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HILLSIDE AGRICULTURE

SUB-PROJECT

(HASP)

On-Farm Mango (*Mangifera indica* L.) Cultivar Trials
for Small Hillside farmers
Between 230 and 300 meters Elevation
In the Parish of St. Catherine

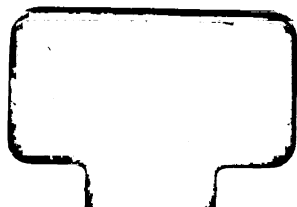
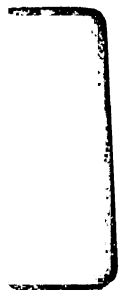
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Jamaica, W.I.

December 1994

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Abstract of Research Presented to the Hillside Agriculture Project (HAP) in Partial Fulfillment of Requirements for the Hillside Agriculture Sub-Project (HASP).

ON-FARM MANGO (*Mangifera indica* L.) CULTIVAR TRIALS FOR SMALL HILLSIDE FARMERS BETWEEN 230 AND 300 METERS ELEVATION IN THE PARISH OF ST. CATHERINE, JAMAICA

By

IICA-CIITA

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November, 1993

This report provides a description and analysis of investigations of five commercial mango cultivars (*Mangifera indica* L. cv.'s *Hayden*, *Tommy Atkins*, *Nelson*, *Keitt* and *Kent*), out-planted in November, 1991, between 230 and 300 meters elevation, grown under local farm conditions in two previously untested regions (Kendal and Newport) in the Parish of St. Catherine, Jamaica. A randomized complete block design was used to control variability in field conditions. Plants at both sites received 113 g of 8-21-32 fertilizer and 1.8 kg of bioganic fertilizer mixed into the soil at planting. At Kendal each plant received 113 g of 8-21-32 twice per year at the onset of the rainy season. The amount of fertilizer was increased to 226 g per tree in May, 1993.

Information was collected on stem diameter and height. Other data intended to be gathered included time to flowering and production. Analysis of variance was used to determine the difference in diameter. Analysis of residual maximum likelihood enabled the data from both sites to be combined and the cultivars and environmental interaction to be estimated.

The three cultivars at the Kendal site which received continuous applications of fertilizer for one year responded with *Hayden* growing the largest diameter followed by *Tommy Atkins* and *Nelson*. The three cultivars at the unfertilized Newport site responded with *Kent* growing the largest diameter followed by *Keitt* and then *Tommy Atkins*. The three cultivars at the Kendal site grew significantly larger diameters than the three cultivars at the Newport site. The different response could possibly be attributed to the different fertilizer regime, sites, or some combination of fertilizer and environmental interaction.

Further research data needs to be collected to determine differences in the time to flowering and production. An increase in the number of trials and cultivars tested would prove germane to determining the potential for growing export quality mangoes in the area.

