



Yakima Valley

Sustainability and Tree Fruit Production

David Granatstein

*WSU-Center for Sustaining Agriculture
and Natural Resources
Wenatchee, WA USA*

IFTA Annual Conference, Pasco, WA, Feb. 28, 2011



Outline

- What is 'sustainability'?
- Examples for tree fruit
- Measuring sustainability
- Opportunities





Profitable – but sustainable ?

Eroded wheat field

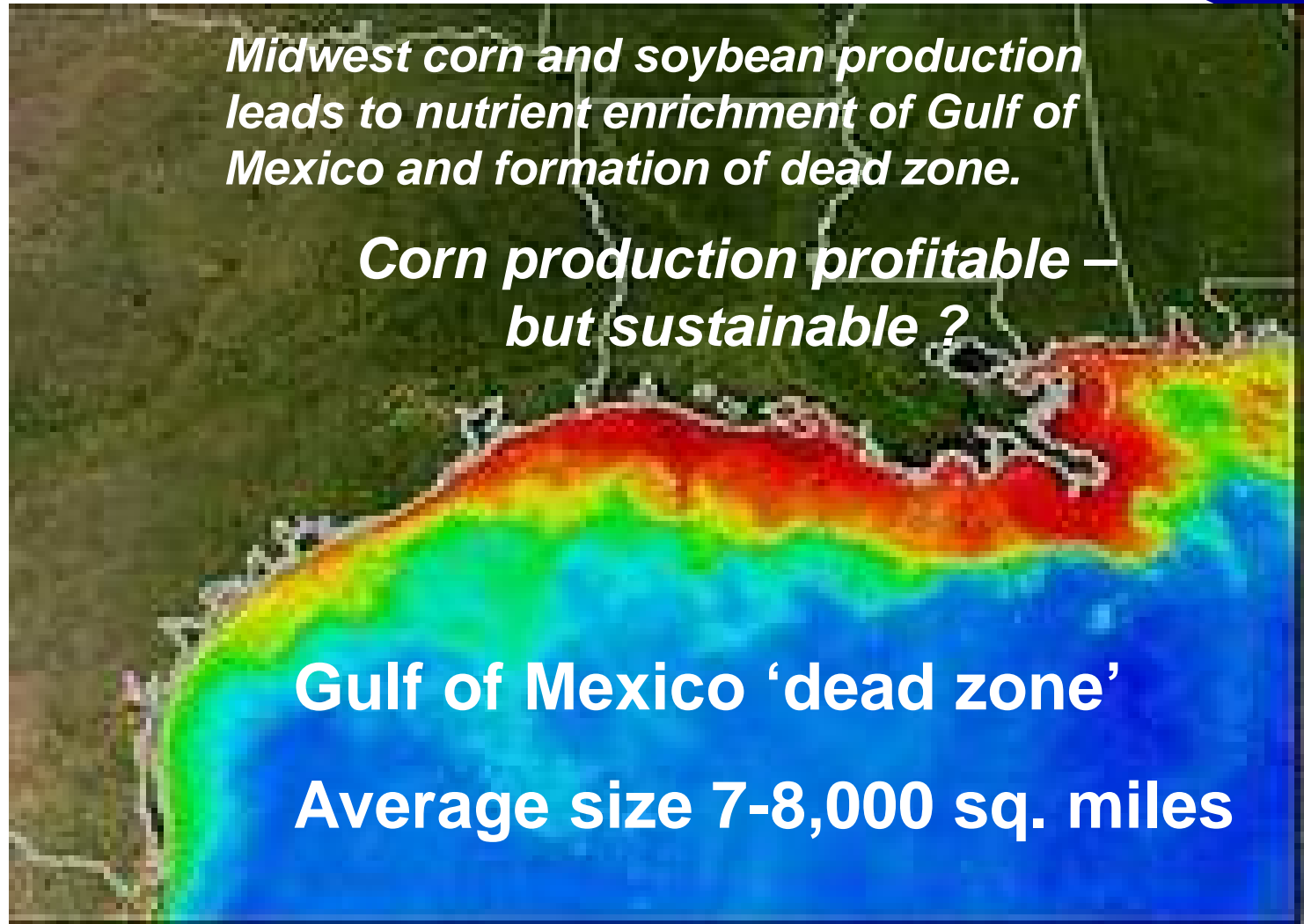
>30 tons soil loss/ac/yr

5 bu soil lost for 1 bu wheat

Midwest corn and soybean production leads to nutrient enrichment of Gulf of Mexico and formation of dead zone.

Corn production profitable – but sustainable ?

Gulf of Mexico 'dead zone'
Average size 7-8,000 sq. miles





No-till organic with cover crop roller.



Kura clover – corn intercropping.

Alternative practices are available and being implemented.

Mark Vicker's Farm
Coffee County Georgia



No-till and cover crop.



Contour strip crop, crop rotation.

Western Iowa Watershed Redesign

- **Wells Creek watershed**
 - **Sediment -56%**
 - **Nitrogen -63%**
 - **Water runoff -24%**
 - **Downstream**
 - **Cleanup cost -56%**

- **Chippewa Study Area**
 - **Sediment -35%**
 - **Nitrogen -51%**
 - **Water runoff -21%**
 - **Downstream**
 - **Cleanup cost -35%**

Burkhart et al., 2005

**Strategy: more integration of
crops and livestock**



Tree fruit does not have a lot of these problems . So what are the sustainability issues?

Sustainability Issues

Pesticides



- Worker exposure
- Residues on fruit
- Regulations
- Drift
- Pest resistance
- Water quality
- Endangered species

