Organic Weed Control in Vegetable Production Systems

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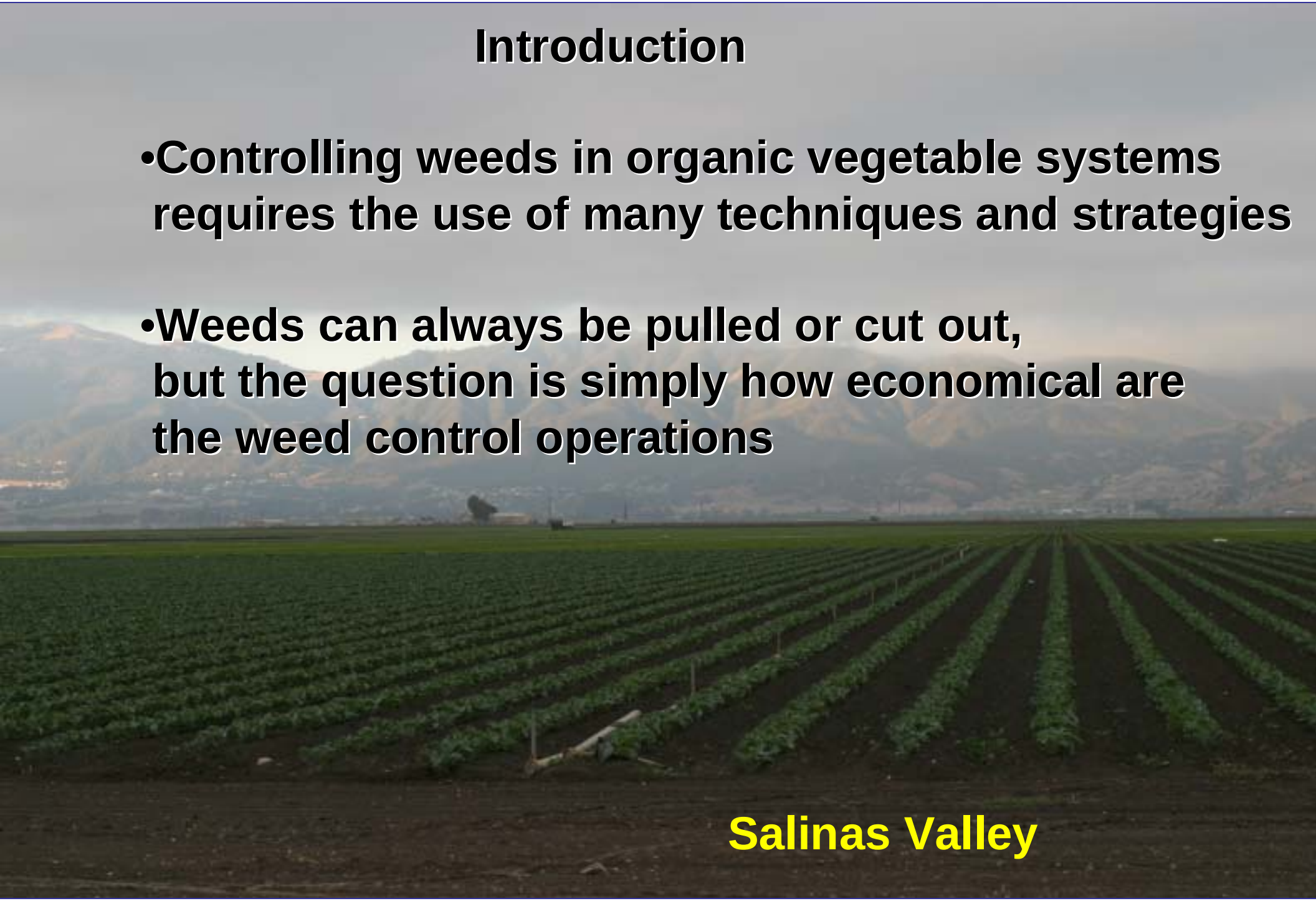
Introduction

- Controlling weeds in organic vegetable systems requires the use of many techniques and strategies

- Weeds can always be pulled or cut out, but the question is simply how economical are the weed control operations



Recent cost studies documenting weeding costs in organically produced broccoli and leaf lettuce

- Sample costs to produce organic broccoli
- Sample costs to produce organic leaf lettuce

http://www.agecon.ucdavis.edu/outreach/crops/cost.htm

- go to CEMonterey and go to the publication links

Comparison of Organic vs Conventional Leaf Lettuce Production Costs

System	Costs $/A	Percent of Growing Costs
Organic[1]	257	8
Conv.[2]	132	5

1 – Tourte and Smith, 2004; 2 – Tourte and Smith, 2001

Comparison of Organic vs Conventional Broccoli Production Costs

System	Weed Costs $/A	Percent of Growing Costs
Organic[1]	270	9
Conv.[2]	161	8

1 – Tourte and Smith, 2004; 2 – Smith et al. 2004

- **Any reduction in weeds and in the amount of weed seed or perennial propagules reaching the soil will make subsequent weed control operations less expensive**

- **It is therefore useful to explore ways in which weed infestations come about**

PREDATION

GERMINATION

SOIL SEEDBANK

(Outside & inside field dispersal)