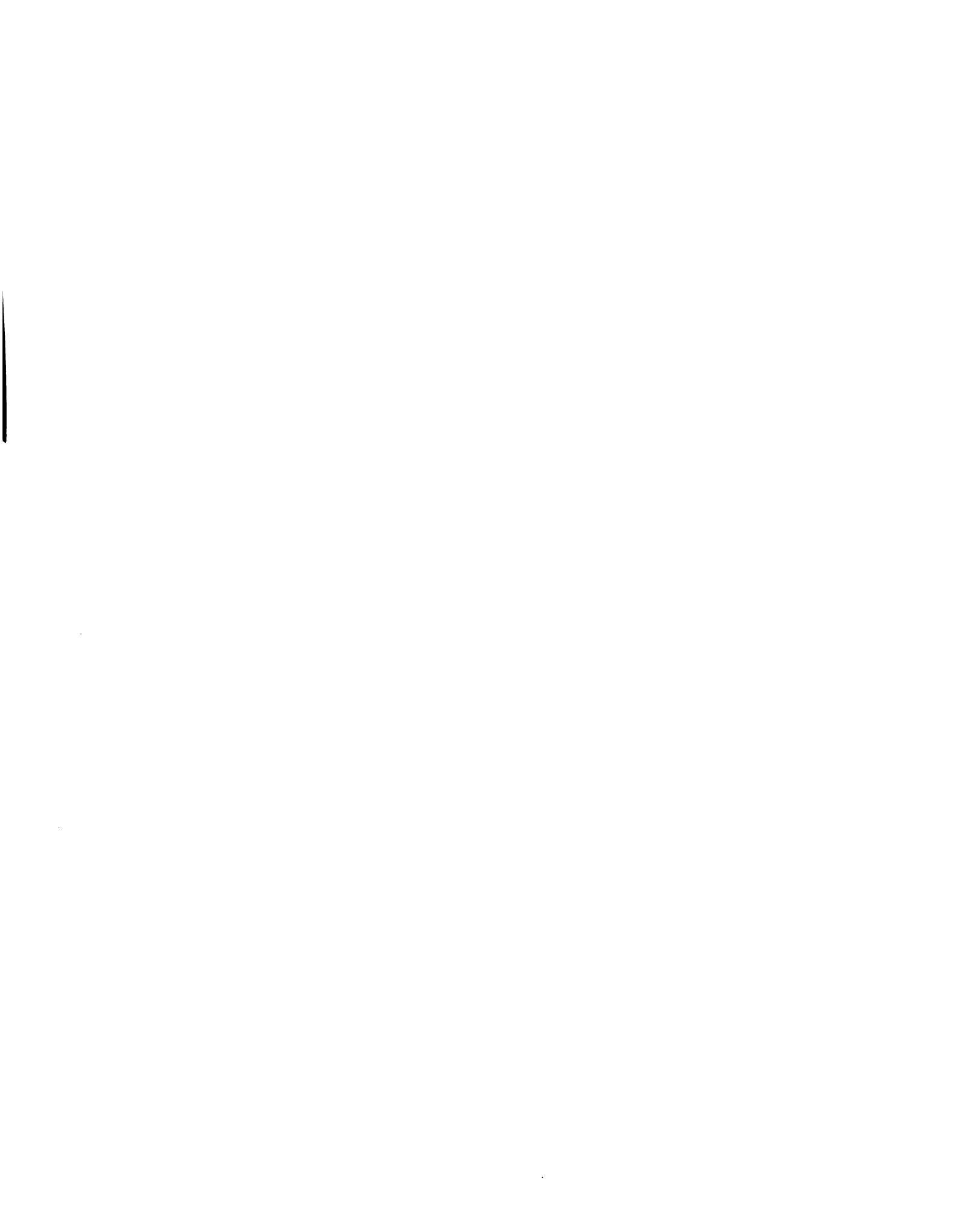


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INTRODUCTION

The Hillside Agriculture Sub-Project (HASP) managed by the Ministry of Agriculture's Research and Development Division (R&DD) and the Inter-American Institute for Cooperation in Agriculture (IICA) was contracted by the Hillside Agriculture Project (HAP) in partnership with the United States Agency for International Development (USAID) to provide support to the HAP. The objective of the Hillside Agriculture Project was to facilitate small hillside farmers to improve the production capabilities of their farming systems, manage soil erosion and fertility, protect the environment and to improve the living standards in farming communities (Suah, 1992). Through the HASP, selected technologies representing potential interventions were compared to local farming practices. The research methodology utilized was part of a Farming System Research and Extension (FSR/E) approach employed by HASP to identify possible solutions to some local farming constraints.

Reason for Mango Cultivar Investigation

A rapid rural appraisal of the project area by the HASP team revealed that farmers had a strong interest in growing export quality mango. However, many farmers felt they had inadequate knowledge of which export quality cultivars would grow and produce in the area and how to cultivate them.

Investigating mango cultivation was attractive to the project personnel because it potentially satisfied several stated objectives of HAP. First, the mango was a relatively fast growing tree (seven to eight meters in 12 to 15 years) which provided soil protection with a dense leaf canopy, ground litter cover, and anchored soil with a combined deep and shallow root system (Purseglove, 1981). Secondly, mango cultivation had a tested history of productive intercropping with banana (*Musa* (AAA Group)), papaya (*Carica papaya* L.), pineapple (*Ananas comosus* (L.) Merr.), annonas (*Annona* sp.), citrus (*Citrus* sp.), avocado (*Persea americana* Mill.), other fruit trees, vegetables, grain crops and root crops (Cambell and Marte, 1993) and was considered to be readily adaptable to the local tradition of intercropping. Finally, mango establishment and maintenance was considered relatively easy, inexpensive and with good potential for economic returns.

Objective

The objective was to test the production of five commercial cultivars of mango, *Mangifera indica* L. cv.'s *Hayden*, *Tommy Atkins*, *Nelson*, *Keitt* and *Kent*, grown on-farm at elevations between 230 to 300 m.

Justification

To provide extension agents, local farmers and researchers with information on the growth and production of the five mango cultivars at elevations and locations previously untested in Jamaica.

