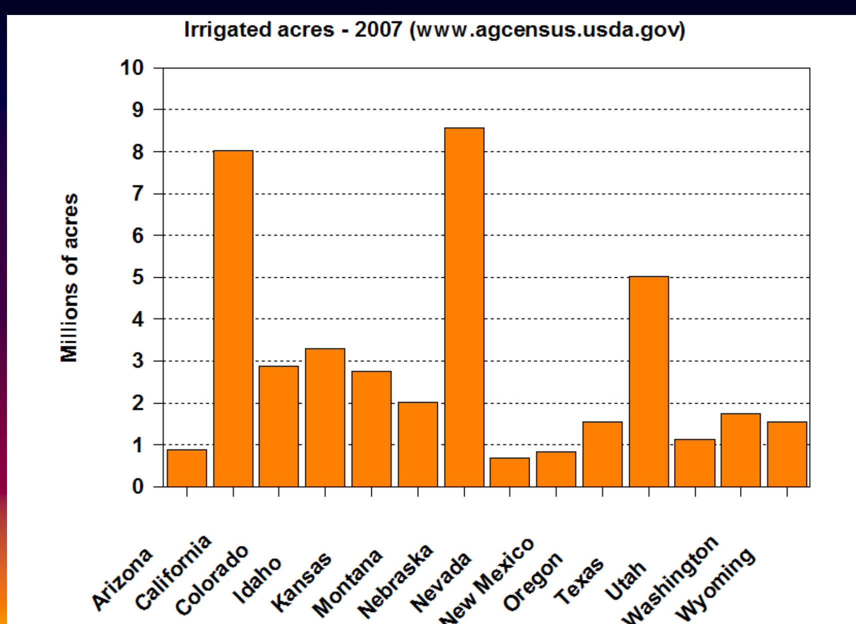
California Agriculture, Water and You

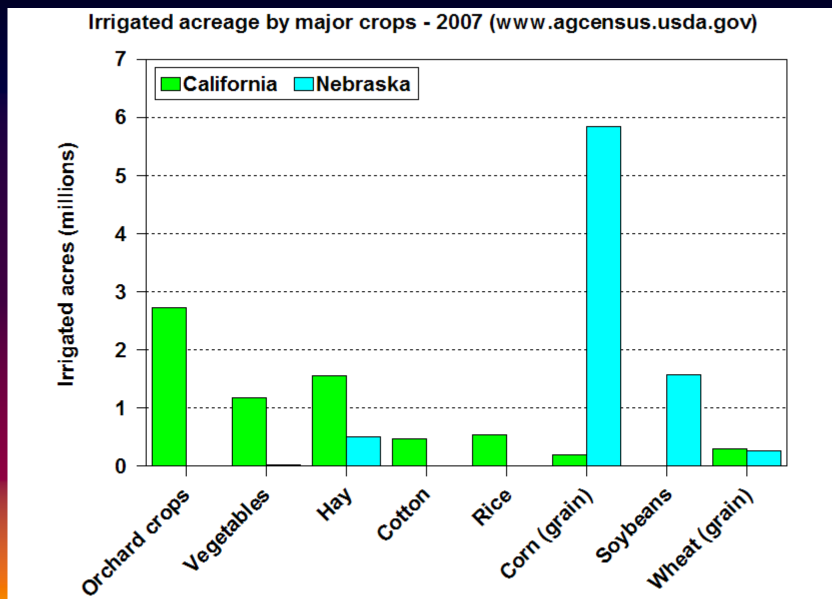
Blaine Hanson

Department of Land, Air and Water Resources

University of California, Davis

brhanson@ucdavis.edu





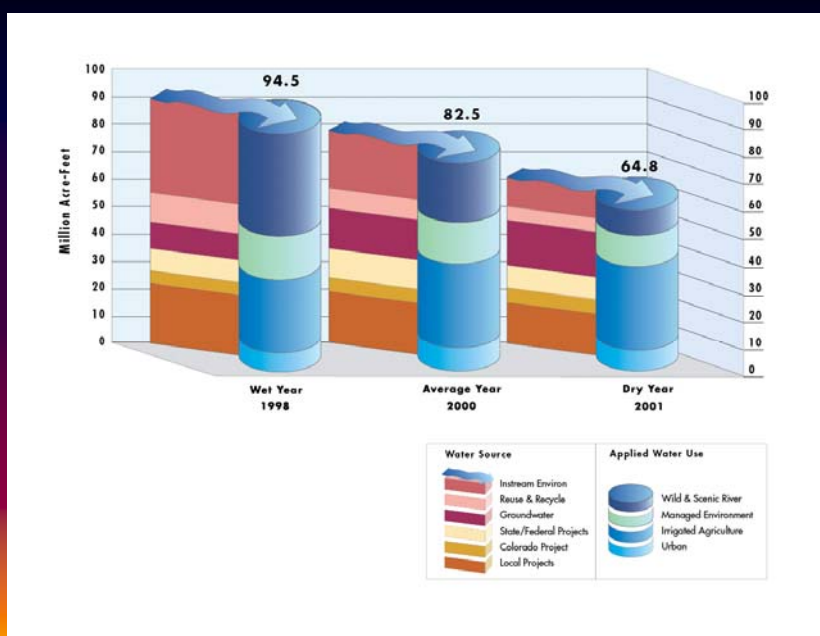
Irrigated acreage by major crops - 2007 (www.agcensus.usda.gov)
Irrigated acres (millions)
California
Nebraska
0
1
2
3
4
5
6
7
Orchard crops
Vegetables
Hay
Cotton
Rice
Corn (grain)
Soybeans
Wheat (grain)