FAILED GERMINATION

- **Pathogens**
- **Deep burial**
- **Environment**

PHYSIOLOGICAL DEATH

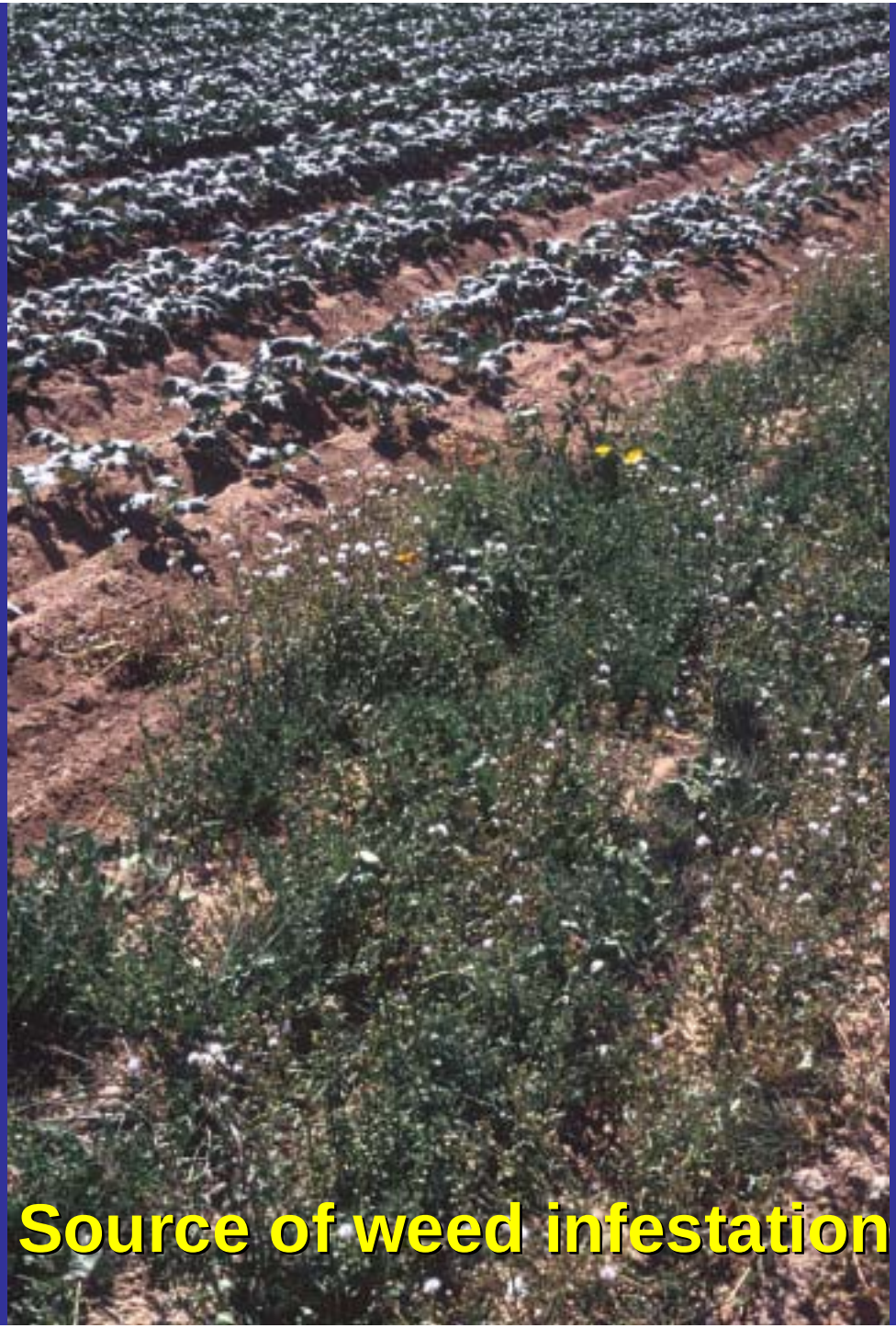

Aerially dispersed weed seed, can invade from outside the field, doesn't reside in the seedbank
UC Statewide IPM Project
© Regents, University of California

Non-aerial dispersed seed that rains down onto the soil surface and resides for many years in the soil seedbank

- Weeds require water, nutrients and light. They rob these from the crop
- The goal is to utilize production practices to provide an opportunity for the crop to gain an advantage over the weeds
- If successful, it allows the crop to out compete and reduce the availability of resources to the weeds. If the use of various organically acceptable techniques can give the crop a competitive advantage, subsequent hand weeding operations and costs can be minimized.

Organically Acceptable Techniques

- **Cultural Practices**
  - **Managing the Weed Seedbank**
    - **Sanitation (reducing seed set, or seed sources)**
    - **Carrying weeds (seed) out of field**
  - **Fooling Weed Seeds (manipulating weed seed germination)**
    - **Pre-germination**
    - **Stale bed**
    - **Seed capping**
    - **Planting to moisture**
    - **Buried drip irrigation**
  - **Crop Competition**
  - **Cover Crops - Eric**



Weeds Around Edge of Field

Carry Weeds Out of Field

Purslane in bags carried to edge of field

Effects of preirrigation of listed beds on weed emergence in subsequent lettuce crop