METHODOLOGY

Farmer Participant Selection

Farmers were nominated for participation in the research by the Farmers Action Committee Team (FACT) in cooperation with HASP agronomist. Selection criteria were that farmers 1) had to be active members of the local FACT organization, 2) had to have land on a slope of 20% or greater, 3) had to have a homogeneous area large enough to accommodate the experiment, 4) were willing to conform to research standards as pertained to spacing, weeding, fertilization, and other cultural practices, and 5) had to be willing to allow other farmers and researchers access to the research/demonstration plot for training purposes.

Research Design

The experiment consisted of two sites in St. Catherine between 230 and 300 m elevation. A randomized complete block design was used to control variability in out-planting conditions. Blocks were arranged along slope contours. Plants were spaced at six meter in a square design and did not compensate for existing trees. Each block was divided into three plots. Each plot was planted in a single cultivar consisting of nine trees at the Kendal site and six trees at the Newport site. Plants at both sites received 113 g of 8-21-32 fertilizer and 1.8 kg of bioganic fertilizer mixed into the soil at planting. In addition the Kendal site received 113 g of 8-21-32 twice per year at the onset of the rainy season with the amount of fertilizer being increased to 226 g per tree in May, 1993. The trees in Newport were subjected to the traditional method of mango management which differed in that there were no fertilizer applications after the initial

planting. The cultivars of *Mangifera indica* L. tested under these conditions were:

- A) Tommy Atkins
- B) Hayden
- C) Nelson
- D) Keitt
- E) Kent

On each site three cultivar of mangos were tested. At the Kendal site Tommy Atkins, Hayden, and Nelson were tested while at the Newport site Tommy Atkins, Keitt, and Kent were tested (Appendix A).

Planting Material

The planting stock of mango cultivars Keitt and Kent were produced at Ewarton Nursery, St. Catherine. The rootstock was the local mango variety known as 'stringy' mango. The kernel was removed from the stone and direct seeded into cylindrical polyethylene grow-bags measuring 33 x 15 cm filled with a potting medium consisting of one part sand and two parts soil (soil type unknown). The grow-bags were packed under 75% shade cloth and irrigated as needed. After three to four weeks 18-9-18 fertilizer was applied at a rate of 113 g per plant. If a fungus developed on the plants the entire stock was sprayed with a slurry of wettable sulphur at a rate of 1.4 kg per 94 liters of water mixed with Kocide at 0.45 kg per 94 liters of water (it was unknown if the plant stock was sprayed). At approximately three months the rootstock was top-grafted and three months after the plants were sold.

The Tommy Atkins, Hayden, and Nelson planting material were produced at Sutton's Nursery in Clarendon. Ninety percent of the rootstock was produced from the local mango variety 'stringy' mango, while 5% was gathered from the mango variety #11, and 5% came from other varieties. The kernel was removed from the stone and direct seeded into cylindrical polyethylene grow-bags measuring 33 x 15 cm filled with a potting medium consisting of three parts of top-soil (soil type unknown) to one part biogonic/chicken manure and fertilizer (composition unknown). The grow bags were packed under 75% shade cloth and irrigated as needed. If a fungus developed on the plants the entire stock was sprayed with undisclosed treatment. At approximately three months the rootstock was top-grafted with budwood grown in a mother orchard on the property. If a desired variety was absent then workers traveled throughout Clarendon to find the appropriate budwood. Three months after top-grafting the plants were sold.

Out-planting

In November, 1991, at the onset of the rainy season the treatments were out-planted at both sites. A digging fork was used to prepare holes approximately 60 cm square and 30 to 50 cm deep. Bioganic fertilizer (1.8 kg) was mixed in the hole. Polyethene bags were removed and the outer roots manually disturbed. Seedlings were planted with the root collar at soil level. After planting, 113 g of 8-21-32 was applied in a band around the leaf-drip area.

Mortality

When mortality occurred plants were replaced with the same cultivar and subjected to the same management regime as the previous plant. Only one seedling died.

Data Procurement

Measurements concerning stem diameter and height were collected at planting and thereafter at three month intervals (Appendix B). A line was painted at the base of each mango tree to facilitate consistency in the measurements.

Time to flowering and yield were measurements of interest. Month of flowering and amount (low, medium, high) were to be recorded. Yield was to be measured by number and kg of fruits produced per tree. As of November, 1993, the trial plants had not flowered.

Analysis

Analysis of variance (ANOVA) was used to determine the difference in diameter between cultivars at sites. Analysis using residual maximum likelihood enabled the data from the two sites to be combined and the cultivars and environmental interaction to be estimated. The mango cultivar Tommy Atkins served as the common link between cultivars and sites.

