Banana Trials: A Potential Niche and Ethnic Market in Georgia

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Annual cropping production (ACP) is a technique used worldwide to target favorable market conditions. This technique has allowed commercial banana production outside the traditional production belt such as South Africa, Thailand, Israel, and China. In 2003 an evaluation of thirty-three cultivars was initiated near Savannah, Georgia to determine their suitability for ornamental, nursery, and ACP for niche/ethnic markets under Georgia weather conditions. In South Georgia and other temperate regions around the world, the pseudostems are normally killed to ground level during most winters. However, excellent plant growth rate, good flowering, and limited commercial fruit production was observed. Identifying one or more cultivars with potential to produce commercial fruits may result in a huge market opportunity, especially because the United States is the largest consumer and net importer of bananas. Despite the erratic fruit production, male flowers, leaves for cooking, and suckers for ornamental purposes have potential to generate significant farm income in this belt. Of the cultivars investigated, 'Musa 1780' (believed to be an 'Orinoco' type), 'Sweet Heart,' 'Dwarf Namwah,' 'Ice Cream,' 'Kandarian,' and 'Belle' cultivars were the most successful, but the growing season was slightly too short. The study was conducted from 2003 to 2006. Data was analyzed using Proc Mixed.

The influx of immigrant populations into the U.S. and agro-tourism have created the need for niche and ethnic markets (Fonsah, Krewer, and Rieger 2004, Fonsah 2004). Several studies have demonstrated that bananas can be cultivated in subtropical regions and marketed locally and internationally (Tang and Liu 1993; Robinson 1993; Lahav et al. 1993; Fonsah and Chidebelu 1995). Taiwan and Thailand still export specialty bananas all over the world, including to the United States.

Bananas are an important source of foreign currency for the governments of producing countries, and the fruit serves multiple purposes for consumers. For instance, it is a staple starch and is also used as a dessert fruit; for beer production, livestock forage, roofing thatch, cooking wraps, and plates; and as a shade tree and medicinal plant (Fonsah and Chidebelu 1995; Stover and Simmons 1987). Thailand and Taiwan have monopolized the sales of bananas overseas, but this source of income has declined somewhat from the 1990s. Ethnic Thai bananas retail for $1.79 per pound compared to an average of $0.48 per pound for the regular Latin American–grown Cavendish variety (Fonsah, Krewer, and Rieger 2005).

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In the southern and coastal districts of Georgia, some mature fruits are produced following mild winters (low temperatures in the mid-20s °F, −3 to −5 °C) if the plants are grown in protected locations with a microclimate. The pseudostem must survive the winter for fruit production. Bananas are often killed to near ground level by winter freezes of −7 to −11 °C (Stover and Simmons 1987; Robinson 1996), but these extreme temperatures seldom occur in the region.

The United States imports over $1.1 billion worth of bananas annually, making it the largest importer in the world. Although bananas are produced in Hawaii and Florida, they are mostly for local markets and consumption. Large exports to Japan were recorded from 1999 to 2001 when 1,760 acres were planted, with production as high as 29 million pounds and farm-gate value of $10.4 million. Florida has recorded ethnic banana farm-gate value of $2.5 million annually in past years (HASS 2001; Fonsah, Krewer, and Rieger 2004).

Since there is a high demand for both ethnic (specialty) and the regular Cavendish varieties of bananas and the United States is a net importer, the development of a cold-tolerant cultivar for fruit production would create a new business venture for the food industry. This study investigated whether a cold-tolerant and short-cycle cultivar could be grown for fruit production using the perennial and ACP (annual cropping production) technique under Georgia weather conditions. Thirty-three different cultivars were used to determine which would be

suitable for fruit production. An additional group of 12 cultivars was planted as large container plants to test the ACP system.

Methods

The experiment was conducted at the University of Georgia Bamboo Farms and Coastal Gardens in Savannah, Georgia, latitude 32.133' N, 81.2'W, elevation 14 meters (45 feet). The environmental conditions and cultural practices were described in Fonsah et al. (2004). Field experimental design was a randomized complete block with five single-plant replications. Plants were set on a raised bed about three feet wide and 12 inches high. The hexagonal planting technique was used, with plant spacing of eight by eight feet. Dolomitic limestone was used to adjust soil pH to 6.5 before planting. Preplant soil nutrient levels were medium for potassium and high for phosphorus, so no preplant fertilizer was applied (Fonsah, Krewer, and Rieger 2004).

