

Brief Overview of California Spinach



California Spinach Production and Postharvest Handling Grateful Acknowledgement to Contributors: Images and Content

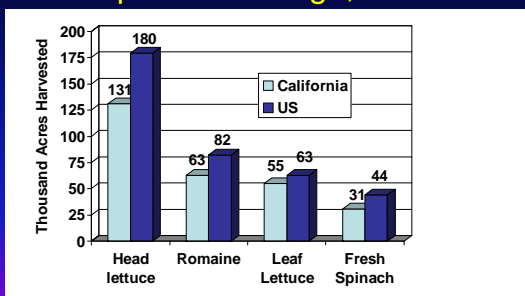
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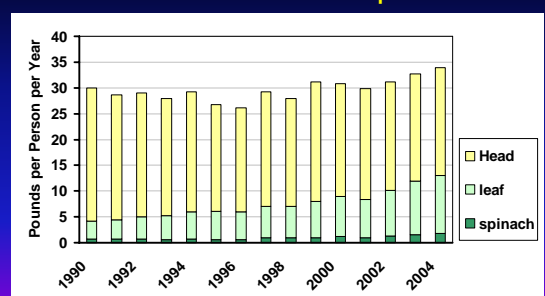
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Harvested Lettuce and Fresh Spinach Acreage, 2005



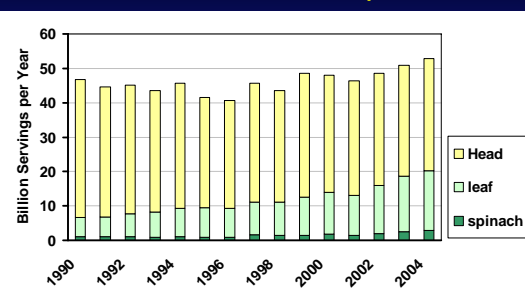
Source: National Agricultural Statistical Service