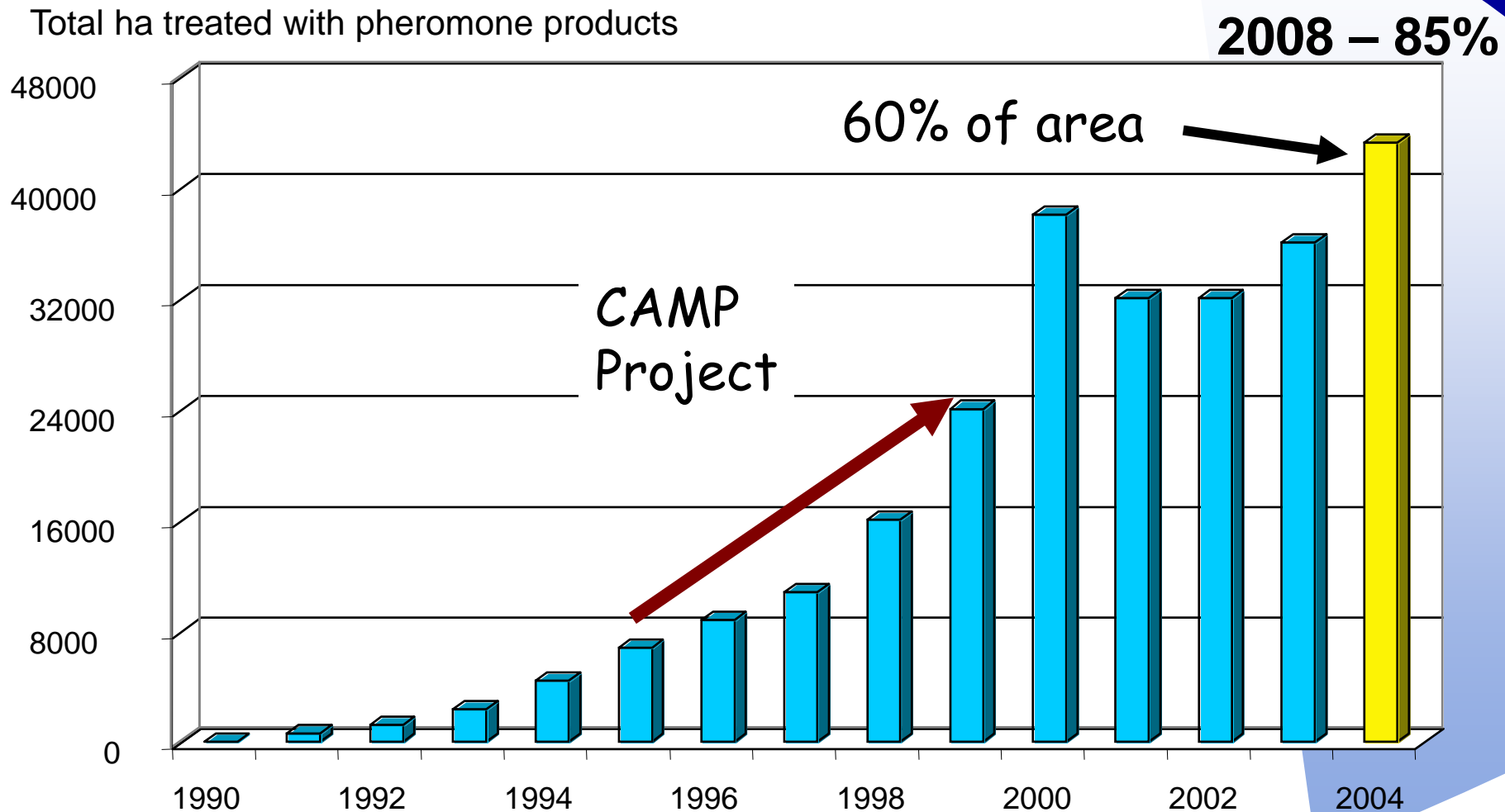
Sustainability Issues

Pesticides

IPM and Biocontrol in Washington Apples

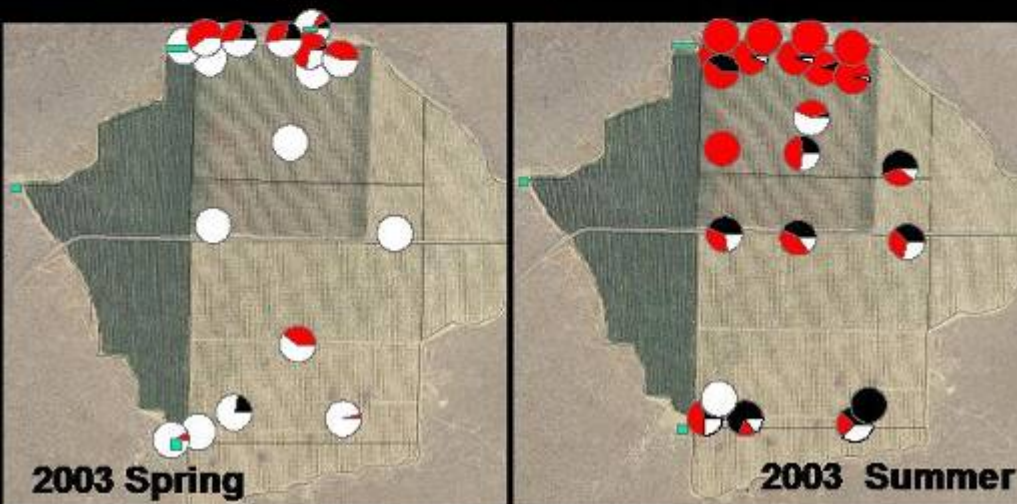
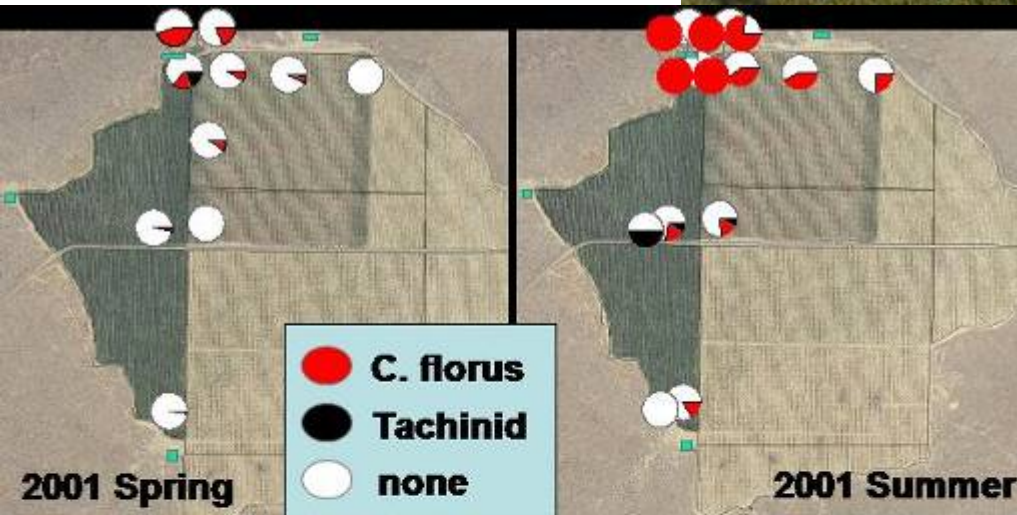
<u>Pesticide</u>	<u>Total kg a.i./yr</u>	
	<u>1989</u>	<u>2000</u>
Guthion	193,270	117,680
Dimethoate	5,410	60
Malathion	28,820	1,730
B.t.	370	11,090
Spinosad	n.a.	3,000
<u>Practice</u>	<u>% growers using</u>	
Field monitor	91	99
Econ. threshold	37	92
Use biocontrols	34	81

Codling moth pheromone products used in Washington apple and pear orchards



Source: J. Brunner

Agro-ecosystem Redesign 'Rose Gardens'



Rose gardens planted in 2000;
parasitism increases thru the
summer and has increased
from 2001-2005

Courtesy: T. Unruh

Sustainability Issues

Water

Water conservation

- micro sprinklers, drip irrigation
- soil moisture monitoring
- deficit irrigation

