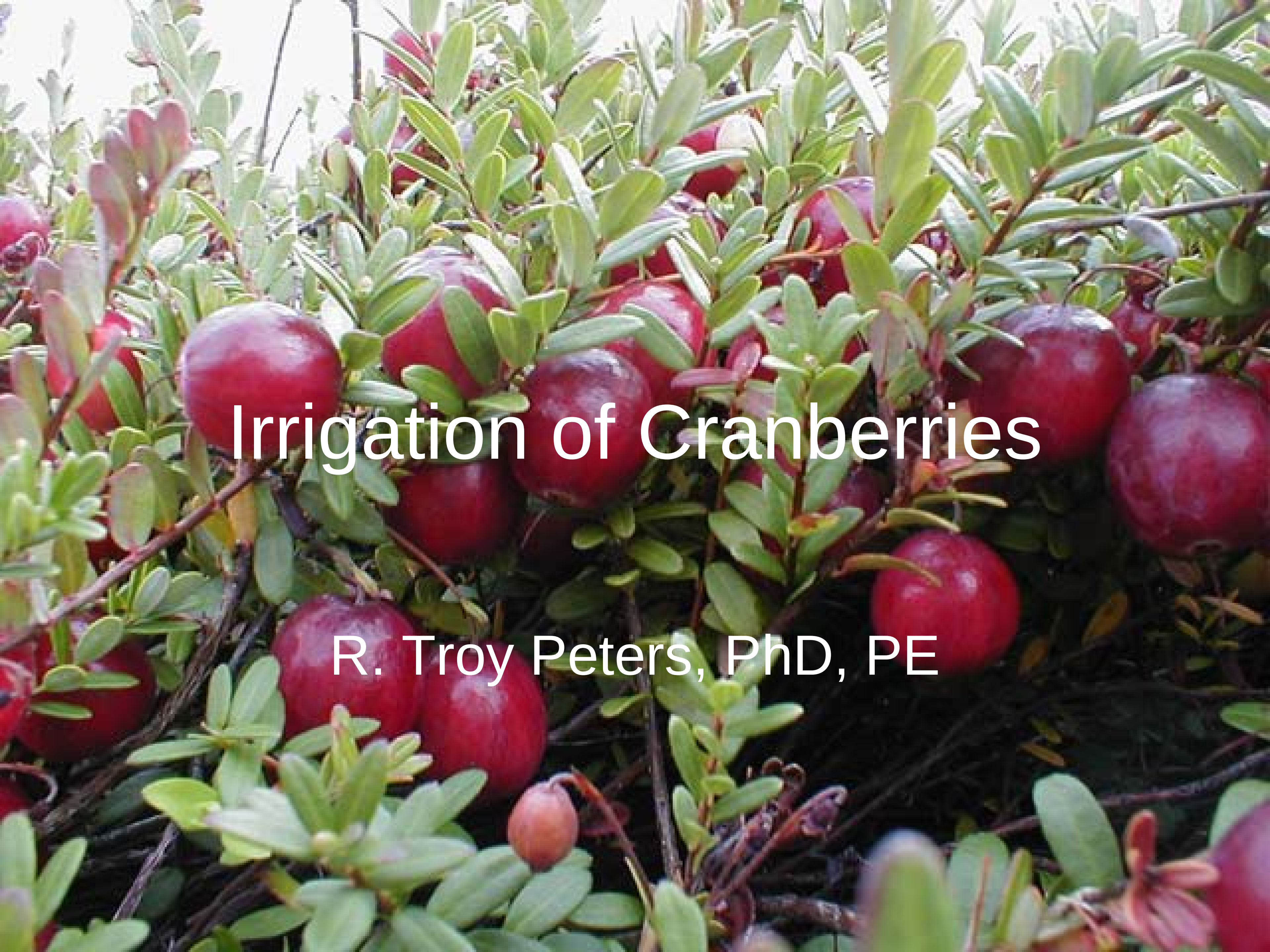
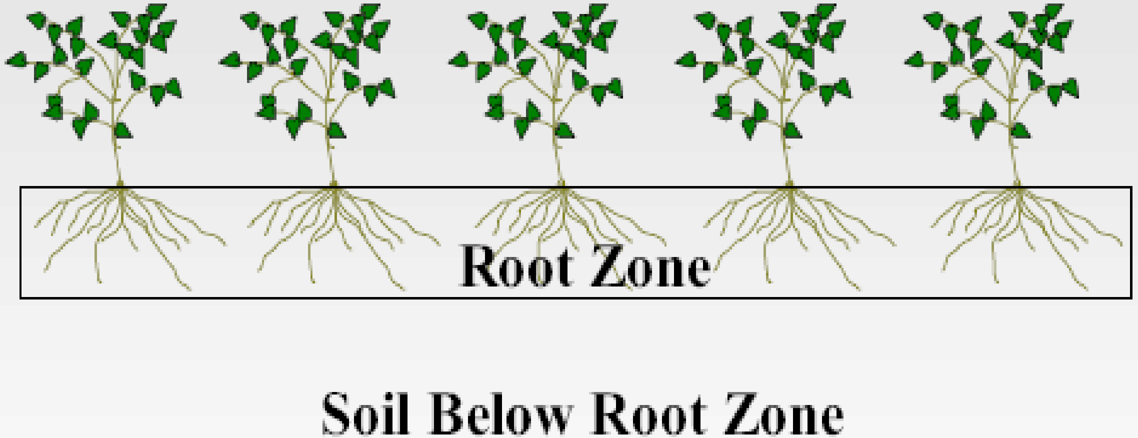