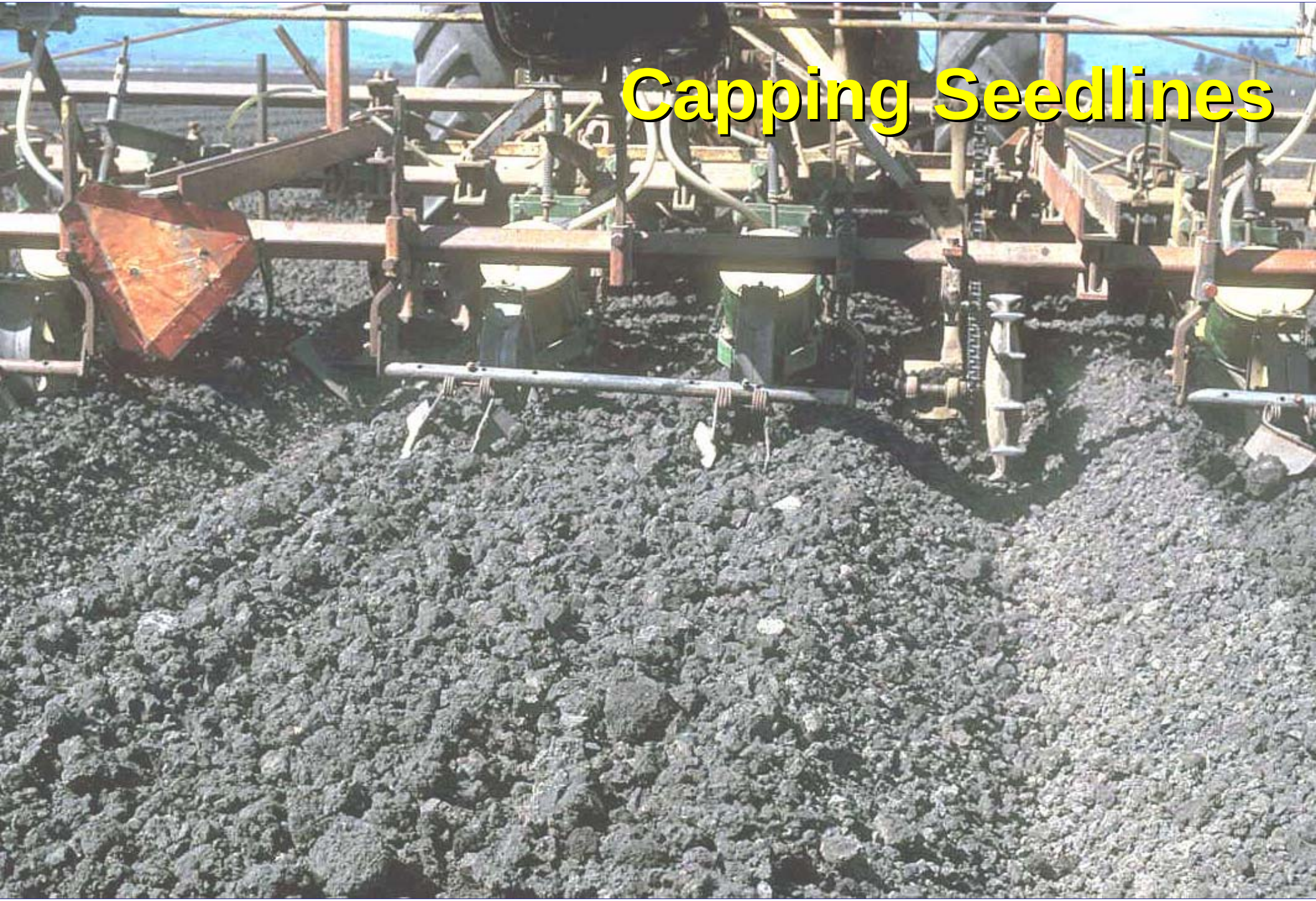
No preirrigation

Preirrigation

Can reduce weed emergence in subsequent cash crop by up to 50%

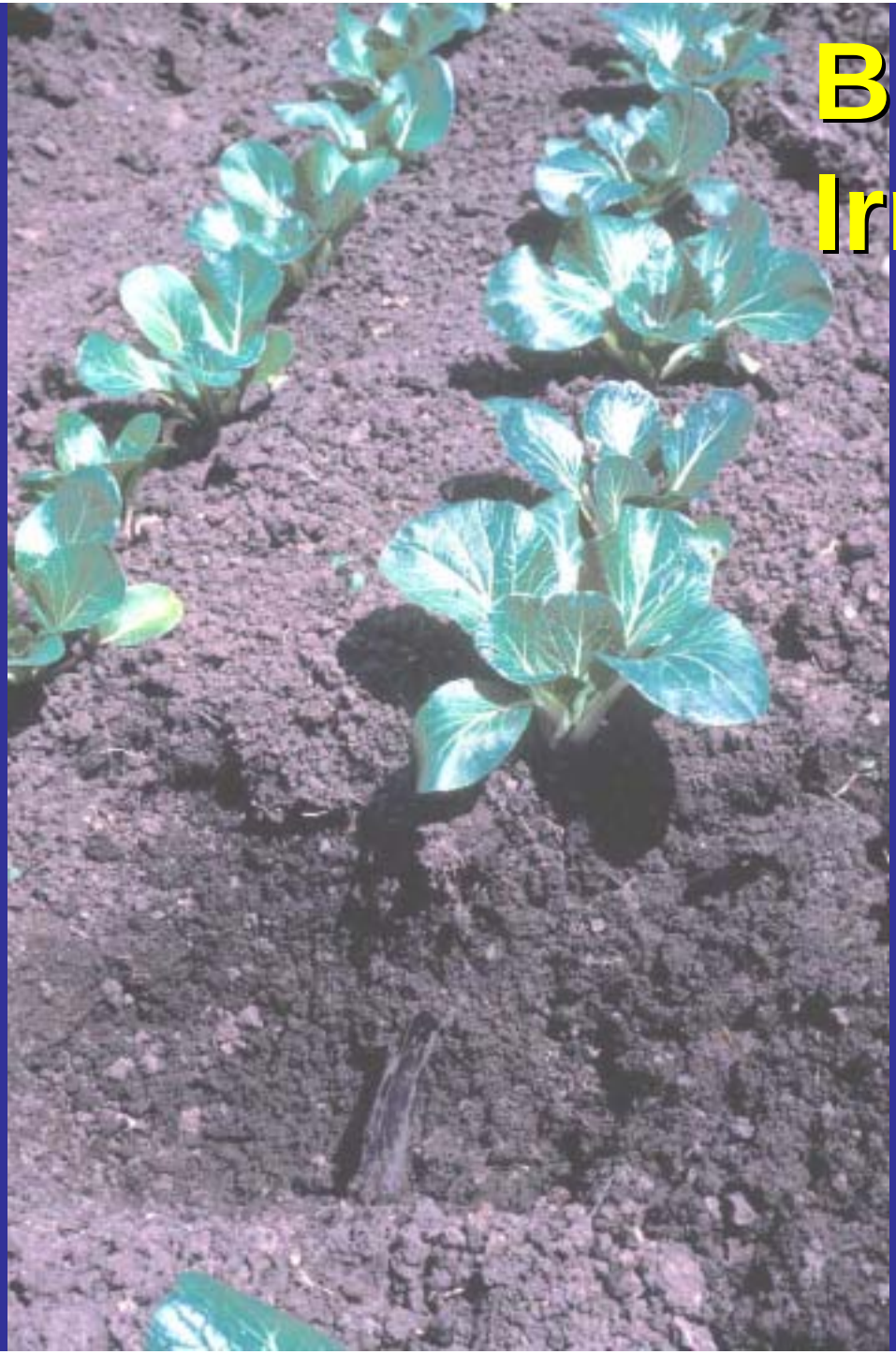
Pre germination

Stale Bed Technique: Pre-germinate and kill flush of weeds on shaped beds, prior to planting cash crop