The nature of on-farm experimentation should be considered when reviewing these results. On-farm trials often do not control the environment to the extent of research stations and therefore, levels of significance may need adjustment. Instead of using formal statistical significance of $p = 0.01$ or 0.05 , a range of significance from $p = 0.01$ to 0.20 should be considered. Furthermore, where significant differences were indicated between treatments, care must be employed not to propose absolute recommendations on results from only two sites.

RESULTS

Site Characteristics

The Kendal site was located on a 0.4 ha, 20% sloping, east facing hillside at the approximate latitude 18° 12' N and longitude 76° 56' W. Prior to the establishment of the experiment, the site was used continually to cultivate mixed crops including sugar cane (*Saccharum officinarum* L.), plantain (*Musa* (Group AAB)), banana, scotch bonnet pepper (*Capsicum frutescens* L.), red pea (*Phaseolus vulgaris* local cv. red pea), tomato (*Lycopersicon lycopersicum* (L.) Karst.), and sweet potato (*Ipomoea batatas* (L.) Lam.). Livestock manure was occasionally applied to some of the cash crops. Agricultural chemicals such as herbicides, insecticides and fungicides were never applied.

At the time of establishment the field at Kendal was mix cultivated with eating sugarcane, coconut (*Cocos nucifera* var. *Maypan*), avocado, June plum, banana, pigeon peas (*Cajanus cajan* (L.) Huth), tomato, and red peas. As the cash crops (pigeon peas, tomato, and red peas) were harvested they were not replaced.

The experiment in Newport was located on a 0.3 ha, 35% sloping, east facing hillside site at the approximate latitude 18° 11' N and longitude 76° 57' W. Previous to the mango establishment, sections of the field had been cultivated with gungu pea and pineapple.

At the time of establishment the Newport site was used for cow pasturage. Widely scattered throughout the property were breadfruit (*Artocarpus altilis* (S. Parkinson) Fosberg), coconut and stringy mango. In August, 1993, the field was hand plowed and planted in cash crops of pumpkin (*Cucurbita moschata* (Duch. ex Lam.) Duch. ex Poir.) and red peas.

Climate

Rainfall records for Riversdale, St. Catherine, between 1950-1980 show that 75% of this time rainfall equalled or exceeded 1,552 mm yearly. There were two moist periods, May to June and September to October (Figure 1). There was a dry period between January and March.

The mean minimum and maximum temperatures for Riversdale between 1950 and 1980 indicated that August was the warmest month with a mean maximum daily temperature of 30.9° C. February was the coolest month with a mean minimum daily temperature of 18.3° C (Figure 2).

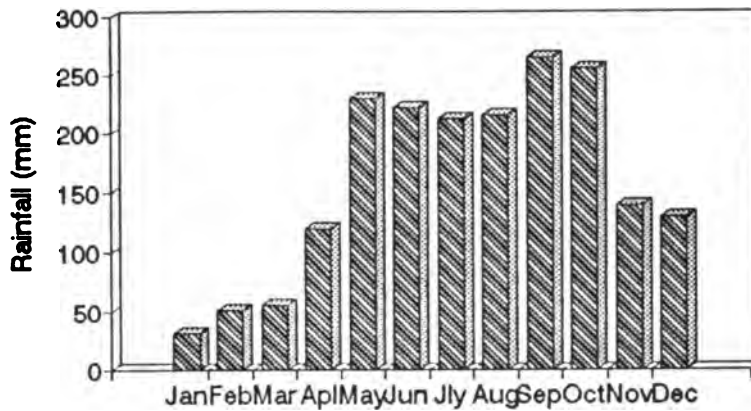


Figure 1. Records for Riversdale, St. Catherine, between 1950-1980 expressed as mm\mo reached or exceeded 75% of the years. There were two wetter periods, May to June and September to October while January to March was the dry period.

