Evaluation of Young Fruit Tree Performance in Hillside Trials in Trinidad and Tobago

Laura B. Roberts-Nkrumah
Department of Food Production
Faculty of Agriculture and Natural Sciences
University of the West Indies
St. Augustine Campus
Trinidad and Tobago

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Abstract

This study was based on on-farm trials that were established with small farmers in the Maracas/St. Joseph Watershed in Trinidad and Tobago to evaluate the potential of fruit trees to improve the sustainability of crop production on their hill-side plots. An evaluation of the performance of 3 to 3.5-year old trees was conducted using quantitative methods on four farmers' holdings and a qualitative approach with two farmers. All farmers planted mango (*Mangifera indica* L.) and three also grew at least one of the following species, pomme cythere (*Spondias dulcis* Forst.), sapodilla (*Manilkara zapota* van Royen), carambola (*Averrhoa carambola* L.) and sour cherry (*Phyllanthus acidus* Skeels). The study examined the level of congruence between the farmers' and the researcher's evaluation, the criteria used and the factors identified as affecting tree performance. There was general agreement on the evaluation and the farmers explained the environmental, management and socio-economic context in which production occurred. Income was the major factor affecting tree management but this was also related to labour, gender and health status.

INTRODUCTION

It is widely recognised that tree crop production on hillsides can minimise land degradation by improving soil chemical and physical conditions including moisture content, and by protecting against erosion and loss of organic matter (Young, 1989). Accordingly, several agroforestry projects, utilising fruit tree species because of their income-generating potential, have been established on hillside areas in the Caribbean, including the Maracas/St. Joseph Watershed in the Northern Range of Trinidad and Tobago. Roberts-Nkrumah (1999) pointed out the lack of information on whether these benefits were achieved and the relevance of tree survival and early growth performance.

This study was based on the University of the West Indies/Inter-American Development Bank Tree Crop Project that began in 1996 with the aim to develop sustainable tree-crop based production systems for high rainfall, hillside locations in the Caribbean. Participatory research activities are being conducted with a group of small farmers in the Maracas/St. Joseph Watershed through on-farm trials to assess the economic and environmental benefits of treecrop-based systems.

The objectives of the study were:

- to evaluate the survival and growth of young trees using both quantitative and quail-tative data to obtain both descriptions and explanations of performance;
- to identify the level of congruency between the farmers' and the researcher's evaluation and identification of factors affecting tree performance.

MATERIALS AND METHODS

The study was conducted on trees established between September 1997 and February, 1998 on four farmers' holdings which ranged from 0.31 to 0.61 ha with slopes of 22^0 to 30^0. The farmers differed in several characteristics - one farmer was a land

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owner, the others were squatters; only one farmer depended entirely on the farm for his livelihood; two farmers lived on-farm; one farmer was female. They also chose to grow fruit crops for different reasons, either for fresh fruit sale or for processing.

The farmers selected to grow the following fruit crop species:
Farmer A – mango cv. Graham (*Mangifera indica* L.), sour cherry (*Phyllanthus acidus* Skeels) and carambola (*Averrhoa carambola* L.).
Farmer B – mango cv. Starch and pomme cythere (*Spondias dulcis* Forst.)
Farmer C – mango cv. Starch and sapodilla (Manilkara zapota van Royen)
Farmer D – mango cv. Starch.

Data Collection and Analysis

1. **The Quantitative Approach.** Data on tree survival, tree height, canopy depth, mean canopy width and stem girth were collected and observations made on tree appearance and pest and disease incidence up to March 2001. Descriptive statistics were used to analyse the performance of each species on each farm and analysis of variance was used to compare the performance of the mango trees among farms. The statistical software was NCSS 2001.
2. **The Qualitative Approach.** This was participant-oriented because it sought the views of farmers who were participating in the on-farm trials. Two farmers were selected using purposive sampling. Both farmers had a full-time presence on the farm, one was female, 58 years old with grown children and the other was male, 40 years old with a young family and their mango trees differed in the level of performance. Semi-structured interviews were held with both farmers in November, 2001. Data, the farmers' words , were recorded using notes and a tape recorder, after obtaining their consent to record and publish. The data were analysed by coding the responses according to major categories for the evaluation. Subcategories were created for the criteria used for evaluation and for the factors influencing tree performance.

RESULTS

Quantitative Data

1. Tree Survival. Survival rates varied among species and among farms. Survival rates were fair to excellent for mango, very good for pomme cythere and good for sour cherry and sapodilla. All the carambola plants died. Trees in the trials with Farmers B and D had the highest rates of tree survival (Table 1).

Plant deaths were due to attacks by leaf-cutting ants (*Atta* sp.), accidental destruction during weed control operations, fire and drought.

2. Tree Performance. In terms of vegetative growth, the performance of all species was highly variable as indicated by all growth parameters (Tables 2, 3 and 4).

Mango. Some mango trees were able to attain very good growth for their age especially on Farmers B's and C's holdings. Very highly significantly ($P<0.000$) lower values were obtained for all growth parameters on Farmers A's and D's plots (Table 2). Most trees have flowered or borne fruit.