Capping Seedlines

Planting to Moisture

Buried Drip Irrigation



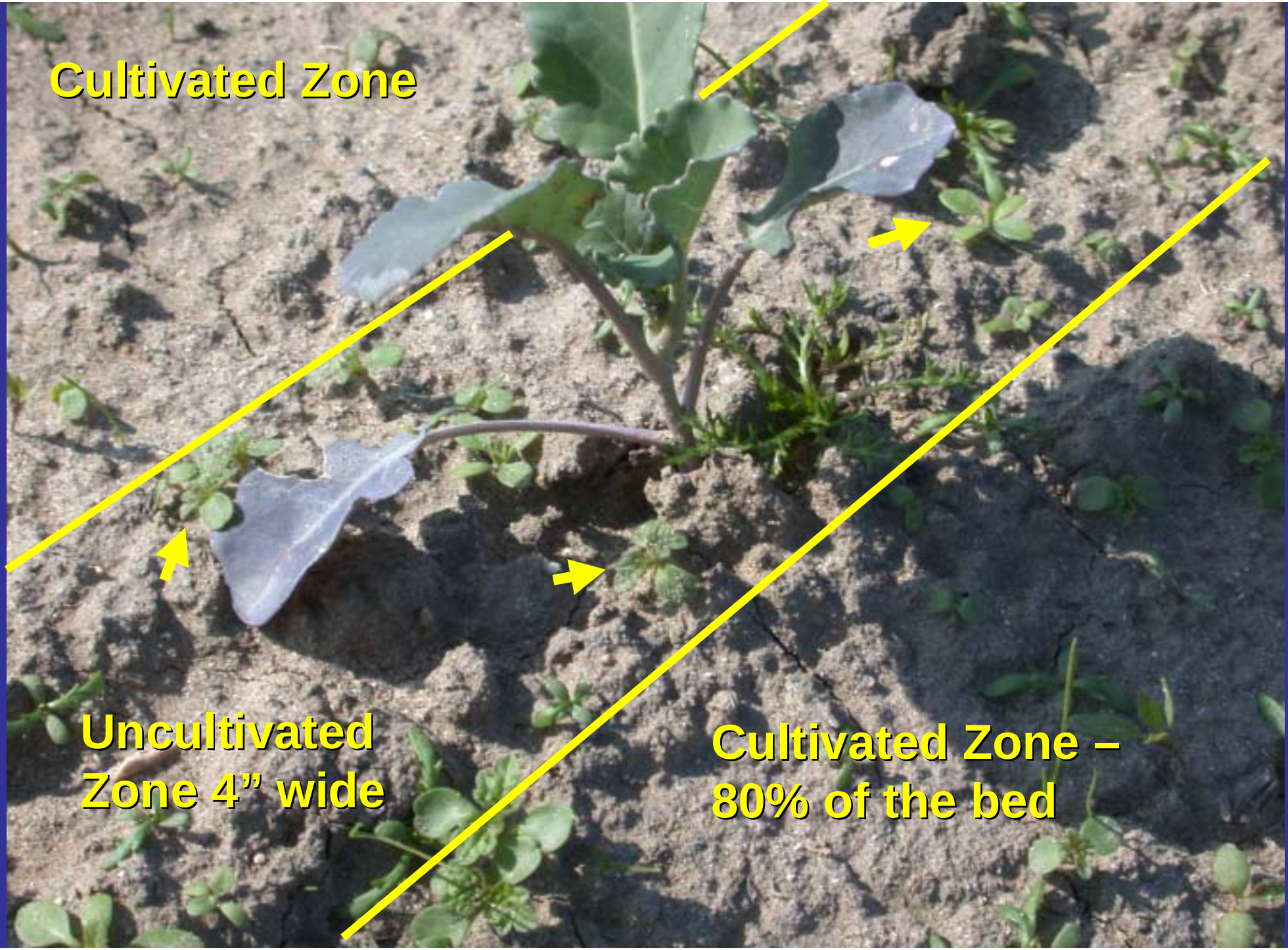
Cover Crops and Weeds

Organically Acceptable Techniques

- **Cultivation**
  - **Deep Plowing**
  - **Close Cultivation**
  - **Frequency of cultivation (kill weeds prior to seed set) – can eliminate perennial weeds**
  - **Cultivation Technology**
    - **Lazar guided cultivators**
    - **Various cultivators capable of removing weeds from the seedline of tough stemmed crops**
    - **Computer assisted weeders (not yet available)**

Plowing (burying weed seed)