Phenological data such as planting-to-shooting time and shooting-to-harvest time were collected. Pomological data such as bunch emergence, bunch quality in terms of overall cosmetic appearance (OCA), bunch size, hand-class, and number of fingers were also collected. The cultivars were grown under replicated and uniform conditions. The combinations of these characteristics were used to determine quality attributes which are required by the market. Banana quality specifications vary from market to market and from country to country. For instance, the European Union (EU) banana quality regulations stipulate under uniformity state that "The contents of each package [box] must be uniform and consist exclusively of bananas of the same origin, variety and/or commercial type and quality." These quality specifications are mandatory to all the main groups, sub-groups, and cultivars of dessert bananas marketed in the European community including those used in this experiment (Fonsah, Krewer, and Rieger 2005; Commission of the European Communities 1994).

The cultural practices adopted and banana cultivars grown have a direct relationship to finger length, diameter, curvature, and quality based on the targeted domestic, regional, or international markets. However, the finger diameter alone is not a necessary and sufficient condition for a premium price. The size, finger length, curvature, and OCA are all important quality specifications needed for marketability, distribution, and premium price. For instance, premium price can be obtained from the French market with an average minimum circumference of 35 mm, a minimum finger length of 17 cm, and an acceptable OCA (Table 1). That would immediately place the fruits in the "Extra" category, commanding a premium price. Category I fruits get the second best price, while Category II gets the lowest price (Fonsah 2003; Fonsah and Chidebelu

Table 1. French Imported Banana Market Quality Regulations and Requirements.

Calibration	Categories Extra	Category I	Category II
Minimum length of fruit	17 cm (6.63 inches)	16 cm (6.24 inches)	15 cm (5.85 inches)
Minimum grade or calibration	34 mm (1.06 inches) for fruits 17-20 cm (6.63-7.8 inches) long	32 mm (1 inch) for fruits 16-20 cm (6.24 – 7.8 inches) long	30 mm (0.94 inch) for fruits 15-17 cm (5.85 -6.63 inches) long
Minimum grade or calibration	35 mm (1.09 inches) for fruits > 20 cm (> 7.8 inches) long	34 mm (1.06 inches) for fruits > 20 cm (>7.8 inches) long	32 mm (1 inch) for fruits > 17 cm (> 6.63 inches)

Source: *La Qualite de la Banane* (1980). Translated by the authors.

1995; *La Qualite de la Banane* 1980).

The United Kingdom mini-pack or small bananas require a finger length of 13–15.5 cm, a calibration (caliper grade) of 37–45 mm, four to eight fingers per cluster, and an acceptable OCA to command a premium price. The market in the United States, on the other hand, does not differentiate prices in terms of grading, finger length, and OCA, as the bananas are sold strictly by weight (Fonsah and Chidebelu 1995).

In commercial plantations around the world, a minimum of six hands per bunch (after dehanding either false +1 in an ideal weather condition or false +2 during a period of extreme rainfall and less sunshine) is accepted for harvesting, packaging, distribution, and marketing. A plantation producing an average of nine hands per bunch (after dehanding false +1 or false +2) is considered a well-managed operation in terms of supply and/or yield (Fonsah et al. 2007; Robinson, Fraser, and Eckstein 1993). Certain markets (e.g., Japan) prefer hand-pack bananas for cultural and religious reasons, so these will obtain a premium price. A combination of four, five, six, or seven hands per 29-pound box can be sold in Japan for $15 during a price slump and up to $20 during peak price periods (Fonsah 2003).

Robinson (1996) showed that finger-length development occurs before, during, and after the bunch emerges, but the fastest growth rate of four mm/day occurs in the first four weeks and slows down thereafter. This finger-growth pattern and age are directly correlated with the quality of marketable fruits. A similar trend is applicable to the bunch weight and hand class if the pulp:peel ratio increases from 0.17–1.82 in 80 days in the tropics with a fresh pulp:peel ratio of 1.0 in 70 days. The pulp:peel ratio is higher in a subtropical environment such as Georgia and varies with the cultivars (Robinson 1996; Stover and Simmons 1987).

The ambient and soil temperatures were taken using a data logger-Model CR7 from Campbell Scientific, Logan, Utah. In the first year, the plants in the experimental plot were fully grown after seven months. All cultural practices recommended for growing quality marketable bananas, such as weed control, fertility application, sucker pruning, and deleafing, were adopted (Fonsah et al. 2004; Robinson 1996; Fonsah and Chidebelu 1995).