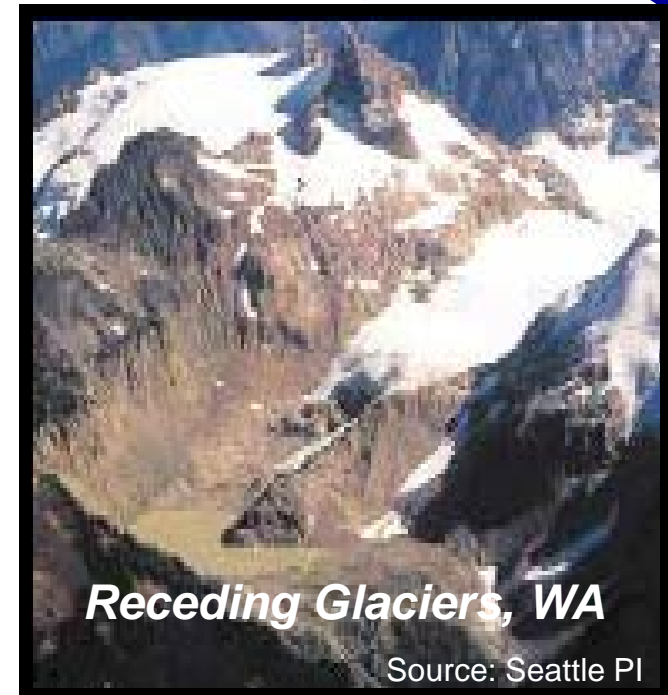
Apples, Quincy, WA

NRCS handbook (1985) 47"

Quincy grower 12"



Photo: L. Schrader



Source: Seattle PI

Water Supply

- Lower summer flows
- Endangered fish

Sustainability Issues

Energy

- Tractors
- Wind machines
- Pumps
- Trucking
- Fruit storage and packing
- Transport to markets



Sustainability Issues

Labor

- Availability
- Cost
- Safety, training
- HR practices
- Community effects



USA Pears

Social Sustainability

Broetje Orchards “...75% of our profits to local, domestic, and international projects.”



The screenshot shows the Broetje Orchards website with a green header and a yellow navigation bar. The navigation bar includes links for Home, Vista Hermosa Foundation, Snake River Housing, and Contact Us. Below the navigation bar, the main content area is divided into sections. The first section is titled "Snake River Housing Inc." and describes it as an affiliate organization of Broetje Orchards. The second section is titled "Vista Hermosa Foundation" and describes its mission and programs. There are two images: one showing a group of children and one showing an aerial view of a residential development.

Home Vista Hermosa Foundation Snake River Housing Contact Us

BROETJE ORCHARDS

Who We Are Marketplace Our Responsibility News

Snake River Housing Inc.

Snake River Housing Inc., an affiliate organization of Broetje Orchards, was created to manage the community of Vista Hermosa founded by Ralph & Cheryl Broetje in

Vista Hermosa Foundation

Vista Hermosa Foundation was established by Ralph and Cheryl Broetje in 1988 in response to the need for quality, affordable childcare for low-income and farm-working families in southeastern Washington State.

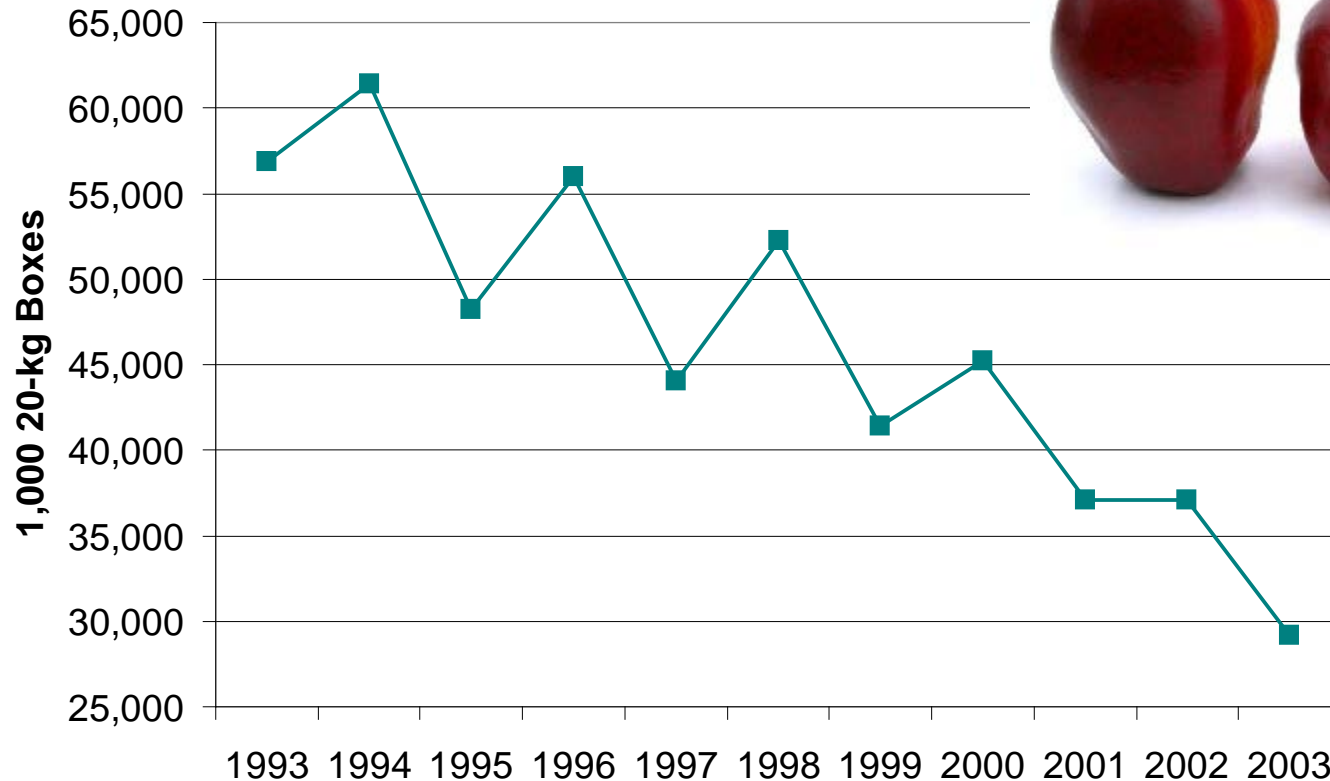
Today, we serve as the charitable arm of Broetje Orchards to carry forth its mission of "bearing fruit that will last" (John 15:16). We receive over 50% of all Broetje Orchards' profits annually to administer six core programs.

- [New Horizon Early Childhood Education Center](#). An on-site daycare licensed by the State of Washington for 71 children ages 1 month to 4 years old.



Sustainability Issues

Demand



Decline in 'Red Delicious' apple production – Washington State

Sustainability Issues

Demand

US per capita fresh fruit consumption 1970-2004:

Orange -33% Banana +48%

Grape +177% Total +24%

Apple - flat, slight decline; Cherry - increase

Predicted 5-8% increase for fruit from 2000-2020

Greater emphasis on fruit and vegetable consumption

– ‘Five A Day’ campaign

Growth in pre-sliced fruit – convenience factor, healthy snack food

New fruit varieties, more focus on flavor



Sustainability Issues

Profitability

WSU study – high density Fuji apple, 40 ha farm

Variable costs	\$7350 / ha
Fixed costs	\$6867 / ha
Labor	\$ 3.12 / box
Total growing + harvest	\$10.28 / box
Warehouse costs	\$ 7.50/ box
Breakeven	\$17.78 / box
Ave. price 2000	\$12.75 / box
Loss	\$6916 / ha



1995-2002 – price > breakeven in 4 of 8 years

(Schotzko, 2004)

