Brief Overview of California Spinach

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California Spinach Production and Postharvest Handling
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Harvested Lettuce and Fresh Spinach Acreage, 2005

Source: National Agricultural Statistical Service

US Per Capita Consumption of Lettuce and Fresh Spinach

Source: USDA, Economic Research Service

US Annual Servings of Lettuce and Fresh Spinach

Source: USDA, Economic Research Service

US Per Capita Consumption of Fresh Spinach

Source: USDA, Economic Research Service
US Annual Servings of Fresh Spinach

![Graph showing US annual servings of fresh spinach from 1990 to 2004.](source: USDA, Economic Research Service)

Evolving Production and Postharvest Management Enhances Quality, Value, and Consumer Appeal

- Consumer Demand Increases
- Production Innovation and Consolidation Follow

Spinach: *Spinacia oleracea*

- Production volumes
- Preharvest management
- Harvest management
- Postharvest management

U.S. Spinach Production

- ~ 25,000 ha (65,000 acres)
- ~ 317,000 MT
- ~ $260 M annual value - reported
- ~ $350 M annual value – estimated

U.S. Fresh-Market Spinach Production (1000 cwt)

<table>
<thead>
<tr>
<th>County</th>
<th>2004</th>
<th>2005</th>
<th>% change</th>
</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td>4,590</td>
<td>5,270</td>
<td>14.8</td>
</tr>
<tr>
<td>Arizona</td>
<td>1,050</td>
<td>1,090</td>
<td>3.8</td>
</tr>
<tr>
<td>Texas</td>
<td>250</td>
<td>210</td>
<td>-16.0</td>
</tr>
<tr>
<td>New Jersey</td>
<td>171</td>
<td>200</td>
<td>17.0</td>
</tr>
<tr>
<td>Other states</td>
<td>205</td>
<td>231</td>
<td>12.7</td>
</tr>
<tr>
<td>United States</td>
<td>6,266</td>
<td>7,001</td>
<td>11.7</td>
</tr>
</tbody>
</table>

Source: USDA, National Agricultural Statistics Service, Vegetables Annual Summary, September 18, 2006

![Map of U.S. showing fresh-market spinach production by county.](County Map)

- Fresno
- Imperial
- Monterey
- Santa Barbara
- San Benito
- Santa Cruz
- San Diego
- San Luis Obispo
- Yuma, AZ
Preharvest Management

Spinach: *Spinacia oleracea*
- Leaves oval, rounded, or triangular
- Savoy – wrinkled
- Semi-savoy
- Smooth = Flat-leaf – primarily processing
- CA production uses only hybrids
  - ex. Avenger, Bolero, Bossanova, Shasta, Whale

Spinach Seed is Coated but not Pelleted
- Approx 100 seed per gram
- Residual cortical pericarp remains
- ¼ to ⅜ " deep (1.2-1.9 cm)
- Seeding rates up 10X since 1995
- Average of 3 M seed per acre

Sprinkler Irrigation to Emergence: 5-7 irrigations

Seedbed Preparation

Sprinkler Irrigation to Emergence: 5-7 irrigations

Spinach Seed Germination
Is Inhibited at High Soil Temperatures

- Optimum Temperature: 60 to 65 °F (15 to 18°C)
- Declining from
- Increasing from
Effect of Temperature on Spinach Germination and Susceptibility to Damping-off

<table>
<thead>
<tr>
<th>Temp °F</th>
<th>32</th>
<th>41</th>
<th>50</th>
<th>59</th>
<th>68</th>
<th>77</th>
<th>86</th>
<th>95</th>
<th>104</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to Germ</td>
<td>63</td>
<td>23</td>
<td>12</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>% Germ</td>
<td>83</td>
<td>96</td>
<td>91</td>
<td>82</td>
<td>52</td>
<td>28</td>
<td>32</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Soil Type, Temperature, and Irrigation Management Effect:
- Stand
- Root infection
- Leaf morphology

Fertilizer Application

Hand Cultivation of Weeds

Avg. $3,500 per acre
Crop cycle
- Fresh - 25 to 55 d
- 3 "turns" per year
- Rotation is variable
- Processor - 70-120 d
Economically important diseases of spinach

- **Downy mildew** - *Peronospora farinosa f. sp. spinaciae*
- **White rust** - *Albugo occidentalis*
- **Fusarium wilt** - *Fusarium oxysporum f. sp. spinaciae* (Fos)
- **Seedling diseases** - *Fusarium oxysporum f. sp. spinaciae* (Fos)
- **Foliar leaf spots** - *Colletotrichum dematium*, *Cladosporium macrocarpum*, *Stemphylium botryosum*, *Heterosporium* sp., *Alternaria* sp., *Abiotic*
- **Virus** - *CMV, BWYV, BCTV*

**July 20-24 2006**

**Important Spinach Diseases**

- **Downy mildew** - *Peronospora farinosa f. sp. spinaciae*
- **White rust** - Not in CA

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**Figure 1.** Epidemic curve of confirmed cases of E. coli O157:H7, cluster 69209H20, by date of illness onset, as of October 6, 2006, 1:00 am EDT

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**San Juan Valley 7/22/06**

**Air Temperature**

| Hours | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|-------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Temp  | 45| 55| 65| 75| 85| 95| 105| 115| 125| 135| 145| 155| 165| 175| 185| 195| 205| 215| 225| 235| 245| 255| 265|

**Soil Temp (F)**

- *San Juan Valley*
- *San Benito*
- *Castroville*
Bunch Spinach Harvest

Mechanical harvest of mature spinach for frozen market

Freezer/Processor Spinach Harvest

Spinach Harvest for Packaged Salad and Blends
Custom built vacuum harvester for baby greens

Respiration rates: Spinach leaves
Data are averages ± SD across 4 stages of leaf maturity

Harvested Product May be Placed Directly into Temperature Conditioned Local Transport

Product Cleaning and Cooling

Credit R. Groppe
De-watering
- Centrifugal-dryers
- Air-beds
- Flash vacuum

Changes in Spinach quality:
Washed and perforated bagged product stored at 4 temperatures