Best Management Practices and Agricultural Biofuels in California

Stephen Kaffka

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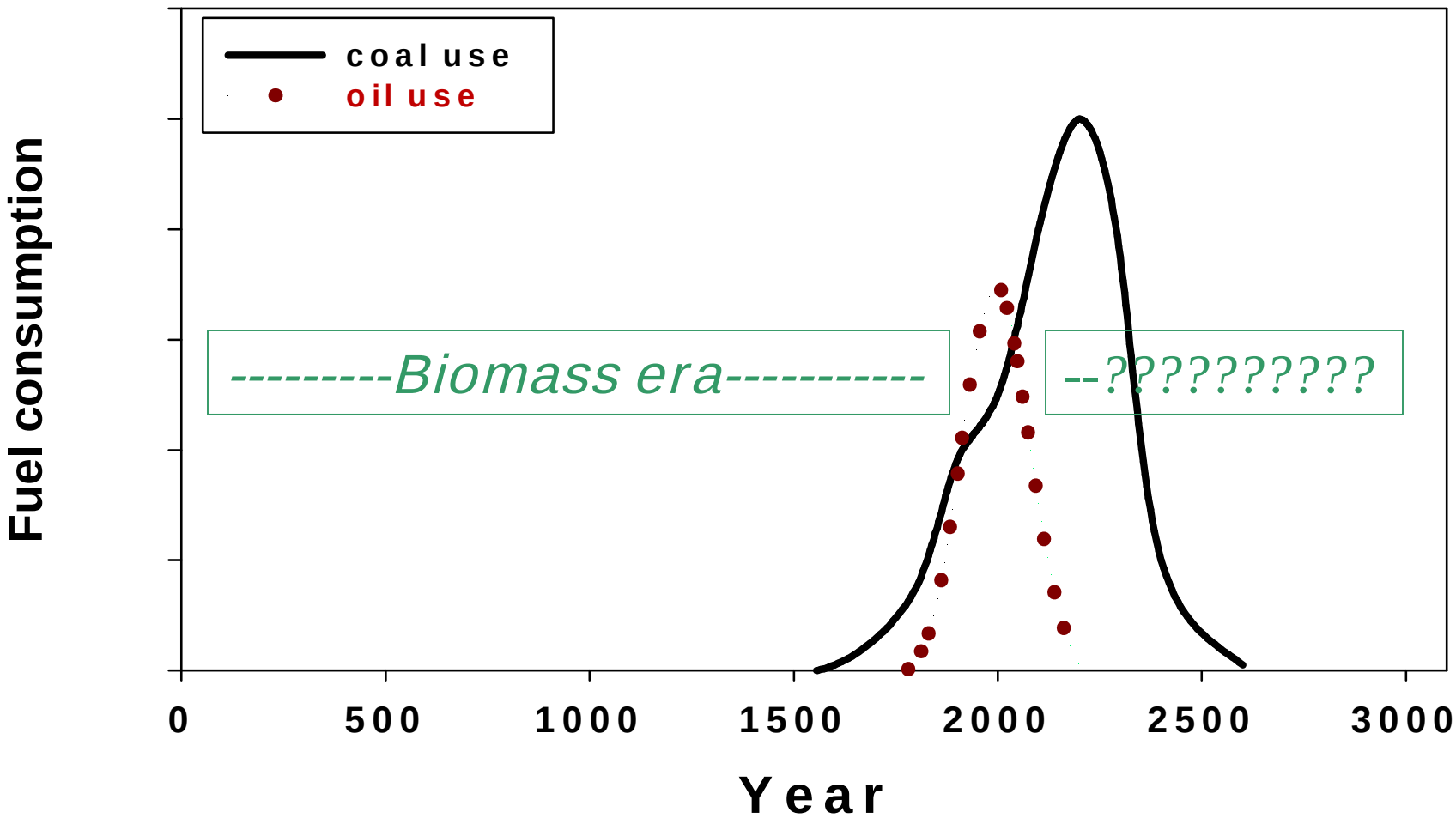
University of California, Davis &

California Biomass Collaborative

August 15, 2008



Expected duration of fossil fuels (0 to 3000 AD)

(redrawn from P.E. Hodgson, 1999)

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Overview:

1. What do we mean by Best Management Practices?
2. Examples of field-scale BMPs
3. Field vs. farm vs. region
4. Changing ideas about BMPs: Sustainability?
5. How to determine if BMPs are being used?
6. Policy implications

The objectives of agriculture:

1. To provide an adequate food supply for a growing human population at a reasonable price.
2. To provide an increasingly high quality diet for all the world's people.
3. To maintain the income of farmers at levels comparable to that of the urban population
4. To maintain the natural resource base of agriculture.
5. To use non-renewable resources prudently.
6. To maintain and provide habitat and resources for other species, and to maintain the function of supporting natural ecosystems.

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Farmers (and agricultural policy makers) attempt to find an optimum balance among all these objectives. Best Management Practices are those that allow farmers to achieve this balance.

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7. **To produce transportation fuels and other forms of surplus energy from crops and residues.**

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Adding this additional objective requires a rebalancing of the original objectives.

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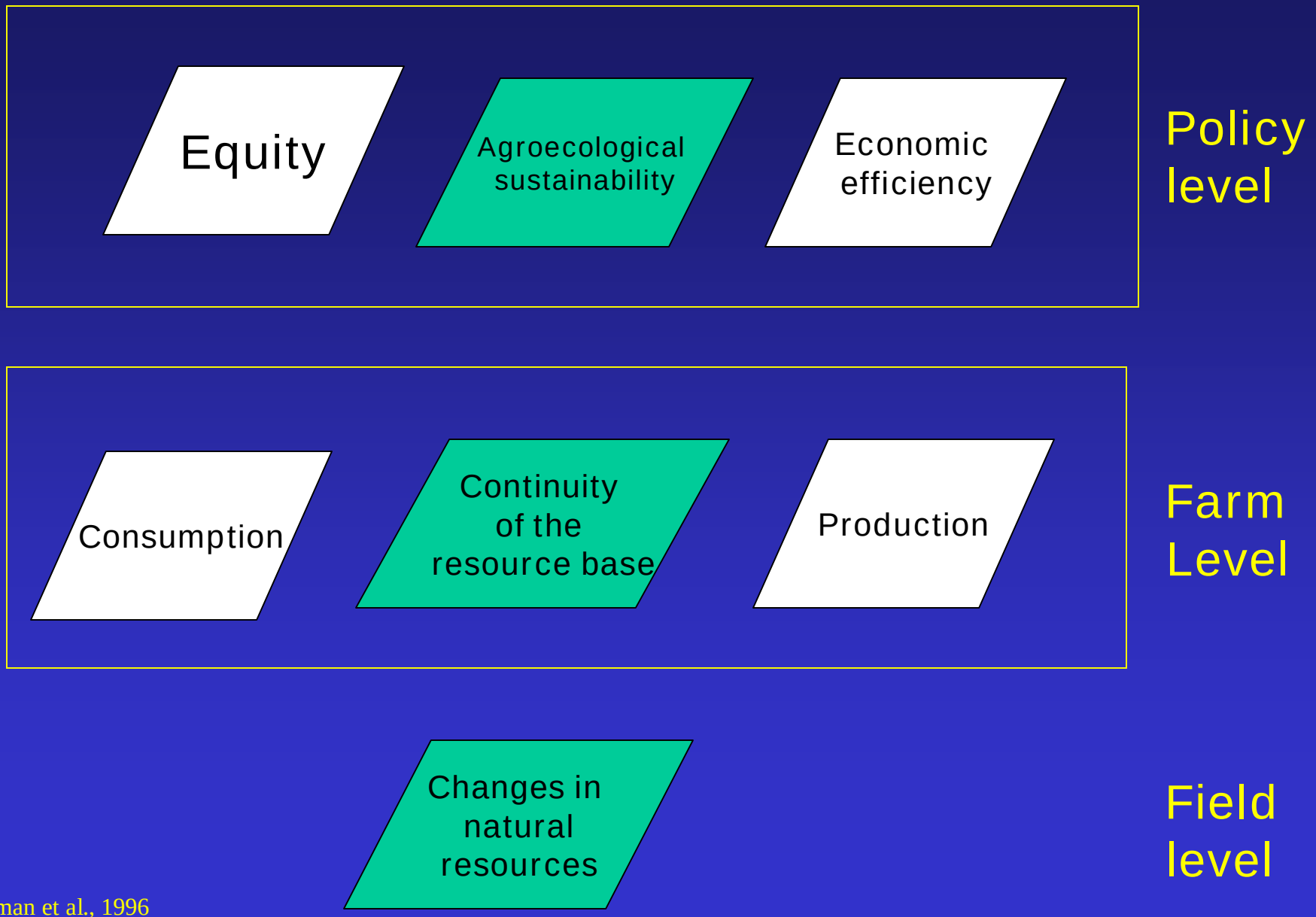
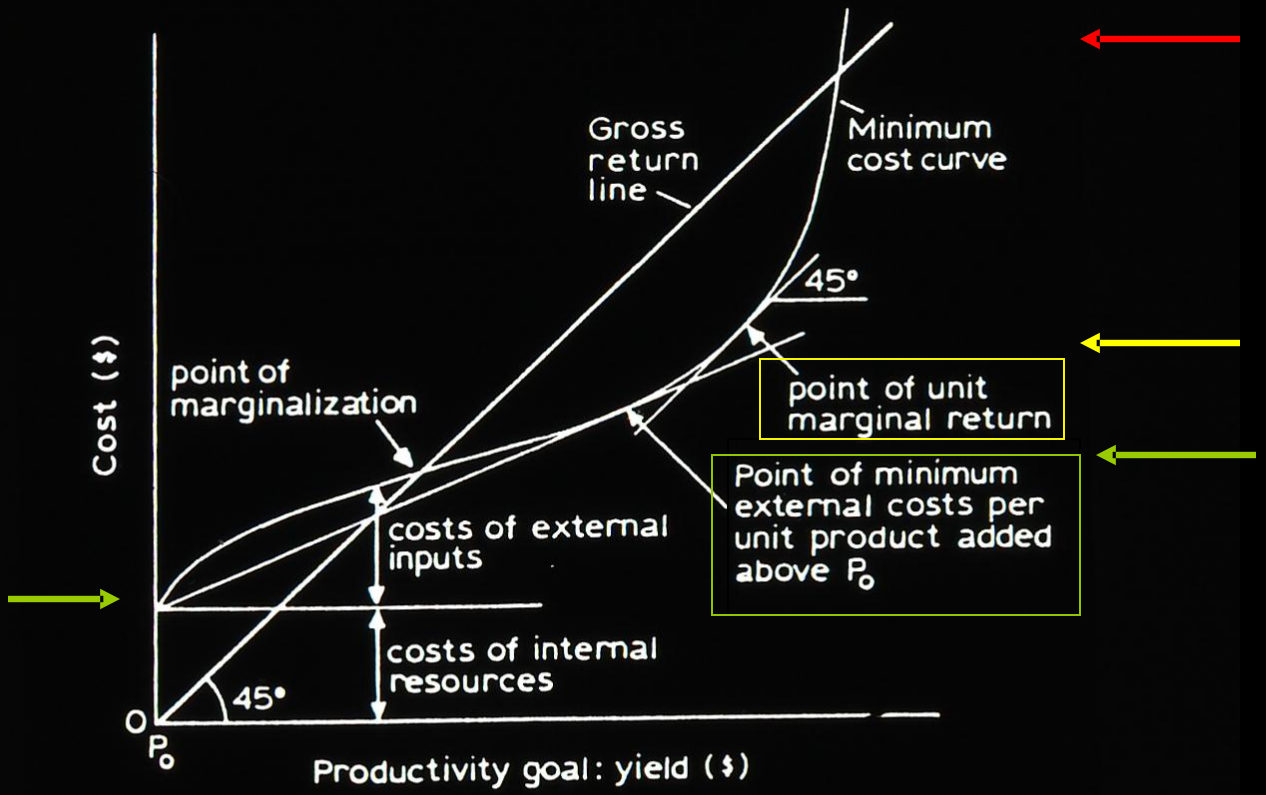
Uncertainties about the future of bioenergy production that affect the development or identification of BMPs

- What will be the best feedstocks?
- What will be the best manufacturing technology?
- What will be the future public policies governing biofuel production and use?
- What will be the supply and price of oil and natural gas in the future?

What we call a BMP depends on the boundary conditions



Kruseman et al., 1996



Cost of land and family labor

Minimum production costs as a function of productivity (or profitablity) goals of farming systems. (de Wit, 1992 adapted from Holt, 1988).

De Wit, 1992, Agric. Sys.

"… a feature of (agricultural) intensification is that it is not the improvement of one growing factor that is decisive, but the improvement of a number of them."

This leads to positive interactions that result in the total effect of all these improvements being larger than the sum of the effects adopted separately.

Increasing returns to total factor productivity :

The need for nutrients and water, expressed per unit surface area, increases with the yield level,

but decreases when expressed per unit yield.

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de Wit 1992

Increasing returns with fewer inputs:

At the highest production levels, it is easier to manage inputs with good efficiency than at lower production levels. (Responses to inputs are better understood and managed).

De Wit, 1992

The overall environmental impact of food production is minimized via intensification.

