Brief Overview of California Spinach

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California Spinach
Production and Postharvest Handling

Grateful Acknowledgement to Contributors:
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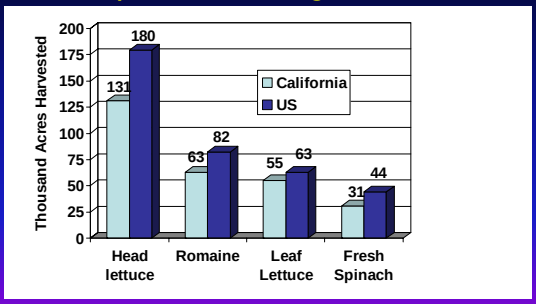
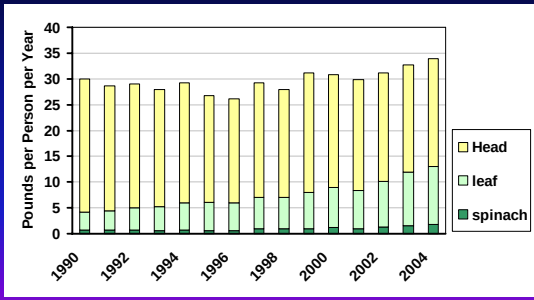
Harvested Lettuce and Fresh Spinach Acreage, 2005



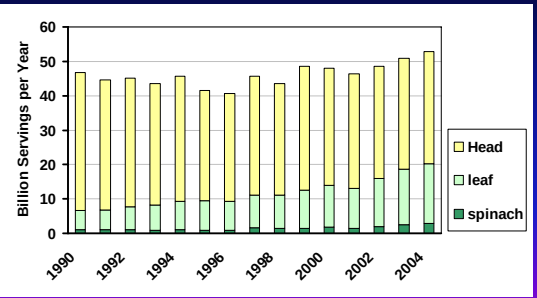
Source: National Agricultural Statistical Service

US Per Capita Consumption of Lettuce and Fresh Spinach



Source: USDA, Economic Research Service

US Annual Servings of Lettuce and Fresh Spinach



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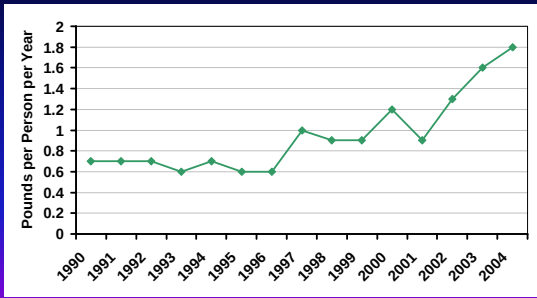
US Per Capita Consumption of Fresh Spinach



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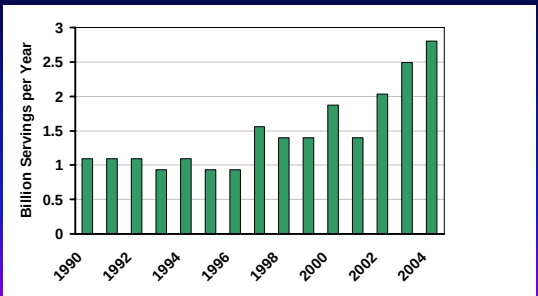
US Annual Servings of Fresh Spinach



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

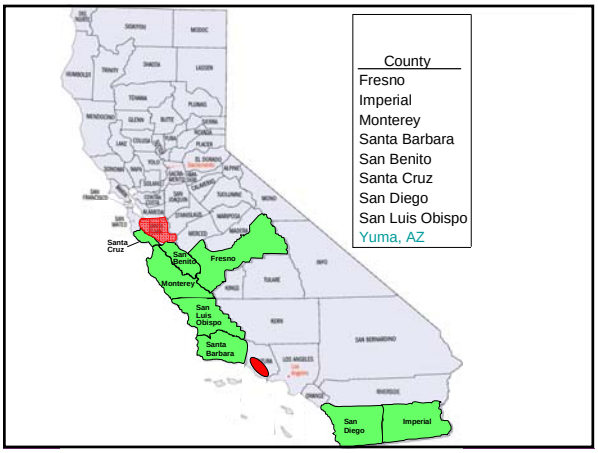
U.S. Spinach Production

- ~ 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)