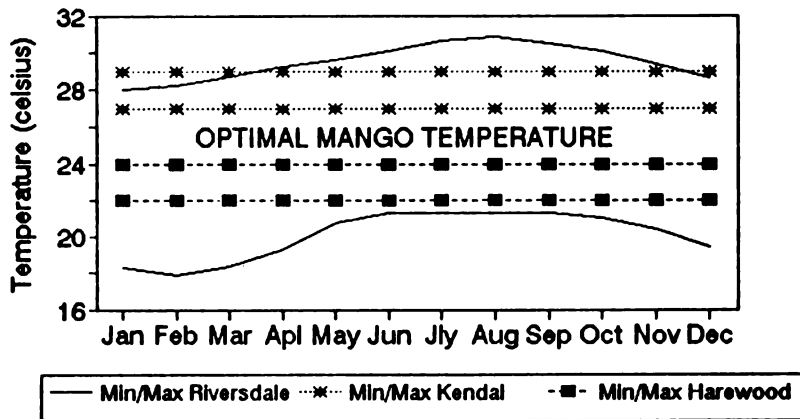


Figure 2. Mean minimum and maximum (min/max) temperatures for Riversdale between 1950 and 1980 compared with the recommended optimal mango temperature range, between 24-27°C (Cambell and Marte, 1993), and the expected min/max temperatures in Kendal and Newport (MINAG/IICA, 1992). For Riversdale, August was the warmest month with a mean maximum daily temperature of 30.9°C and February was the coolest month with a mean minimum daily temperature of 18.3 °C. The mean min/max range for Kendal was 27-29°C while the mean min/max range for Newport was 22-24°C.

Selected characteristics considered optimal for mango cultivation were compared to each site (Table 1). The table indicated that excessive rainfall may limit mango production. Cambell and Marte (1993) reported that amount and distribution of rainfall were important in mango production and that areas with a dry period prior to flowering having an annual rainfall of 500 to 1000 mm were best.

Table 1. Optimal site conditions recommended by Cambell and Marte (1993), and Purseglove (1987) for growing mango compared to the site conditions of Newport and Kendal, St. Catherine.

Site Condition	Altitude (m)	Rainfall (mm)	Min/Max Mean Temp. (°C)	pH (H ₂ O)	Soil
Optimal for mango	1-500	500-1000	24-27	6-7	deep, sandy loam
Newport	243	1552	22-24	6	Newport silty clay loam
Kendal	259	1552	27-29	7	Flint River sandy loam

Stem Diameter

The ANOVA for diameter differences between treatments at the fertilized site in Kendal showed a significant difference eight months after planting ($p = 0.12$). The mango variety Hayden had the largest diameter (38.4 mm) followed by Tommy Atkins (35.4 mm) with Nelson having the smallest diameter (34.2 mm). This trend continued in November, 1993, approximately one year after planting. The mango variety Hayden had the largest diameter (46.6 mm) followed by Tommy Atkins (42.6 mm) with Nelson having the smallest diameter (40.0 mm) (Figure 3).

The analysis for the rate of change between treatments at the fertilized Kendal site seemed to indicate that diameter was increasing faster in Hayden (18.6 mm) than either the Tommy Atkins (15.8 mm) or Nelson (15.1) ($p = 0.30$) (Figure 4).

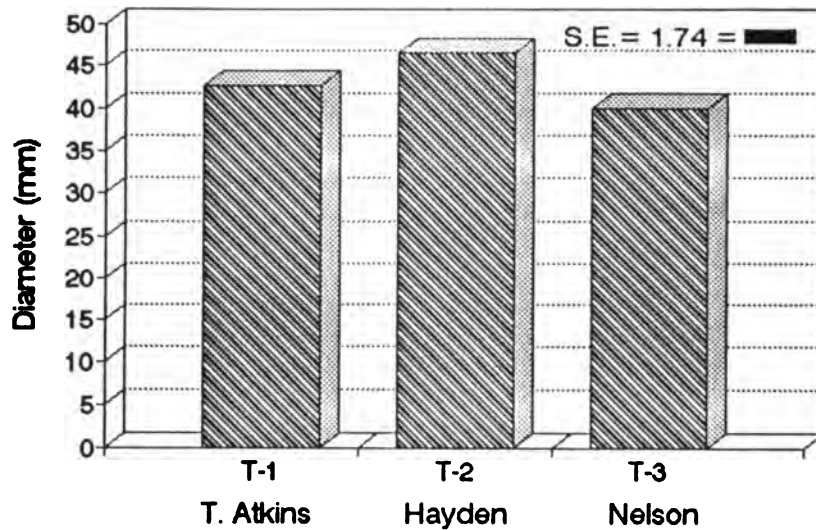


Figure 3. The ANOVA for the diameter differences between three mango cultivars receiving fertilizer indicated a significant difference one year after planting ($p = 0.05$). Hayden exhibited the larger diameter (46.6 mm) with Tommy Atkins having the next largest (42.6 mm) and Nelson having the smallest diameter (40.0 mm).