But while the need for energy, fertilizers, and biocides per unit product is lowest, local environmental standards may be threatened

… and

Cropping systems tend to become specialized, with fewer crops grown in the areas where it is most efficient to produce them.

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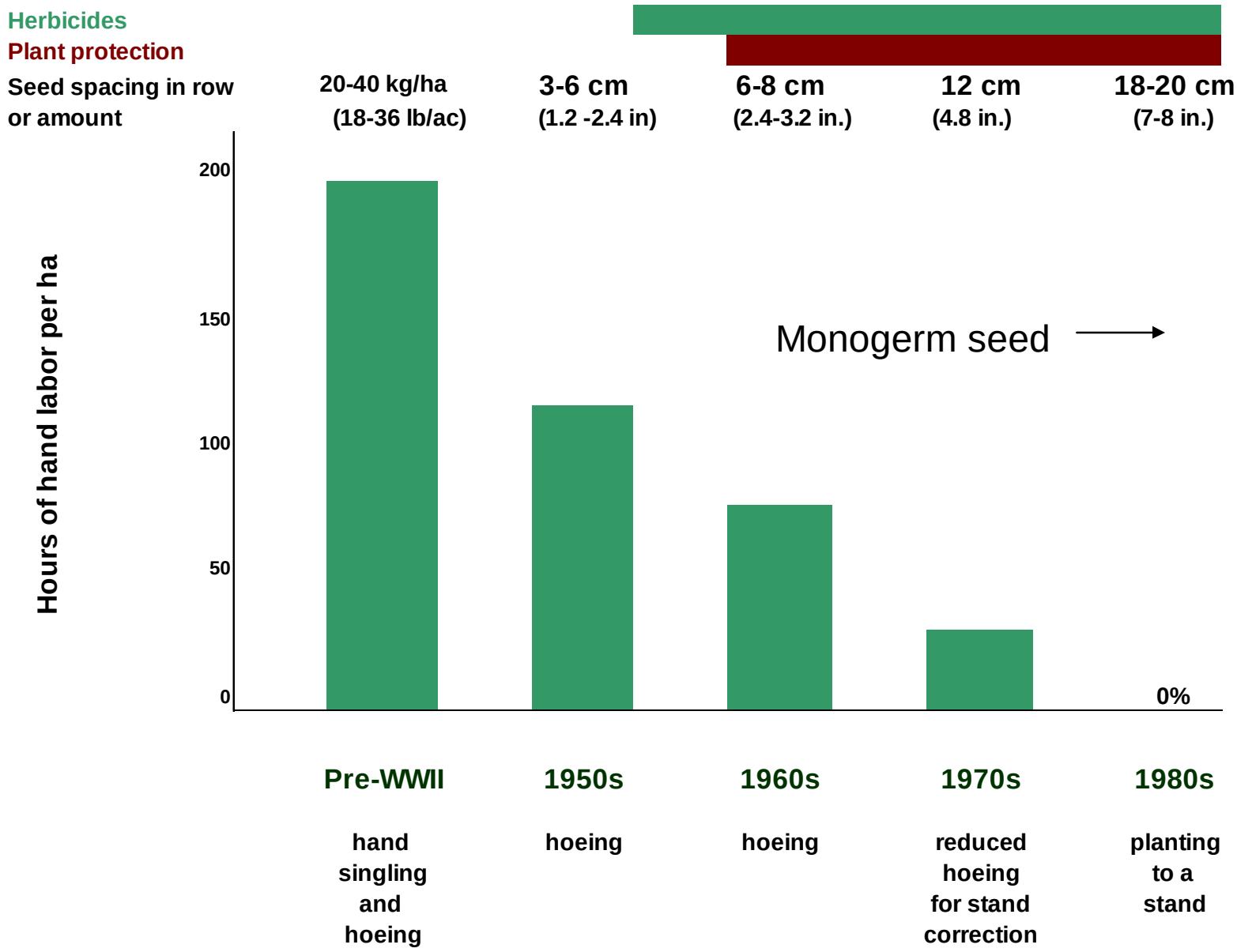

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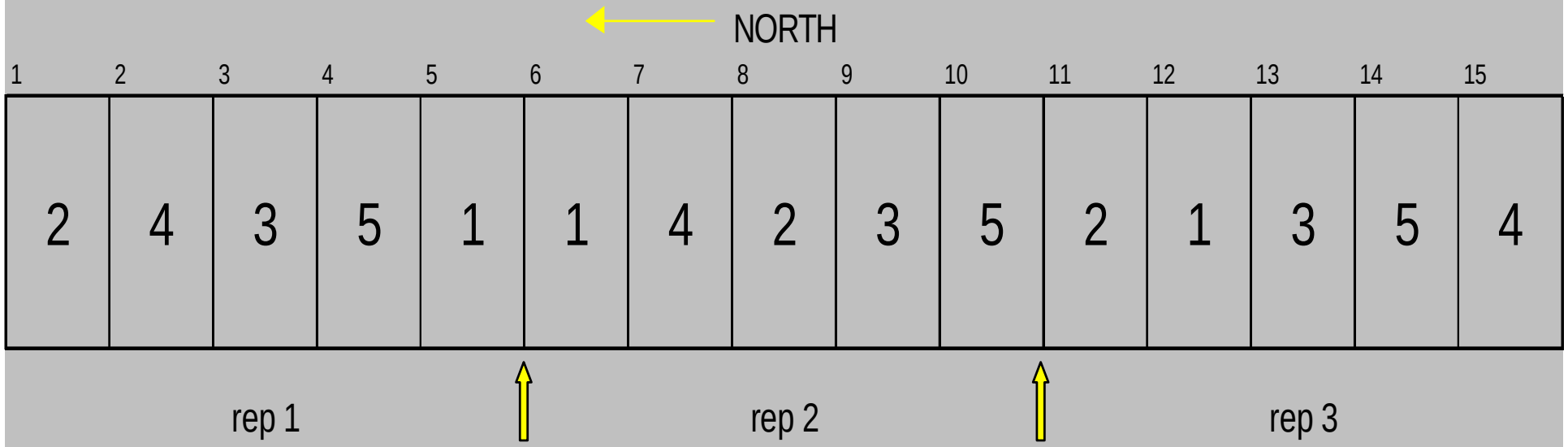
Goals of the SB Pest Management Alliance Program-CA DPR

- To promote reduced risk pest management practices. Reduced risk means reducing the use of P65 chemicals: those suspected of being carcinogens or toxic to the nervous, or endocrine systems (chlorpyriphos, methmyl, diazinon).
- To demonstrate successful reduced risk pest management practices.

Imperial Valley Seedling Protection Trial (PMA)

Field Location: Orita 4

Grower: Curt and Tom Rutherford



Treatment

1. Grower Standard Practice - marked with ORANGE flags
2. Gaucho 480
3. Control
4. Xentari (Bacillus thuringiensis) - marked with GREEN flags
5. Control + Lorsban at first sign of emergence - marked with ORANGE flags

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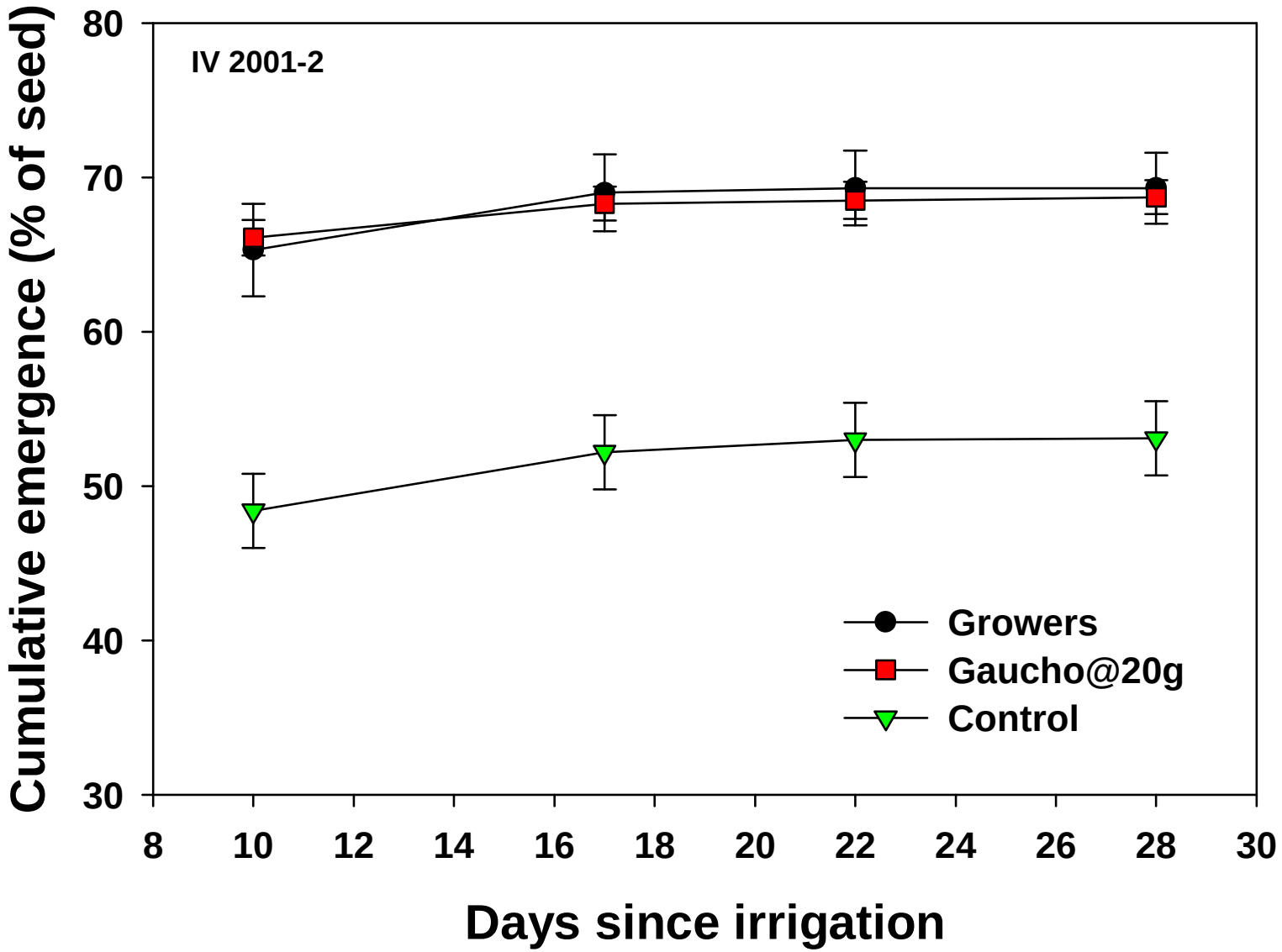


Stand establishment in the IV (1999)

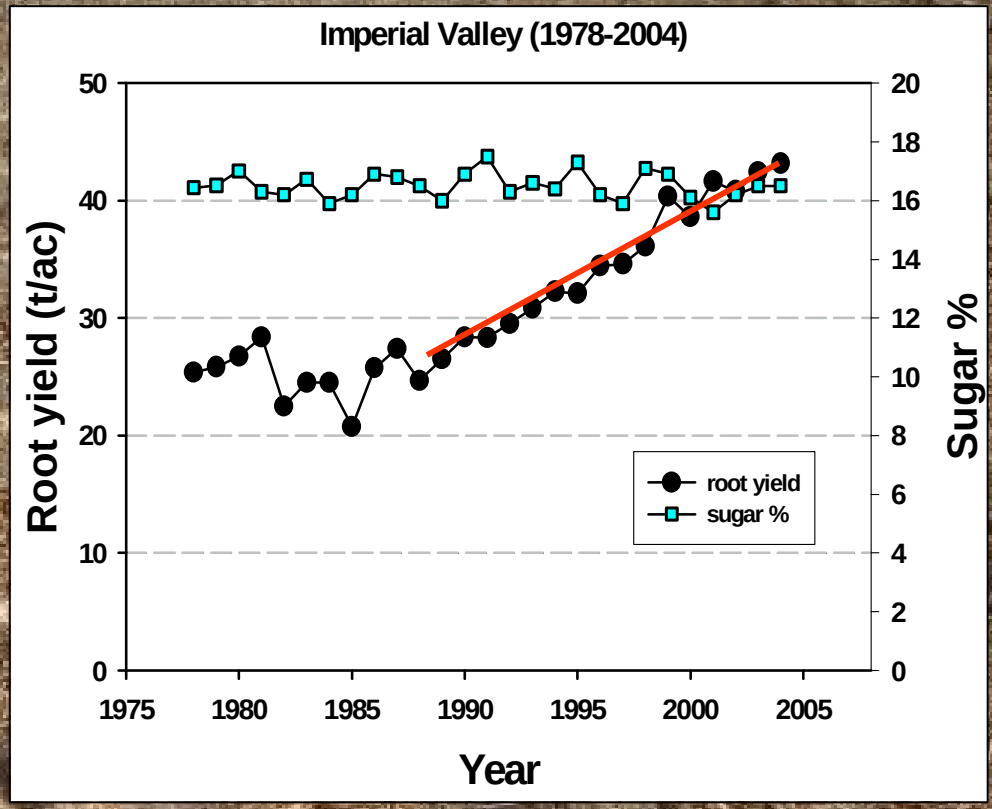
Treatments	***Cumulative Emergence %***	***Cumulative post emerg. mortality (%)***	***Pre-emergence loss (%)***	***Established (%)***
Grower's	**82.2**	**2.7**	**17.8**	**79.3**
Gaucho	**79.4**	**5.1**	**20.6**	**74.1**
Control	**56.3**	**8.1**	**43.7**	**47.5**
Bt	**55.6**	**5.5**	**44.4**	**49.7**
C+1 spray	**58.2**	**6.2**	**41.2**	**51.6**