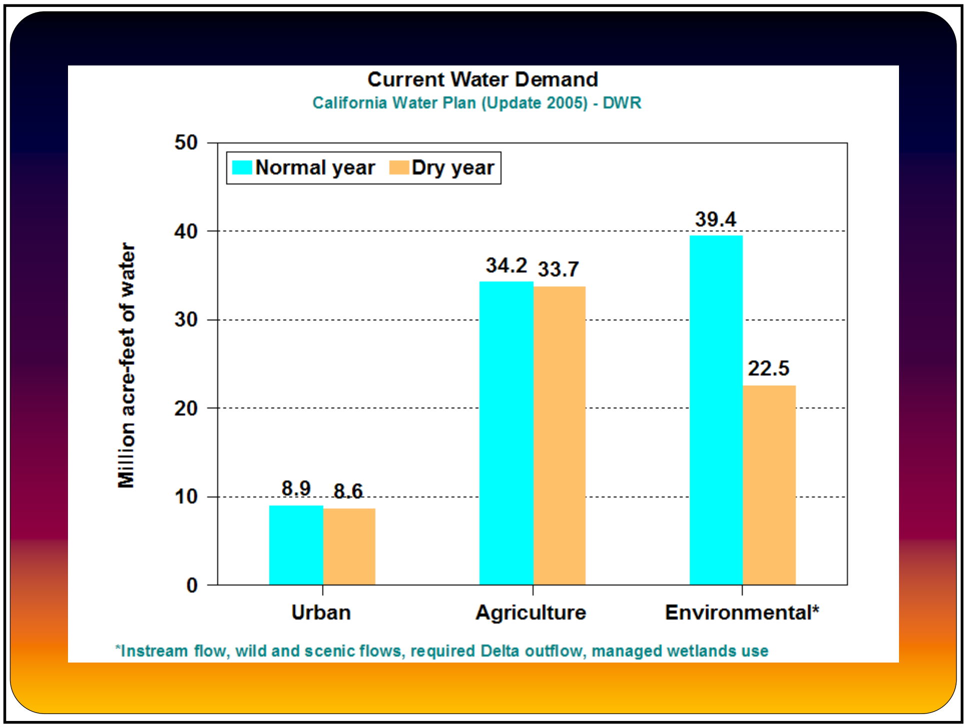
What percentage of California's water does agriculture use?

