



Overview

- Background
- Pitahaya production worldwide
- Why pitahaya research?
- Current research efforts at UC
- Field observations & results to date
- Marketing and Economic Prospects
- What next?

The Pitahaya

- Also known as Strawberry Pear, Dragon Fruit in South East Asia, Pitahaya in Mexico and Pitaya in Central America
- Native to tropical America, range from Southern Mexico to Northern South America
- Taken by the french to South East Asia at the turn of the 19th century

Pitahaya Types

- Several species of *Hylocereus* identified, but there is uncertainty about proper identification
- Differentiated by stem & fruit characteristics (bracts, shape and fruit color - skin and flesh)
- Two commonly available in CA:
 - *Hylocereus undatus* (red skin, white flesh)
 - *Hylocereus* sp. (primarily red skin & red flesh)
- Many *Hylocereus* hybrids (several skin and flesh colors combinations, from yellow to deep magenta or dark red)
- *Selenicereus megalanthus* - Yellow or Colombian, yellow, thorny skin and white, translucent flesh
 - Reclassified as *Hylocereus megalanthus*

Why Pitahayas?

- Great potential as a new, water efficient crop for Southern California
- Increasing demand for new, healthy and exotic fruits
 - Current demand exceeds supply, current prices are high (retail @ \$ 3-8/pound)
 - Relatively high antioxidant activity when compared to other subtropical fruits
- Makes great landscape plant - fruiting cactus, water efficient, very adaptable

Fruit Uses

- Used in refreshments in Central America
- Red flesh used as colorant in the processed food industry (Snapples, Sobe, Pitaya+)
- Consumed fresh, as a desert item in the US, Canada, and Europe
 - Sliced in salads or cut in half and served chilled, with flesh eaten with spoon
- Used for decoration – Southeast Asia, US
- Great potential for value added products (ice cream, chips, chewy bars, wine, yarn dye, etc.)

Dragonfruit Production



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Source: Bill Gerlach/Melissa's Specialty Produce Cooperative California

Pitahayas in California



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UCCE San Diego County

U.S. Production

- US production is limited, but acreage increasing rapidly (1000-1200 acres)
 - California (400 - 500 acres.)
 - Florida (500 - 600 Acres)
 - Hawaii (100 - 200 Acres)
- Mostly white fleshed varieties used for fresh consumption or for décor/garnish
- Market is turning red...Pink/Red fleshed varieties becoming more popular
- Red fleshed varieties sell at higher price

Central & South America

- Nicaragua is main producer of *Hylocereus* sp. (red flesh) in Central America
 - 1000-1200 Hectares planted under various
 - Fresh fruit exported to Canada and Europe (APRONOT) & pulp exported to US and Japan
- Colombia top producer of yellow pitahaya (*S. megalanthus*)
- Ecuador also producing both *Hylocereus* sp. and *S. megalanthus*
- Backyard/small scale production in Guatemala, El Salvador, Honduras, Costa Rica

Nicaraguan Production



Asia, Africa, Australia

- Vietnam main producer of *Hylocereus undatus* in South East Asia (Est. 40,000 Has)
 - Predominantly white flesh fruit, but converting to red flesh
 - Export based industry targeting the US, China & Europe
 - Fruit exported to the US must be irradiated – very costly!
- Thailand (~ 3000 Has.), Malaysia (~500 Has.), Indonesia, Taiwan and the Philipines also becoming important producers
- Israel (~100-200 Has.) has been significant producer/ shipper to the European Union
- South Africa and Australia increasing production

Varieties??

- Several species & up to 70 different clones available in Southern California
- No data or information available on the performance of various clones
- Lack of reliable information about varieties a major challenge to growth of industry
- 19 varieties under experimentation at SCREC, 30+ under observation

Commercial Varieties?