Close Cultivation

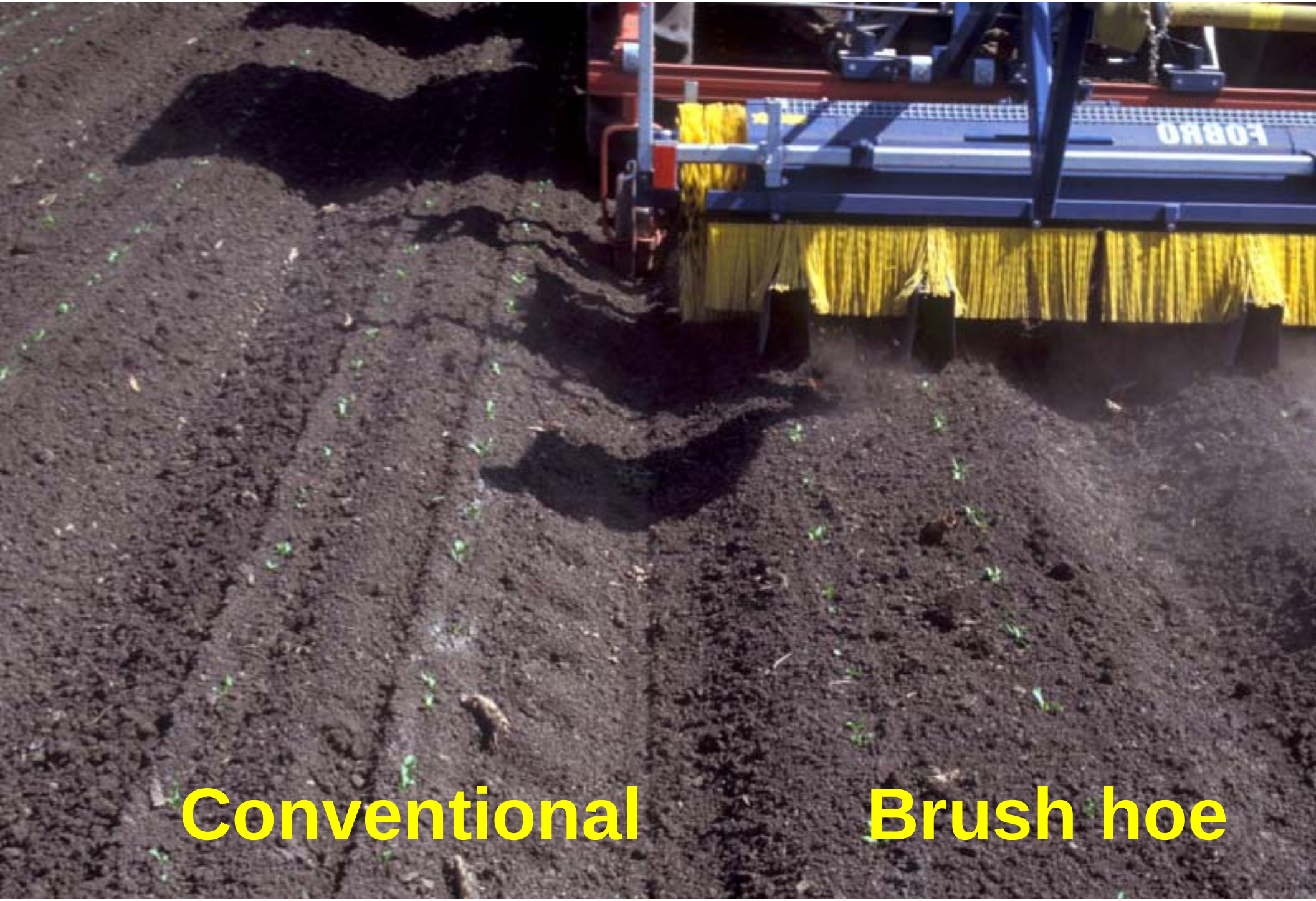

Cultivated Zone
Uncultivated Zone 4” wide
Cultivated Zone – 80% of the bed

4” wide cultivation strip

3” wide cultivation strip

Typical cultivation sled for the 2nd cultivation of lettuce

Brush Hoe


Conventional
Brush hoe

Brush hoe 2.9 inch strips


Conventional
Brush Hoe

Comparison of Brush Hoe and Conventional Cultivation

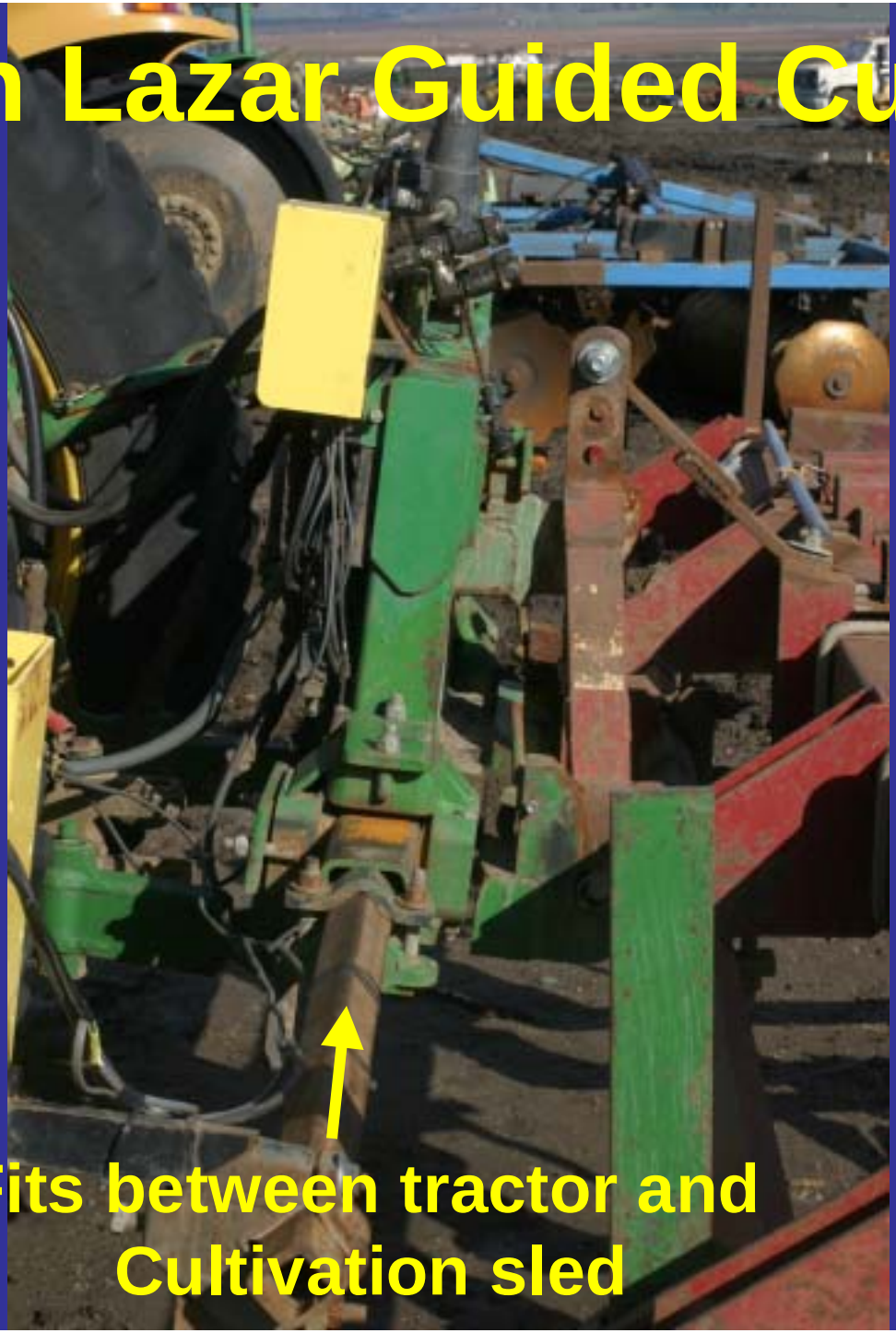
	Brush Hoe	Conventional Cultivator	Difference
Weeds/ft Of row	12.9	27.3	14.4
% Weed Control	60.7	38.4	22.3
Hours/Acre to Weed	15.8	19.9	4.1

Brush Hoe Summary

- Brush hoe is capable of cultivating close (2 7/8” wide strip) to seedline with no adverse effects on the crop
- The machine we used was slower than conventional cultivator (2.5-3 vs 4-5 mph) and required two people to operate


Flex Tined Cultivator
More effective on tough
stemmed crops

Eco Dan Lazar Guided Cultivator



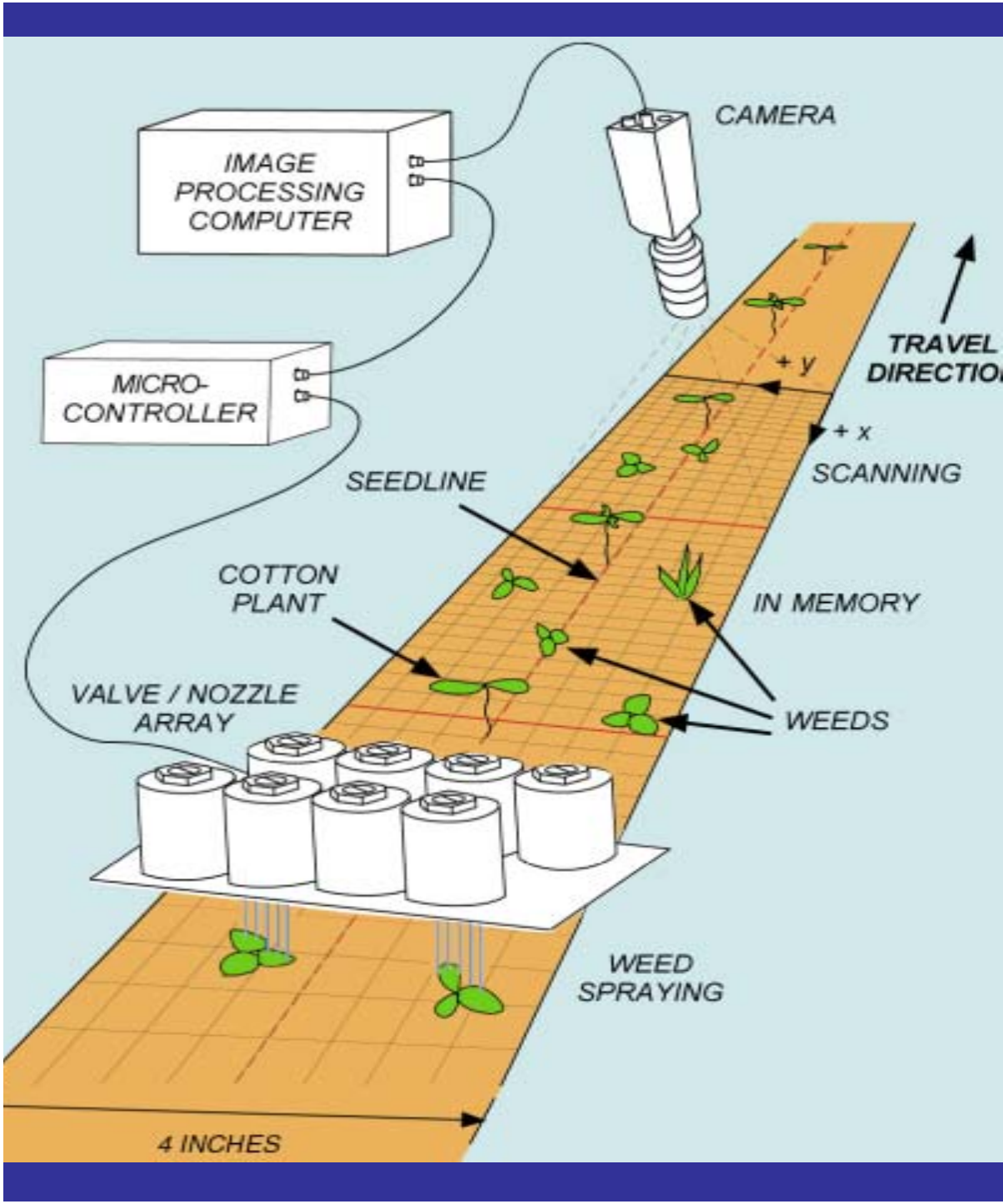
Fits between tractor and
Cultivation sled