Irrigation of Cranberries

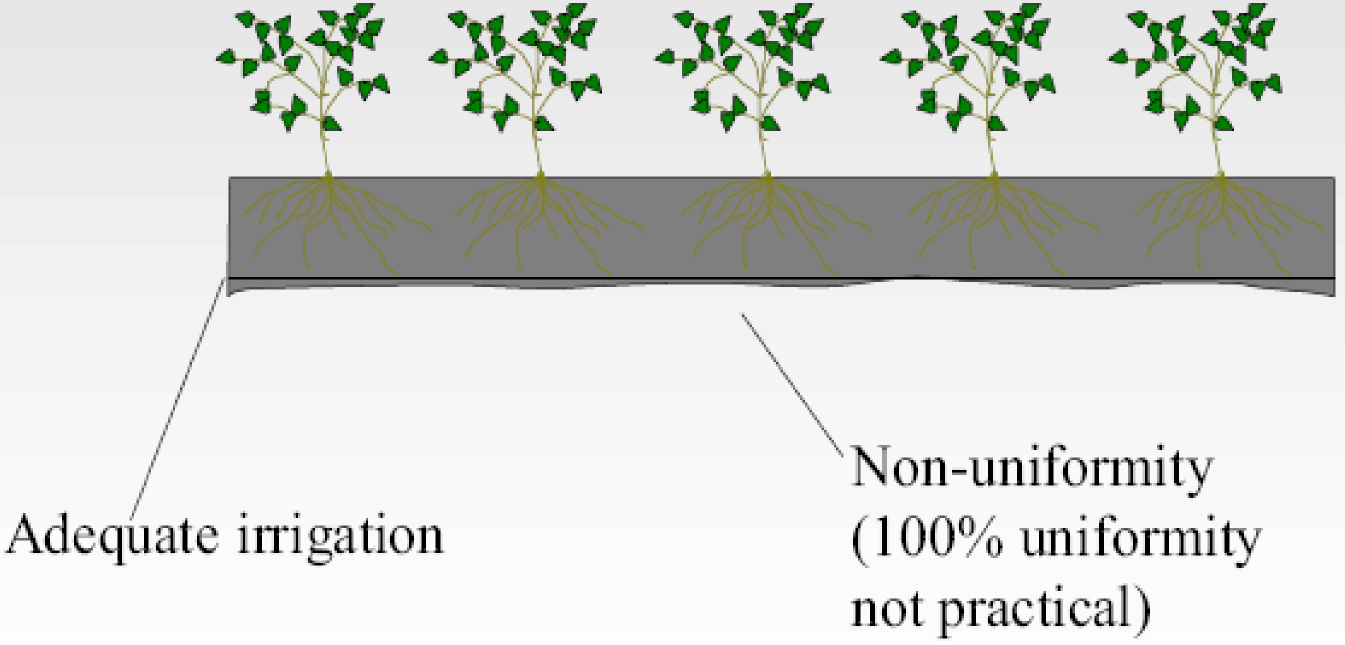
R. Troy Peters, PhD, PE

Uniformity & Efficiency



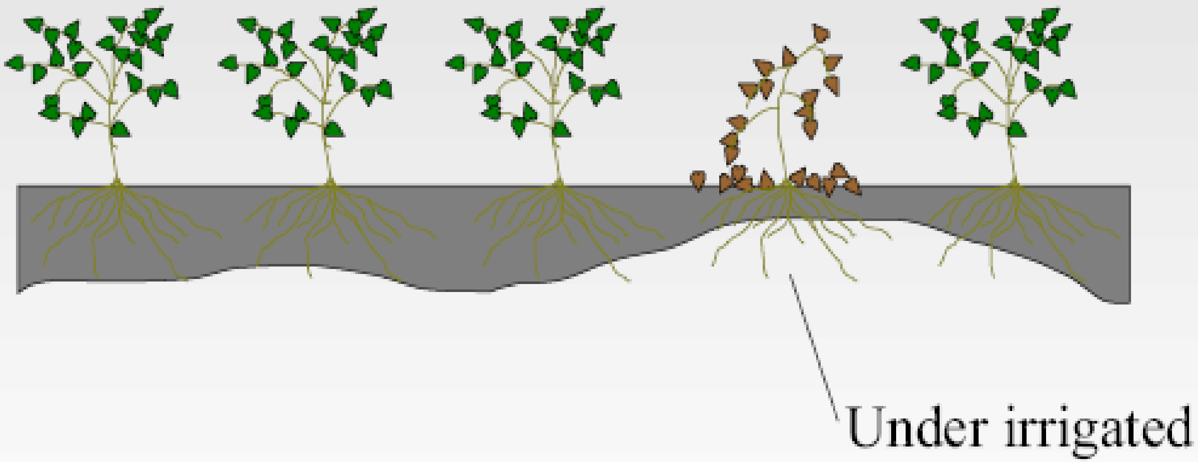
Courtesy Michael Dukes Univ. Florida

Uniform -- Efficient



Courtesy Michael Dukes Univ. Florida

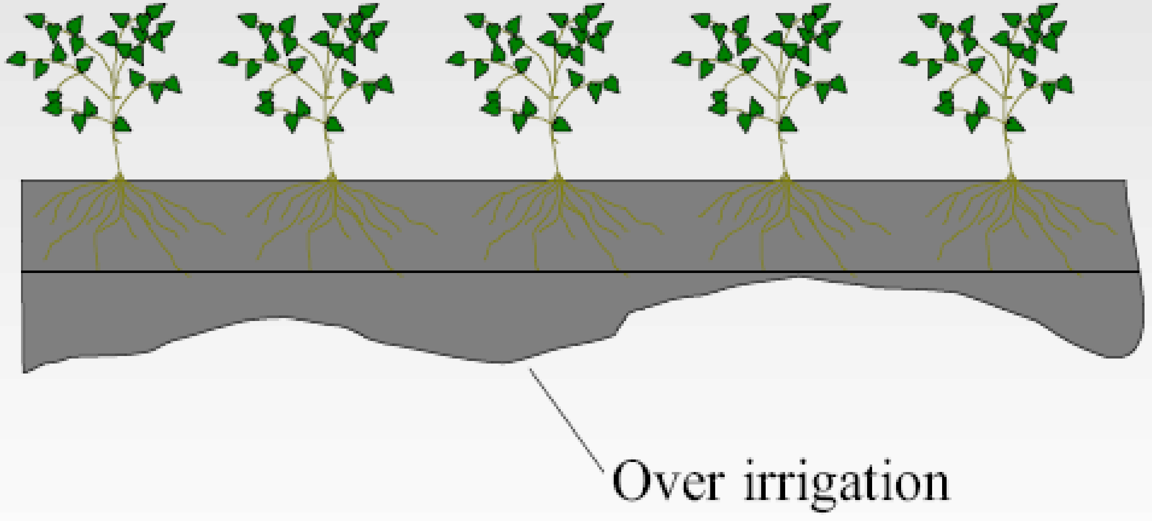
Non-uniform -- Inefficient



UNIVERSITY OF FLORIDA
Institute of Food and Agricultural Sciences

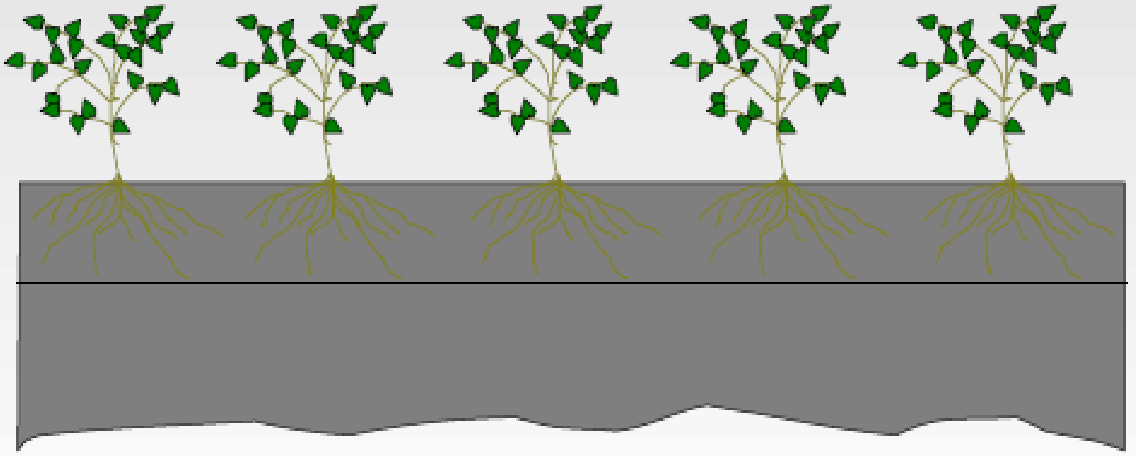
Courtesy Michael Dukes Univ. Florida

Non-uniform -- Inefficient



Courtesy Michael Dukes Univ. Florida

Uniform -- Inefficient



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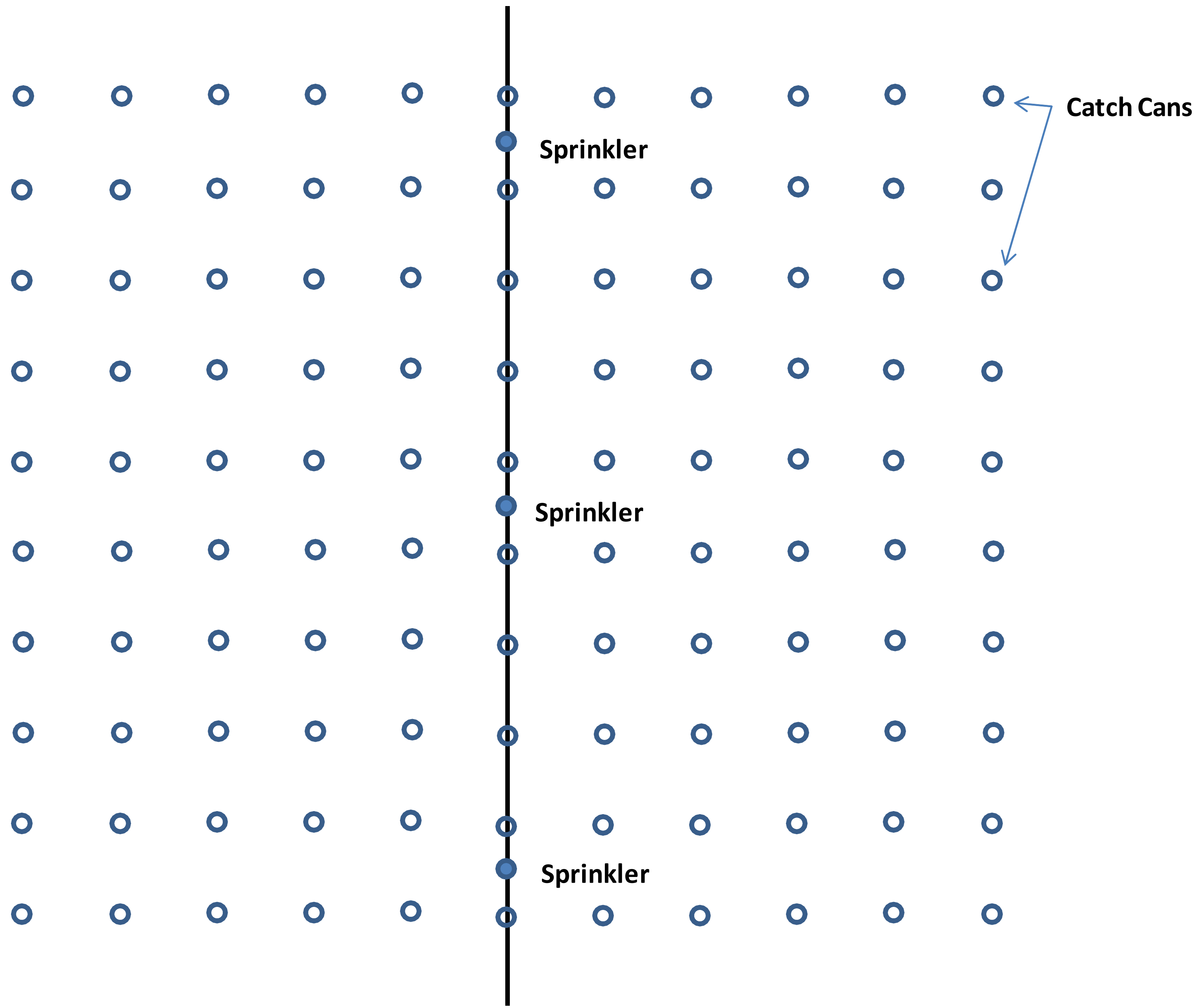
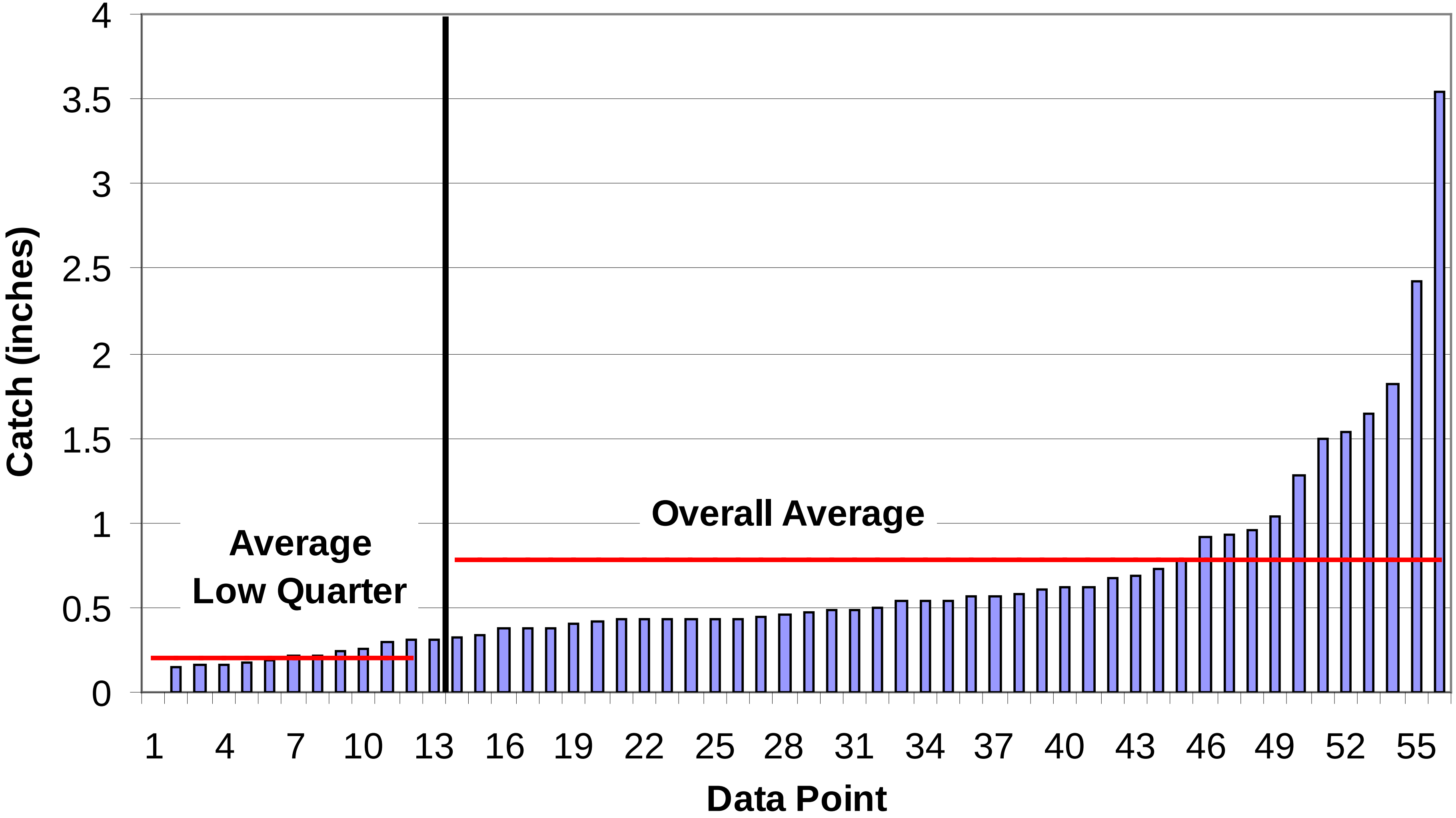

Catch Cans
Sprinkler
Sprinkler
Sprinkler

$$DU = \frac{AvgLowQuarter}{Avg}$$



Christiansen Coefficient of Uniformity

$$CU = 1 - \frac{\sum |z - m|}{\sum z}$$

where:

CU = coefficient of uniformity

z = individual catch (in)

m = average catch (in)

Uniformity

- Better yields
- Improved crop quality (more uniform)
- Less water used = $$ savings
- Less lost fertilizers
- Less mess
- Better for the environment
- Chemigate or fertigate with confidence

Irrigation Efficiency

Irrigation Efficiency Defined

$$ApplicationEfficiency = \frac{WaterStoredInSoil}{WaterApplied}$$

$$Efficiency = \frac{WaterBenficiallyUsed}{WaterFlowingOntoField}$$

Forms of Water Loss

- Wind Drift
- Droplet Evaporation
- Evaporation from Foliage
- Evaporation from Soil Surface
- Runoff
- Deep Percolation
  - Overwatering
  - Non Uniformity


Runoff

Improve Efficiencies By:

- Get a good design
- Maintain your system
  - Replace worn nozzles
  - Fix leaky pipes
- Improve management
  - Irrigation Scheduling
  - Operate at designed pressure and flow
  - Irrigate on calm cool days
  - Increase Application Rate

Why Should I Care?