- Five clones grown commercially in Nicaragua
 - Orejona, Rosa, Cebra, Lisa, San Ignacio
 - Many other clones available
 - All produce fruit without hand pollination
- Several clones promoted as “superior” but no replicated research data available
- Improved, proprietary varieties available from Israel, Taiwan and private breeders in US
- Big challenge for commercial production and main reason for our research project

Research Efforts to Date

- Evaluated varieties for commercial production in California (Bender, Tanizaki)
- Develop post harvest management and information and strategies (Cantwell, Tanizaki)
- Genetic characterization of pitahaya accessions using AFLP markers (Douhan, Vidalakis, Pagliacia)
- Confirm presence of Cactus Virus X (CVX) and screen pitahaya accessions for the virus (Mathews, De Soto, Aguiar, Tanizaki)
- Sensory evaluation of selected varieties of Pitahaya (Cantwell, Arpaia, Ovenland)

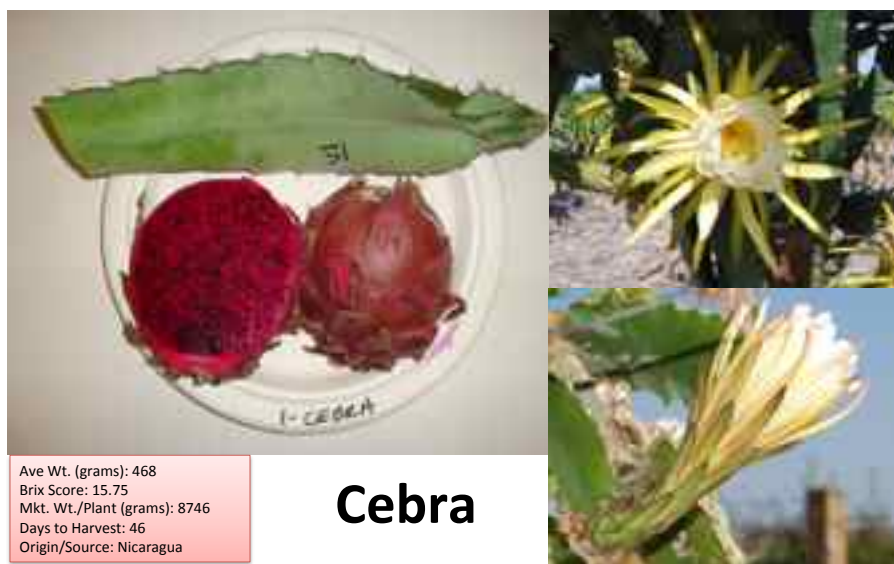
Ongoing/Future Research

- Evaluation of selected varieties in Ventura and Riverside Counties (De Soto, Aguiar)
- Determine irrigation requirements for Pitahaya cultivars Lisa and Physical Graffiti under two trellis systems (De Soto, Tanizaki)
- Evaluate selected pitahaya varieties under shade (De Soto, Aguiar)
- Monitor and catalogue pests and disease incidence (Wilén, Bethke, Downer)

Varieties Under Study

- Cebra (Nic)
- Rosa (Nic)
- Orejona (Nic)
- Lisa (Nic)
- Sin Espinas (Nic)
- San Ignacio (Nic)
- Mexicana (Mex)²
- Colombiana (SD/Col)³
- Valdivia Roja (Mex)
- Bien Hoa Red (SD)¹
- Bien Hoa White (SD)²
- Delight (SD)
- American Beauty (FL)¹
- Haley's Comet (FL)
- Physical Graffiti (FL)
- Vietnamese Giant (FL)²
- Yellow Dragon (FL/Col)³
- Seoul Kitchen (FL)
- Armando (Nic)*
- El Grullo (Mex)*

Pitahaya Guide



Ave Wt. (grams): 468
Brix Score: 15.75
Mkt. Wt./Plant (grams): 8746
Days to Harvest: 46
Origin/Source: Nicaragua

Cebra



The image for 'Rosa' features a central photograph of two dragon fruit fruits on a white plate, one cut open to show the pink flesh. Above the fruits is a green, segmented stem with a leaf. To the right, there are two smaller photographs: the top one shows a white dragon fruit flower with yellow stamens, and the bottom one shows a yellow dragon fruit flower. A pink box on the left contains the following text:

Ave. Wt. (grams): 384
 Brix Score: 16.05
 Mkt. Wt./Plant (grams): 7217
 Days to Harvest: 45
 Origin/Source: Nicaragua