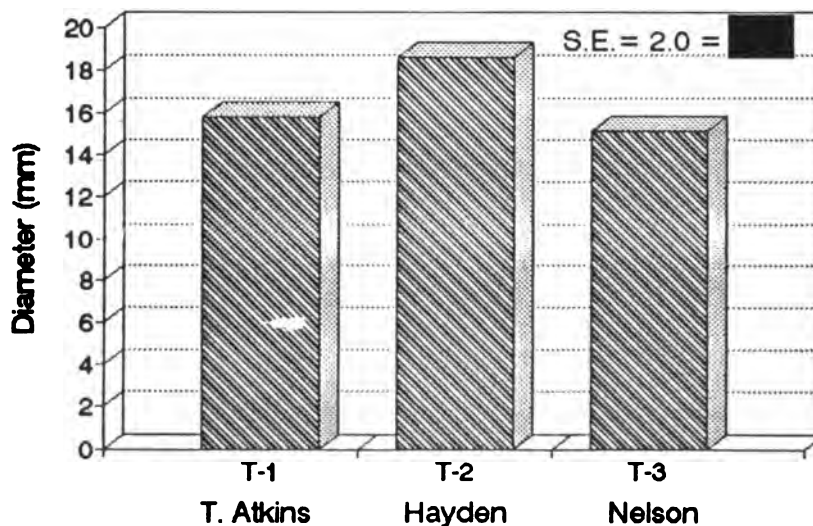


Figure 4. The rate of diameter change for the treatments at the fertilized site in Kendal indicated that the diameter was increasing faster with Hayden (18.6 mm). The varieties Tommy Atkins and Nelson were changing at approximately the same rate (15.8 and 15.1 mm, respectively) ($p = 0.30$).

The ANOVA for diameter differences between treatments at the unfertilized site in Newport showed a significant difference nine months after planting ($p = 0.13$). The mango variety Kent had the largest diameter (24.3 mm) followed by Keitt (22.1 mm) with Tommy Atkins having the smallest diameter (20.3 mm). This trend continued till November, 1993, one year after planting. The mango variety Kent had the largest diameter (27.8 mm) followed by Keitt (25.6 mm) with Tommy Atkins having the smallest diameter (22.5 mm) ($p = 0.13$) (Figure 5).

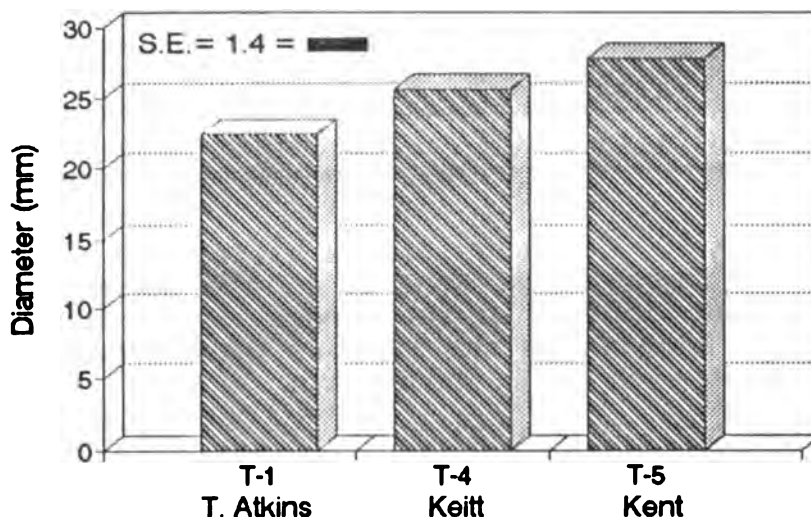


Figure 5. The ANOVA for the diameter differences between three unfertilized mango varieties indicated a significant difference one year after planting ($p = 0.13$). Kent exhibited the larger diameter (27.8 mm) with Keitt having the next largest (25.6 mm) and Nelson having the smallest diameter (22.5 mm).

The analysis for the rate of change between treatments at the unfertilized site in Newport indicated no significant difference between the cultivars. However, the rate of diameter growth of the variety Tommy Atkins (13.4 mm) was less than the varieties Keitt (22.7 mm) or Kent (21.4 cm).