	2004	2005	% change
California	4,590	5,270	14.8
Arizona	1,050	1,090	3.8
Texas	250	210	-16.0
New Jersey	171	200	17.0
Other states	205	231	12.7
United States	6,266	7,001	11.7

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



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

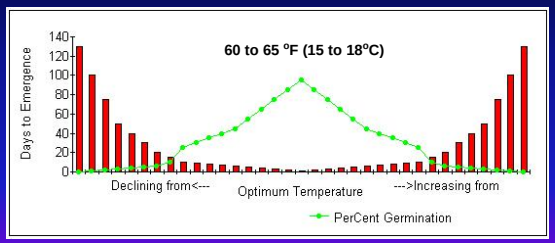
Spinach Seed is Coated but not Pelleted

- Approx 100 seed per gram
- Residual cortical pericarp remains
- ½ to ¾ " deep (1.2-1.9 cm)
  - Seeding rates up 10X since 1995
    - Average of 3 M seed per acre

Seedbed Preparation

Sprinkler Irrigation to Emergence: 5-7 irrigations

Spinach Seed Germination Is Inhibited at High Soil Temperatures



Effect of Temperature on Spinach Germination and Susceptibility to Damping-off

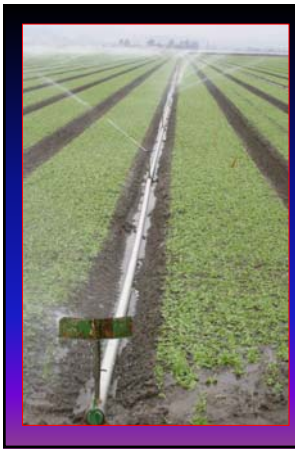
Temp °F	32	41	50	59	68	77	86	95	104
Days to Germ	63	23	12	7	6	5	6	0	0
% Germ	83	96	91	82	52	28	32	0	0

Soil Type, Temperature, and Irrigation Management Effect:

- Stand
- Root infection
- Leaf morphology

Fertilizer Application

Hand Cultivation of Weeds



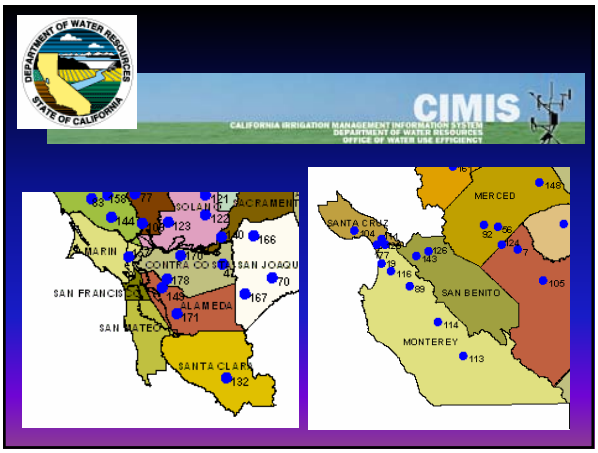
Avg. $3,500 per acre

Crop cycle

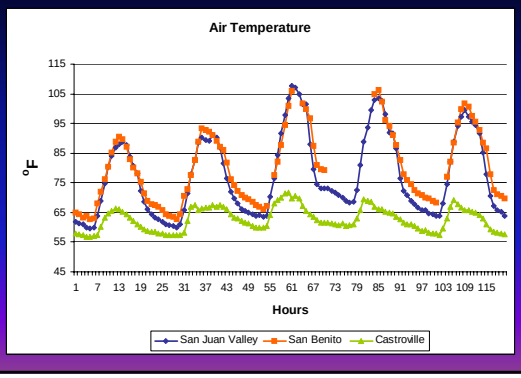
- Fresh - 25 to 55 d
- 3 “turns” per year
- Rotation is variable
- Processor - 70-120 d