In 2003 we used drip irrigation and pine-bark mulch. The combination of drip irrigation and mulching did not work properly because fertilizer was applied manually. During drought periods most of the fertilizer remained on top of the mulch and could not reach the plants for uptake. The combination of mulching and herbicides efficiently controlled weeds and kept the field clean.

In 2004 we changed to a solid-set under-tree irrigation system with sprinklers. This system was more efficient than the drip system in terms of pressure, even water distribution, and dissolving applied fertilizers for plant uptake. Although types and quantity of fertilizer applied per plant were discussed in the experimental design section by Fonsah et al. (2004), Replications One, Two, and Three had a different treatment from Replications Four and Five. Consequently, Replications Four and Five exhibited symptoms of serious potassium deficiency.

In 2005, fertilizer recommendation was increased to 2.4 lbs of 10-10-10 and 0.78 lbs of muriate of potash per plant. Unfortunately, our recommendation was not respected, and only half the dose was applied in April and May. Furthermore, because of a shortage of irrigation pipe, our solid-set irrigations system was dismantled from time to time, thus creating water stress on the banana plants; under normal conditions, banana plants require about 50 mm of water per week for optimum growth performance. Sucker pruning cycles were not respected, either. Only two of the recommended four cycles were done because we wanted to leave enough suckers to sell at the University of Georgia Bamboo Farm and Coastal Gardens Fall Festival.

In 2006, all the operations—fertility, sucker pruning, weed control, deleafing, irrigation, and recommended fertilizer doses—were strictly respected. Data for that year was analyzed with Proc Mixed (SAS 2000).

Results and Discussions

In the first year (2003) only three plants actually produced bunches by 25 weeks after planting. Of those, two were 'Kandarian' cultivars (Fonsah, Krewer, and Rieger 2004). After the first frost in the fall of that year, all the plants had scorched leaves. Low temperature for the winter was −6.6 ^{o}C on December 21, 2003. Surprisingly, many of the plants had pseudostems that survived the winter and showed green leaves on March 18, 2004 but were

killed by a very late frost on March 23 (−1.4 °C). Although some plants survived the severe winter, photosynthesis was inhibited due to the absence of leaves. The fruits produced by plants without leaves were generally of poor marketable quality, inferior OCA, and showed malformed fingers. Normally, frosty weather also delays bunch emergence, harvesting, packaging, and eventually product penetration/distribution into the local market (Fonsah and Chidebelu 1995).

In May 2004, 13 months after planting, the cultivar 'Musa 1780' produced its first bunch. Since three leaves were not enough to carry the bunch to maturity, the bunch was intentionally destroyed using the bell chop technique, which enhanced the translocation of nutrients to the ratoon. The ratoon plant produced another bunch in October of the same year, five months later. Nine other plants followed this trend from a planting that contained five replications in most cases. These were three 'Brazilian,' three 'Musa 1780,' and one each of 'Orinoco,' 'Dwarf Namwah,' and 'Ice Cream' (Fonsah, Krewer, and Rieger 2005; Robinson 1993, 1996; Fonsah and Chidebelu 1995).

In addition, thirty-seven plants produced bunches by November, 2004 (Table 2), compared to three in 2003. The cultivars 'Manzano' and 'Raja Puri' produced bunches in all five replications while 'Musa 1780' and 'Sweet Heart' produced bunches in three replications (Fonsah, Krewer, and Rieger 2005). The number of hands per bunch ranged from three for 'Frank Unknown' to nine for 'Dwarf Namwah.' The heaviest bunch weights were 13.5 lbs for 'Dwarf Namwah,' 13.0 lbs for 'Kummunaba,' 12.0 lbs for 'Musa 1780,' and 9.67 lbs for 'Sweet Heart' (Table 2).

In 2005, a total of forty-five plants produced fruits, out of which fifteen bunches emerged in August (Table 3). Again, the cultivars 'Manzano' and 'Raja Puri' produced bunches in all five replications,

Table 2. Fruit Characteristics of Bunches that Emerged from July to November, 2004.