← Sensor
ECO-DAN
DK-3490 KVISTGAARD
DENMARK
CE 02

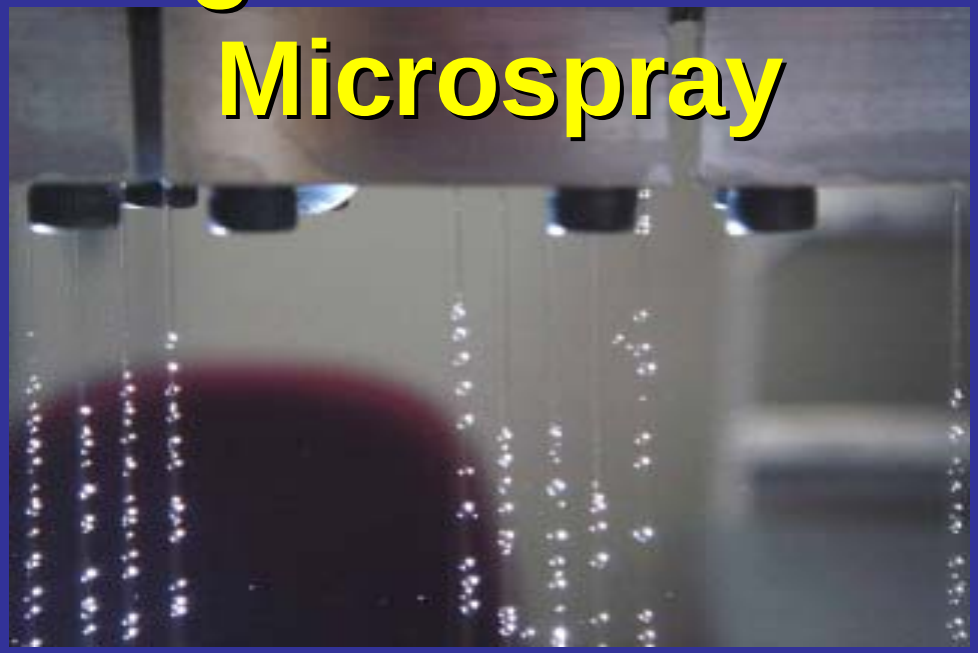
Sliding adjustment mechanism

Robotic Weed Control Concept

- Real-time weed sensing
  - Minimum Objectives
    - 3 km/h travel speed
    - 3 mm diameter weed detection.
    - Robust to real-world conditions.
      - Wind, rain delays,
      - Blemished plants
- Real-time weed control
  - Minimum Objectives
    - 1 cm^2 control area
    - Conventional & Organic compatible