The analysis of residual maximum likelihood was performed on the adjusted diameter means of all the mango cultivars. The analysis adjusted the diameter values for site, block, and site by treatment effects. Between October, 1992, and August, 1993, and between August and November, 1993, there was no significant difference in diameter of the five varieties nor was there a significant cultivar by site interaction. The mean effect of the treatments for November were:

Treatment	1	2	3	4	5
Diameter (mm)	32.87	36.58	32.12	34.55	35.89

The standard error of differences between pairs were:

	1	2	3	4
2	1.52	-	-	-
3	1.52	1.48	-	-
4	1.63	2.10	2.10	-
5	1.63	2.10	2.10	1.64

However, there was a significant difference between sites according to the mean diameter size of the mango plants ($p < 0.001$). The mean diameter of the mangos in November, 1993, in Kendal was 43.41 mm while the Newport plants had a diameter mean of 25.38 mm with a standard error of 1.67 (Figure 6).

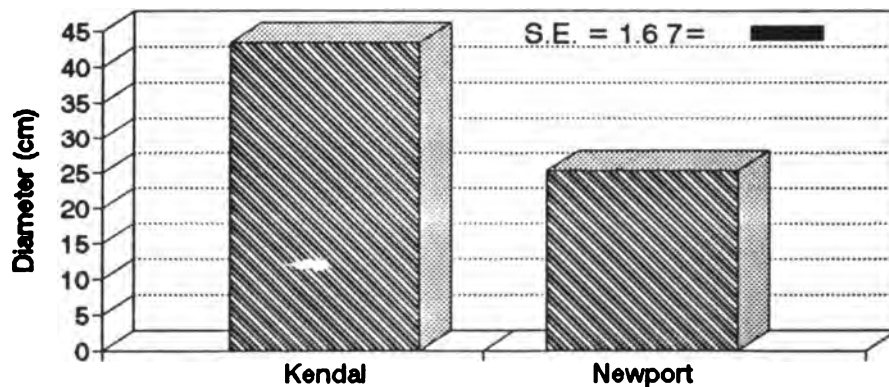


Figure 6. Analysis of residual maximum likelihood between August and November, 1993, showed a significant difference between sites according to the mean mango diameter. The mango plants at Kendal had the larger mean diameter (43.41 mm) compared to the varieties at Newport (25.38 mm).

SUMMARY AND DISCUSSION

The mango cultivars at the Kendal site (Tommy Atkins, Hayden, and Nelson) received continuous applications of fertilizer and responded after one year with Hayden growing the largest diameter (46.6 mm) followed by Tommy Atkins (42.6 mm) and Nelson (40.0 mm). The cultivars at the unfertilized Newport site (Tommy Atkins, Keitt, and Kent) responded with Kent growing the largest diameter (27.8 mm) followed by Keitt (25.6 mm) with Tommy Atkins (22.5 mm). The cultivars at the Kendal site grew significantly larger diameters than the cultivars at the Newport site.

The difference in response between sites could possibly be attributed to the different fertilizer regime, to site differences, or some combination of the two. Site differences at Kendal of potential importance may include the occurrence of Flint River sandy loam with a pH of 7 and a slightly warmer mean temperature.

Speculation based on the general expected response of most plants to early applications of fertilizer leads the researcher to infer that the future response of the mango trees at Kendal may be an increase in flower production, and if successfully pollinated, an increase in the size and amount of fruit compared to the Newport site, after taking into account the expected response of the average expected yield of each cultivar.

Future Research

This research on mango variety trials was begun in 1991. It was scheduled to finish in December, 1993. Because of the short duration of the experiment only preliminary information on early growth could be ascertained. Information on potential production could be speculative only. It was the opinion of all parties involved with the research that the most valuable results have yet to be measured. These include the number of months to flowering, the time of flowering, and the amount of production. Therefore, data germane for determining the value of the cultivars will be forthcoming. The parties involved appealed to the agencies involved to continue the data gathering and analysis for several years.

Other research recommendations include increasing the number and elevation of sites as well as the number of mango cultivars being tested in the area.

APPENDIX A
BLOCK AND PLOT LAYOUT

SITE: Kendal

TREATMENT:

T1= Nelson = white
T2= Hayden = orange
T3= Tom. At. = yellow

N

Block 1, Plot 1 T2	Plot 2 T3	Plot 3 T1
Block 2 T2	T3	T1
Block 3 T2	T1	T3

SITE: Newport

TREATMENT:

T1 = Kent
T2 = Keitt
T3 = Tom. At.