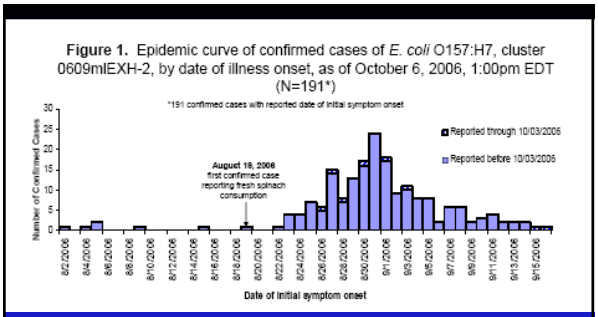
Economically important diseases of spinach

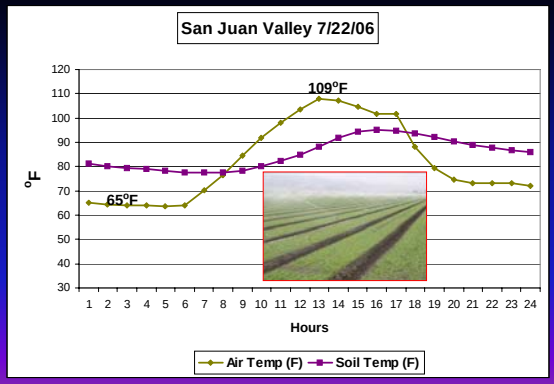
- Downy mildew -*Peronospora farinosa* f. sp. *spinaciae*
- White rust -*Albugo occidentalis*
- Fusarium wilt -*Fusarium oxysporum* f. sp. *spinaciae* (Fos)
- Seedling diseases -Fos, *Pythium* sp., *Rhizoctonia solani*, *Phytophthora* sp.
- Foliar leaf spots -*Colletotrichum dematium*
  Cladosporium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



July 20-24 2006

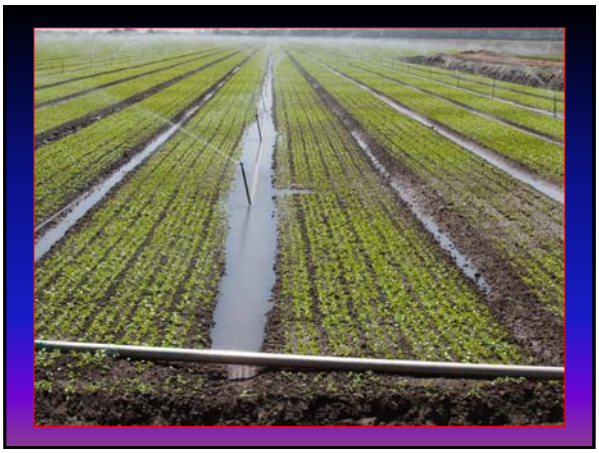






Important Spinach Diseases

- **Downy mildew**
  (*Peronospora farinosa* f. sp. *spinaciae*)
- **White rust: Not in CA**
  (*Albugo occidentalis*)




Bunch Spinach Harvest


Mechanical harvest of
mature spinach for frozen market

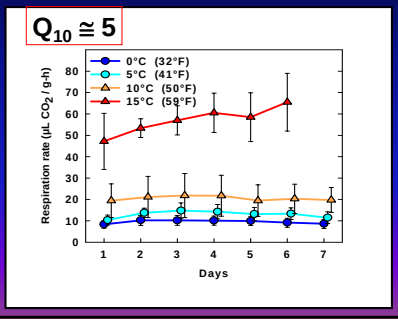

Freezer/Processor Spinach Harvest


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

De-watering
- Centrifugal-dryers
- Air-beds
- Flash vacuum

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