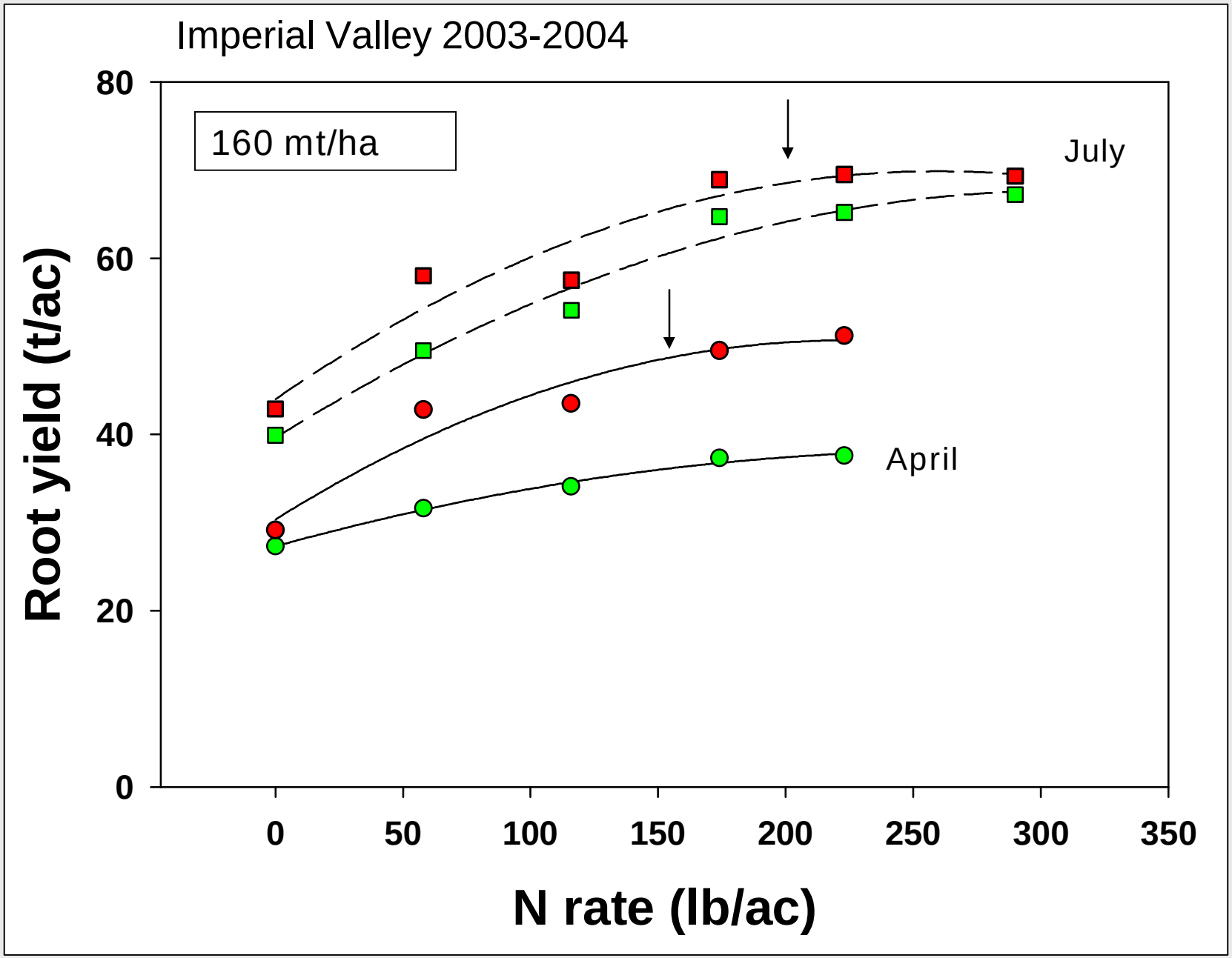
Comparative costs, IV-PMA

1999	$/ac	2000	$/ac	2001	$/ac
Growers	73.50	*Growers*	64.20	*Growers*	52.70
G@45g	72.45	*G@45g*	43.40	*G@45g*	31.50
Bt	91.10	*G@20g*	19.30	*G@20g*	14.00
Control	0	*Control*	0	*Control*	0
Control+	16.00	*G@45g+*	60.55	*G@45g+*	53.00
Seed Rate(ha)	165,000		90,000		70,000

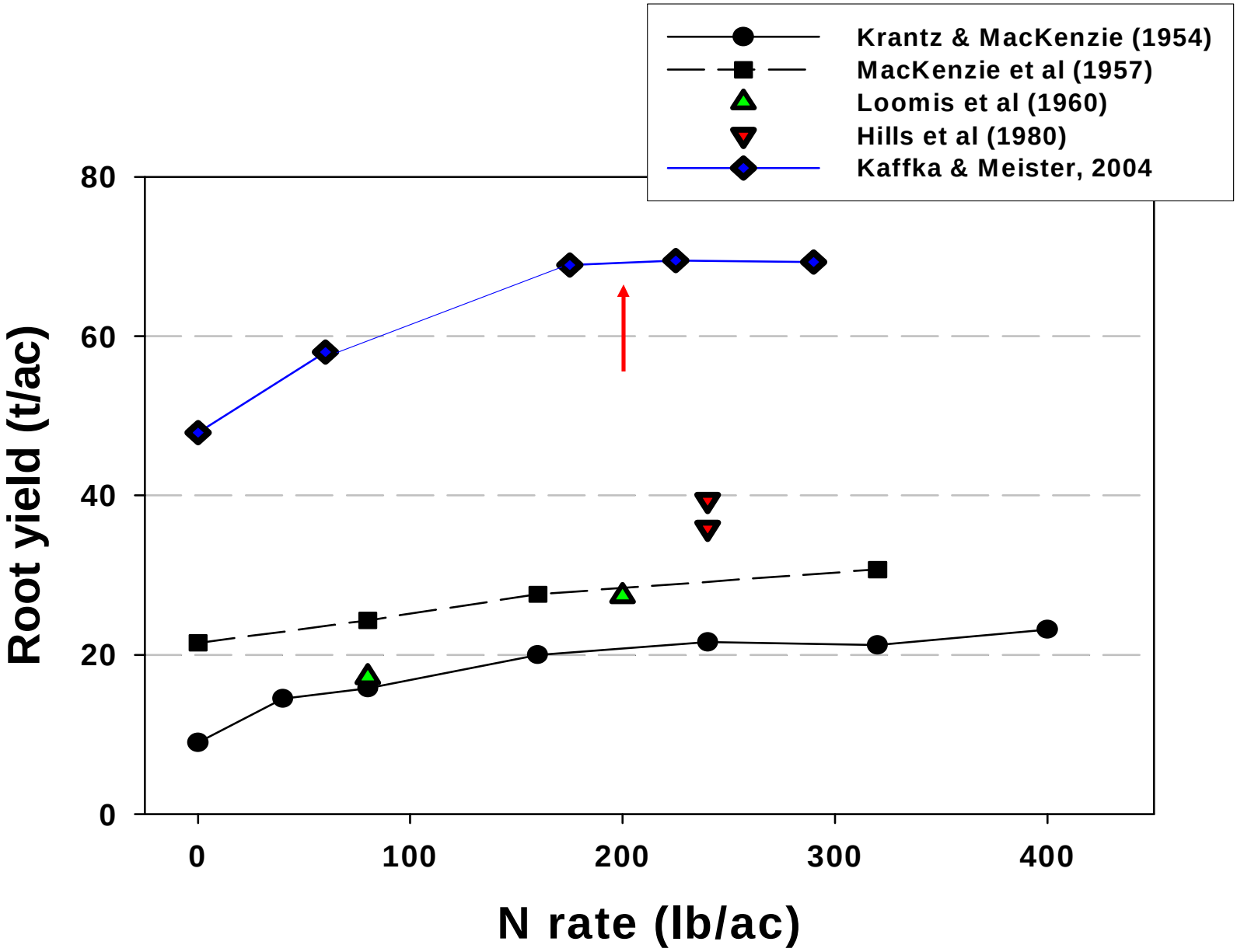
Desert Sky Farms, Imperial Valley, July harvest