N

Block 1, Plot 1 T2	Plot 2 T1	Plot 3 T3
Block 2 T3	T2	T1

APPENDIX B

MANGO CULTIVAR RESEARCH DATA

FOR DATA ENTRY:

SITE 1 = KENDAL Treatment 1 (T1)=Tommy Atkins, T2=Hayden, T3=Nelson

SITE 2 = HAREWOOD T1=Kent, T2=Kitt, T3=Tommy Atkins

FOR ANALYSIS:

T1=Tommy Atkins, T2=Haden, T3=Nelson, T4=Kent, T5=Keitt

CODES:

* = discrepancy in values

? = unknown value

0 = mortality of plant

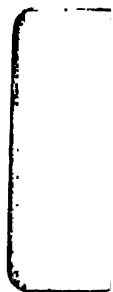
0 followed by value = replanted

Note: the difference in dates
between site 1 and site 2
were cause by lack of records.

SITE	BLOCK	TREAT	LOCATION	DATE:	DATE:	DATE:	DATE:
				day/mo/yr	12/2/92	11/8/93	20/10/93
				DIA.	DIA.	DIA.	DIA.
1	1	1	1	22.5	35	38	
1	1	1	2	*42	35	38.5	
1	1	1	3	22	31.5	37	
1	1	1	4	17	0	0	
1	1	1	5	25	29.5	36.5	
1	1	1	6	23	30	34.5	
1	1	1	7	25	43.5	51	
1	1	1	8	18	26.2	33	
1	1	1	9	32	44	32	
1	1	2	1	24	32.5	42	
1	1	2	2	25	40.5	47.5	
1	1	2	3	37.5	39	48	
1	1	2	4	35	45	55	
1	1	2	5	31	36.6	46	
1	1	2	6	0	0	0	
1	1	2	7	28	33	43	
1	1	2	8	20	24.4	28	
1	1	2	9	24	32.8	39	
1	1	3	1	24	31	38	
1	1	3	2	22	28	32	
1	1	3	3	24	34	39.5	
1	1	3	4	17	27	33	
1	1	3	5	27	34	38.5	
1	1	3	6	7	0	0	
1	1	3	7	0	49	53	
1	1	3	8	25	32.5	35	
1	1	3	9	23	35.3	43	
1	2	1	1	30	37	49	
1	2	1	2	26.5	32	32	
1	2	1	3	37	48	63	
1	2	1	4	20	28	34.5	
1	2	1	5	28	32.5	43.5	
1	2	1	6	36	47	60.5	
1	2	1	7	0	0	0	

1	2	1	8	0	0	0
1	2	1	9	30	41	62
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1	2	2	2	22	50.5	61
1	2	2	3	23	28.5	37.5
1	2	2	4	20	33.5	41
1	2	2	5	30	47	54.5
1	2	2	6	30	49	61.5
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1	2	3	9	32.5	0	51.5
1	3	1	1	25	37	47.5
1	3	1	2	33	42.5	53
1	3	1	3	25	30.5	32
1	3	1	4	23	33.5	42
1	3	1	5	0	0	0
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1	3	1	7	0	0	0
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1	3	2	9	30	41.5	49
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1	3	3	2	24	29	4
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1	3	3	4	22.5	27.2	31.5
1	3	3	5	27.5	37	41.5
1	3	3	6	22.5	33.5	42
1	3	3	7	27.5	43.5	50.5
1	3	3	8	20	31	34.5
1	3	3	9	33	36	41
				29/9/92	11/8/93	1/11/93
SITE	BLOCK	TREAT	LOCATION	DIA.	DIA.	DIA.
2	1	4	1		18.7	20.8
2	1	4	2	6.1	26.9	30.6
2	1	4	3		22.6	25.4
2	1	4	4		23.7	26.2
2	1	4	5	7	24.2	32
2	1	4	6		21.1	26
2	1	5	1		18	20.7
2	1	5	2	6.2	19.8	17.6

2	1	5	3		26.5	32.8
2	1	5	4		30.1	32.4
2	1	5	5	5.6	28.1	32.6
2	1	5	6		25.9	30.8
2	1	1	1		21.9	24.4
2	1	1	2	4.6	25	27.4
2	1	1	3		15.5	17.6
2	1	1	4		0	0
2	1	1	5	5.4	17.2	19.4
2	1	1	6		18	19.9
2	2	4	1		22.3	24.7
2	2	4	2	6.5	27.2	30.1
2	2	4	3		19.4	18.2
2	2	4	4		0	0
2	2	4	5	5.3	15.9	23
2	2	4	6		22.6	26.4
2	2	5	1		25.2	28.1
2	2	5	2	6.8	23.1	29
2	2	5	3		23	25.8
2	2	5	4		21	24.2
2	2	5	5	7.9	26.2	33
2	2	1	3	*	0	0
2	2	1	4		21.3	23.3
2	2	1	5	5.3	19.2	20.3
2	2	1	6		15.9	18.2



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