Sustainability Issues

Demand and Profitability

	<u>2007</u>	<u>2008</u>	<u>2009</u>	<u>2010</u>
	- - - - - \$/box FOB - - - - -			
All varieties	21.40	16.72	19.05	19.93
Red Delicious	19.73	14.52	16.36	16.67
Honeycrisp	44.66	44.18	40.61	45.80



Sustainable Pricing

Shepherd's Grain – price based on transparent cost of production plus reasonable rate of return

Sustainability

Sustain: to endure, to last indefinitely

Sustainability – a goal we move towards, not a threshold that is crossed



Sustainable Agriculture

- Balance **economic**, **environmental**, and **social** aspects
- “A more sustainable farm” vs. “A sustainable farm”
- Is easier to say what is NOT sustainable than what is
- Is best judged in hindsight
- Is a relative term, depending on assumptions, conditions (e.g., energy, irrigation)

Agricultural sustainability:

- Ability of farms and agricultural landscapes to **evolve** indefinitely under farmer management and public policy toward greater productivity of goods and services and toward effective interfaces with **changing** biological, economic and social environments. *--Richard Harwood*

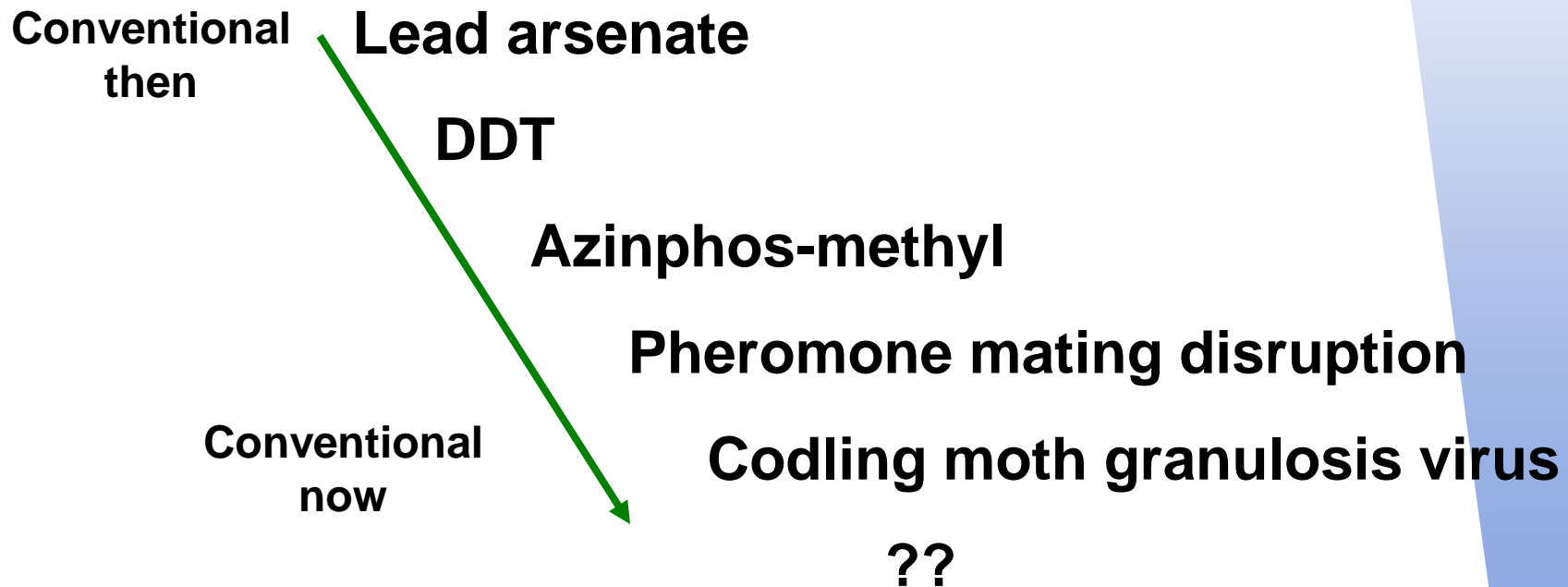


Can agriculture be “sustainable” if
the rest of society is not?

Sustainability is Relative

Pest management successes – IPM, biocontrol,
reduced risk products

Apple - *Cydia pomonella* control – change over time



Has fruit production become more sustainable?



‘Pedestrian’ orchard benefits:

- economic (faster returns, higher quality fruit, potentially lower labor costs for maintenance)
- environmental (better IPM)
- social (less risk of worker injury with few or no ladders)

How do we measure sustainability in agriculture?

System comparison studies

- long term studies
- do they use the latest technology?

Established standards

- soil erosion (tolerable soil loss)
- water quality (10 mg/L nitrate)
- pesticide residues, worker exposure

Indices – soil quality, Env. Impact Quotient

Economics – profitability, new farmers

Social – family farms, community impacts, food quality and human health

No single unifying measure

Effect of orchard management system on sustainability indicators

WSU Apple Systems Trial - Zillah, WA USA

	<u>Conv.</u>	<u>Integrated</u>	<u>Organic</u>
Total energy input (MJ/ha)	516,489	488,661	445,328
Environmental impact rating	2,893	2,211	466
Soil quality rating	0.70	0.81	0.83
TCSA 6th leaf (cm ²)	28.0	28.2	28.5
Fruit yield 1996-99 (MT/ha)	210	205	198
Variable costs (\$/ha/yr)	10,145	9,666	9,124

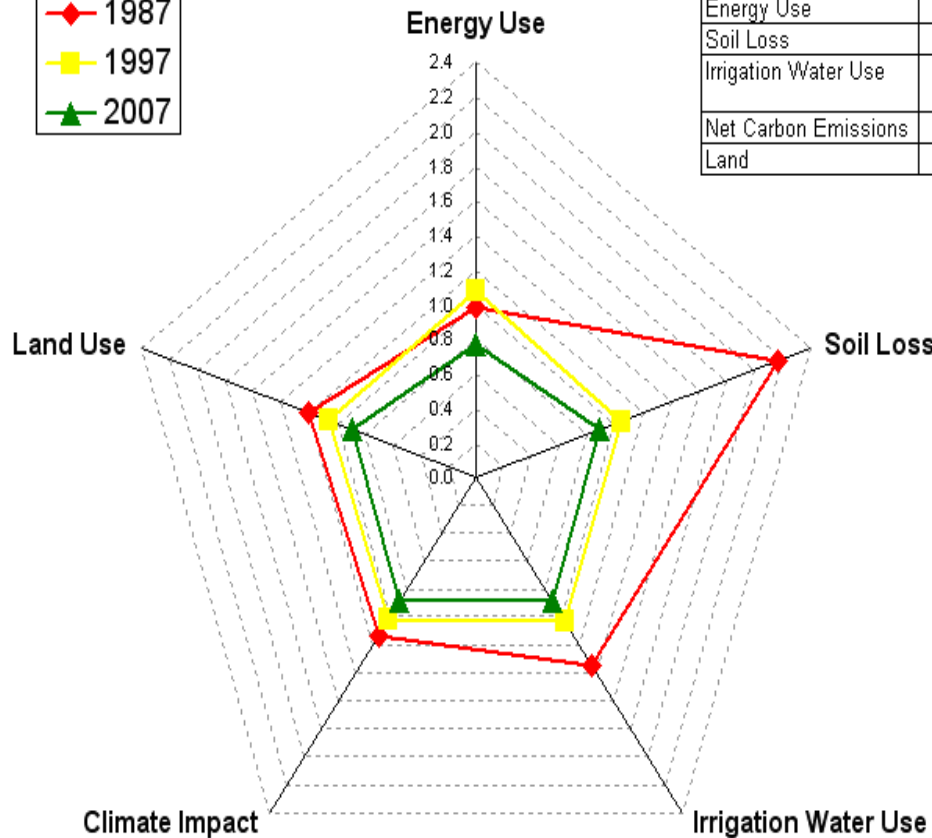
(Reganold et al., 2001)