Pomme cythere. These were the largest trees. Most achieved a typical size for their age (Table 4). All trees have borne fruit.

Sour cherry. This species generally achieved a satisfactory size of its age and trees were taller and had greater canopy depth than the mango on the same farm (Table 4). Some trees have borne fruit several times while others have never flowered.

Sapodilla. These trees were generally the smallest among the fruit crops. Only 33% achieved a satisfactory size for their age (Table 4).

All farmers, except Farmer B, infrequently controlled weeds resulting in a generally high level of infestation, no nutrients were applied and attack by leaf-cutting ants was evident. During the dry season, the trees on most farms were subjected to drought and some of Farmer A' trees were damaged by fire.

Qualitative Data

1. Tree Performance. Both farmers were quite pleased with the performance of their trees. Among the criteria that they used were:

Growth and Fruit Production. Farmer B: ..the majority of trees, they are well developed. I was able to get a good bearing from them last year for the first time.

The Level of Inputs. Farmer A: Their progress good for not using fertilizer.

Personal Benefits. Farmer A: At my age there is not much to live for. This project gives me something to look forward to.

Factors Influencing Tree Performance Positively. Use of soil conservation measures: Farmer B: It (use of contour drains) make so much of a good difference, because even when you plant your crop…it tends to keep your soil moist for a few days after the rains. Crop protection: Farmer B: I like if I clean the fruit (trees), to clean it properly.. I like to have it (the weeds) on a low level. Possible benefits from insects: Farmer A: I don't know, but the trees the bachacs (leaf cutting ants) eat really looking good and I never use pesticide on them.

Factors Influencing Tree Performance Negatively. Soil acidity: Farmer A: Maybe it's the acidness that has some of the trees small. Low soil nutrient status: Farmer B: …it (the soil) must be lose some of its nutrients after the length of time planting…so it might require some fertiliser to some extent…probably that could be one of the reason too. Pests and diseases: Farmer A: They (the trees) have termites too. I don't know what we could use for that. They say the peppermint oil with boric powder and bleach. Fire: Farmer A: I don't know if it's the fire. Some (trees) scorch and stay short.

Socio-Economic Factors Affecting Tree Performance. Access to labour and quality of labour: Farmer A: Labour hard to get, all the farmers who could help busy and the young ones lazy. They want the money but they not doing the work. Farmer B: Some people work nasty; they throw grass on top grass. Health: Farmer A: (She is diabetic and does not see well) I do the fruit (trees), but I can't do much. Gender: Farmer A: The men so smart. They know when you have the money. If the work will take two days they make it take four. They smart. They have more brains than me. Income: Farmer A, who derived little income from the farm, except for the seasonal sale of pigeon peas, said about her need for money: I don't need any big set of money you know, Doc'. Farmer B, who planted short term crops and reported selling up to $60,000 annually in peppers only, operated on a more commercial scale: I sell on a wholesale basis. Praedial larceny: Farmer A, whose farm is located near to the road, said: …plenty praedial larceny. The neighbours take …who didn't take, forget to take. Farmer B, whose farm is located in about two miles from the closest road, compared his experience with praedial larceny to those of farmers in more accessible areas: I don't have much problem, but those farmers outside have real pressure.

DISCUSSION

The results of this study showed that the growth of the surviving trees was generally satisfactory. There were several trees of each species that demonstrated the potential of these species to perform comparably in this environment. There is concern , however, for the declining rate of tree survival with Farmers A and C. This concern arises from the importance of canopy cover to alleviate the problems associated with run-off and low organic matter content. When the mango trees were 18 months old, with higher survival rates, the canopy cover was less than 1% of the soil surface (Roberts-Nkrumah, 1999). Even with more than 100% increase in all growth parameters since that first evaluation, it was unlikely that surface cover had increased markedly with fewer surviving trees. Therefore, the expectation that the trees would eventually provide at least 30% surface cover might take considerably longer to achieve than previously expected. Canopy cover was especially important where, as on three of these farms, intercropping with short-term crops was seasonal.

Consistent with the participatory research paradigm used in these on-farm trials this study revealed that both the farmers and the researcher use the same evaluation

criterion of tree growth. Whereas the researcher sought different measures of growth, the farmers' evaluation considered overall tree size and was more comprehensive because they included fruit production and related overall performance to the relative use of inputs such as fertiliser. Another evaluation criterion the farmers used was the overall worth of the trees to them. Both farmers valued their potential environmental benefits. For Farmer B, they would increase the productivity of the land. For Farmer A, the trees were compatible with her preference for organic farming and she also had the personal value of just seeing the trees grow. Within this context, both farmers were more patient than the researcher about the achievement of the benefits of planting trees.