Cultivar	Hand class/ bunch**	Total fingers/ bunch	Fingers (mean no.)	Bunch weight (lbs)	Age at harvest (weeks)
Brazilian	5.0 ab	51.1 bcd	10.1 a	9.00 a	5.3 bc
Dwf Namwah	8.0 a	140.3 a	17.3 a	13.50 a	5.1 bc
Dwf Orinoco	4.0 b	42.0 cd	10.5 a	4.00 a	2.6 e
Frank Unknown	3.5 b	34.2 d	9.9 a	6.00 a	4.1 d
Goldfinger FHIA 1*	8.5 a	120.0 ab	13.9 a	9.00 a	4.6 cd
Kummunaba	6.0 ab	70.1 abcd	11.5 a	13.00 a	7.3 a
Manzano	8.0 a	109.4 abc	13.7 a	9.00 a	4.6 cd
Musa 1780*	5.0 ab	57.9 bcd	11.5 a	12.00 a	5.4 b
Pace	7.0 ab	91.5 abcd	13.0 a	6.00 a	2.9 e
Raja Puri	7.0 ab	97.2 abcd	13.9 a	8.80 a	5.0 bc
Saba	6.0 ab	98.8 abcd	16.9 a	8.00 a	4.9 bc
Sweet Heart	5.0 ab	78.1 abcd	10.4 a	9.67 a	3.3 e
LSD (0.05)	4.0	74.3	9.1	12.77	0.8

*Fundacion Hondurena de Investigacion Agricola (FHIA) is a banana breeding program created in Honduras in 1959 by United Fruit Company and donated to Honduran government in 1984.

**Hand-class refers to the number of hands on a bunch. A hand that is divided into two or more group of fingers is called a cluster, which is what is sold in a grocery store.

Means with the same letter in a column are not significantly different ($P \geq 0.05$) according to the PDIFF option in PROC MIXED (SAS 2000) with Satterthwaite option on the model statement.

Table 3: Banana Cultivars that Produced Fruits August – December 2005, by Replication.

Rep #1	Rep #1	Rep #3	Rep #4	Rep #5
Sweet Heart	Manzano	Manzano	Manzano	Sweet Heart
Manzano	Sweet Heart	Brazilian	Belle	Manzano
Belle	Gold finger	Gold finger	Gold finger	Kumunaba
Frank Unkown	Belle	Musa1780	Raja Puri	Pace
Musa1780	Pace	Pace	Ice Cream	Musa1780
Ice Cream	FHIA 18	Saba	Dwf Namwah	FHIA 18
Saba	Dwf Orinoco	FHIA 18*	Kandarian	Dwf Orinoco
Dwf Namwah	Dwf Namwah	Kalela	Frank Unknown	Raja Puri
Raja Puri	Raja Puri	Dwf Orinoco		
		Dwf Namwah		
		Raja Puri		

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followed by 'Dwarf Namwah' in four replications. 'Sweet Heart,' 'Belle,' and 'Musa 1780' produced bunches in three replications.

The best results were obtained in 2006, when eighty-three plants produced bunches. Table 4 shows only actual mature fruits that were harvested between August and December 2005 from twenty-eight plants. Fruit maturity in this study is defined as bunches that are ten weeks or older prior to harvesting.

Pomological Characteristics

The number of hands per bunch ranged from zero to ten (Tables 2 and 4). Plants of zero hand-class were either at the peeping or bending stage, thus making it impossible to count the number of hands or fingers because the inflorescence was still intact. As a result, these bunches are not shown in Tables 2 and 4. Hand-class was determined after dehanding false +1. In 2004 the cultivars with the highest number of hands were 'Gold Finger,' 'Dwarf Namwah,' 'Manzano,' 'Raja Puri,' and 'Pace' (Table 2). In 2006, the cultivars with the highest number of hands were 'Dwarf Namwah,' 'Belle,' 'Sweet Heart,' and 'Kumunaba.' In terms of weight, 'Sweet Heart,' 'Kofi,' 'Kandarian,' 'Praying Hands,' 'Brazilian,' and 'Ice Cream' dominated (Table 4).

Supply-Side Considerations

An investigation of the phenological characteristics is vital in determining the supply, quality, quantity, distribution, and marketability of this newly emerging product in Georgia. Phenology in this study refers to planting-to-shooting time, shooting-to-harvest time, and shooting-to-shooting time in the ratoon crop. Shooting-to-harvest time was very crucial in determining when Georgia-produced bananas could be available for distribution and marketing. Perfect timing in the supply of a product could result in a premium price. It is important that bunches be harvested before the first frost, which in southeast coastal Georgia usually occurs in mid-November. Therefore, our market window is between October 15 and November 15. With this date in mind, we need ten to 12 weeks for the fruit to mature and ready for harvest. Calculating backward, bunch emergence is expected to start in July.

