are part of the "residual harvest" and it would be is advisable to eliminate them, so as to prevent them competing with plants that are developping normally. However, their elimination is not recommended in plots where plantain is grown continously.

In spite of the problem explained above, yields from high density farming, two to three plants per section, will still be greater and increases of 2 358 and 1 290 bunches per hectare may be observed for densities of 5 000 and 3 332 plants per hectare respectively, compared to normal densities. This implies additional yields of 28.8 and 17.4 tonnes per hectare for densities of 5 000 and 3 332 plants respectively, over yields from 1 666 plants per hectare.

Technological requirements

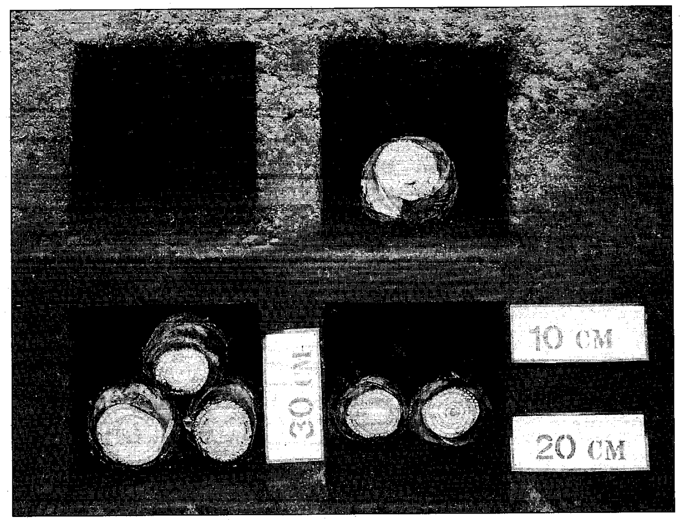
For this system to be efficient and profitable, the following recommendations should be put in place:

Corm size: This factor merits special consideration, since the success of the system depends on correct selection of corms. It is very important that the corms be of uniform weight and size.

According to Herrera *et al.* (1990), it is possible to use suckers of between 0.25 and 1.25 m in height which provide corms between 0.66 and 2.5 kg (Figure 2). Corms should be graded according to size when they are being prepared so as to form homogenous groups. This process makes for uniform growth and development and allows for staggered

Figure 2: *The corm size merits special consideration since the success of the system depends on their correct selection.*

Figure 3: *The size of the hole is 30 to 40 cm in depth while the length and breadth depends on the size grade of the corm as well as on the number of plants intended for sowing in each site.*



harvesting, i.e. the first plants to be harvested will be those whose corms were the largest, followed by those whose corms were smaller and so on.

Once the corms have been sorted, it is advisable to apply a preventive chemical treatment, consisting of insecticides and fungicides with an adherent, using a back pack sprayer. Corms should be sprayed thoroughly to ensure complete coverage.

Hole size: This should be 30 to 40 cm in depth, while the length and breadth will depend on the size grade of the corm as well as on the number of plants intended for sowing in each site. (Figure 3 p.13).

Levelling: Despite the use of graded corms, it has been observed that, among plants of each productive unit, one or two may present marked differences in size and thickness of the pseudostem, which are apparently due to the physiological age of the corm. In this case, it is necessary to resort to "levelling by pruning or cutting back" (Figure 4 , 5a & 5b). This consists of either partly or completely eliminating leaf growth, or completely cutting back the pseudostem of the most developed plant(s) to a minimum of 10 cm above ground level (or to a greater height according to the relative development of the plants to be cut back).

The best time for pruning is the moment when the plants have produced the fifth leaf, which in warm and temperate climates is about 1 to 1.5 months after the appearance of the first leaf. This principle is based on the fact that the first twelve leaves produced have no effect on growth and production factors (Belalcázar *et al.*, 1990).

Fertilization: This should be undertaken after preliminary soil analysis. Experiments on soils in temperate climates have shown that fertilisers can be applied in three stages: 30 % after levelling, 50 % three to four months after planting (at the ten to fifteen leaves stage) and 20 % at the 28 to 32 leaf stage.

Irrigation: This is a fundamental requirement for development, growth and productivity of the plant. In the high density system, plants must have sufficient water for their needs. Therefore, in zones where there may be rainfall deficiencies (levels below 1 800 mm per annum), it is necessary to consider installing an irrigation system to meet the needs of the plantation during periods of drought.

Sanitary controls: For the control of yellow Sigatoka (*Mycosphaerella musicola*) in coffee-producing zones, it is advisable to practise monthly defoliation of dead leaves, broken green leaves hanging down the pseudostem, and leaves with necrotic lesions covering more than a third of the surface (Merchán and Belalcázar, 1990). High density fields show a lesser incidence of the disease, which agrees with the findings of Israeli and Nameri (1967) and of Marcelino and Quintero (1987) in their studies of black Sigatoka (*M. fijiensis*) on banana and plantain. This factor could be related to the increase in length of the pathogen's life cycle caused by environmental modifications, such as light and temperature, within the plantation.