Rosa

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The image for 'Orejona' features a central photograph of two dragon fruit fruits on a white plate, one cut open to show the pink flesh. Above the fruits is a green, segmented stem with a leaf. To the right, there are two smaller photographs: the top one shows a white dragon fruit flower with yellow stamens, and the bottom one shows a yellow dragon fruit flower. A pink box on the left contains the following text:

Ave. Wt. (grams): 438
 Brix Score: 15.78
 Mkt. Wt./Plant (grams): 4598
 Days to Harvest: 45
 Origin/Source: Nicaragua

Orejona

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The image for the 'Lisa' variety features a central photograph of two dragon fruit fruits in a glass dish, one whole and one cut open to show the white flesh and black seeds. The dish is labeled 'F-LISA'. To the right, there are two smaller photographs: the top one shows a large, pale yellow dragon fruit flower in bloom, and the bottom one shows a dragon fruit branch with several buds and a young fruit.

Ave. Wt. (grams): 465
Brix Score: 17.02
Mkt. Wt./Plant (grams): 13319
Days to Harvest: 44
Origin/Source: Nicaragua

Lisa

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The image for the 'Sin Espinas' variety features a central photograph of two dragon fruit fruits in a glass dish, one whole and one cut open to show the white flesh and black seeds. The dish is labeled 'S-SIN ESPINAS'. To the right, there are two smaller photographs: the top one shows a large, pale yellow dragon fruit flower in bloom, and the bottom one shows a dragon fruit branch with several buds and a young fruit.

Ave. Wt. (grams): 393
Brix Score: 16.5
Mkt. Wt./Plant (grams): 3527
Days to Harvest: 43
Origin/Source: Nicaragua

Sin Espinas

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The image for San Ignacio features a central photograph of two dragon fruit fruits on a white plate, one cut open to show the white flesh and black seeds. The plate is labeled "6-SAN IGNACIO". To the right, there are two smaller photographs of dragon fruit flowers: one is a close-up of a white flower with a yellow center, and the other shows a yellow flower in bloom against a blue sky.

Ave. Wt. (grams): 552
Brix Score: 15.6
Mkt. Wt./Plant (grams): 12712
Days to Harvest: 48
Origin/Source: Nicaragua

San Ignacio

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The image for Mexicana features a central photograph of two dragon fruit fruits on a white plate, one cut open to show the white flesh and black seeds. The plate is labeled "7-MEXICANA". To the right, there are two smaller photographs of dragon fruit flowers: one is a close-up of a white flower with a yellow center, and the other shows a yellow flower in bloom against a blue sky.

Ave. Wt. (grams): 495
Brix Score: 14.04
Mkt. Wt./Plant (grams): 9165
Days to Harvest: 40
Origin/Source: Nicaragua

Mexicana

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Ave. Wt. (grams): <200
 Brix Score: 20.90
 Mkt. Wt./Plant (grams): 0
 Days to Harvest: 150-180
 Origin/Source: SD/Col.

Colombiana

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Ave. Wt. (grams): 250
 Brix Score: 17.9
 Mkt. Wt./Plant (grams): 8588
 Days to Harvest: 40
 Origin/Source: Mexico

Valdivia Roja

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Ave. Wt. (grams): 360
 Brix Score: 18.9
 Mkt. Wt./Plant (grams): 1477
 Days to Harvest: 41
 Origin/Source: San Diego

Bien Hoa Red


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Ave. Wt. (grams): 388
 Brix Score: 11.85
 Mkt. Wt./Plant (grams): 7394
 Days to Harvest: 37
 Origin/Source: San Diego

Bien Hoa White

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The image for the 'Delight' variety features a central photograph of a dragon fruit on a white plate, with one cut open to show its pink flesh and black seeds. The plate is labeled '12- DELIGHT'. To the right, there are two smaller photographs of the dragon fruit's white, star-shaped flowers with yellow centers, one in bloom and one as a bud. Below the main image is a pink box containing the following text: 'Ave. Wt. (grams): 371', 'Brix Score: 18.08', 'Mkt. Wt./Plant (grams): 14931', 'Days to Harvest: 41', and 'Origin/Source: San Diego'. The word 'Delight' is printed in large black font to the right of the pink box. At the bottom of the slide is the University of California Cooperative Extension logo.