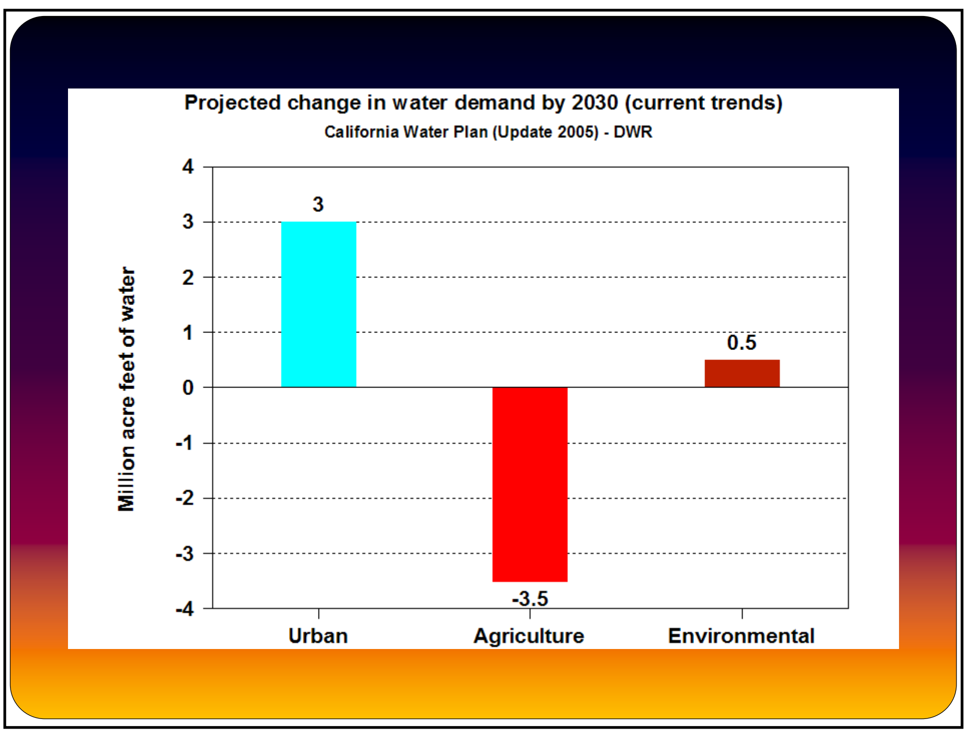
- 80 %
- 52 %
- 29 %

Answer: all are correct depending on the basis used to determine the percentage

- **80 %: based on the developed water supply**
- **52 %: based on the total water supply of a dry year**
- **29 %: based on the total water supply of a wet year**




Current Water Demand
California Water Plan (Update 2005) - DWR
Normal year
Dry year
Million acre-feet of water
50
40
30
20
10
0
8.9
8.6
34.2
33.7
39.4
22.5
Urban
Agriculture
Environmental*
*Instream flow, wild and scenic flows, required Delta outflow, managed wetlands use


Projected change in water demand by 2030 (current trends)
California Water Plan (Update 2005) - DWR
Million acre feet of water
4
3
2
1
0
-1
-2
-3
-4
3
-3.5
0.5
Urban
Agriculture
Environmental

Perceptions of agriculture

Agriculture wastes water!

Agriculture wastes water!

Agriculture wastes water!

Agriculture wastes water!

Agriculture wastes water!

Stop growing alfalfa

Grow only almonds or other high-cash value crops

Low, stable (water) prices have encouraged some farmers to waste water and to pour it on low-value crops like rice and alfalfa, while others struggle to sustain valuable almond trees (The Economist, London).

Improving the irrigation efficiency would save enough water to meet urban/industrial needs

Using 1000 acre-feet of water to grow a grain crop would generate about $400,000 in net returns. Using 1000 acre-feet of water in high-tech industry would generate $400,000,000 in returns

"It takes $750 worth of retail water to grow $150 worth of wholesale cotton. That's just not rational," Lloyd Carter, President of California's Save our Streams Council (Feb. 2009)

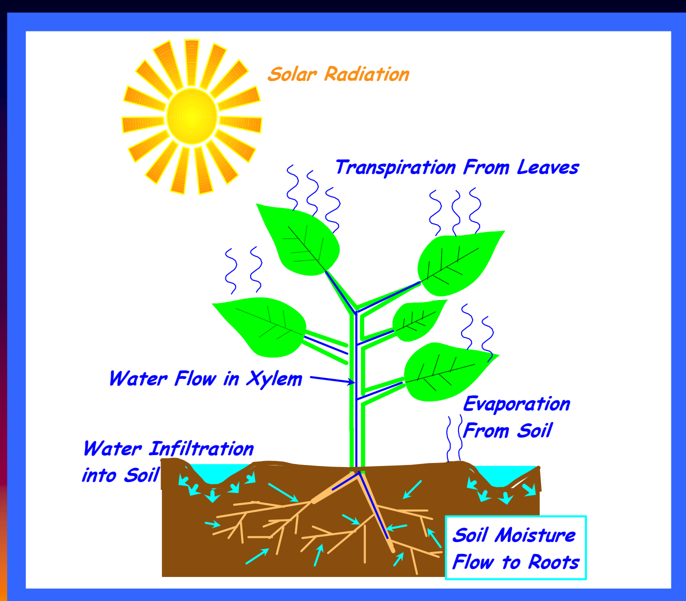
Water needs in California

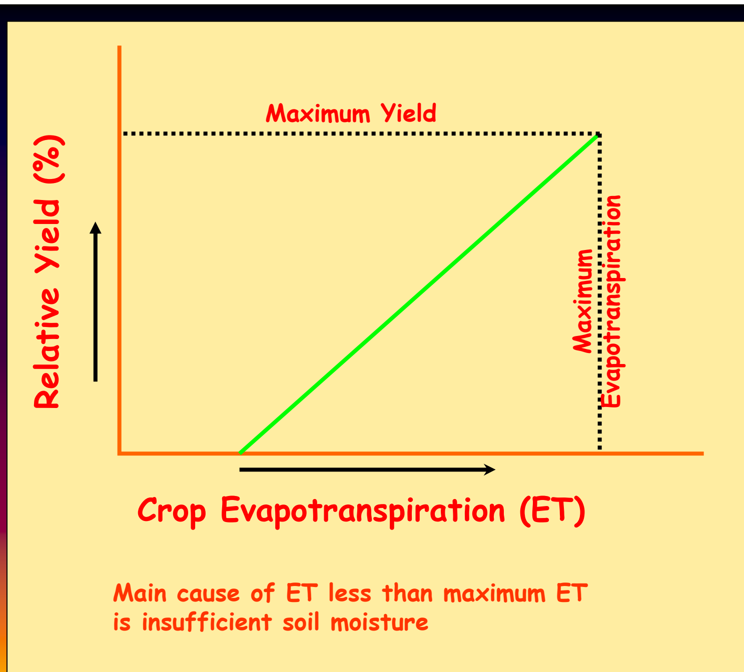
- We require water for urban/industrial needs
- We need water to protect the environment
- We need water to produce food?