Figure 4: "Leveling by cutting back" consisting of cutting back the most developed plant(s).

Advantages of the system: The adoption of the high density system described above constitutes a profitable option for the farmer as it offers the following advantages:

1) Production increases of 125 to 224 %, according to the density of the population, and even greater when compared with traditional populations of 1 000 plant per hectare.
2) Greater ease of plantation planning in order to harvest at different times of the year and thus get a better market price.
3) Optimal land use, since plants hitherto spread over 3 to 5 ha now take up 1 ha only.
4) High production of good quality corms after harvesting, which reduces the cost of this factor for subsequent plantings.
5) Use of low weight corms (0.5 -1 kilos), which brings about a reduction in installation costs between 60 and 21 % respectively (see Table 2).
6) Rational farming management from the point of view of environmental sustainability and conservation, by savings in the use of products for controlling pests, diseases and weeds. The use of fungicides for controlling yellow Sigatoka and black Sigatoka is considerably reduced.
7) The cost of weed control diminishes with the increase of population density, by 66.7 % and 72 % respectively for densities of 3 332 and 5 000 plants per hectare, when compared with a density of 1 666 plants per hectare.

Economic efficiency

Comparison of the rates of return on the investment (RRI) (see Table 3) shows that, for farmers who have to buy land, the best choice is a density of 5 000 plants per hectare, which produces an effective quarterly return of 4.85 % for the duration of the project. On the other hand, for farmers who already own the land, the optimal density would be 3 332 per hectare, with returns of 21.72 %.

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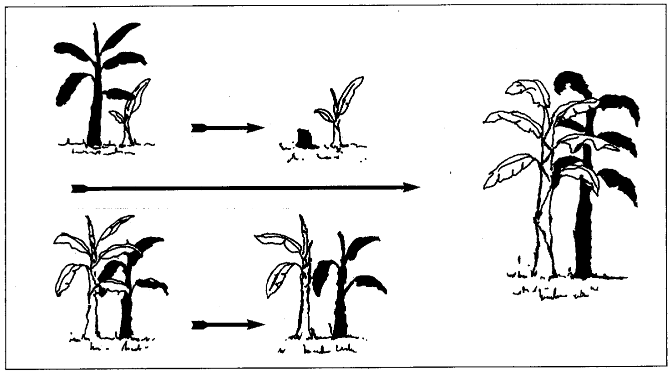

Figure 5a: *"Levelling by pruning" consisting of pruning the plant by partial elimination of the foliage.*

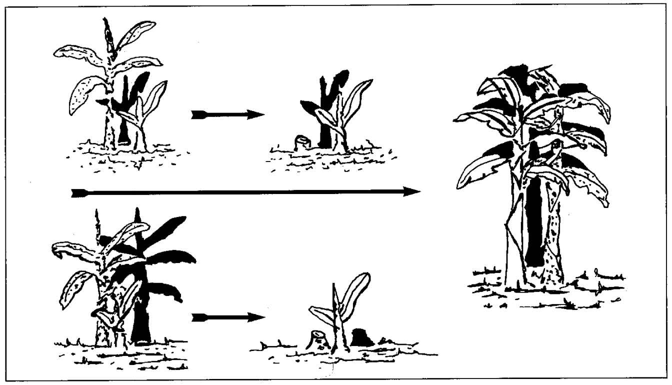

Figure 5b: *"Levelling by cutting back".*

Table 2: *Costs of management based on corm size up to the time of planting / Calculations based on 1 600 corms/ha.*

Planting Material Height of sucker(m)	Weight of corm (kg)	Number of man days	Total cost ($)	Cost in relation to control (%)	Savings in relation to control (%)	Savings in pesos
0.25	0.66	9.5	11 395	39.8	60.2	17 193
0.50	1.00	10.2	12 195	42.6	57.4	16 393
0.75	1.66	10.8	12 994	45.4	54.6	15 594
1.00	2.13	13.8	16 593	58.0	42.0	11 995
1.25	2.54	14.8	17 792	62.2	37.8	10 796
1 leaf stage	3.25	16.2	19 392	67.8	32.2	9 196
5 leaf stage	4.13	18.5	22 391	78.3	21.7	6 197
10 leaf stage (control)	6.92	23.8	28 588	100.0		

Source: ICA Centro Satélite de Plátano y Banano C.I. El Agrado. Comité Cafetero del Quindio and IDRC. Canada. 1990.

Table 3: *Comparison of quarterly rates of return for three densities of planting. Plantain farming. El Cortijo farm. Quimbaya.1990.*

Density of population (plants/ha)	Duration of the project (months)	Rates of return on the investment (RRI) %	
		Including the value of land	Excluding the value of land
1 666	15	2.4	17.9
3 332	18	4.2	21.7
5 000	21	4.9	20.8