- Even if the water is free, poor irrigation management has very real costs
- Yields and quality are *very strongly* correlated with irrigation water management
- Expensive fertilizers washed out
- Environmental damage

Over-Irrigating

- Increased incidence of plant diseases
  - Blights, molds, rots, wilts
- Reduced storability
- Difficulty with harvesting and cultural operations
- Less oxygen in root zone, yield loss
- Additional labor, pumping, fertilizer costs

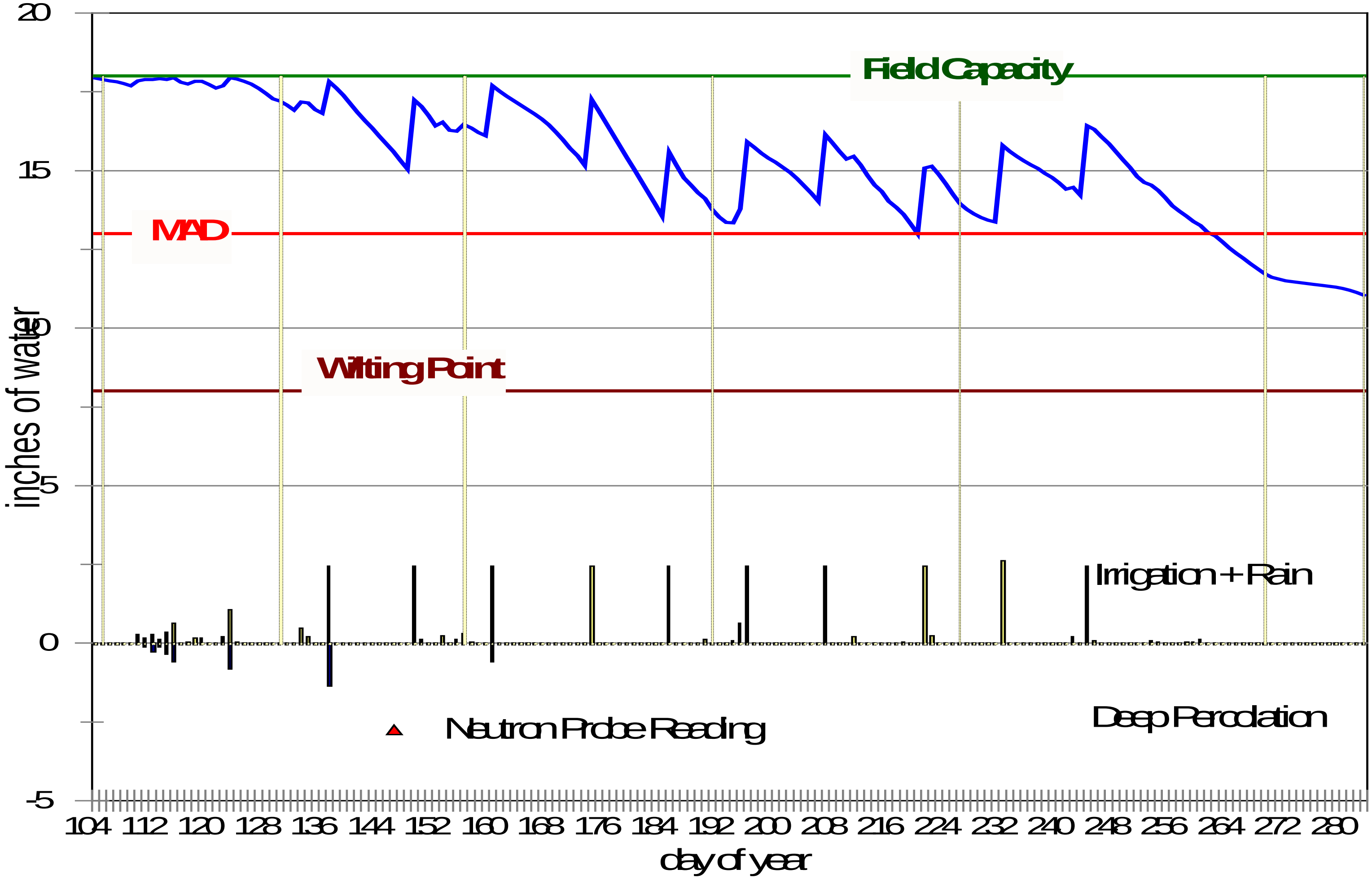
Benefits

- Most things that decrease your irrigation costs also benefit the environment
  - More flow for fish, less dirty water returning to rivers
  - Less consumption of energy
  - Less fertilizer, pesticides in streams and groundwater
  - More carbon sequestration (takes CO_2 out of the air)

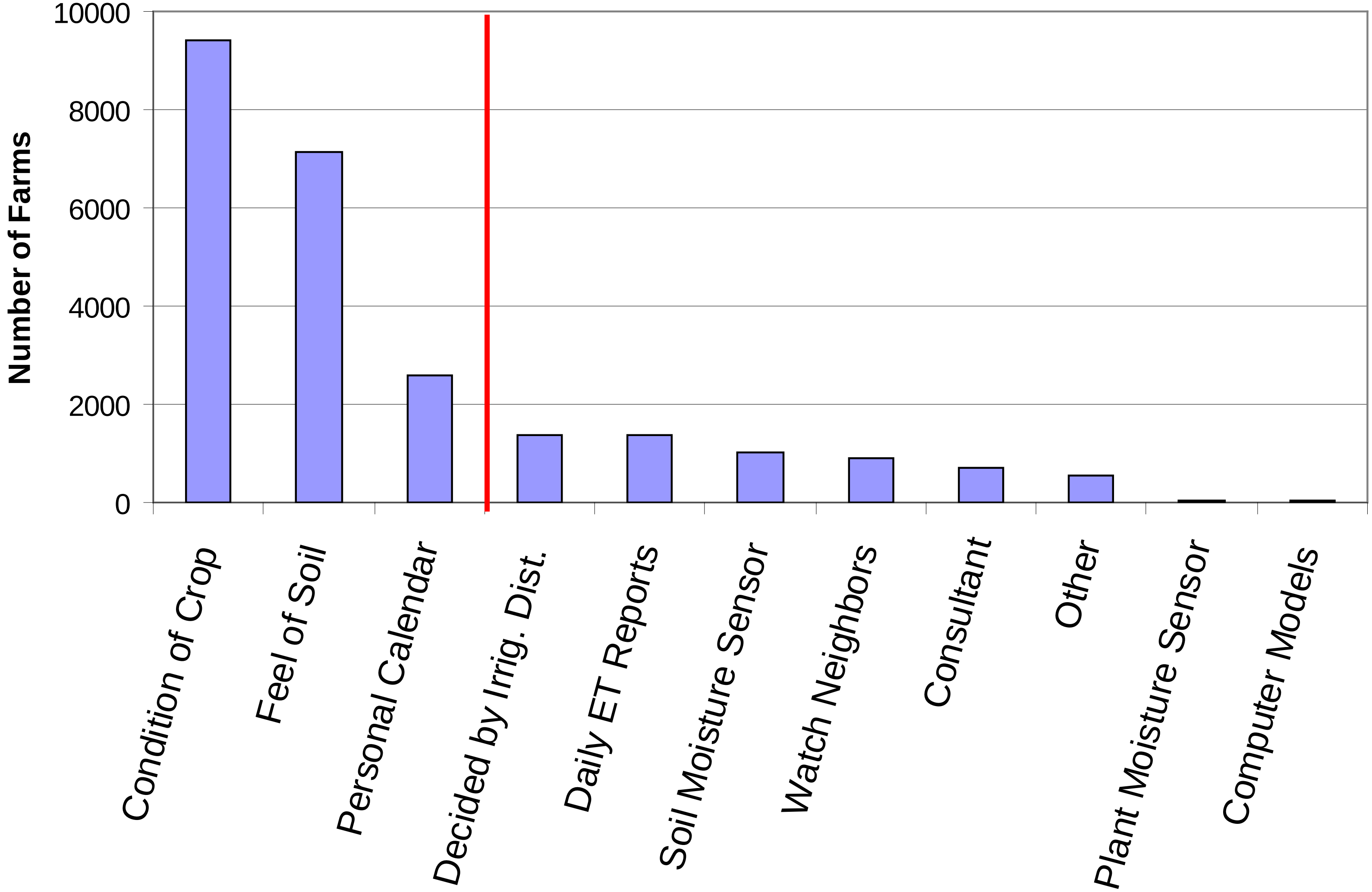
But Make Some Real Money!