The farmers and the researcher also largely agreed on the environmental and cultural factors influencing tree performance. Soil moisture availability and satisfactory weed control were beneficial influences on Farm B. Soil acidity and low nutrient status were common environmental problems on all farms, whereas, fire, seasonal drought and pest attack were farm-specific. One factor that was common to all farmers in this study was the low level of inputs to the trees, except for Farmer B who differed in the level of crop protection and to some extent, nutrition provided. This low input management approach to tree crop production is common among small farmers in the Caribbean even where the trees generate income (Timyan, 1996).

The factor that emerged as the major determinant of tree crop performance was income. Where the farm did not generate the required level of household income, farmers typically sought off-farm employment, which is consistent with earlier findings (Ali, 1885; Roberts-Nkrumah et al. 1999). Even where the farm was the sole source of income, as with Farmer B, short-term crops provided a better cash flow and total annual income. This income from short-term crops encouraged Farmer B in full-time farming and facilitated better crop protection for the trees but not improved crop nutrition because the trees were not yet providing a level of income to justify such inputs.

Farmer A provided further insights into issues that affect income generation from the farm. Apart from her own outlook on her financial requirements, her health limited her ability to provide her own labour for tree maintenance or for short-term cash crop production and income generation. Without adequate income, she could not easily procure labour. There was also the issue of gender, in that, unlike Farmer B, she was at a disadvantage in her negotiations for labour and possibly crop security.

CONCLUSION

The performance of the fruit trees in the on-farm trials was generally good as evaluated both by farmers and the researcher. The quantitative data were useful for comparison with previous measurements of survival and growth and for obtaining an early indication that tree death and slow growth were likely to reduce or delay the benefits from the trees. The qualitative data explained the environmental, crop management and socio-economic context within which tree crop performance took place and should, therefore, be assessed. Since a major factor determining performance appeared to be the adequacy of income-generation by tree crops to justify inputs by farmers, it might be necessary for on-farm research projects of this nature to make direct intervention, with the farmers' approval, for improved soil fertility during early tree growth to better secure long-term sustainability.

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Tables

Table 1. Survival rates of fruit trees in four on-farm trials in the Maracas/St. Joseph Watershed, Trinidad and Tobago.

Farmer	Species	No. Established	No. Surviving	Survival Rate (%)
A	Mango	35	22	63
	Sour Cherry	36	25	69
	Carambola	36	0	0
B	Mango	26	26	100
	Pomme Cythere	26	22	85
C	Mango	58	25	43
	Sapodilla	38	27	71
D	Mango	28	27	96

Table 2. Comparison of mango tree growth in four on-farm trials in the Maracas/St. Joseph Watershed, Trinidad and Tobago.

Farmer	N	Plant Height (m)	Canopy Depth (m)	Canopy Width (m)	Stem Girth (m)
A	22	1.78b	1.42b	1.48b	4.84b
B	26	2.56a	2.07a	2.06a	5.60b
C	25	2.71a	2.18a	2.38a	8.12a
D	27	1.88b	1.38b	1.22b	3.20b

Values followed by the same letter in the same column are not significantly ($P<0.05$) different.

Table 3. Growth of mango trees in four on-farm trials in the Maracas/St. Joseph Watershed, Trinidad and Tobago.

Farmer	Species	N	Plant Height (m)	Canopy Depth (m)	Canopy Width (m)	Stem Girth (m)
A	Mango	22	1.78 (.11)	1.42 (.11)	1.48 (.08)	4.84 (.43)
		Range	0.8 – 2.78	0.4 – 2.34	0.51 – 2.05	1.5 – 10.5
B	Mango	26	2.56 (.14)	2.07 (.14)	2.06 (.17)	5.60 (.49)
		Range	1.0 – 3.8	0.67 – 3.37	0.63 – 4.0	1.5 – 12
C	Mango	25	2.71 (.16)	2.17 (.20)	2.38 (.18)	8.12 (.48)
		Range	1.4 – 5.0	0.76 – 4.50	0.7 – 3.85	2.75 – 12.25
D	Mango	27	1.88 (.11)	1.38 (.98)	1.22 (.79)	3.2 (.21)
		Range	0.7 – 2.65	0.35 – 2.16	0.45 – 1.89	1.5 – 5.5

Table 4. Growth of fruit trees in four on-farm trials in the Maracas/St. Joseph Watershed, Trinidad and Tobago.

Farmer	Species	N	Plant Height (m)	Canopy Depth (m)	Canopy Width (m)	Stem Girth (m)
A	Sour Cherry	25	2.16 (.11)	1.80 (.12)	1.20 (.10)	4.4 (0.34)
		Range	1.25 – 3.60	0.57 – 3.20	0.50 – 2.2	2.0 – 9.25
B	Pomme Cythere	22	4.83 (.43)	3.76 (.42)	3.34 (.31)	12.08 (0.92)
		Range	1.3 – 9.0	1.2 – 6.92	0.40 – 5.75	2.0 – 18.75
C	Sapodilla	27	1.77 (.13)	1.37 (.12)	1.07 (.08)	2.27 (0.16)
		Range	0.6 – 3.0	0.28 – 2.37	.48 – 1.96	1 – 4.5