147.4 t/ha, 15.3 % sucrose, 22.6 t sugar/ha





Sugar beet yields in the Imperial Valley



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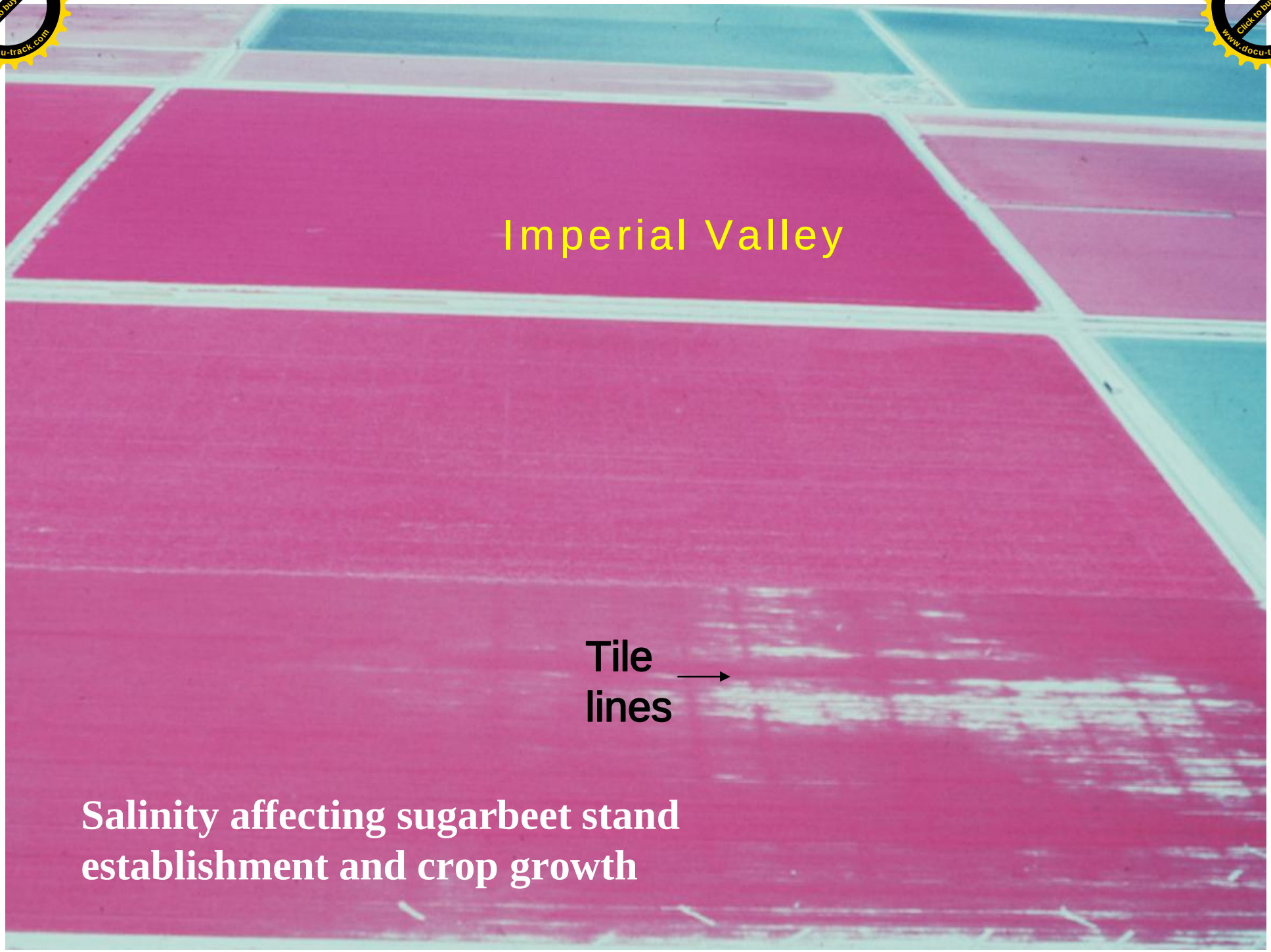
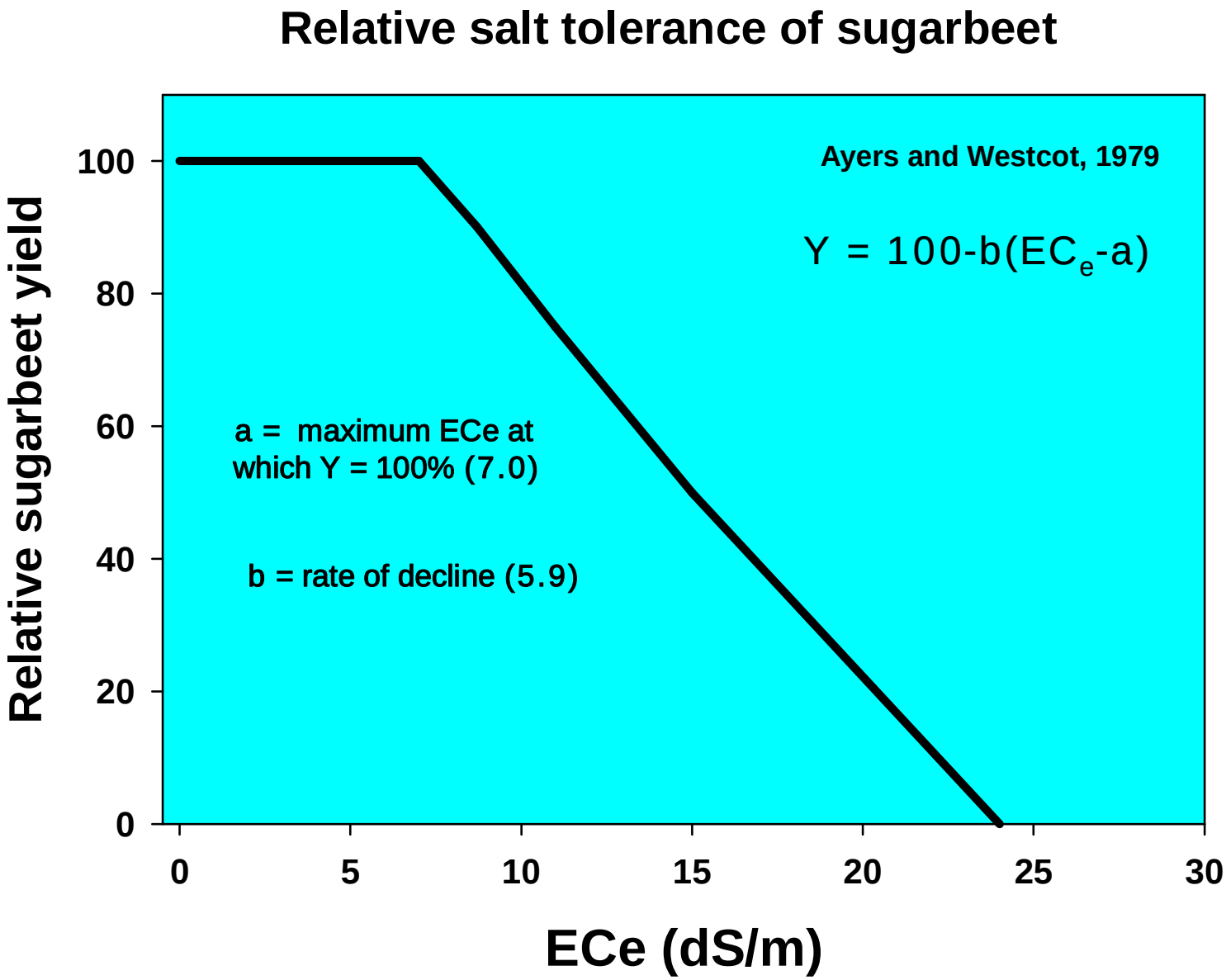
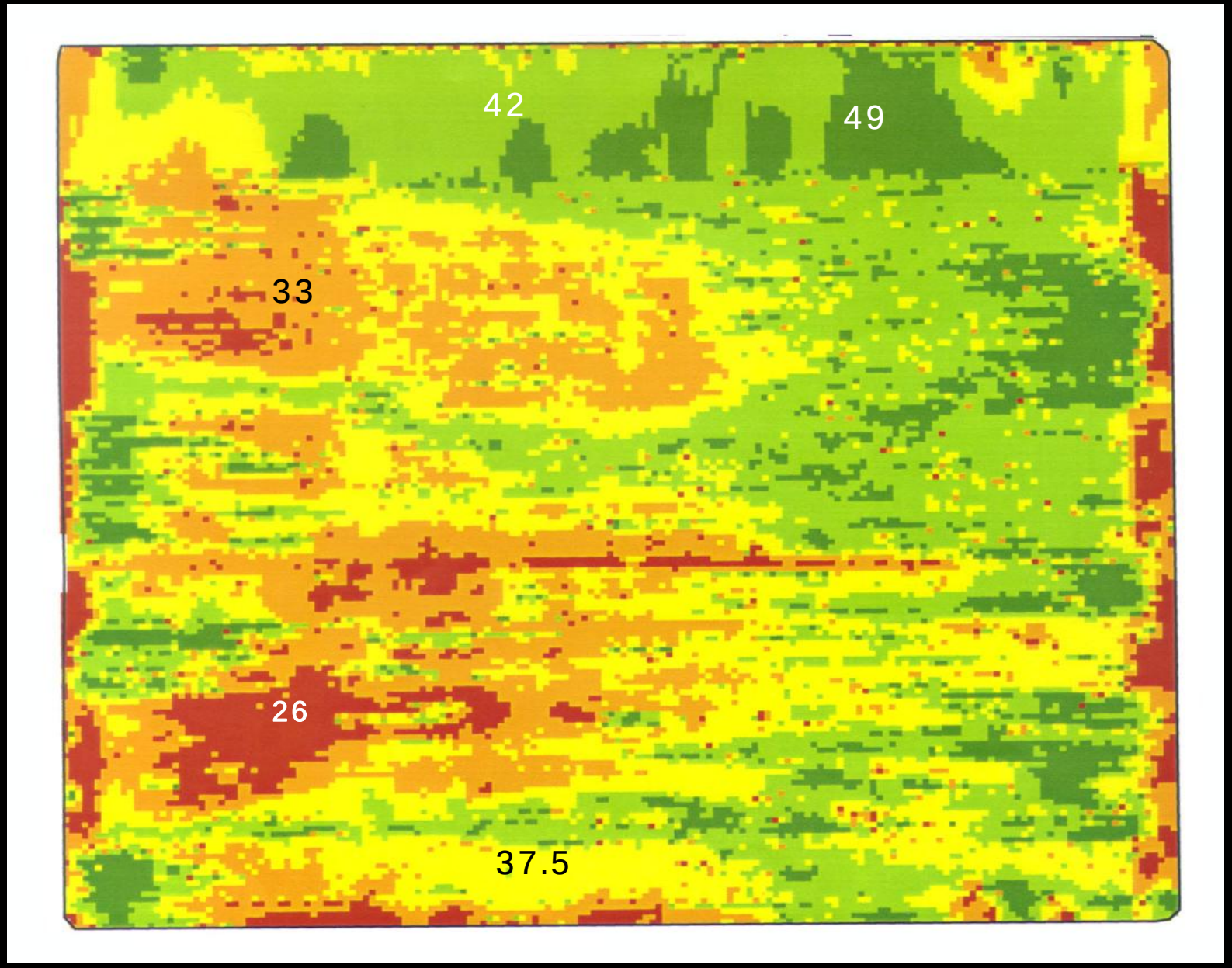


Salinity affecting sugarbeet stand establishment and crop growth



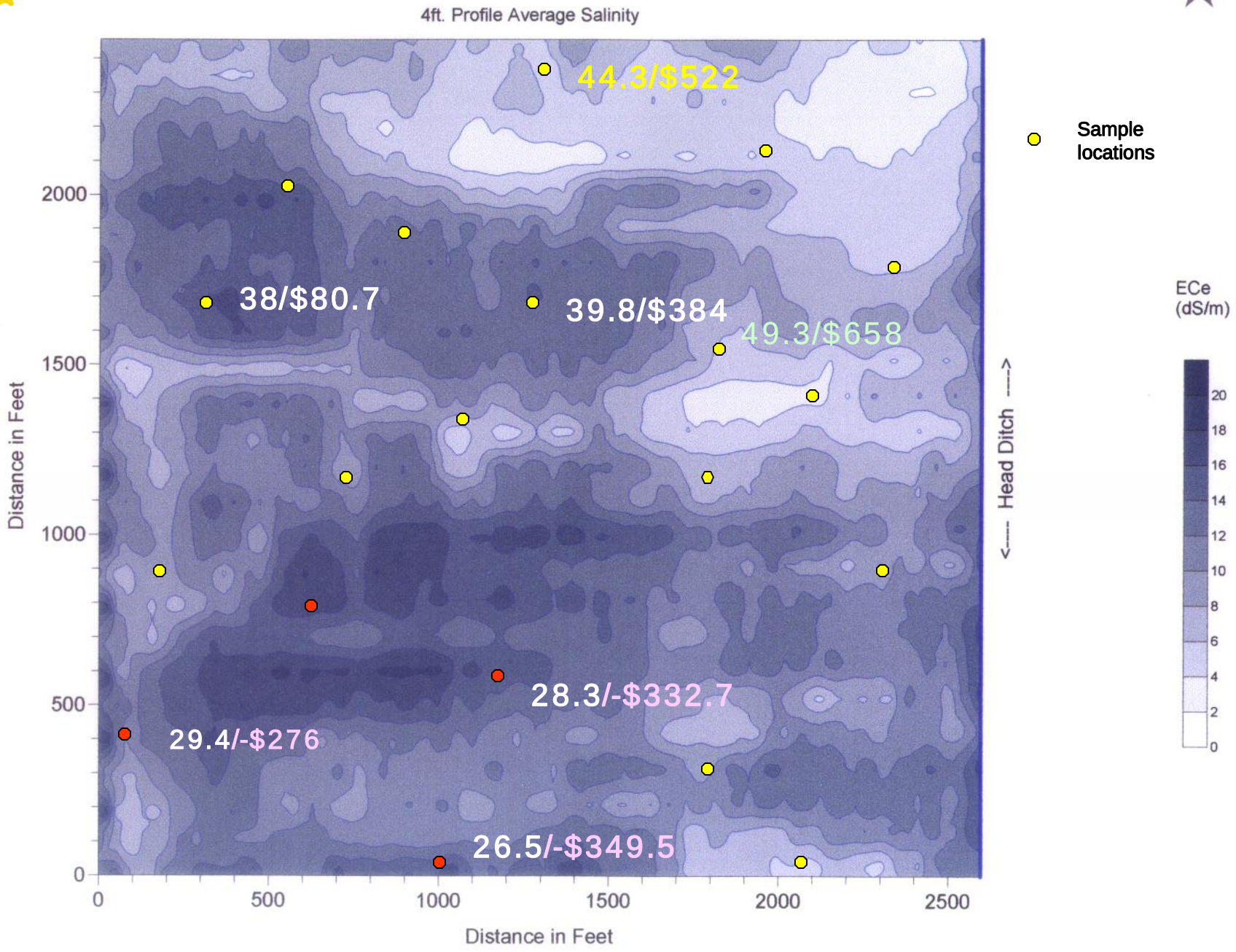
Yield monitor and GPS in use at harvest

IV-2000-2001, Sugar beet yield map (t/ac). Yield declined with increasing salinity