- Saving money small compared to the yield increases and crop quality improvements common from improved *irrigation water management.*

Good Irrigation Scheduling



Methods Used in Washington to Determine When to Irrigate



Levels of Irrigation Scheduling

Worst

- Guessing / Same schedule all season
- Kicking the dirt / Looking at the plants

Less profitable

- Look and feel method using shovel or soil probe
- Checkbook method / ET (AgWeatherNet)
- Soil moisture monitoring
- Neutron probe + checkbook (consultant)

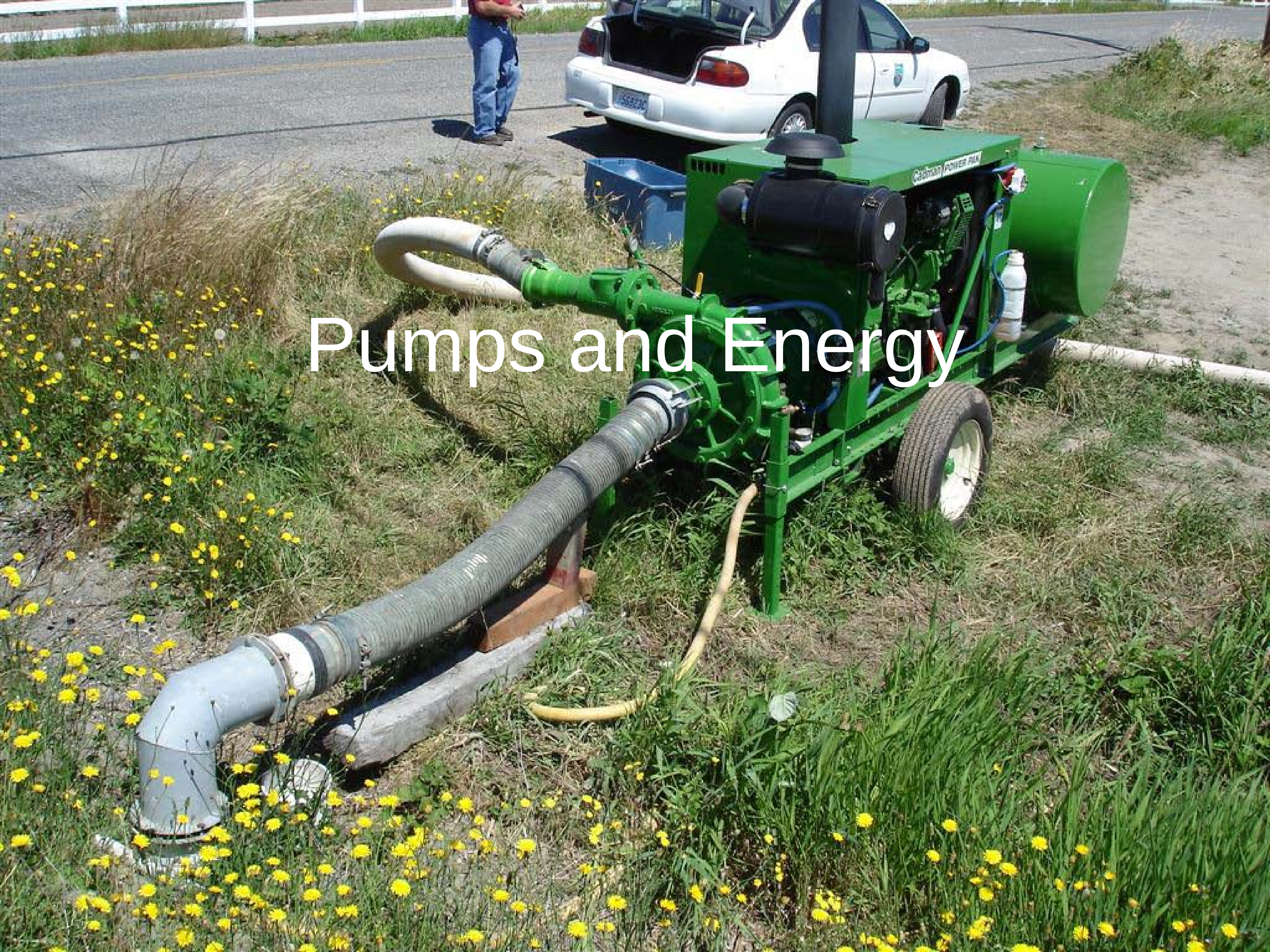
  especially cost effective for high value vegetable crops

Profitable growers

Best

Questions?

Pumps and Energy

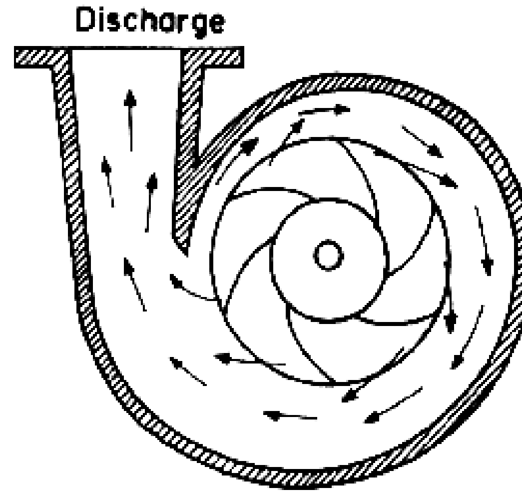


Water and Power

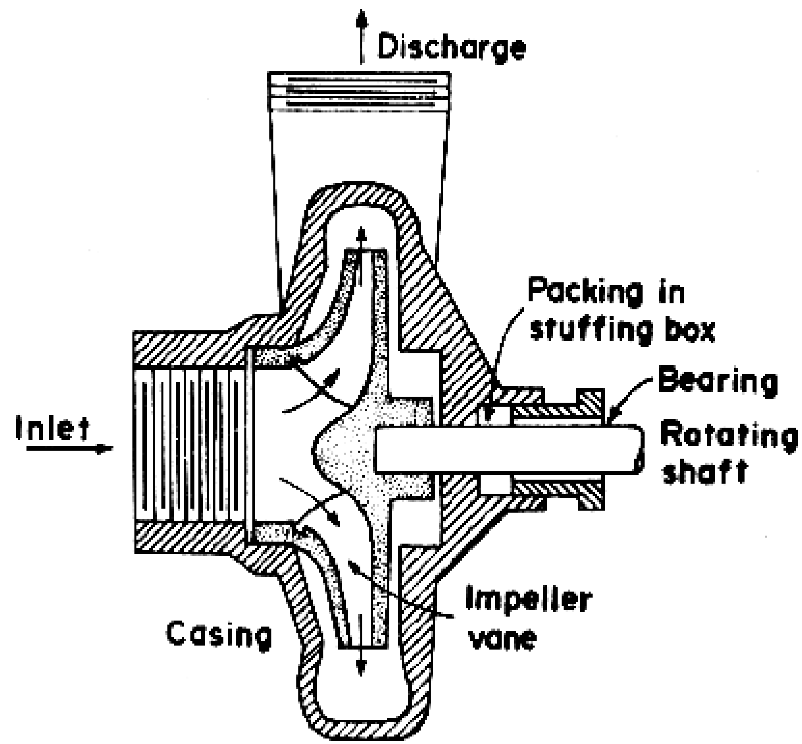
$$Power = \frac{Flow \times Pressure}{Efficiency / 100}$$

Pay for power (kW) over time (hrs) = kW-hr (KWH)