Ave. Wt. (grams): 371
Brix Score: 18.08
Mkt. Wt./Plant (grams): 14931
Days to Harvest: 41
Origin/Source: San Diego

Delight

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The image for the 'American Beauty' variety features a central photograph of a dragon fruit on a white plate, with one cut open to show its pink flesh and black seeds. The plate is labeled '15- AMERICAN BEAUTY'. To the right, there are two smaller photographs of the dragon fruit's white, star-shaped flowers with yellow centers, one in bloom and one as a bud. Below the main image is a pink box containing the following text: 'Ave. Wt. (grams): 380', 'Brix Score: 18.51', 'Mkt. Wt./Plant (grams): 5566', 'Days to Harvest: 43', and 'Origin/Source: Florida'. The word 'American Beauty' is printed in large black font to the right of the pink box. At the bottom of the slide is the University of California Cooperative Extension logo.

Ave. Wt. (grams): 380
Brix Score: 18.51
Mkt. Wt./Plant (grams): 5566
Days to Harvest: 43
Origin/Source: Florida

American Beauty

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Ave. Wt. (grams): 482
Brix Score: 16.7
Mkt. Wt./Plant (grams): 5979
Days to Harvest: 38
Origin/Source: Florida

Haley's Comet

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Ave. Wt. (grams): 374
Brix Score: 17.93
Mkt. Wt./Plant (grams): 23429
Days to Harvest: 40
Origin: Florida

Physical Graffiti

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The image for the Vietnamese Giant variety is a composite. On the left, a white plate holds a whole red dragon fruit and a cross-section showing the white, seed-filled interior. The plate is labeled '16-VIETNAMESE GIANT'. On the right, two photographs show the plant's flowers: a large, white, star-shaped flower with many long, thin petals, and a smaller, yellowish flower.

<p>Ave. Wt. (grams): 338 Brix Score: 15.6 Mkt. Wt./Plant (grams): 6511 Days to Harvest: 41 Origin/Source: Florida</p>

Vietnamese Giant


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The image for the Yellow Dragon variety is a composite. On the left, a white plate holds a whole yellow dragon fruit and a cross-section showing the yellow, seed-filled interior. The plate is labeled '17-YELLOW DRAGON'. On the right, two photographs show the plant's flowers: a large, yellow, star-shaped flower with many long, thin petals, and a smaller, white flower.

<p>Ave. Wt. (grams): <200 Brix Score: 21.15 Mkt. Wt./Plant (grams): 0 Days to Harvest: 150-180 Origin: Florida/Colombia</p>
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Yellow Dragon


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A composite image for the 'Seoul Kitchen' dragon fruit variety. On the left, a white plate holds a sliced dragon fruit showing its white flesh with black seeds, a whole red dragon fruit, and a green leaf. The plate is labeled '12- SEUL KITCHEN'. On the right, two photographs show the plant's flowers: a large, star-shaped white flower with yellow center, and a smaller, star-shaped yellow flower.

Ave. Wt. (grams): 518
Brix Score: 12.18
Mkt. Wt./Plant (grams): 15379
Days to Harvest: 41
Origin/Source: Florida

Seoul Kitchen

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A composite image for the 'Armando' dragon fruit variety. On the left, a white plate holds a sliced dragon fruit showing its white flesh with black seeds, a whole red dragon fruit, and a green leaf. The plate is labeled '14- ARMANDO'. On the right, two photographs show the plant's flowers: a large, star-shaped white flower with yellow center, and a smaller, star-shaped yellow flower.