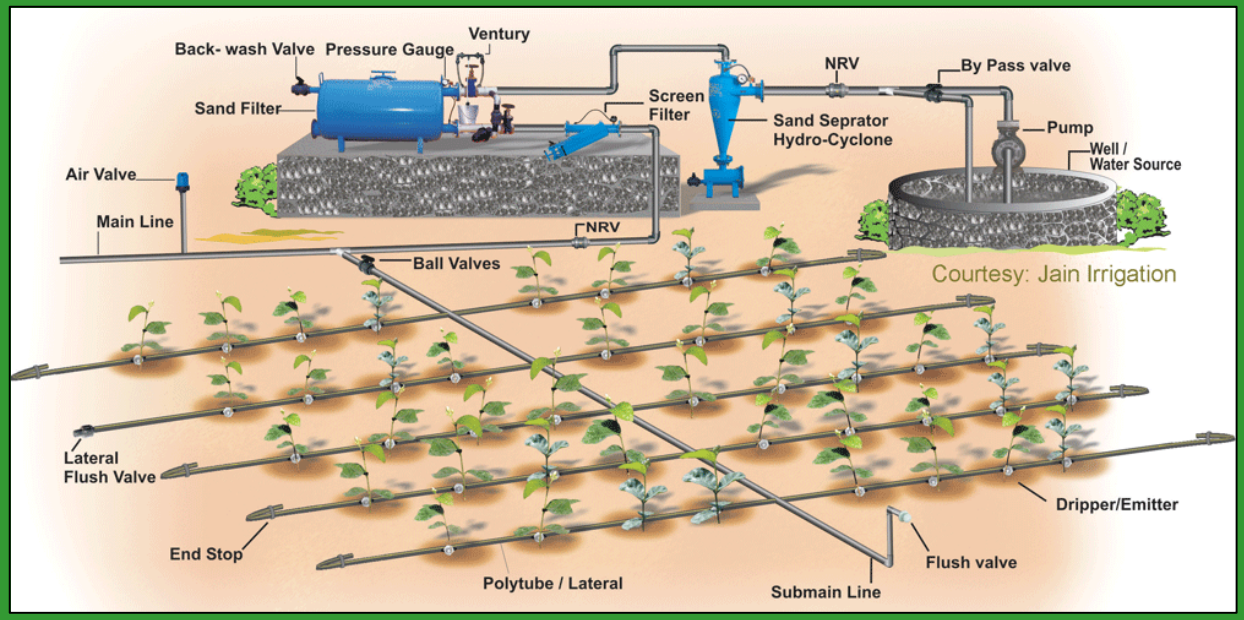


Map 8 - IsoSalinity Contours

Returns over variable costs



Drip irrigation

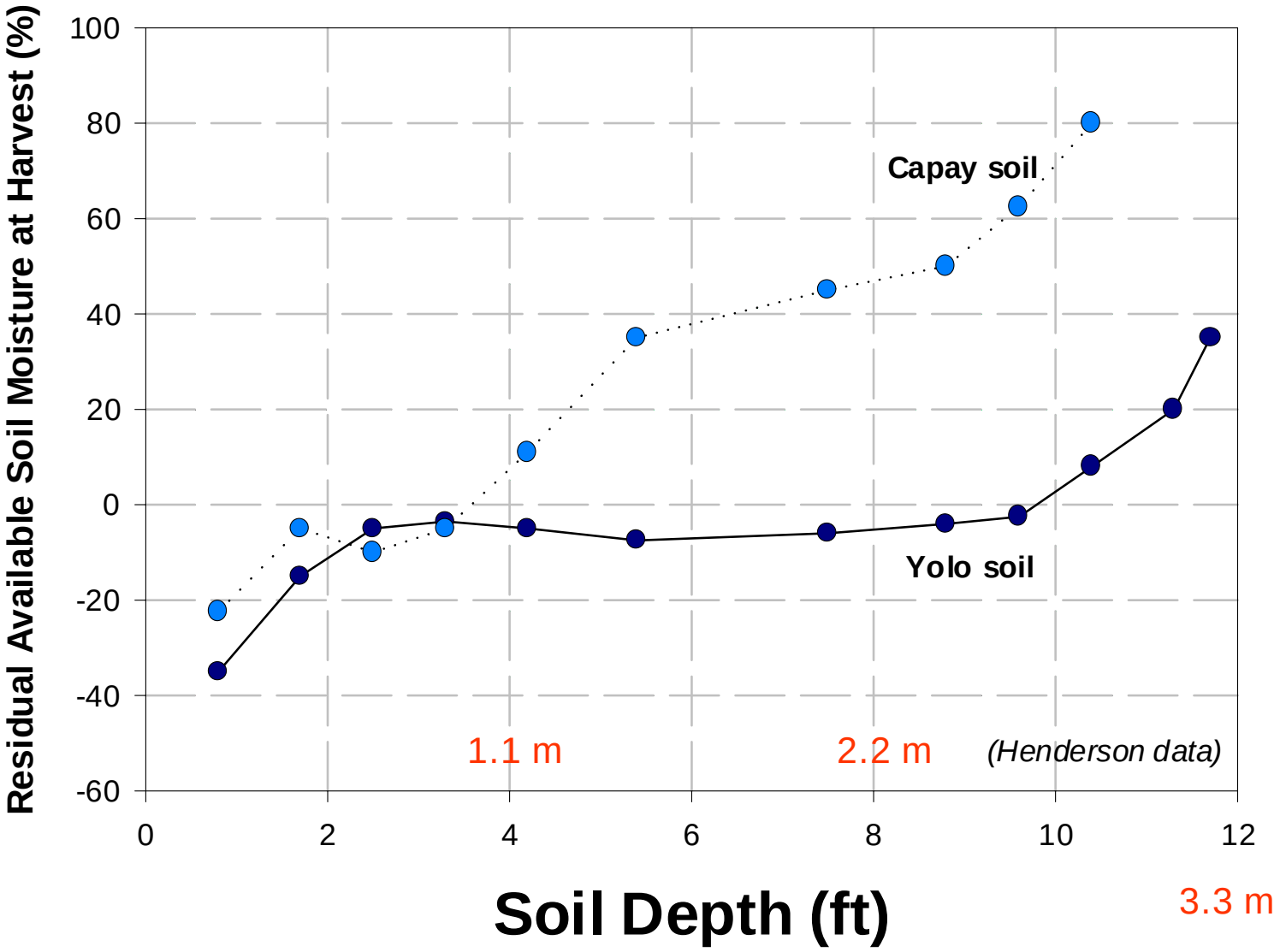


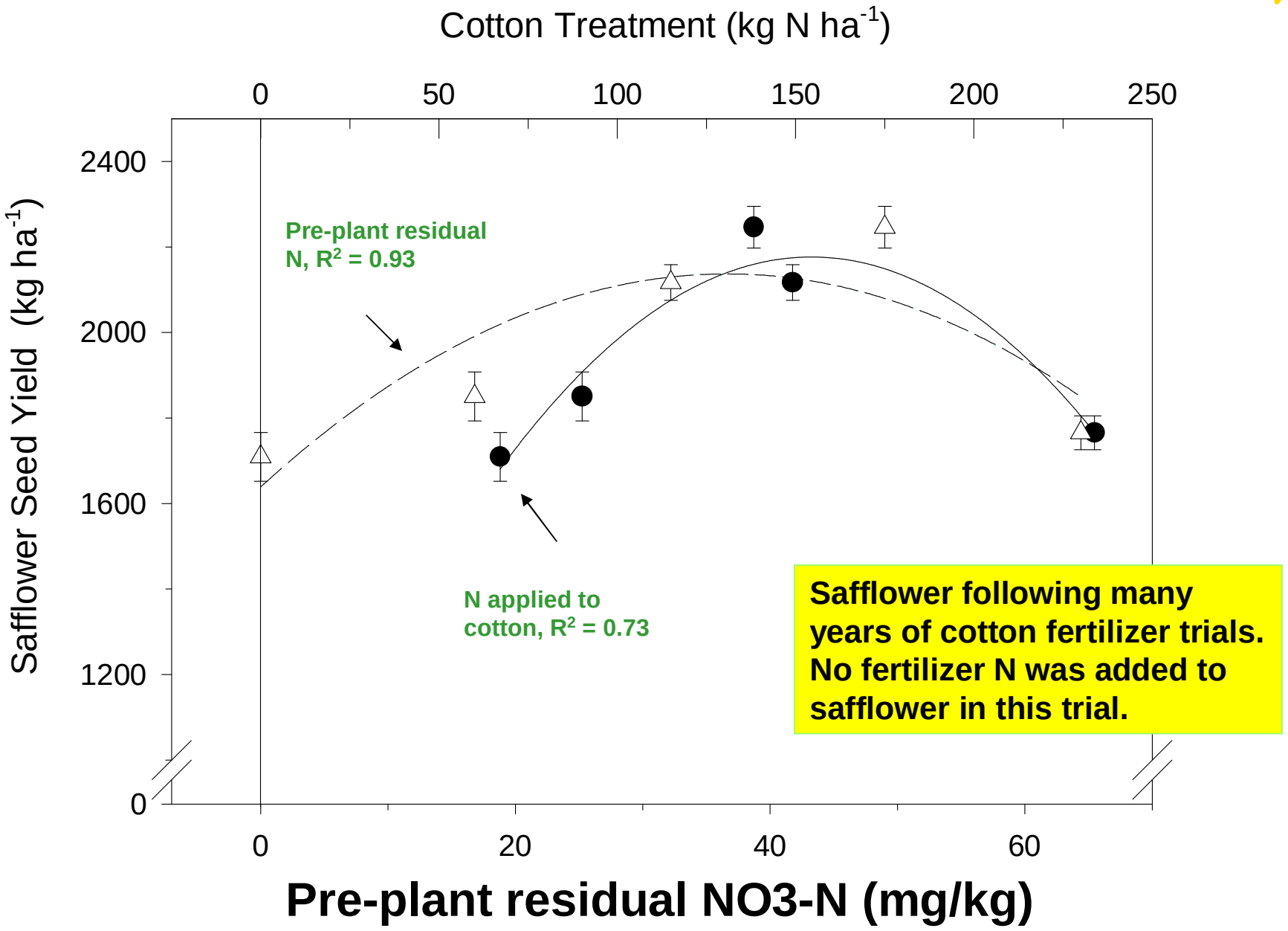
Safflower and Residual Nitrogen Management

Stephen Kaffka, Elias Bassil, Bob Hutmacher

Plant Sciences, UC Davis

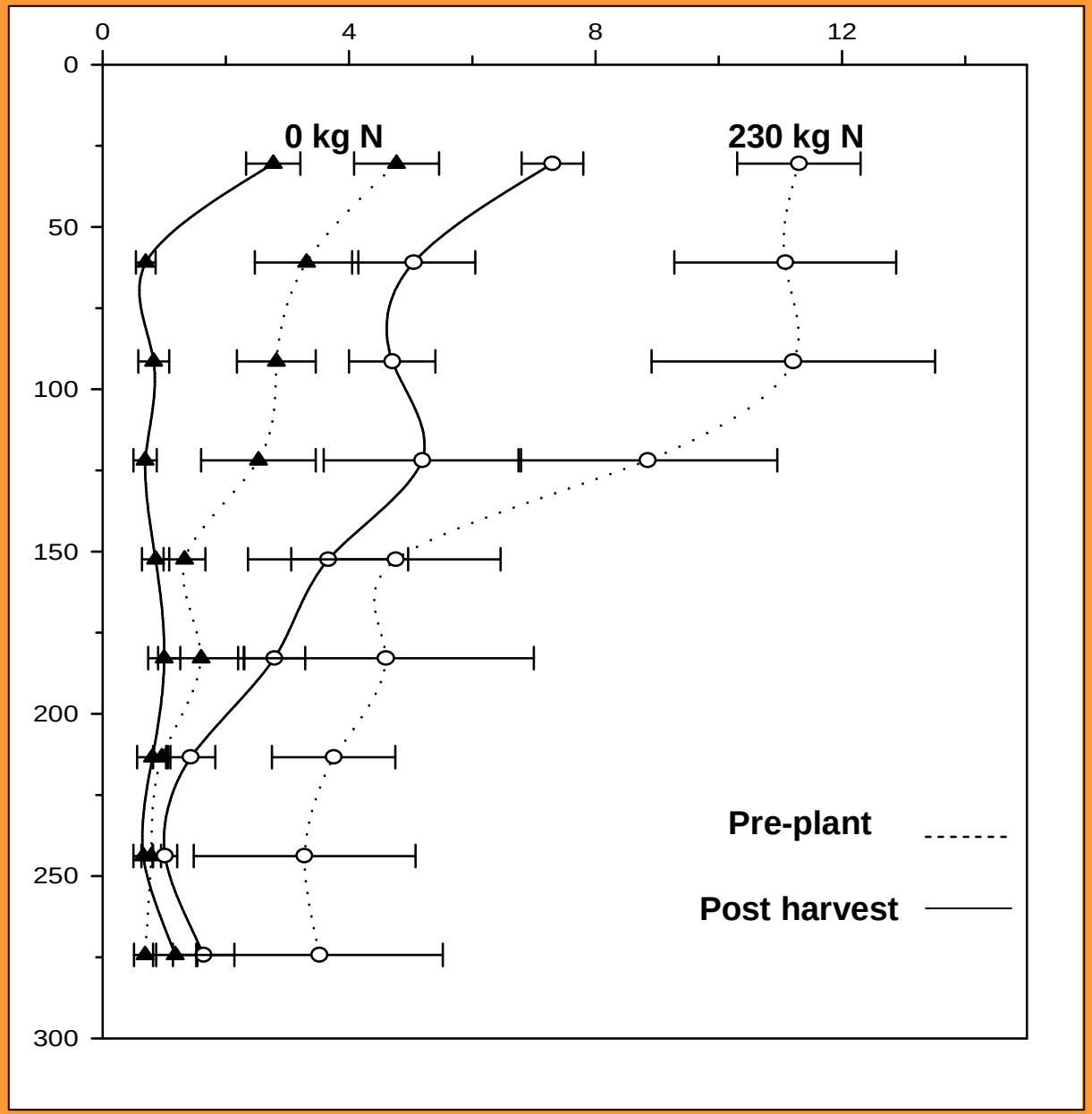
Soil Moisture Use and Soil Depth





Safflower following many years of cotton fertilizer trials. No fertilizer N was added to safflower in this trial.