US Per Capita Consumption of Lettuce and Fresh Spinach



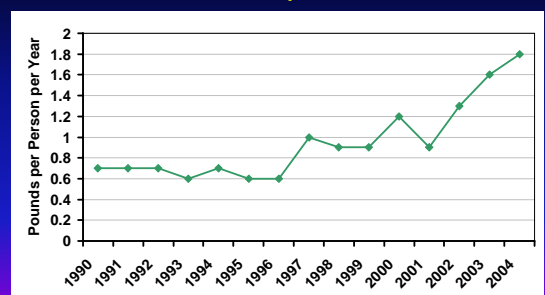
Source: USDA, Economic Research Service

US Annual Servings of Lettuce and Fresh Spinach



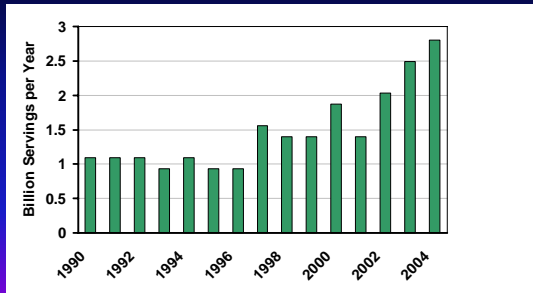
Source: USDA, Economic Research Service

US Per Capita Consumption of Fresh Spinach



Source: USDA, Economic Research Service

US Annual Servings of Fresh Spinach



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

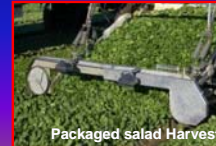


Preharvest Management



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

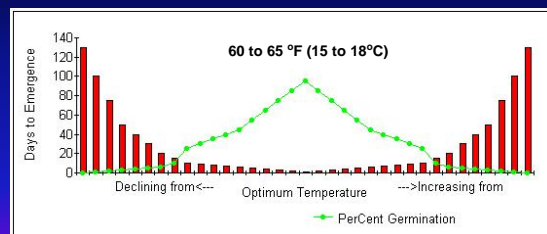
Seedbed Preparation



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



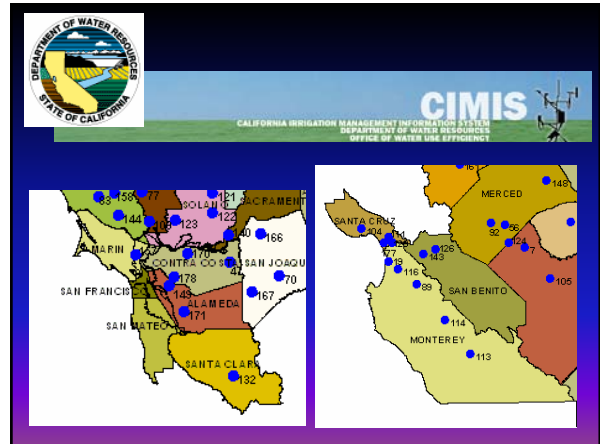
Hand Cultivation of Weeds



- 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

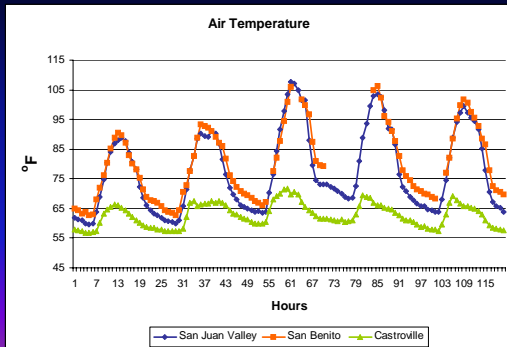
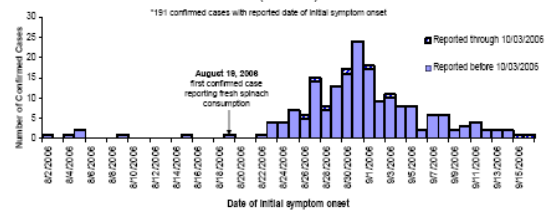
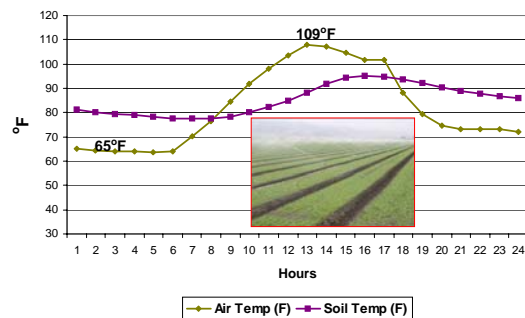


Figure 1. Epidemic curve of confirmed cases of *E. coli* O157:H7, cluster 0609miEXH-2, by date of illness onset, as of October 6, 2006, 1:00pm EDT (N=191*)

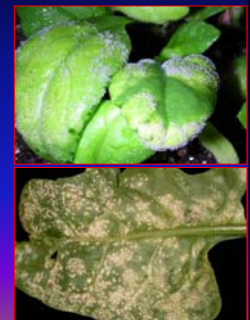


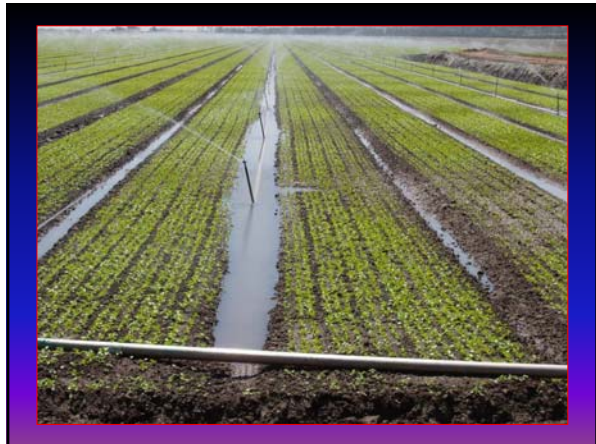
San Juan Valley 7/22/06



Important Spinach Diseases

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





Bunch Spinach Harvest

A worker wearing a grey long-sleeved shirt and bright yellow protective pants is kneeling in a field, harvesting bunch spinach. The worker is using a tool to cut the plants. To the right, a smaller inset image shows a large field of mature spinach plants ready for harvest, with a tractor and other equipment visible in the background.A close-up photograph of bunch spinach leaves, showing their vibrant green color and serrated edges. Below this, a smaller inset image shows workers in a field harvesting bunch spinach. One worker in a red shirt is bent over, cutting plants, while another worker is visible in the background.

Mechanical harvest of mature spinach for frozen market

A tractor equipped with a mechanical harvester is shown in a field, cutting mature spinach plants. The harvester is a large, specialized piece of machinery designed for efficient harvesting of leafy greens. The field is filled with rows of mature spinach plants.

Freezer/Processor Spinach Harvest

A tractor with a mechanical harvester is shown in a field, cutting mature spinach plants. The harvester is a large, specialized piece of machinery designed for efficient harvesting of leafy greens. The field is filled with rows of mature spinach plants.

Spinach Harvest for Packaged Salad and Blends

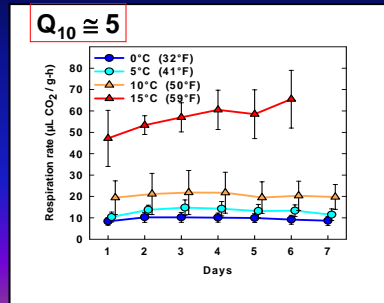
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Custom built vacuum harvester for baby greens



Respiration rates: Spinach leaves

Data are averages \pm 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