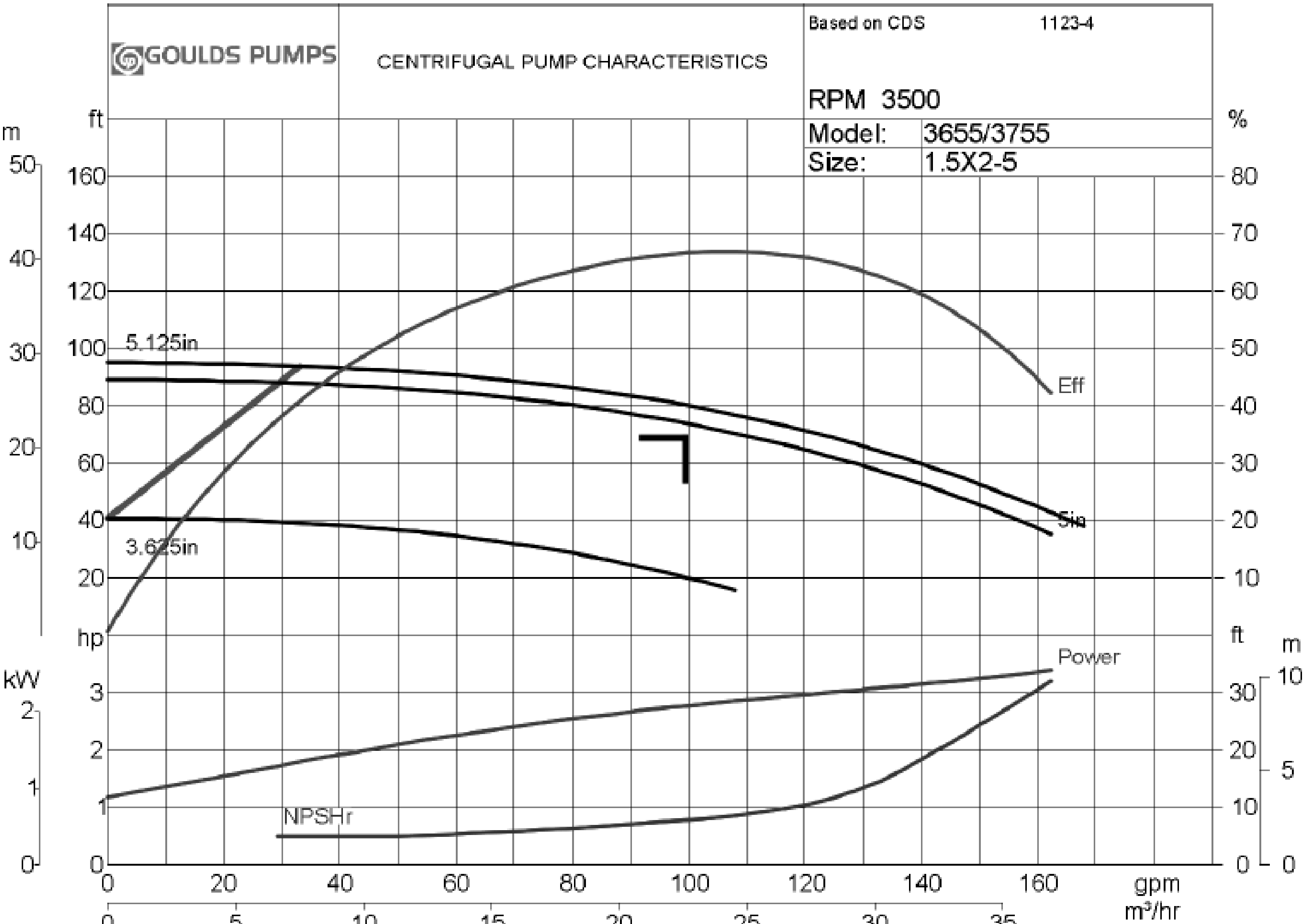
Centrifugal Pumps

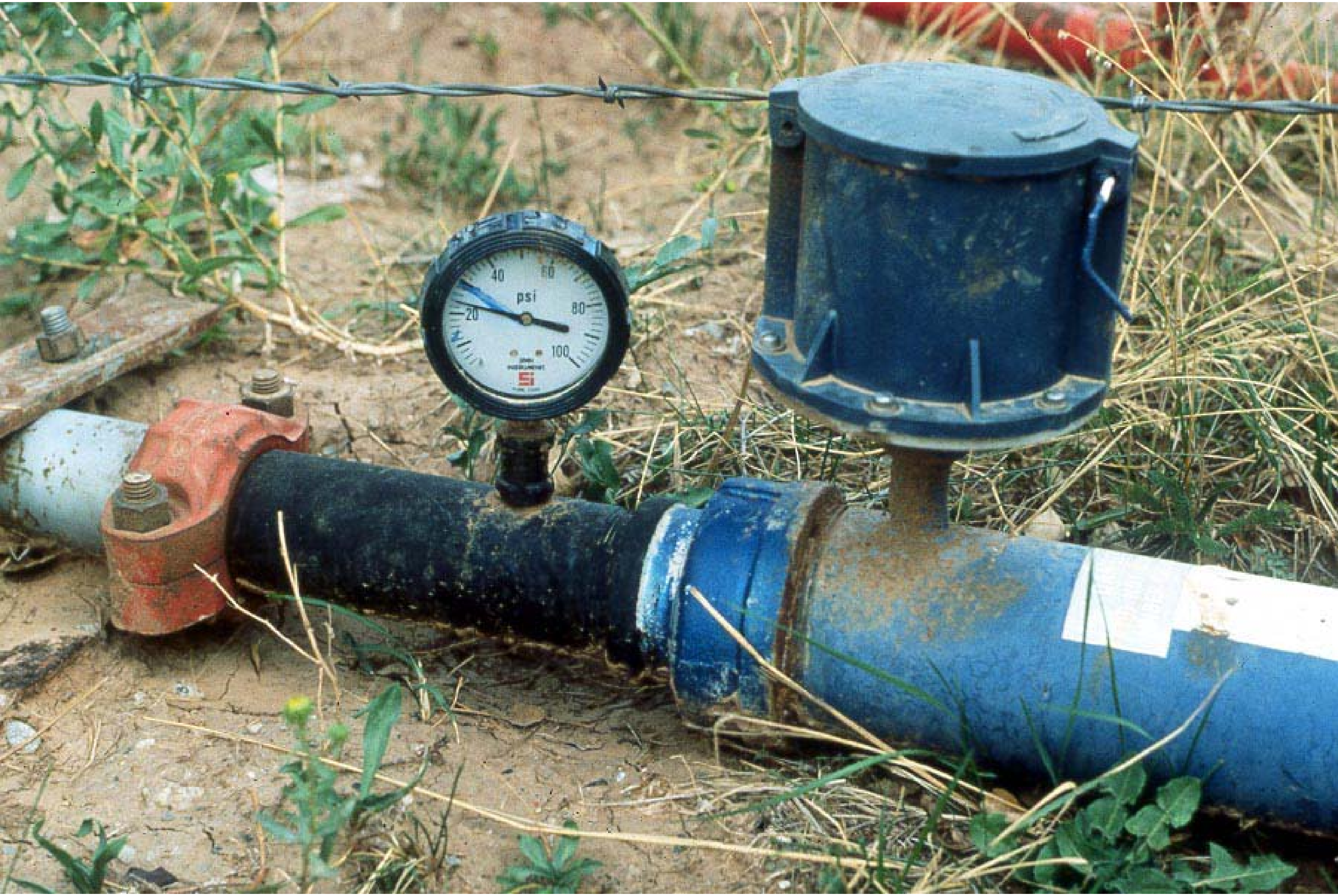


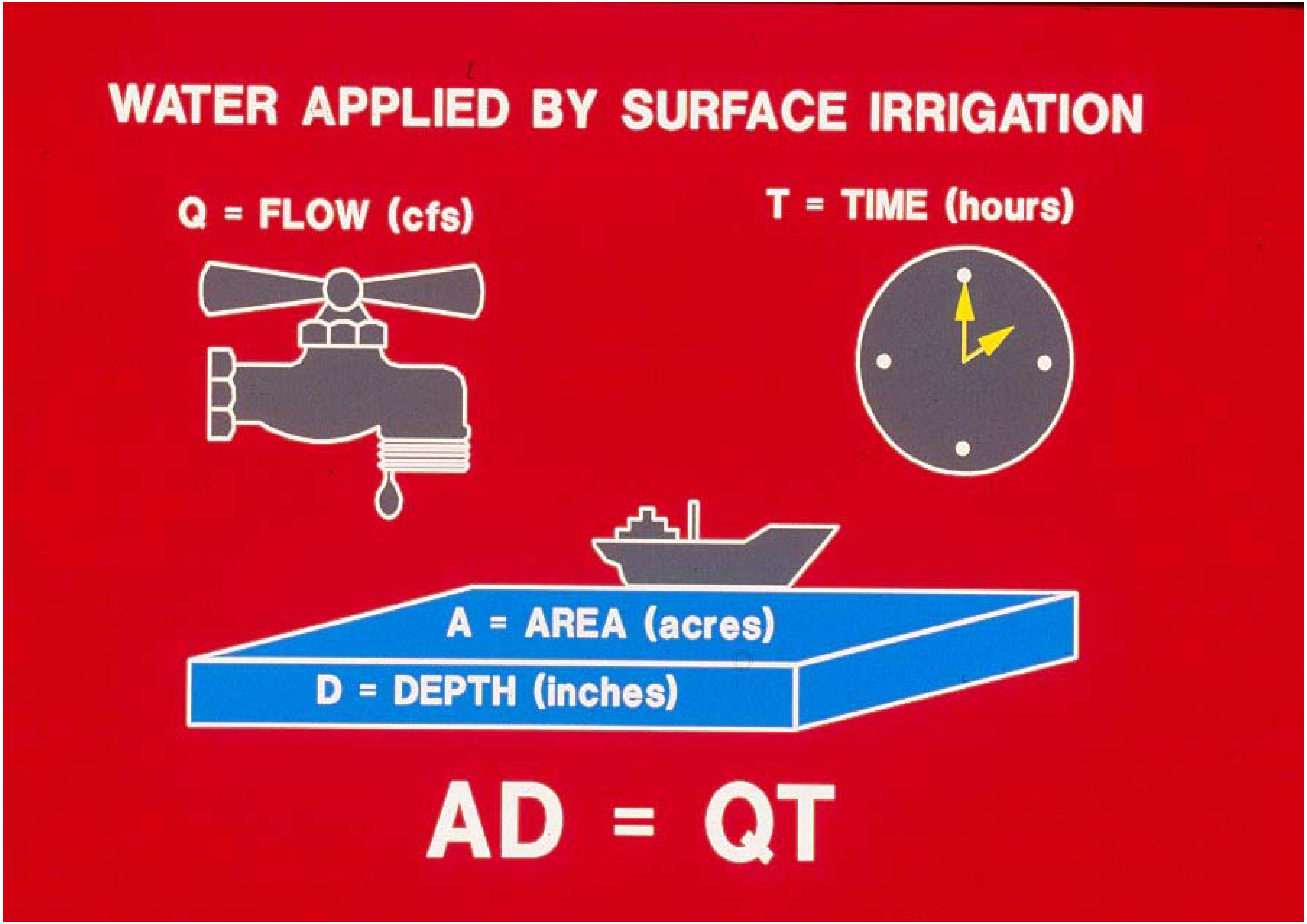
a. Volute centrifugal pump cross section



b. Horizontal centrifugal pump cross section


GOULDS PUMPS
CENTRIFUGAL PUMP CHARACTERISTICS
Based on CDS 1123-4
RPM 3500
Model: 3655/3755
Size: 1.5X2-5
5.125in
3.625in
5in
Eff
Power
NPSHr
m
ft
%
hp
kW
gpm
m³/hr


psi
20
40
60
80
100


WATER APPLIED BY SURFACE IRRIGATION
Q = FLOW (cfs)
T = TIME (hours)
A = AREA (acres)
D = DEPTH (inches)
AD = QT

Simple Unit Conversion

1 in/day = 18.86 gpm/acre

(use 19 to get close)

- Multiply maximum water use requirement in inches per day by 18.86 gpm/acre.
- Divide gpm/acre by 18.86 to get in/day.

Examples:

0.2 in/day = 3.8 gpm/acre

7.5 gpm/acre = 0.4 in/day

CALCULATING APPLICATION RATE

- Set Sprinklers
  - AR = (96.3 x Qn) / (Ss x Sl) x Eff.
- Center Pivot
  - AR = (96.3 x Qc) / (Ac x 43,560) x Eff.
- Drip Tubing
  - AR = (0.963 x Qt) / (St) x Eff.

3 phase vs. Single phase

- Power is generated in 3 phase
- 3 phase is ideal for electric induction motors
- Higher starting torque
- More efficient
- Less expensive
- Smaller motor
- Simple and reliable (less vibration)
- 3 phase motors are more efficient at higher hp
- Necessary for pumps > 10 hp
- Not typically supplied to residences

Variable Frequency Drives

- Changes motor spin speed. AC$\rightarrow$DC$\rightarrow$AC
- Solid state. No moving parts. Cost $\downarrow$ Quality $\uparrow$
- Works with existing motor and pump.
- Can use a 3-phase motor on single phase power source

www.joliettech.com

Variable Frequency Drives

- Power savings.
  - No burning up pressure across valves.
  - Soft starts – longer pump life
- Produce heat that must be vented.
- ~ $100/hp installed
- Possible cost share from power company. (BPA)
- Cost effective if flows vary widely and for long periods of time.