Change in soil NO3-N during growth (mg/kg)



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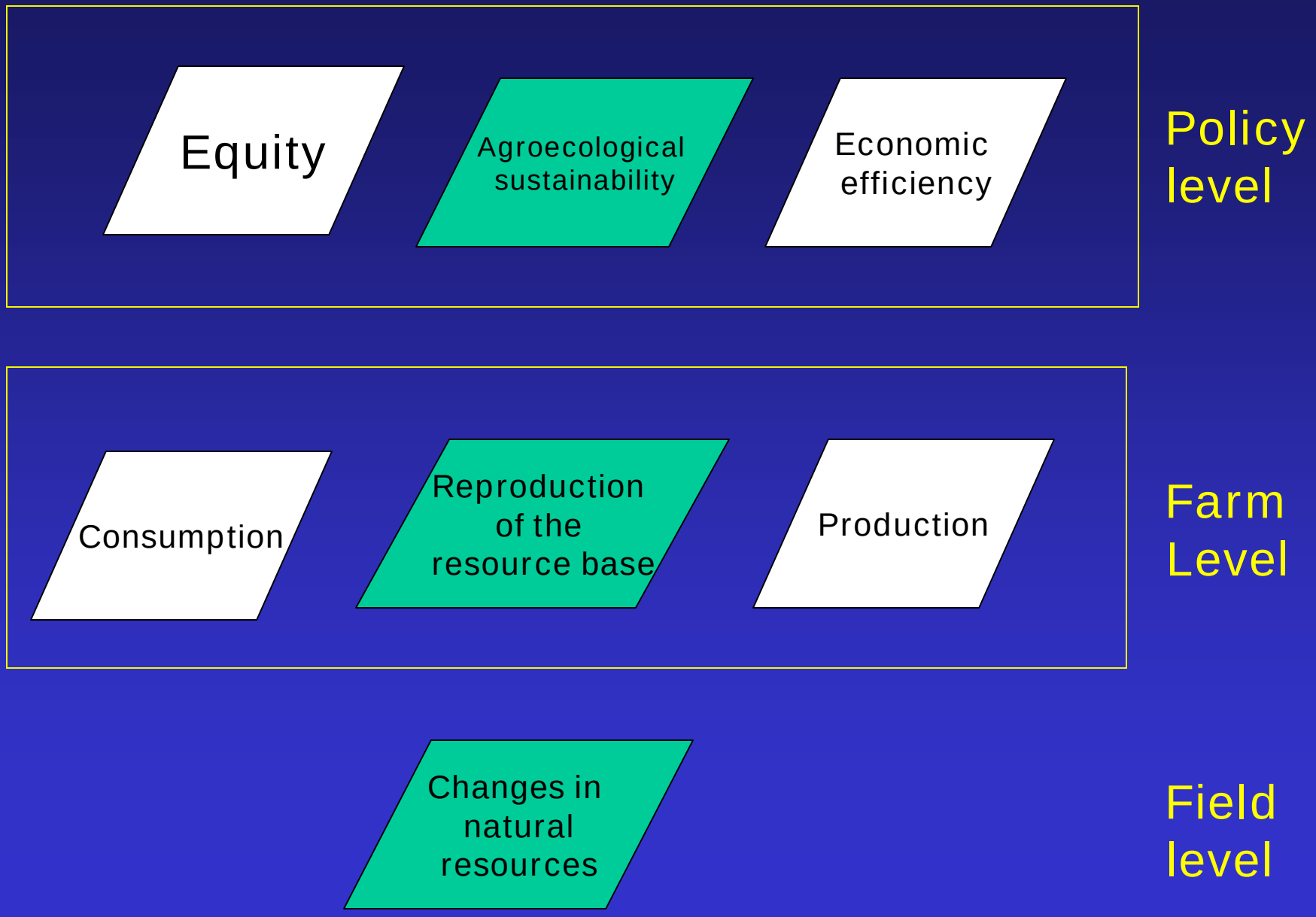
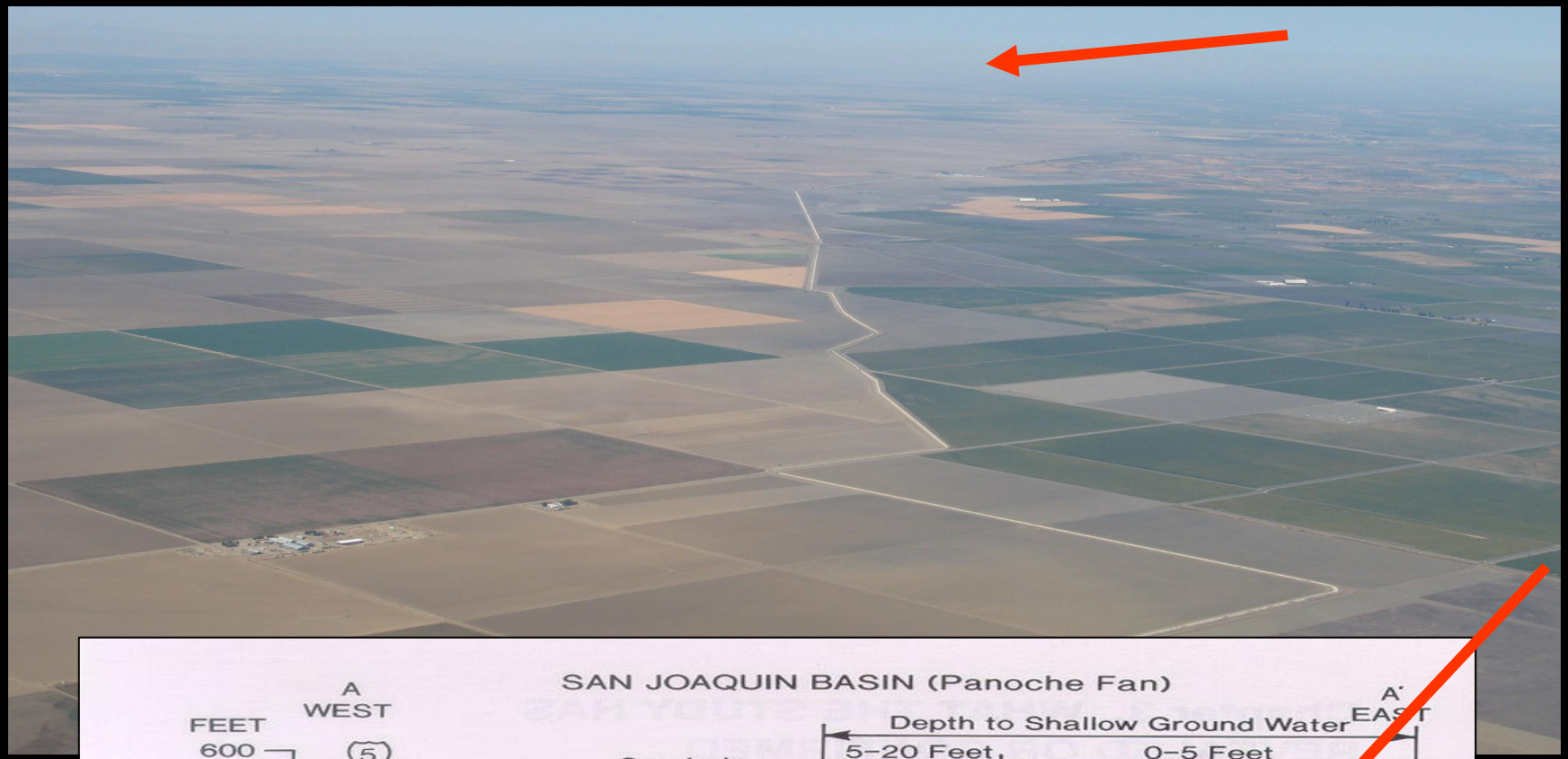
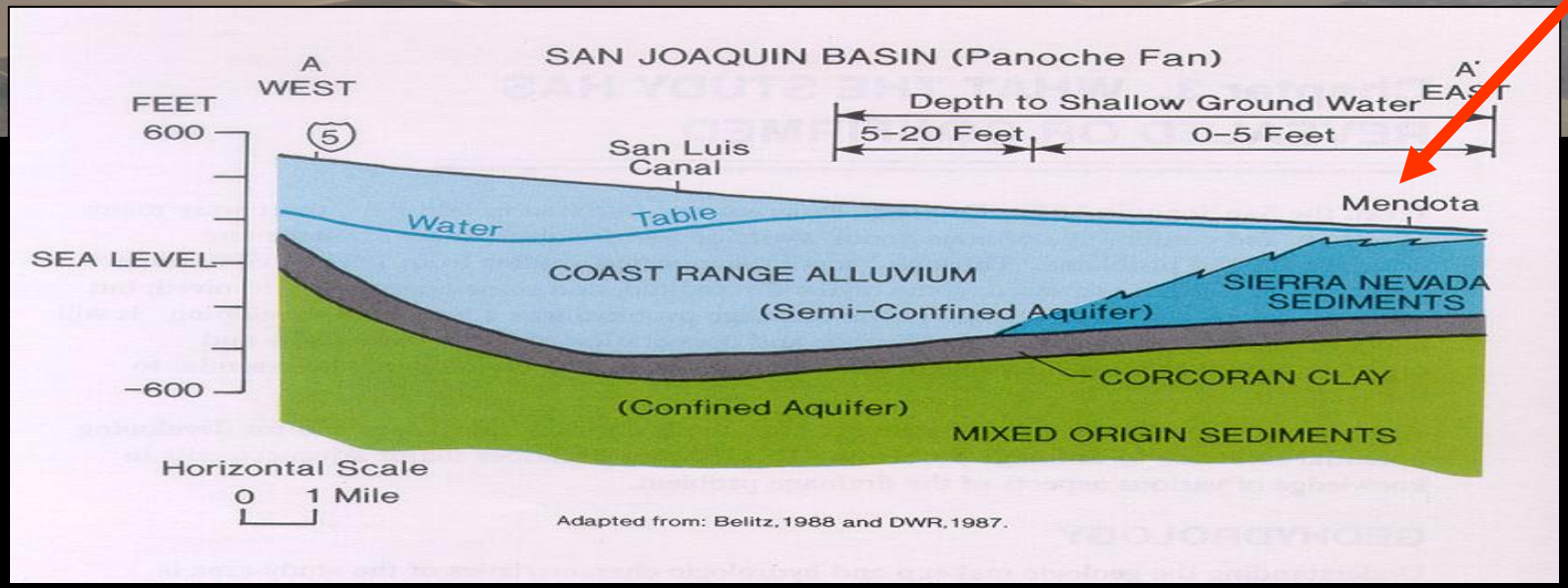
Kruseman et al., 1996



Retired land in the western San Joaquin Valley

WSJV on left; ESJV on right About 25 miles south of Mendota





Within-valley (mid-term) solutions to the salinity/drainage problem

- Land-retirement
- Waste water treatment
- Evaporation ponds
- Modification of irrigation and drainage practices
- Reuse of drainage water

Evaporation pond in the San Joaquin Valley

Drainage water reuse

Advantages:

- Reduces the volume of drainage water for disposal
- Protects groundwater
- Reduces the costs of disposal
- Provides positive income?

Disadvantages:

- Accumulation of salts
- Accumulation of trace elements (B, Se, Mo,…)
- Adverse effects on soil physical properties like infiltration

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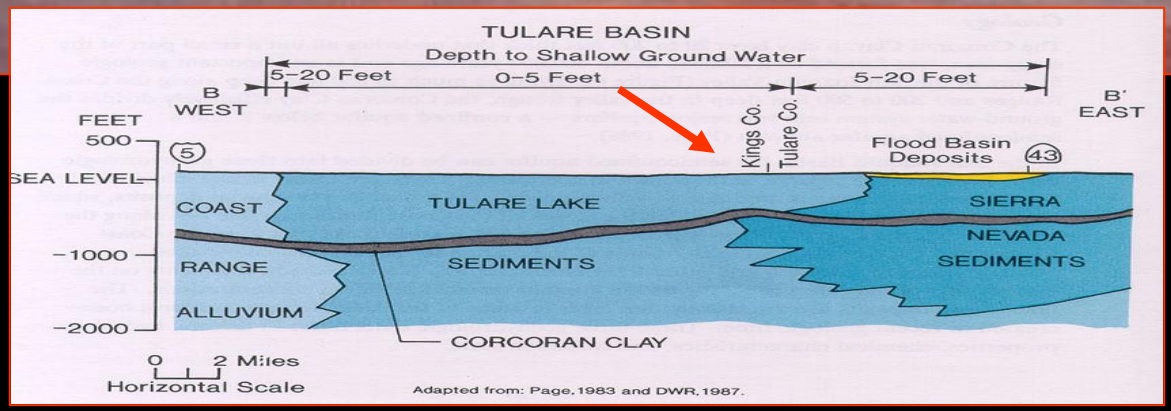
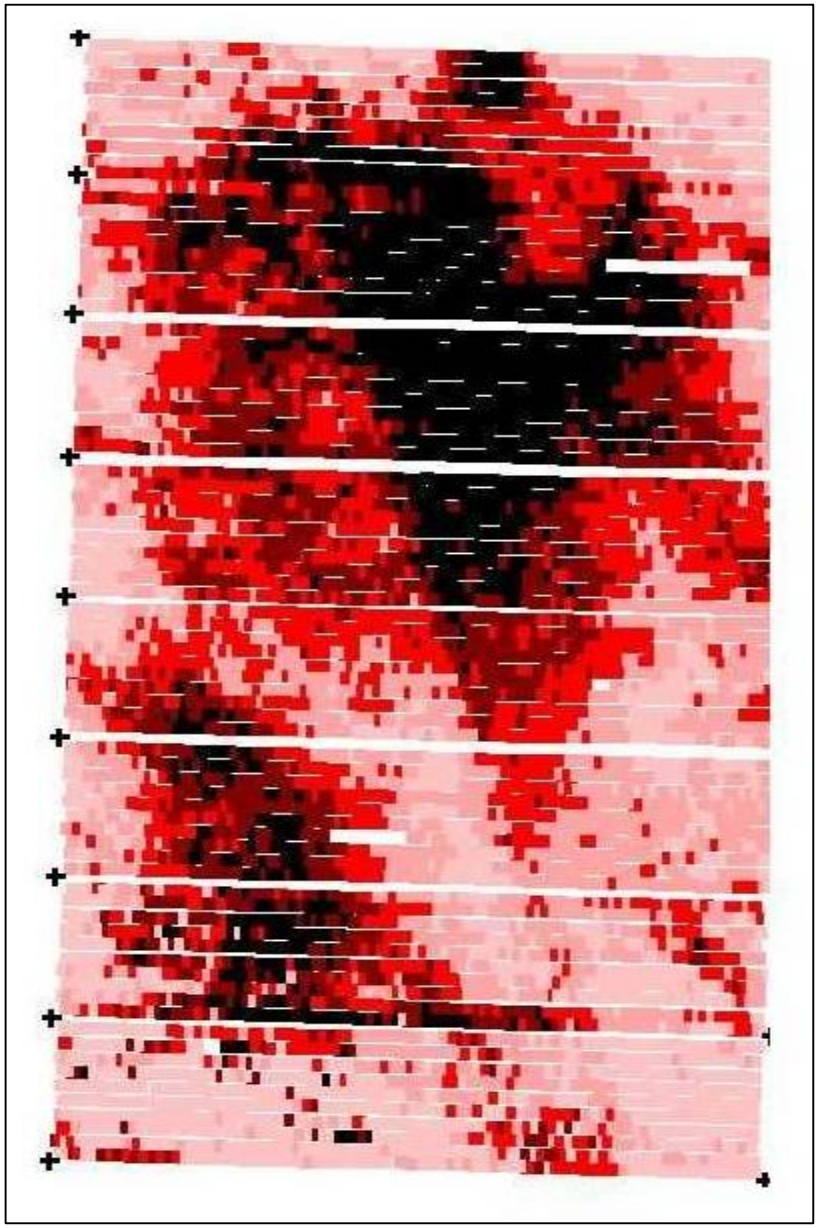
Drainage water reuse

If drained with tiles, approximately 200,000 +/- ha (500,000 ac) of land with shallow water tables in the San Joaquin Valley requires 20,000 ha (50,000 ac) of evaporation ponds to dispose of the drainage water. This is far more than currently available (or foreseeable).