How much water does agriculture really need?

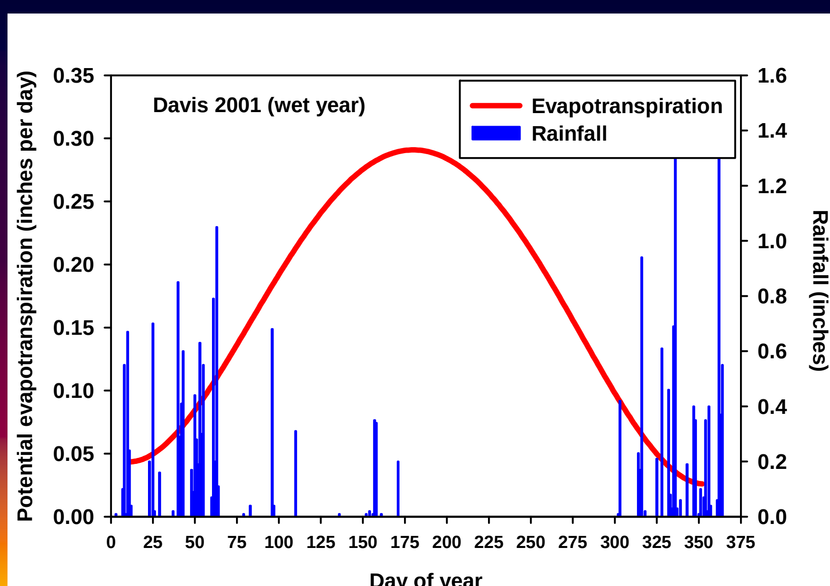
What is evapotranspiration (ET)?

- Evapotranspiration: crop water use
  - Water evaporation from plant leaves (transpiration)
  - Water evaporation from soil surface
  - More than 95% of the water uptake by plants is evaporated
- Factors
  - Climate: solar radiation, temperature, humidity, wind
  - Plant: crop type, stage of growth, health
  - Soil moisture content
- Units
  - Volume of water
    - One acre-inch = 27,160 gallons
    - One acre-foot = 325,900 gallons
  - Depth of water: inches, feet, cm, mm
    - One inch of water = 1 acre-inch ÷ 1 acre
    - Standardized water use (independent of field size)





Why irrigate?



Measuring evapotranspiration (ET)

- Difficult and expensive to measure
- Even more difficult to separate transpiration and soil evaporation
- Methods
  - Lysimeter
  - Meteorological methods
  - Soil moisture measurements
- California Irrigation Management Information System (CIMIS)
  - Simple method for calculating ET
  - Developed from measured ET data
  - Network of weather stations Installed and maintained by the University of California and California Department of Water Resources