Fieldprint Calculator Results for Corn

Corn Efficiency Indicators (Per Unit of Output, Index 2000 = 1)



Year	2000	Unit
Energy Use	0.057	Million Btu/bushel
Soil Loss	28.7	Pounds soil/bushel
Irrigation Water Use	5.6	Thousand gallons/Incremental bushel due to irrigation
Net Carbon Emissions	3.0	Pounds Carbon/bushel
Land	0.013	Acres/bushel

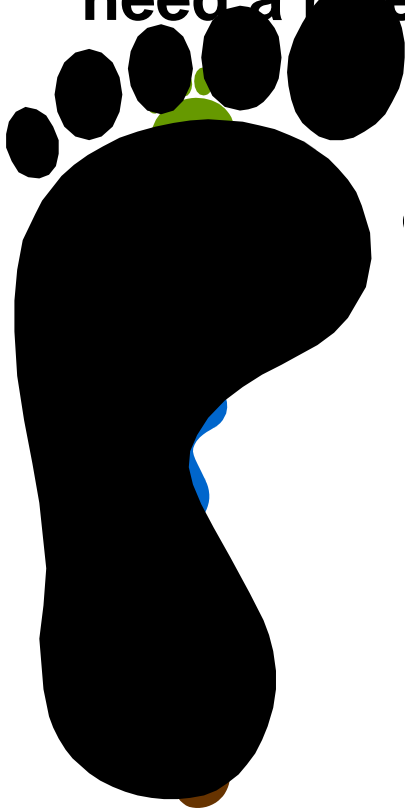


(Values are expressed as 5-year centered averages.)

Source: Keystone Alliance

What is a footprint ?

**A measure of the impact of a system, practice, or product on one or more environmental factors;
need a reference point**



Life Cycle Assessment

**An environmental analysis;
“cradle to grave”**

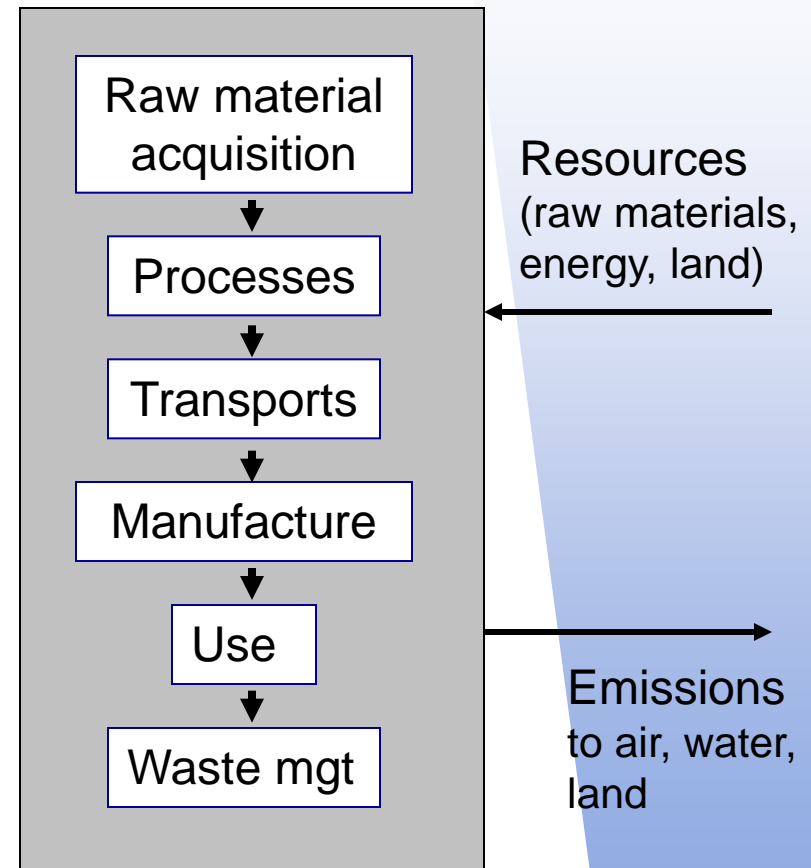
Life Cycle Assessment

Started in the 1970s as an *environmental analysis tool*; “cradle to grave”; initial focus on industrial, manufacturing processes; ISO 14400 standard.

Steps:

- Goal and scope definition
- Inventory analysis
- Life cycle impact assessment
- Interpretation and presentation of results

Life Cycle Model



Apple

Small inherent footprint

**Plant seed; water (rain or irrigate);
pick fruit; eat; throw away core**

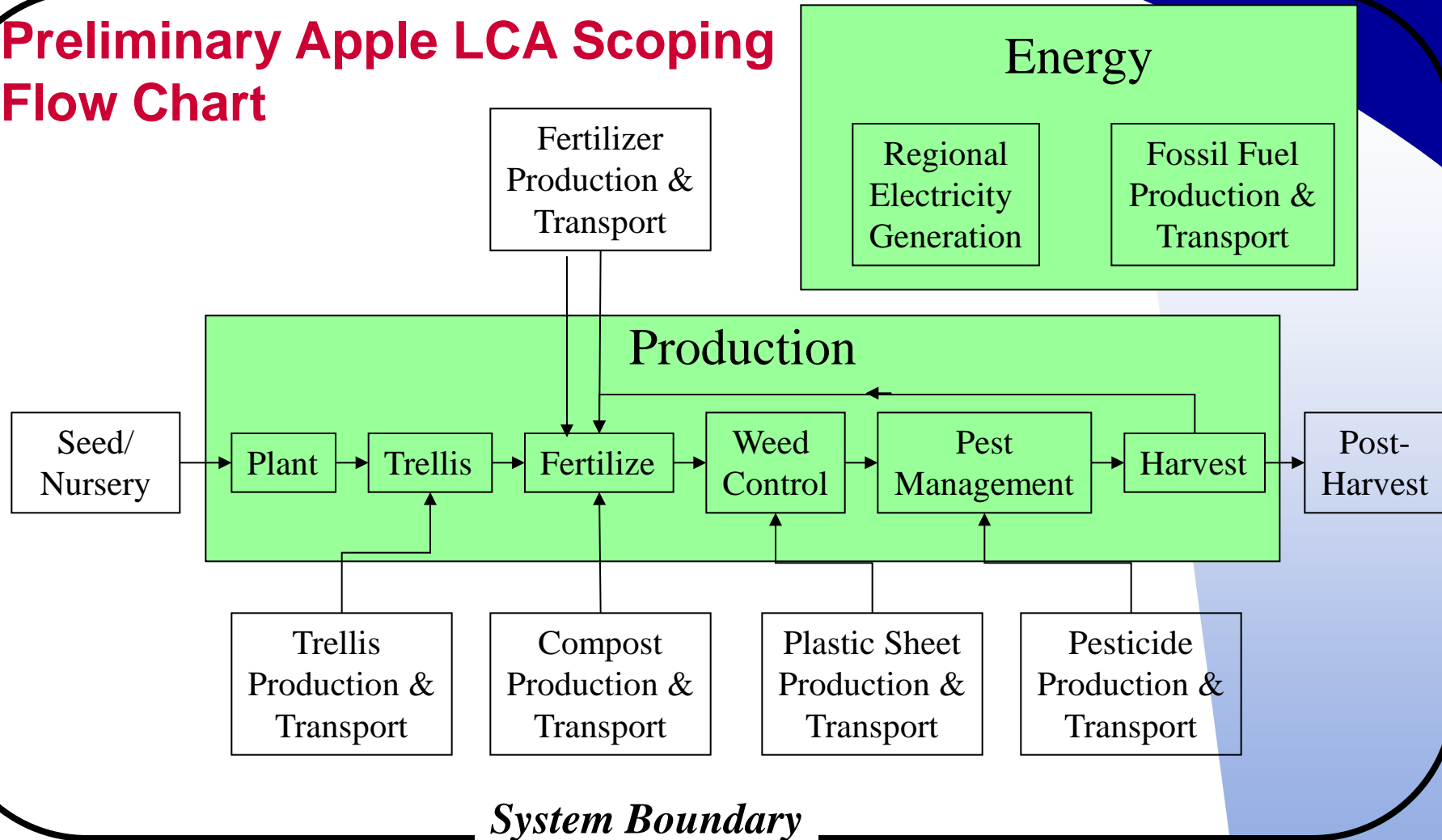
As we add management, we add footprint:

- tractors to plant trees;
- irrigation piping and pumps;
- bins, CA storage, packing lines, boxes;
- trucks for transport;
- waste disposal

**Compare to car: everything has a footprint -
Metal, glass, plastic, paint, fuel, paved road**



Preliminary Apple LCA Scoping Flow Chart



Energy is an input to almost all processes; for simplicity, its arrows are not included in this diagram

(IERE, 2001, unpublished)

New Zealand Apple LCA

Energy

Machinery use 64-71%

Fertilizers 5-11%

Total energy = 420-720 MJ/Mt apples

Differences among producers for same operation varied 40-80%

GWP

Energy related CO₂ emissions 34-50%

Fertilizer 25-51%

N₂O: Urea > CAN

GWP = 40-98 kg CO₂e/Mt fruit

Uncertainty: +/-50% is common

Many Different LCA Numbers

	Author	kg CO ₂ e/Mt apple	kg CO ₂ e/ha
NZ	Milia i Canales	40 - 98	2560 - 4802
NZ	Saunders et al.	185	9250
UK	Saunders et al.	272	3808
Europe	Kägi et al.	100 - 170	3157 - 5490

Use LCA to identify 'hot spots', compare production options, improve efficiency, make product claims

What's driving sustainable ag standards and certification?

↓
Evolution over time
↓

Environmental movement

Science

Regulations

Grower interest

Consumer interest in food and farming

Corporate sustainability



Walmart: Sustainability Index

Will ask suppliers about:

- water
- energy
- fertilizer
- pesticides

used per unit of food produced.

**Sustainable Produce Assessment
for producers in 2011**

Involved in:

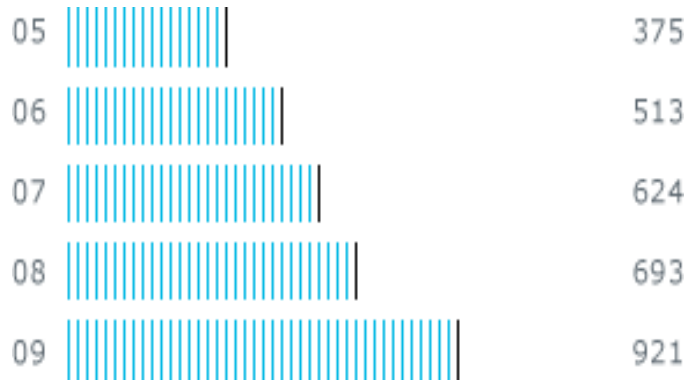
- Sustainability Consortium
 - Stewardship Index for Specialty Crops
 - Field to Market Alliance
- to develop science-based metrics.