Ave. Wt. (grams): 390.5
Brix Score: 16.11
Mkt. Wt./Plant (grams): 4881
Days to Harvest: 41
Origin/Source: Nicaragua

Armando

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El Grullo

Ave. Wt. (grams):
Brix Score:
Mkt. Wt./Plant (grams):
Days to Harvest:
Origin/Source: Mexico

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Several Others Cultivars Under Observation



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Several Others Cultivars Under Observation



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Pitahaya or Dragon Fruit Variety Evaluation Chart

(For Cold Hardiness & Heat Tolerance: 1 = low tolerance & 5 = High Tolerance)

Variety/Origin	Color Skin/Flesh	Cold Hardiness	Heat Tolerance	Avg. Wt. (grams)	Brix Score	Mkt Wt/Plant (grams)	Days to Harvest
1. Cebra (Nic.)	R/R	3.5	3.5	468	15.75	8746	46
2. Rosa (Nic.)	R/R	3.5	3.5	384	16.05	7217	45
3. Orejona (Nic.)	R/R	3.25	3.75	438	15.78	4598	45
4. Lisa (Nic.)	R/R	3.75	4	465	17.02	13319	44
5. Sin Espinas (Nic.)	P/R	2.25	2.75	393	16.5	3527	43
6. San Ignacio (Nic.)	R/R	3.75	4	552	15.6	12712	48
7. Mexicana (Mex.)	P/W	3.25	3	495	14.04	9165	40
8. Colombiana (SD-Col.)	Y/W	1	1	< 200	20.90	0	150-180
9. Valdivia Roja (Mex.)	R/R	5	4.5	250	17.9	8588	40
10. Bien Hoa Red (SD)	GR/F	1.75	1.75	360	18.9	1477	41
11. Bien Hoa White (SD)	P/W	2.5	2.5	388	11.85	7394	37
12. Delight (SD)	R/PW	3	3.5	371	18.08	14931	41
13. American Beauty (FL)	GR/F	2.75	2.5	380	18.51	5566	43
14. Haley's Comet (FL)	R/F	4.5	4.25	482	16.7	5979	38
15. Physical Graffiti (FL)	R/P	4.5	4.5	374	17.93	23429	40
16. Vietnamese Giant (FL)	PR/W	3.25	3.25	338	15.6	6511	41
17. Yellow Dragon (FL-Col.)	Y/W	1	1	< 200	21.15	0	150-180
18. Seoul Kitchen (FL)	PR/W	4	4	518	12.18	15379	41
19. Armando (Nic.)	R/R	4	4	390.5	16.11	4881	41
20. El Grullo (Mex.)*	R/R	4.5*	4.5*	489*	18.11*	U/K	40

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Results to Date

- Most varieties in trial adapted well to growing conditions at SCREC
 - Valdivia Roja, El Grullo*, Physical Graffiti, Haley's Comet and Lisa most tolerant to heat and cold
- Most selections set fruit **WITHOUT** hand pollination
 - Physical Graffiti, Seoul Kitchen, Delight, Lisa and San Ignacio top producing varieties

Results to Date

- Most varieties in trial produce well **WITHOUT** shade, some would benefit from it.
- Fruit size & quality very good, good marketable yields
 - Except for Colombiana/Yellow Dragon, all varieties produced fruit with good market weight
 - Colombiana/Yellow Dragon, Bien Hoa Red/American Beauty, Delight, Physical Graffiti, Valdivia & El Grullo* had the highest brix scores

Results to Date

- External appearance:
 - Sin Espinas, Lisa, Physical Graffiti, Delight, American Beauty and Bien Hoa Red
- Flavor where flesh color is visible:
 - American Beauty, Bien Hoa Red, Physical Graffiti, Delight, Sin Espinas and Lisa
- Flavor in a blind test, flesh color masked with light:
 - Bien Hoa Red, American Beauty, Physical Graffiti, Sin Espinas and Lisa
- Clear differences among varieties in terms of sugars, acids, and antioxidant content
 - See handout on post-harvest and composition analysis

Results to Date

- Recently completed DNA work confirmed suspicions about various cultivars:
 - Bien Hoa Red and American Beauty considered the same
 - Delight, Haley's Comet and Physical Graffiti are very closely related
 - Seoul Kitchen, Vietnamese Giant, Bien Hoa White and Mexicana very closely related
 - Yellow Dragon and Colombiana considered the same
 - Lisa, Rosa, Cebra could considered the same
 - Armando and San Ignacio related related but not same as other Nicaraguan varieties
 - Sin Espinas unique & diferent from other Nicaraguans
 - Valdivia Roja unique, closely related to El Grullo (new entry)
- Variety selection determined by your personal preferences and intended use