Lysimeter

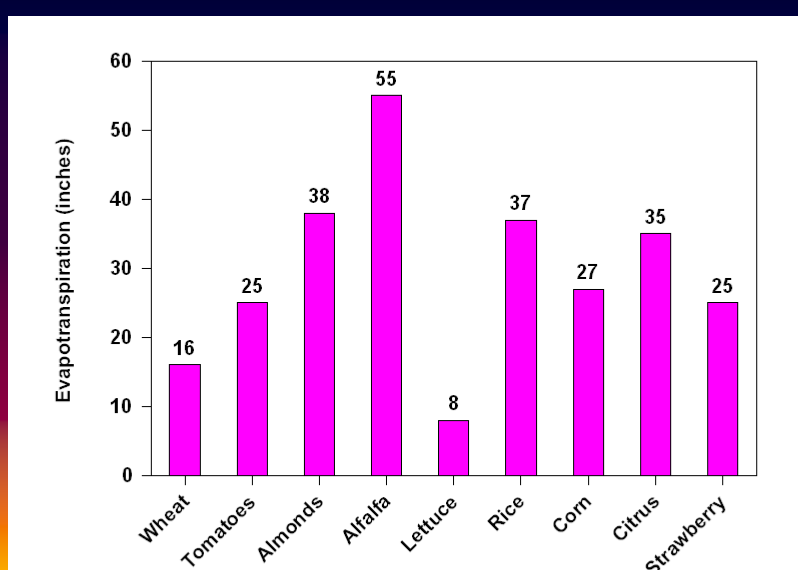
Meteorological Methods

Soil moisture measurements

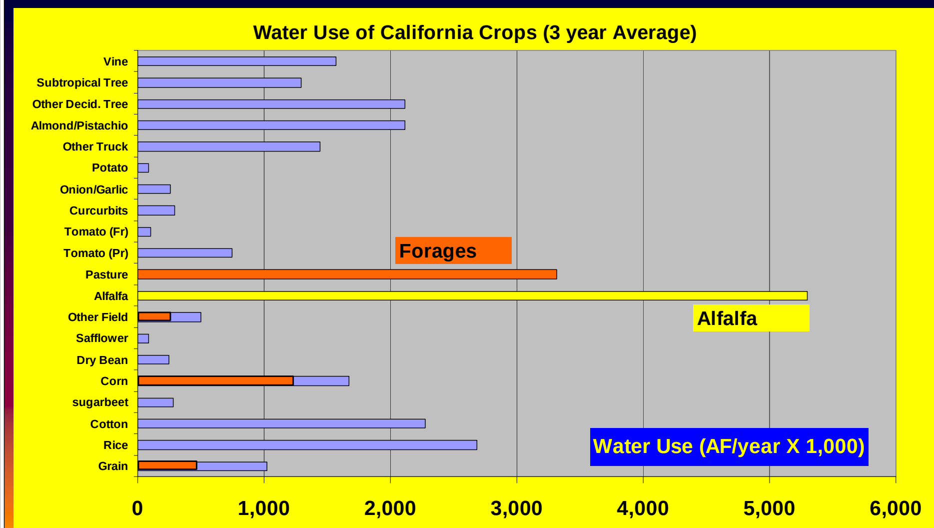
CIMIS weather station – data and complex equations
are used to calculate a reference crop ET

Crop ET = crop coefficient x reference crop ET

Evapotranspiration of selected crops



Water Use of CA Crops



How many like pizza?

What would pizza be like without tomato sauce?

Processing tomatoes

- Products: tomato paste, tomato sauce, ketchup, tomato soup, tomato juice, stewed tomatoes, diced tomatoes
- Seasonal ET of tomatoes = 25 inches of water = 25 acre- inches per acre = 679,000 gallons of water per acre
- 160 acre tomato field: ET of tomatoes = 160 acres x 679,000 gallons per acre = 108,640,000 gallons of water per year (does not include any irrigation system inefficiencies)

How many like ice cream, cheese, milk, yogurt, butter?

Where do dairy products come from?

- Dairy products: ice cream, cheese, milk, yogurt, butter
- Dairy cows produce the milk used to make these products
- Dairy cows eat alfalfa
- 70 % of the alfalfa production in California is used by dairies

Alfalfa

- Products: ice cream, milk, cheese, yogurt, butter
- Seasonal ET of alfalfa = 55 inches of water = 55 acre-inches per acre = 1,493,800 gallons per acre
- 160 acres: ET = 160 acres x 1,493,800 gallons per acre = 239,008,000 gallons of water per year (does not included irrigation system inefficiencies)

Wheat, corn, other grains

- Products: breads, cereals, bagels, muffins, and other products, chicken, steak
- Seasonal ET of wheat = 16 inches of water = 16 acre-inches per acre = 434,500 gallons per acre
- 160 acres: ET = 160 acres x 434,500 gallons per acre = 69,500,000 gallons of water per year (does not included irrigation system inefficiencies)

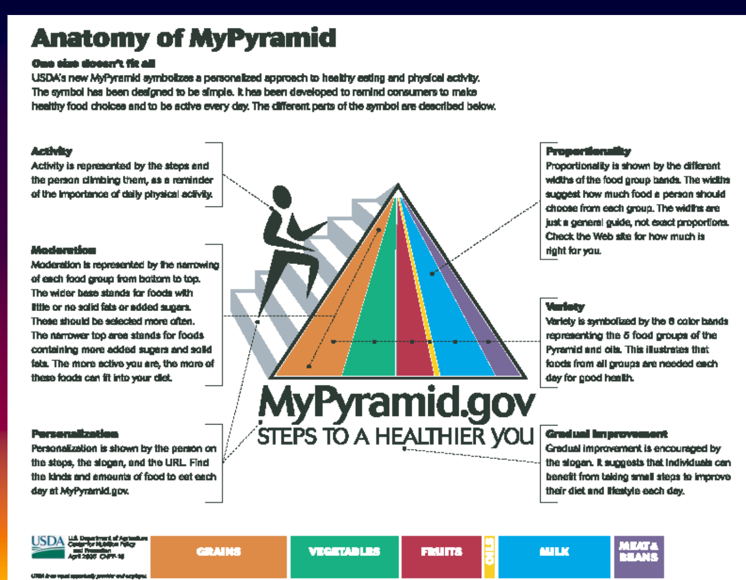
The bottom line: it takes a lot of water to produce the crops that produce our food