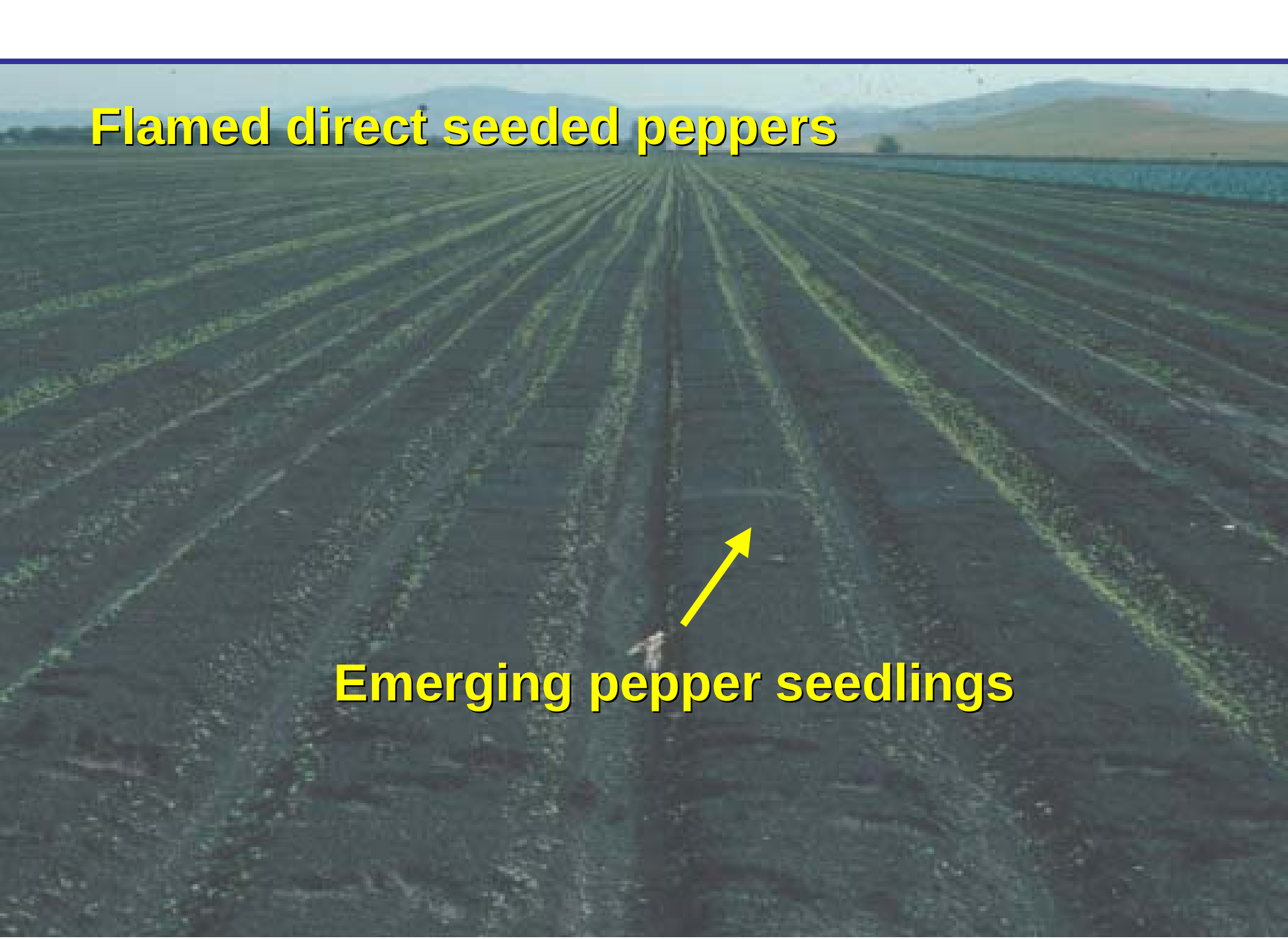
Organic – Hot Oil Microspray



- Canola oil heated to 177 ºC
- Sprayed only on weeds

Organically Acceptable Techniques

- **Flaming**
  - Used to kill weeds following preirrigation
  - Can be used preemergence on slow germinating crop such as pepper and others
  - Works better on small broadleaf seedlings


Flamed direct seeded peppers
Emerging pepper seedlings

Organically Acceptable Techniques

- **Biofumigation**
  - **Mustard cover crops**
- **Soil sterilization**
  - **Solarization**
  - **Steam sterilization**
  - **Other natural agents**

Impact of “Biofumigation” by Mustard Cover Crops on Weeds

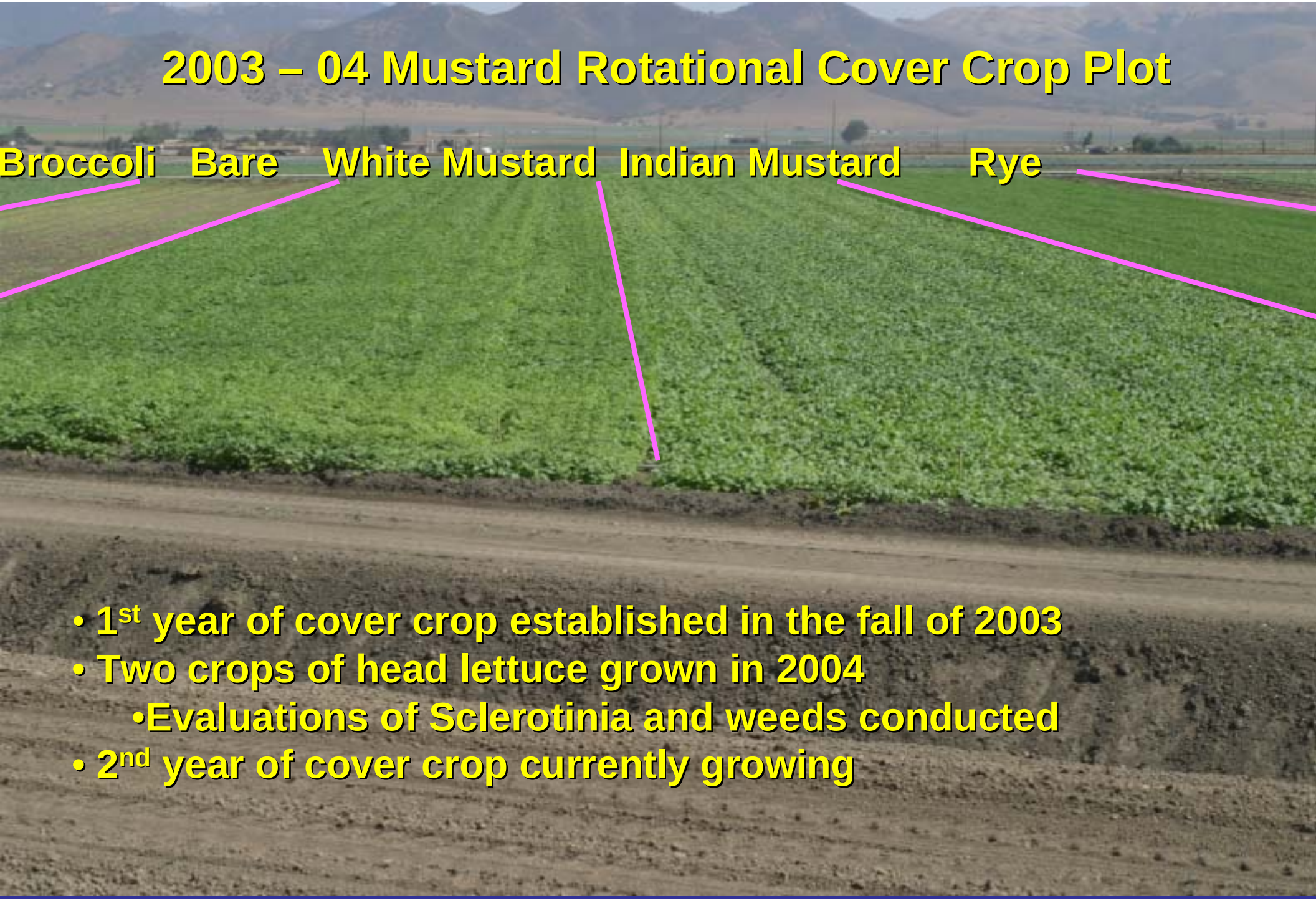
White Mustard
‘IdaGold’


Indian Mustard
‘ISCI 61’

Why Mustard Cover Crops

- Produce a class of chemicals known as glucosinolates
- These materials break down enzymatically to isothiocyanates, thiocyanates, nitriles and isonitriles in the soil which are toxic to nematodes, fungi and weed seeds – biofumigation
- There may also be soil microbiological effects as well

2003 – 04 Mustard Rotational Cover Crop Plot



- 1st year of cover crop established in the fall of 2003
- Two crops of head lettuce grown in 2004
  - Evaluations of Sclerotinia and weeds conducted
- 2nd year of cover crop currently growing