SYSCO 2010 Sustainability Report

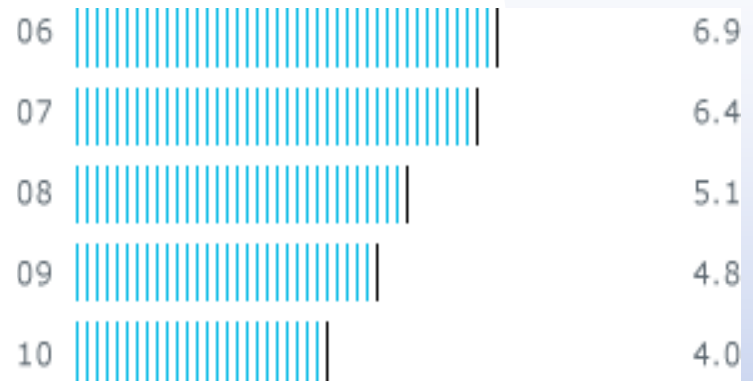
Acres in IPM Program

in thousands of acres



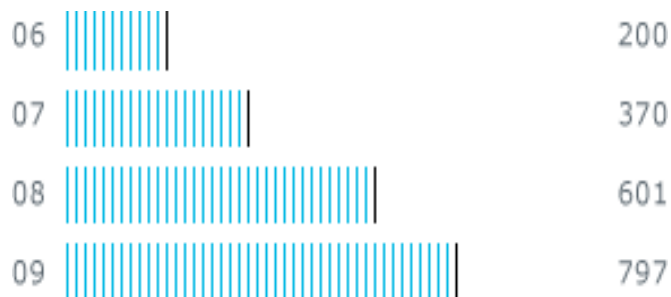
OSHA Recordable Injuries

injuries per 100 employee equivalents



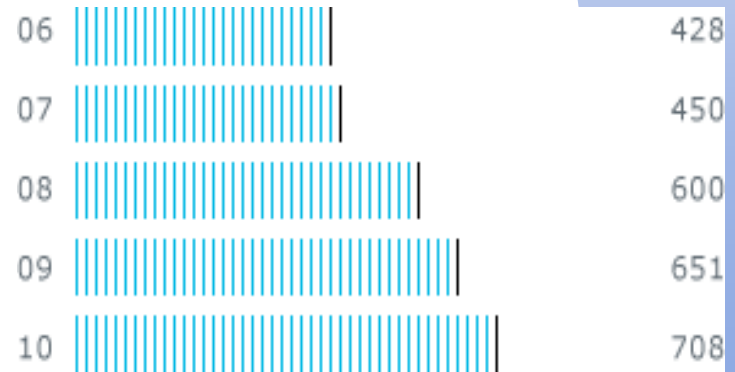
Estimate of Pesticides Avoided

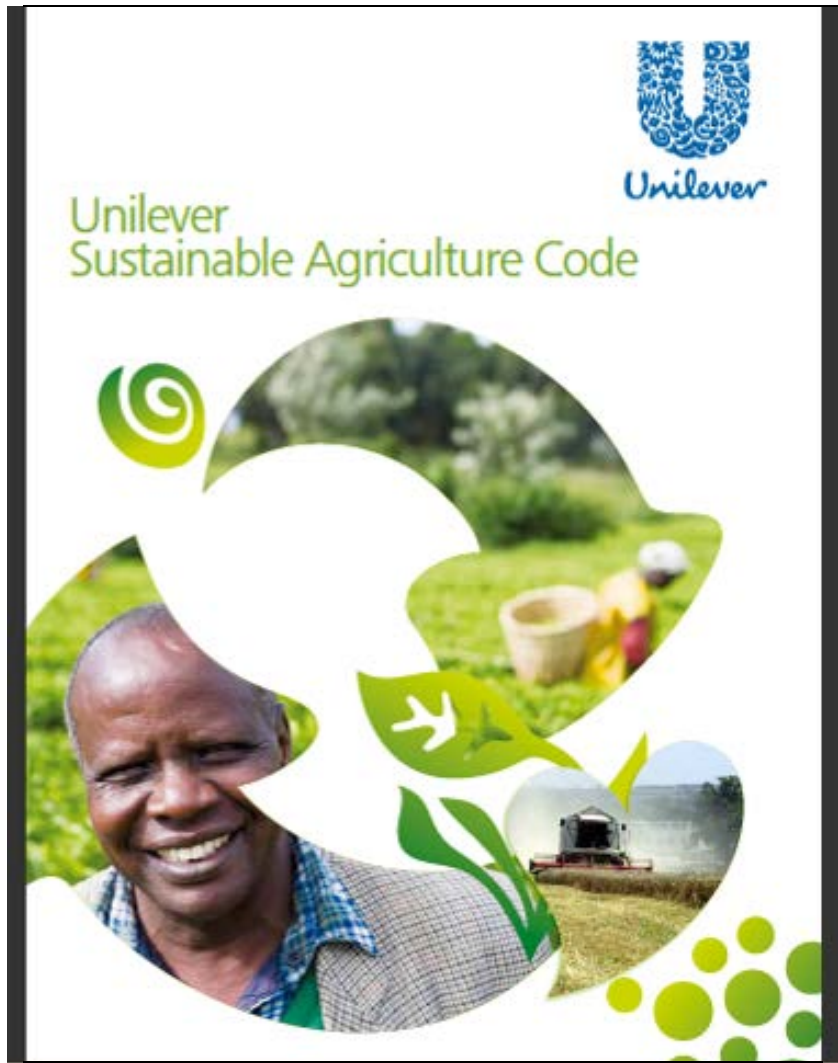
in thousands of pounds of a.i.



Product Purchases from Minority & Women owned Suppliers

in millions of dollars





Published 2010; 76 pp.

Unilever

Continuous improvement

Soil, water, agrochemicals

Biodiversity

Energy, waste

Social and human capital

Metrics

<http://www.growingforthefuture.com/index.php>

Environmental Criteria

	USDA Organic	Food Alliance	Salmon Safe	Protected Harvest			SYSCO	Red Tomato EcoApples; Stone Fruit	Global GAP
				WI Potato	CA Strawberry	Stone fruit			
Soil Quality & Conservation	X	X	X	X	X	X	X	X	Rec.
Water Quality	X	X	X	X	X	X	X		X
Water Use		X	X	X	X	X	X	X	X
Nutrient Mgt	X	X	X	X	X	X	X		X
Biodiversity	X	X	X	X	X		X		Rec.
Wildlife Habitat	X	X	X	X	X	X			Rec.
Air Quality					dust	X	X		
Sensitive area Mgt		X	X				X	X	Rec.
Pollinators		X							
Beneficials Mgt	X	X		X	X			X	
Non-GMO	X	X					X		
GHG Emission				Pt LCA					
Energy Use, Farm				X		X bonus	X		Rec.
Recycling, Farm				X			X	X	Rec.
Packaging, Farm							X		X

GLOBALGAP and SQF

Equivalent acceptance

Additional elements beyond Food Safety

GLOBALGAP standard designed in response to consumer concerns:

- **Food Safety** (strong)
- Environmental protection (baseline...not comprehensive)
- Worker health, safety and welfare (strong)
- Animal welfare

SQF Voluntary Modules:

- Responsible Environment Practice module
 - Responsible Social Practice module
- Source: GLOBALGAP and SQF

Global Food Safety Initiative goal: “Once certified, accepted everywhere.”

Future Sustainability

FOOD = SUNSHINE + OIL

Shifting the Paradigm: Current Solar Income

- More solar energy intersects the earth in 24 hours than is contained in all of the conventional oil reserves the world has (not all of this solar energy could be captured).
- Total global annual consumption of energy (400 quads) is roughly equivalent to 40 minutes of sunlight intersecting earth.

Source: G. R. Davis. Energy for planet earth. Scientific American. September, 1990, p. 55-62.

ENERGY – the fundamental ‘currency’ of life

Solar Energy Capture

Usable Energy

100%

40%

32%

24%

5%

Carbohydrate

Total solar energy hitting earth

- ↳ Non-absorbed wavelengths (60%)
- ↳ Reflection and transmission (8%)
- ↳ Heat dissipation (8%)
- ↳ Plant metabolism (19%)

100 Kcal solar energy yields max.
4-5 Kcal chemical energy stored
per gram dry matter of biomass

PV: 7-17% capture

(Taiz & Zeiger, 2002)