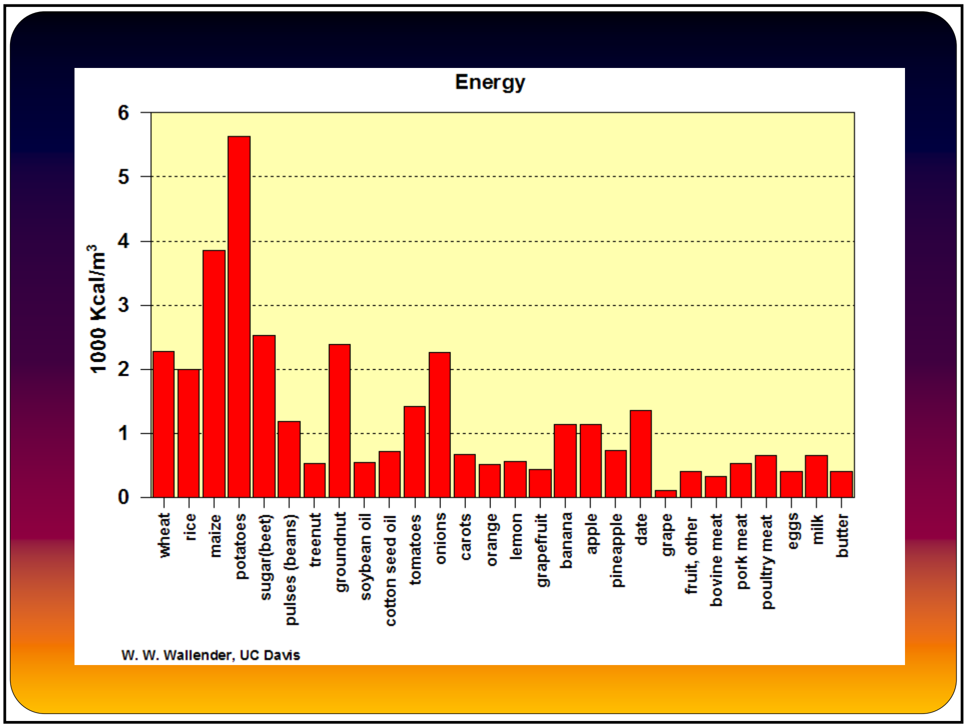
What crops should be grown in California?

Maximize dollar returns?

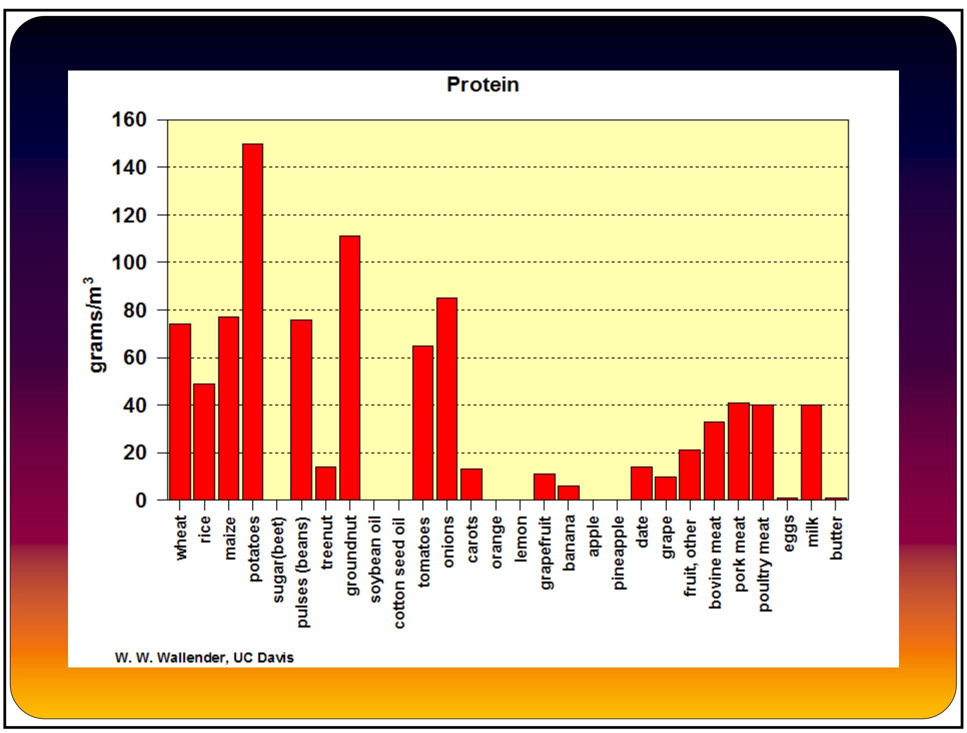
- Only high cash value crops should be grown
  - Tree crops
  - Vegetable crops
  - Tomatoes
- Low cash value crops should not be grown
  - Wheat
  - Corn
  - Cotton
  - Alfalfa?