Cost Sharing

- EQUIP – USDA, NRCS
  - Major efficiency upgrades, surface to sprinkler
- Conservation districts
- Bonneville Power Administration – For energy saving projects.
  - Through electric utility provider.
  - SIS - $5/acre. Grower must get weekly report.
  - $0.15/KWH saved or 70% of improvement, whichever is less.
  - Must verify energy savings

Chemigation Calculators - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://irrigation.wsu.edu

Chemigation Calculators

Irrigation in the Pacific Northwest

- Home
- Irrigation Calculators
  - Drip
  - Sprinkler
  - Center Pivot
  - Chemigation
    - Chemical Injection Rate (Volume)
    - Chemical Injection Rate (Mass)
    - Chemical Injection Rate (Water Chemistry Control)
    - Mixing Dry Chemicals
    - Batch/Bulk Application
    - Maximum Solution Concentration
  - General
  - Residential
  - Water Measurements
- FAQs & Tutorials
- Irrigation Resources
- Washington Irrigation
- Idaho Irrigation
- Oregon Irrigation

Chemigation Calculators

- Chemical Injection Rate (Mass)
- Chemical Injection Rate (Water Chemistry Control)
- Chemical Injection Rate (Volume)
- Maximum Solution Concentration
- Batch/Bulk Application
- Mixing Dry Chemicals

Select a Different Calculator

Chemigation

Chemigation

General term that includes:

- Fertigation
- Herbigation
- Insectigation
- Fungigation
- Nematigation

Advantages of Chemigation

- Economics
- Timeliness
- Reduced soil compaction and crop damage
- Operator safety

Disadvantages

- High management (need to know algebra)
- Additional equipment required

Calculating Injection Rates

1. **Batch/Bulk Applications**
   – Drip, Hand-line, Wheel-lines, Solid set
2. **Continuous Move Injections**
   – Center pivots, Linear Moves, Travelers, Booms
3. **Controlling water chemistry**
   – Drip (algae/bacteria growth control, root intrusion)