Future Sustainability

Sunshine Farm Experiment

50 acre crop and livestock farm, Kansas – 10 year study

Energy generated on farm per year **236 GJ**

Annual energy needed **263 GJ**

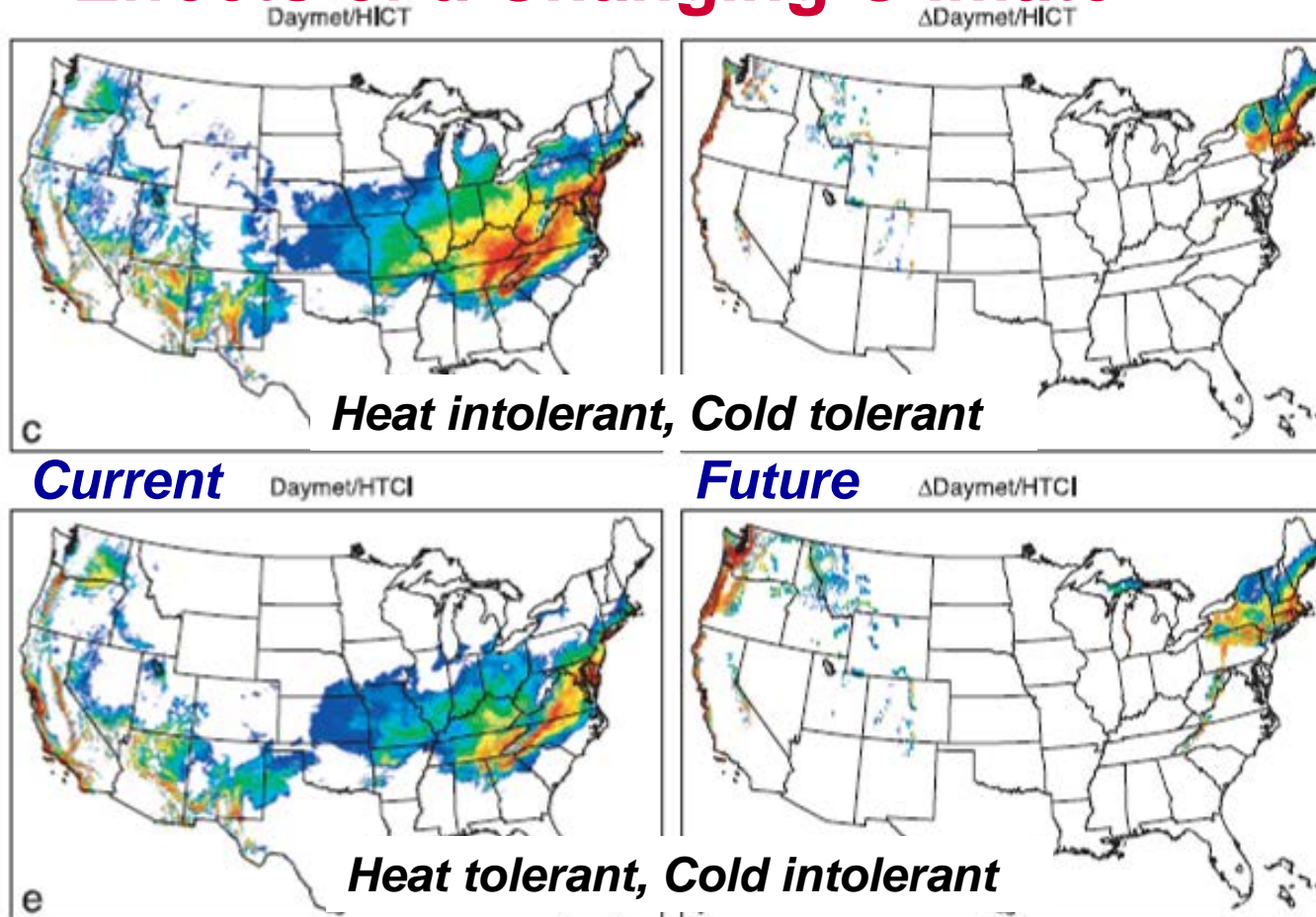
“Amortized” embodied energy **154 GJ**

-- Build some energy production into farms

	<u>Energy ratios</u>
Oil (Saudi)	100
Gas, coal	10-30
Solar, wind	3-10
Renewables from ag	5 or less

(M. Bender, 2003)

Future Sustainability Effects of a Changing Climate



**Premium winegrape area in US declines 81%
by late 21st century under IPCC scenario A2
(White et al., 2006)**

Future Sustainability

Challenges:

- Energy
- Water
- Labor
- Pesticides
- Climate
- Consumer demand

*Genetics/
genomics*



Mechanical cherry harvest

Opportunities:

- Biofuels, solar
- Irr. mgt., mulch
- Mechanization
- Biocontrol
- High tunnels
- Flavor, label identity, nutraceutical content



Shrinking the Footprint

- **Biocontrol practices/products**
- **Less machine use; biofuel, electric vehicles; solar roof; wind machine → wind turbine**
- **Less N; change fertilizer form; use legumes in orchard**
- **Genetics – pest resistance, water and nutrient efficiency, tree habit**
- **Lower impact trellis systems**
- **C stored in soils, trees**



Closing Thoughts

Sustainability – a journey, a goal, not a destination; more than profitability

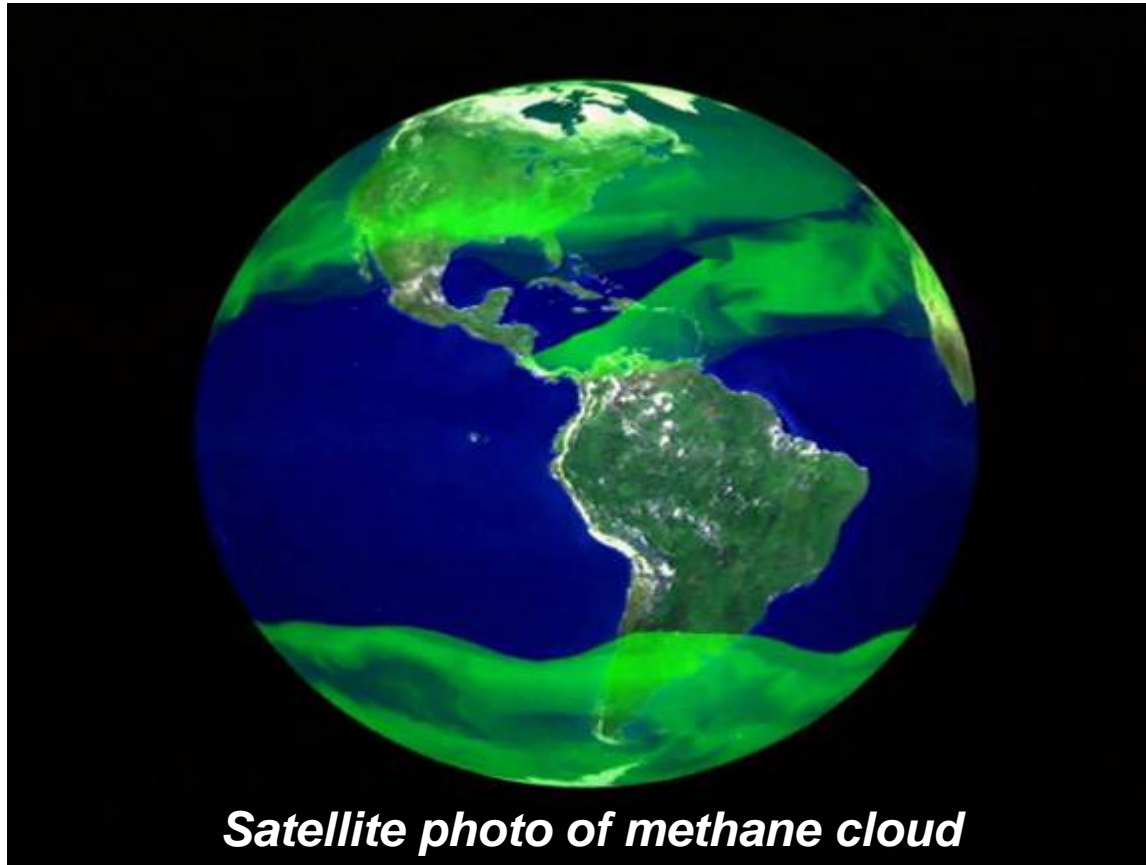
Fruit production has become more sustainable; farms, industry can have continual improvement; let's document

Big challenges – energy, water, labor, pesticides

Tree fruit has sustainability advantages; zero impact farming unlikely



Questions ?



Satellite photo of methane cloud

Recommended read: Paul Dolan, *True to Our Roots*