Mustard Cover Crop Rotational Plot
Weed Evaluations on First Lettuce Crop

Cover Crop Treatment	Lambs-quarters	Burning Nettle	Total Weeds	Cover Crop Biomass T/A
Merced Rye	2.8	1.8	9.4	3.1
Broccoli CC	12.9	7.2	26.3	1.3
White Mustard	2.7	2.9	8.8	2.5
Indian Mustard	4.3	2.6	10.0	2.2
Bare Fallow	4.3	1.3	8.5	-

March 4, 2004

Other Mustard Trials Cover Crop Trials

Short-term Rotational Trials
Weed Evaluations

Cover Crop Treatment	April 2003 Indian Mustard Spinach	Aug 2003 White Mustard Spinach*	May 2004 White Mustard Broccoli*	Aug 2004 Indian Mustard Broccoli*	Average of four trials: Total Weeds/4ft^2
Mustard CC	71.3	29.2	29.1	57.3	46.7
Bare Fallow	86.8	50.0	104.8	100.3	85.5

* Reductions in stand were observed

Solarization

Organically Acceptable Techniques

- Mulches
  - Colored plastic mulches
  - Organic mulches

Colored mulches

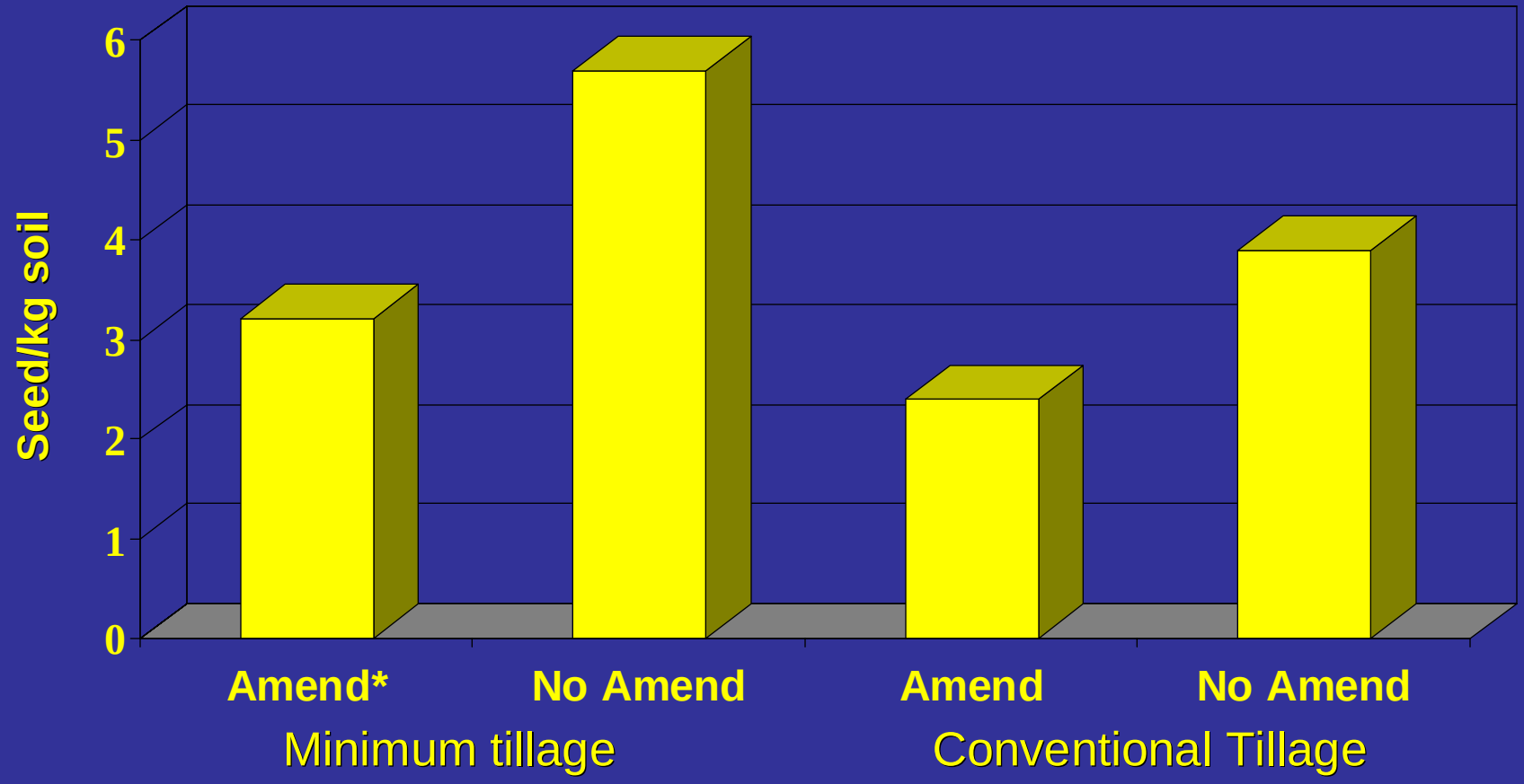
Organic mulch (cowpea residue in Coachella)

Organically Acceptable Techniques

- **Beneficial organisms**
  - **Weeder geese, sheep, etc.**
  - **Soil micro organism consume weed seed and seedlings**

Shepherd's Purse Seedbank Densities to 1 foot depth

Fennimore and Jackson, 2003



*** Cover crop and compost**

Organically Acceptable Techniques

- **Chemical control**
  - Organic herbicides - Benny
    - Contain oils (i.e. clove and thyme), citric acid, acetic acid
    - Generally expensive, but may have a use as selective herbicides over the top of cole crops and onions

2004 Onion Weed Control Comparison Untreated vs Standard Conventional

Treatments	Total Weeds per 4 ft^2	Crop Damage	Hours/A to Weed
Untreated	28.5	0.0	48.4
Standard Chemical	0.5	1.0	1.3

2003 Green Onion Evaluation

Xpress at 20% (Clove & Thyme Oils) in 35 gals/A on green onions


Xpress at 20%

Over the Top Application of Xpress Organic

Treatments	Material per Acre	Crop Damage	Broadleaf Weed Control
Untreated	----	0.0	0.0
Xpress @ 10%	3.5 gals	0.9	2.0
Xpress @ 20%	7.0 gals	1.9	7.5

Summary of Organically Acceptable Weed Control Systems

- There are many and varied techniques available to manage weeds in organic systems
- They do continue to be an expensive production input in organic vegetables
- Cultural practices however remain critical to reducing weed pressure

Summary of Organically Acceptable Weed Control Systems

- The situation with weed control in organic crops has changed in the last 10 years
- The availability of high technology cultivation equipment and organic herbicides are useful new tools
- In the future, computer assisted in-row weeding may prove useful, but initial costs may be high