PACKING/MARKETING

- Few handlers/packers available in SoCal, may have to pack on your own
- Most buyers want fruit commercially packed in 6, 10, and 20 lb. boxes.
- Market preference for red/colored flesh varieties, over \$ 1.00 more per pound
- Most imports from Vietnam, Nicaragua, Florida and California appear on Reports
- Quality, flavor, local...our selling points!

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Pitahaya Market & Price Info

- USDA-AMS Market Report calls everything “Red Pitaya” but refers to skin color, no indication about flesh color.
- www.usda.ams
 - Market News
 - Fruit Vegetables and Specialty Crops
 - Market News Portal – Fruits and Vegetables
 - Fruits
 - Dragon Fruit (Red Pitaya)
 - From here you can refine the report by market, date, etc.

Packaging and Marketing

Date	Market	Origin	Color	Pack	Type	Price US \$
8/18/14	Los Angeles	Nicaragua	Red	10 lbs.	Conventional	32.00 – 33.00
8/18/14	Los Angeles	Vietnam	Red	10 lbs.	Conventional	23.50 – 29.00
8/18/14	Los Angeles	California	Red	10 lbs.	Organic	57.50 – 57.50
8/18/14	Los Angeles	California	Red	6 lbs.	Organic	42.85 – 42.85
8/18/14	San Fran	Nicaragua	Red	10 lbs.	Conventional	38.00 – 38.00
8/18/14	San Fran	Florida	Red	20 lbs.	Conventional	50.00 – 50.00
8/18/14	San Fran	Florida	Red	¼ B.C.	Conventional	60.00 – 65.00

Source: USDA/AMS Website

Packaging and Marketing

Date	Market	Origin	Color	Pack	Type	Price US \$
8/21/14	Los Angeles	Nicaragua	Red	10 lbs.	Conventional	32.00 – 33.00
8/21/14	Los Angeles	Vietnam	Red	10 lbs.	Conventional	30.00 – 35.00
8/21/14	Los Angeles	California	Red	10 lbs.	Organic	57.50 – 57.50
8/21/14	Los Angeles	California	Red	20 lbs.	Conventional	56.00 – 60.00
8/21/14	Los Angeles	California	Red	6 lbs.	Conventional	42.00 – 42.00
8/21/14	Los Angeles	California	Red	6 lbs.	Organic	42.00 – 42.00
8/21/14	San Fran	Nicaragua	Red	10 lbs.	Conventional	38.00 – 38.00
8/21/14	San Fran	Florida	Red	20 lbs.	Conventional	50.00 – 50.00
8/21/14	San Fran	Florida	Red	¼ B.C.	Conventional	60.00 – 60.00

Source: USDA/AMS Website

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Marketing Pitahaya or Dragon Fruit: 10 Things a Distributor Wants (Frieda's Handout)

Understand your customer's business	Labeling and Trace Back
Participate in Marketing	Food Safety and Insurance
Don't be Greedy	Quality Control
Target Dates and Yield Estimates	Pack Size & Pricing
Post-Harvest Control	Variety & Flavor

Success in agriculture depends on marketing what you grow at a profit. Do your homework, develop a business/marketing/food safety plan and spend time talking to prospective buyers or consumers!!

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Economic Prospects

- Great potential as a commercial crop alternative
- Establishment costs are high and can range from \$15000-25000/per acre
- Value per acre can be significant if yield and quality are maximized (> 20,000 lbs/acre)
- Downward pressure on price will continue because of increased domestic production and import volume (\$1.50 to \$3.00/lb. farm gate prices; \$6-8 at CFMs)
- Red fleshed varieties usually sell at a higher price than white fleshed varieties (~ \$1.00/lb)
- Risky Business...BE CAUTIOUS!!

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Results to Date



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The End...Questions??

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