Demand-Side Considerations

Various production and quality problems were encountered in 2004 on fruits which emerged between March and June, such as choking (constriction of flower buds before emergence or presence of the flower bud within the over-wintering "trunk,"

Table 4: Fruit Characteristics of Bunches that Emerged from May to September, 2006.

Cultivar	Hand Class**	Number of fingers	Bunch Weight (lbs.)	Bunch Harvested Date (Julian)
Belle	9.0 a	122.0 abc	22.0 abc	222.0 b
Brazilian	5.0 a	46.0 bc	24.0 abc	297.0 ab
Dwarf Namwah	10.0 a	166.7 a	23.0 abc	314.0 ab
Dwarf Orinoco	4.8 a	46.3 bc	14.3 bc	331.0 a
Ele Ele	5.0 a	24.0 c	12.0 bc	270.0 ab
Hua Moa	6.0 a	31.0 bc	17.0 abc	276.0 ab
Ice Cream	7.5 a	106.0 abc	22.5 abc	298.3 ab
Kandarian	6.7 a	89.3 abc	25.7 ab	297.3 ab
Kofi	5.0 a	62.0 abc	26.0 ab	276.0 ab
Kumunaba	8.0 a	86.0 abc	13.0 bc	339.0 a
Musa 1780	4.0 a	24.0 c	12.0 bc	276.0 ab
Praying Hands	8.0 a	147.0 ab	24.0 abc	297.0 ab
Saba	6.7 a	72.7 abc	14.0 bc	335.7 a
Super Plantain	4.0 a	15.0 c	4.0 c	309.0 ab
Sweetheart	8.0 a	119.0 abc	36.0 a	291.0 ab
LSD (0.05)	6.5	116.8	20.1	101.6

**Hand-class refers to the number of hands on a bunch. A hand that is divided in two or more group of fingers is called a cluster—just like what we buy in a grocery store.
Means with the same letter in a column are not significantly different ($P \geq 0.05$) according to the PDIFF option in PROC MIXED (SAS 2000) with Satterthwaite option on the model statement.

or pseudostem); malformation; and stunting, with very few hands and fingers and insufficient leaves for photosynthesis and fruit development. Furthermore, the quality, minimum finger length, shape, and curvature of these bunches did not meet standard market requirements. However, this was not the case in 2005 and 2006. We believe this was due to the second frost which occurred in March 2004 but not in 2005 or 2006 (Fonsah, Krewer, and Rieger 2005; Commission of the European Communities 1994).

Distribution Channel and Marketability

In our research, the fruits that emerged in July of each year and thereafter were normal, had good marketable quality, and superior OCA. In 2004, total number of fingers per bunch ranged from 30 for the cultivar 'Frank Unknown' to 164 for 'Dwarf Namwah.' Average fingers per bunch ranged from 9.3 to 18.2. Bunch weight ranged from four to 18 pounds. Bunch age ranged from one to seven weeks. At the time of harvesting, none of the bunches had reached maturity age, a minimum of ten to 12 weeks after bunch emergence. Bunch weight is correlated with age and cultivar.

Of the cultivars tested, 'Dwarf Namwah,' 'Ice Cream,' 'Sweet Heart,' 'Belle,' and 'Kandarian' showed excellent potential for marketing and distribution in terms of OCA, finger length, and curvature, if the natural growing season was longer or lengthened by artificial means (i.e. high tunnels, hoop houses, etc.). No quality problem was observed in these cultivars (Fonsah, 2003).

Summary and Conclusion

This study, which was carried out between 2003 and 2006, demonstrates that banana production has the potential to become an important niche

and ethnic market crop in Georgia if the growing season can be lengthened slightly. There were two freeze events in December 2003 and March 2004 that had an adverse effect on fruit development, quality, and quantity available for distribution. Due to these freezing temperatures, plants that emerged between March and June were choked, malformed, and stunted, with very few hands and fingers, and were of poor marketable quality. The fruits that emerged in July of each year and thereafter were normal and would have had good marketable quality if weather conditions had allowed the fruits to mature. The ideal time for banana fruits production in Georgia is from July to August so that harvesting, packaging, distribution and marketing can take place from mid-October to mid-November. Further research is needed to validate our study before any concrete conclusion can be made.

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