Darker color = greater salinity

D. Corwin

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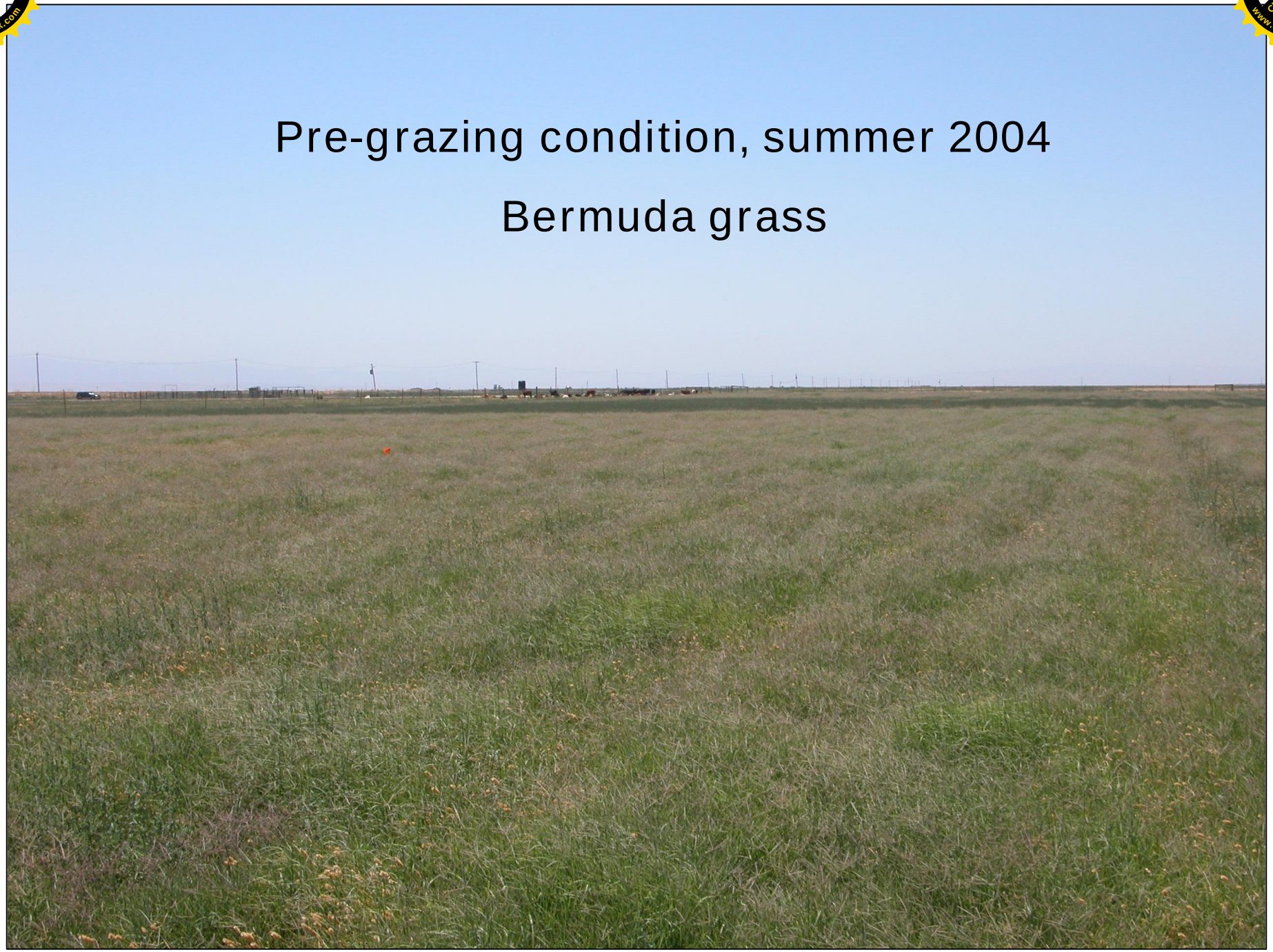
Pre-grazing condition, summer 2004

Bermuda grass



On a high SAR soil, using moderate EC_w irrigation water (2 to 8 dS m^{-1}), no infiltration and drainage problems have been observed where forages have been able to grow during the last nine years. Leaching and reclamation are occurring.

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What do we mean by agricultural sustainability?

The debate over sustainability means discussing the implications of different choices when looking for compromise solutions between two pressures:

1. Economic pressure driving further intensification (higher rates of throughputs per acre and per hour of labor)
2. Ecological limitations or pressure to reduce the rate of throughput because lower input systems may have less local environmental impact.

M. Giampietro, 2004

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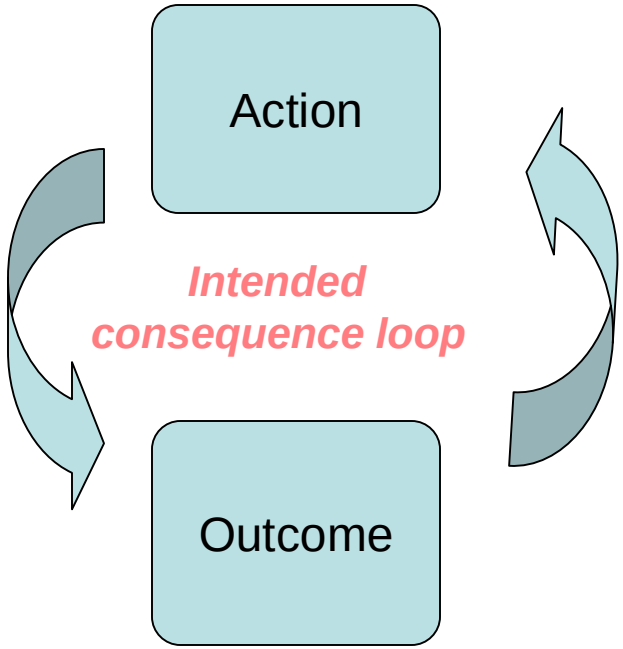

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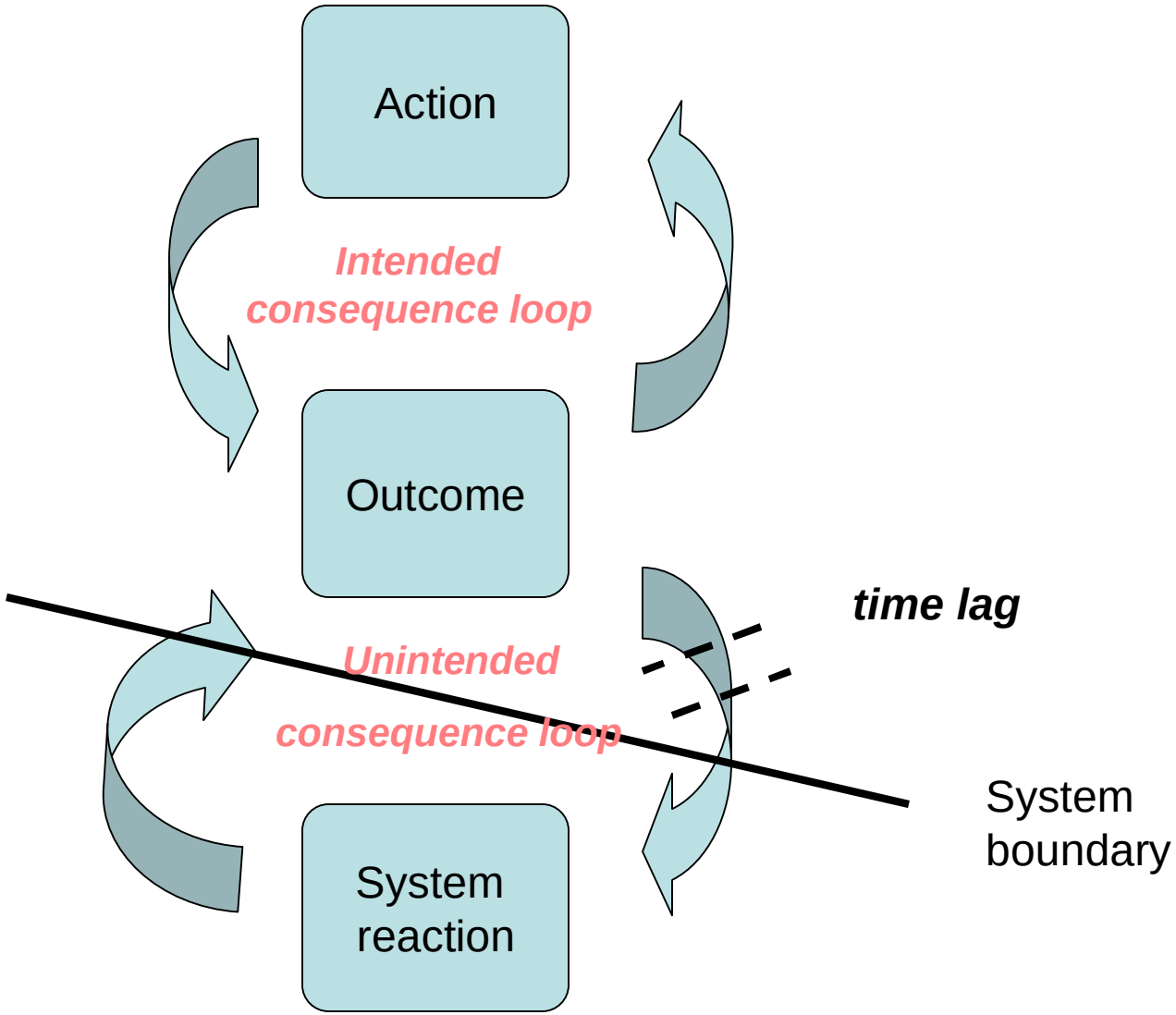