Maximize human health?

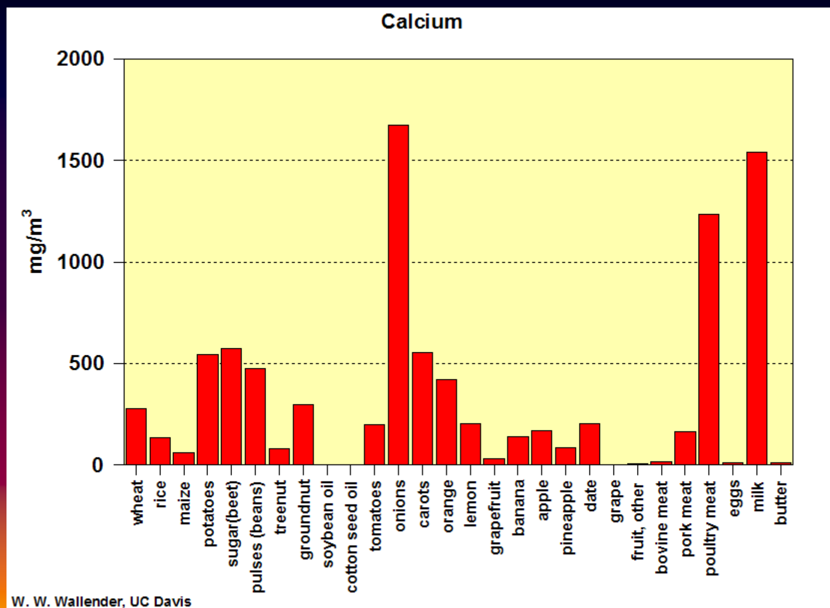




Energy
1000 Kcal/m3
6
5
4
3
2
1
0
wheat
rice
maize
potatoes
sugar(beet)
pulses (beans)
treenut
groundnut
soybean oil
cotton seed oil
tomatoes
onions
carots
orange
lemon
grapefruit
banana
apple
pineapple
date
grape
fruit, other
bovine meat
pork meat
poultry meat
eggs
milk
butter
W. W. Wallender, UC Davis



Protein
grams/m3
160
140
120
100
80
60
40
20
0
wheat
rice
maize
potatoes
sugar(beet)
pulses (beans)
treenut
groundnut
soybean oil
cotton seed oil
tomatoes
onions
carots
orange
lemon
grapefruit
banana
apple
pineapple
date
grape
fruit, other
bovine meat
pork meat
poultry meat
eggs
milk
butter
W. W. Wallender, UC Davis



What crops should be grown in California?

- From a business point of view: grow crops that produce the highest dollar returns
- From a human health point of view: grow crops that are needed to maximize human health
- Current situation: most of the crops grown in California are higher cash value crops
- Concern: how to allocate water for crops that are low-cash value but are necessary for human health

Grow only almonds or other high-cash value crops

Stop growing alfalfa

Low, stable (water) prices have encouraged some farmers to waste water and to pour it on low-value crops like rice and alfalfa, while others struggle to sustain valuable almond trees (The Economist, London).

"It takes $750 worth of retail water to grow $150 worth of wholesale cotton. That's just not rational," Lloyd Carter, President of California's Save our Streams Council (Feb. 2009)

Using 1000 acre-feet of water to grow a grain crop would generate about $400,000 in net returns. Using 1000 acre-feet of water in high-tech industry would generate $400,000,000 in returns.

Would it be in the society's best interest to increase the price of the food products produced from grain to a level where 1000 acre-feet of water generates $400,000,000 from grain production instead of $400,000 (a 1000 % increase)?

The situation

- Agriculture cannot compete economically with the urban/industrial sector for water.
  - Uses a large amount of water per unit of production
  - We do not pay very much for the agricultural products
- Regardless of the economics, if we want food we will have to pay the price in terms of water and land for producing the agricultural products used to produce our food. There is no other choice if we want food?
- Lower-cash value crops provide a major part of our diet
- Does society need food?

Irrigation methods in California

Irrigation efficiency

- Definition: ratio of water beneficially used to amount applied
- Beneficial uses
  - ET – major use
  - Salinity control
  - Frost protection
  - Cooling
  - Drip system maintenance
- Losses affecting the irrigation efficiency
  - Surface runoff – water that runs off the lower end of gravity irrigated fields
  - Deep percolation – water that percolates through the soil below the root zone
  - Evaporation
- On-farm, irrigation district, regional irrigation efficiencies

Which irrigation method is the best?