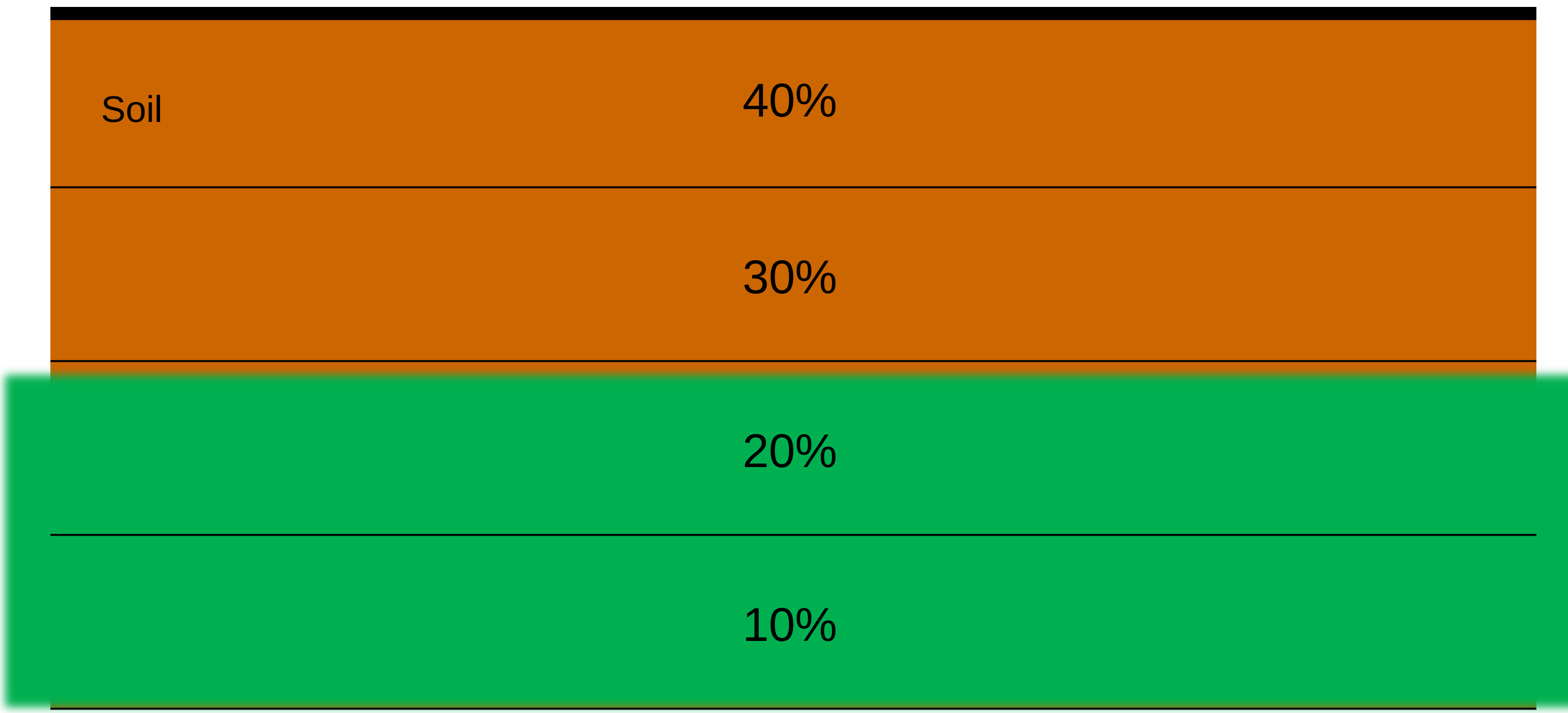
Batch/Bulk Applications

Timing is Key

Batch Applications

- Herbicides and Insecticides
  - Apply during the last few minutes (follow the label)
- Fertilizers
  - Time to put the chemical in the active root zone, and so that the injection is finished before irrigation is done. Rate is less critical

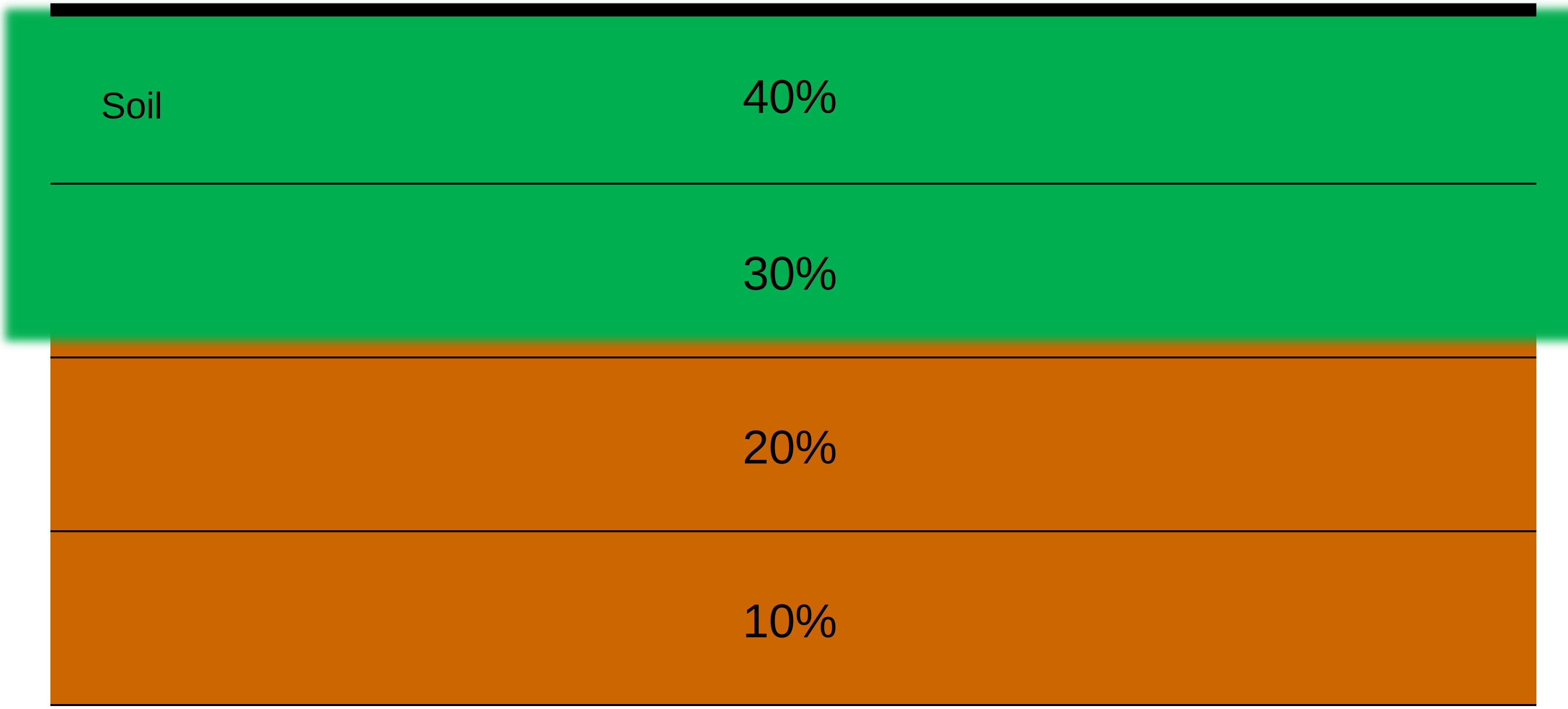
Batch Injection Rates Applied Early in the Irrigation Cycle



More danger of leaching.

Batch Injection Rates Applied Late in the Irrigation Cycle

Don’t leave chemicals in the lines.



Less danger of leaching.

Batch Application

- Weight Method
  - Mix desired amount of material in a convenient amount of water.
  - Inject until it is gone.
  - Injection rate set to limit irrigation line concentration and injection time.
- Volume Method
  - Similar except applying a set volume.

Injection Rate

$$I_c = \frac{Vol}{T}$$

I_c = Injection Rate (gpm)
Vol = Volume of Chemical to inject (gallons)
T = Injection Time (min)

Calculate Injection Rate by Mass

(given lb/acre specs)

$$I_c = \frac{Q_w \times A}{C \times T}$$

I_c = Chemical Injection Rate (gal/min)

Q_w = Quantity of chemical to be applied (lb/acre)

A = Area (acres)

C = Concentration of injected solution (lb/gal)

T = Injection Time (min)

Calculate Injection Rate by Volume
(given pint/acre specs)

$$I_c = \frac{Q_v \times A}{T}$$

I_c = Chemical Injection Rate (gal/min)
Q_v = Quantity of chemical to be applied (gal/acre)
A = Area (acres)
T = Injection Time (min)

Venturi Valves and other proportional rate injectors

Tank mixture concentration is key

Mixing Dry Chemicals

Total Chemical to be Applied

(How much dry chemical to mix with water)

$$W_t = \frac{A \times R_m}{P_{cnt}}$$

W_t = Weight of chemical to be applied (lbs)

A = Area (acres)

R_m = Rate to apply by mass (lb/acre)

P_{cnt} = Percent concentration in mix (%)