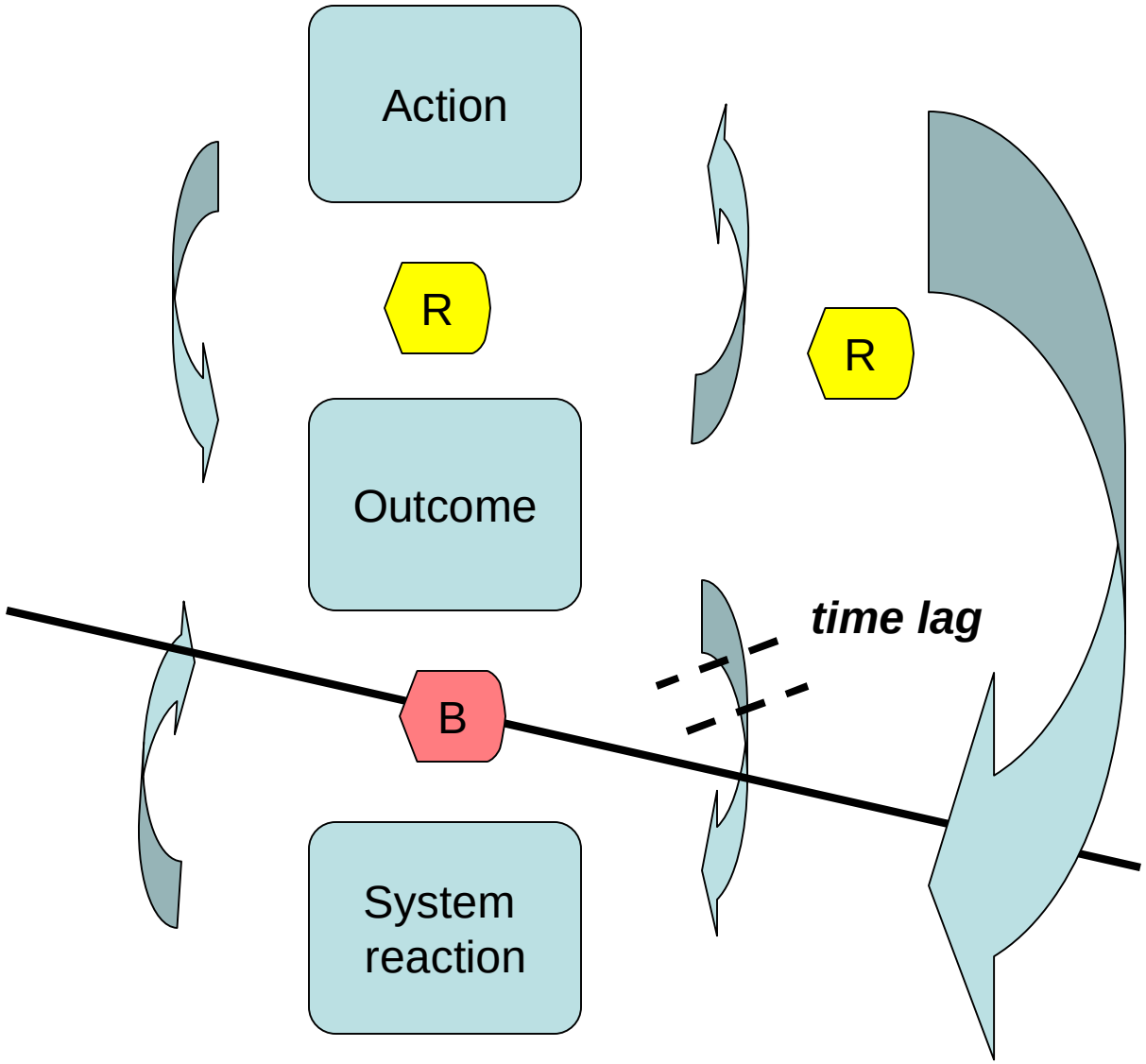

R

Reinforcing feedback loop

Solution feedback loop

B

Balancing feedback loop

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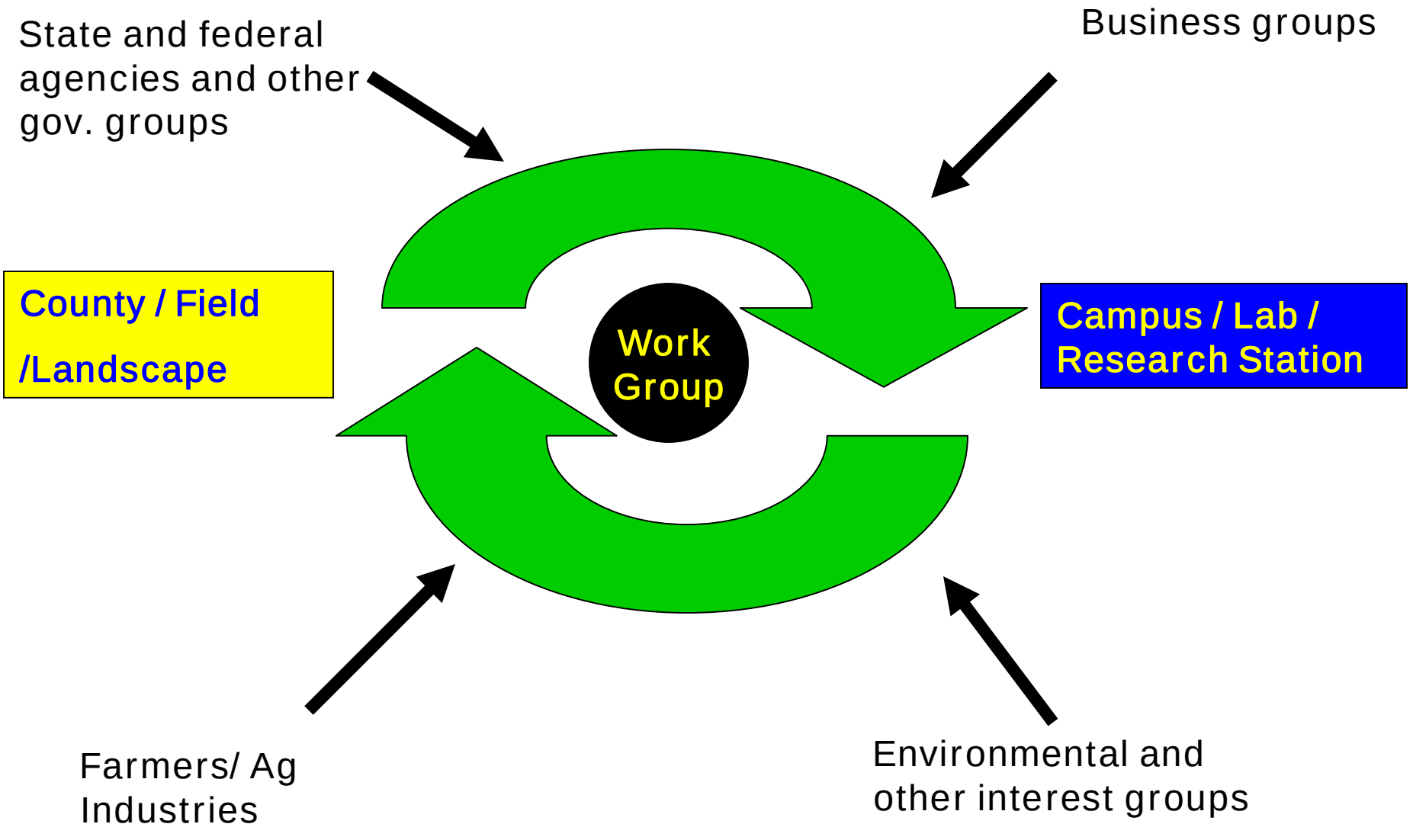
UCANR: Division of Agriculture and Natural Resources



Organizations concerned with BMPs

- University of California/UC Cooperative Extension System
- USDA/ARS
- USDA/NRCS ←
- County Agricultural Commissioners ←
- Resource Conservation Districts
- CA SWRCB
- CA DPR
- CDFA
- CA DWR

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Overview: Policy implications

1. Change is the constant characteristic of agricultural practices
2. Policies, social preferences and external influences are in flux
3. New technology and learning occurs constantly but unpredictably.

To have a good BMP standard for biofuel production, a mechanism for frequent evaluation is needed.

Overview: Policy implications

1. BMP standards should be kept simple but
2. Emphasize process

   A dynamic process for evaluation and guidance for BMPs must be created to advise the CEC and be a constant feature of the regulatory process.
3. Policy should foster and support this capacity.

BEWG: BioEnergy Work Group

What is a UC ANR work group?

Work groups facilitate the application of agricultural research (from basic to applied) to important issues or problems affecting farming in CA

Work groups identify, communicate, and help focus research on emerging issues

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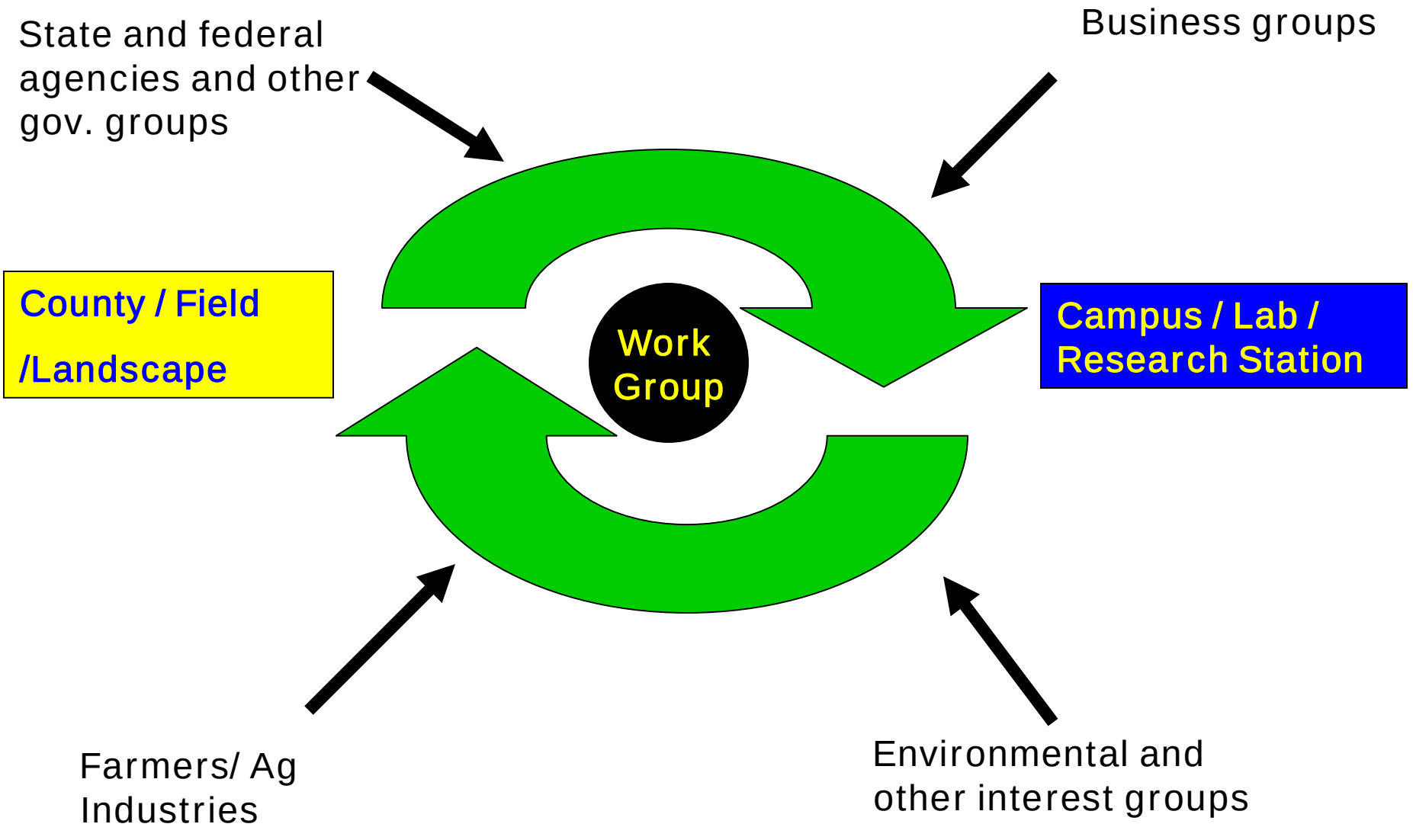
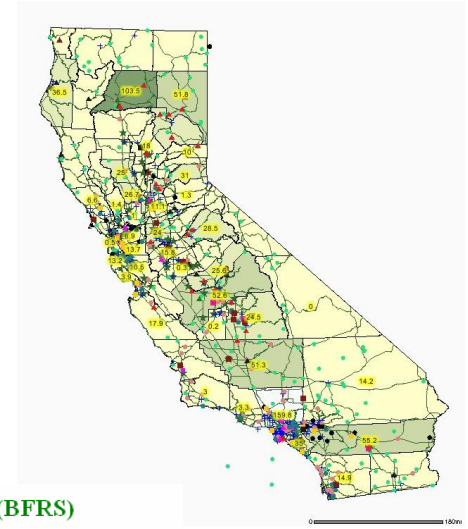


California Biomass Collaborative

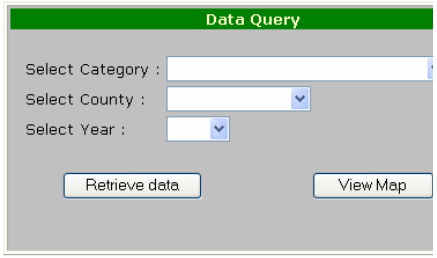
- Statewide biomass coordinating group
- Biomass Facilities Reporting System
- Biomass resource assessments
- Technology assessments
- Planning Functions/Policy
  - Needs Assessment
  - Roadmap for biomass development
- Coordination with State Bioenergy Interagency Working Group



California Biomass Facilities Reporting System (BFRS)
Power Generation Assessments

The BFRS database contains Biomass power plants and related facilities, including thermal station power plants, digesters, landfill gas systems, fermentation plants, bio refineries, other biomass energy converters, material handling and processing operations, and storage units with technical and environmental performance. Gross and technical resources, estimates of electricity capacity and energy from biomass for year 2003, 2005,2007, 2010 and 2017 are included in this database.

Specific information can be retrieved by following steps.



California Biomass Facilities Reporting System (BFRS)
Resource Assessments

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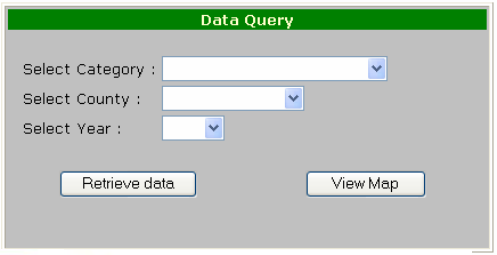

http://biomass.ucdavis.edu
Email: biomass@ucdavis.edu

UCDAVIS · SMUD SACRAMENTO MUNICIPAL UTILITY DISTRICT The Power To Do More.SM · Integrated Waste Management Board