- Gravity irrigation
  - Low capital cost
  - Low labor cost to operate
  - Difficult to manage efficiently
- Sprinkler irrigation
  - Moderate capital cost
  - Low to moderate labor costs to operate
  - Easy to manage
  - Efficiency limited by wind effects
- Microirrigation
  - High capital costs (up to $1,000 per acre)
  - Moderate labor costs
  - Easy to manage
  - Highly susceptible to emitter clogging
  - Require constant attention
  - Precise application of water throughout a field

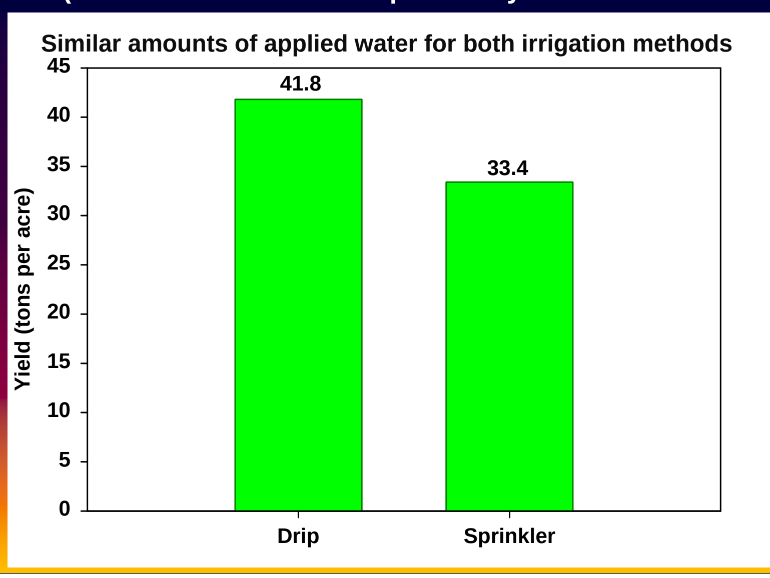
Practical potential irrigation efficiencies

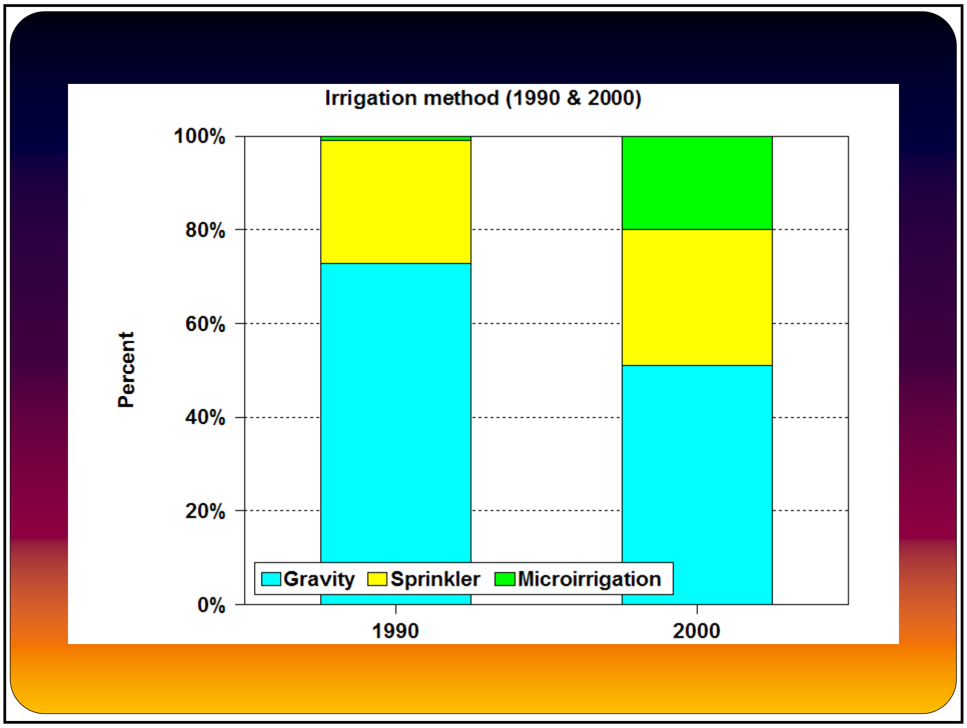
Irrigation method	Irrigation efficiency (%)
Gravity (furrow, flood)	70-85
Sprinkle	
Center pivot	80-90
Other	70-80 (low wind)
Microirrigation	80-90

What encourages changes in irrigation practices?

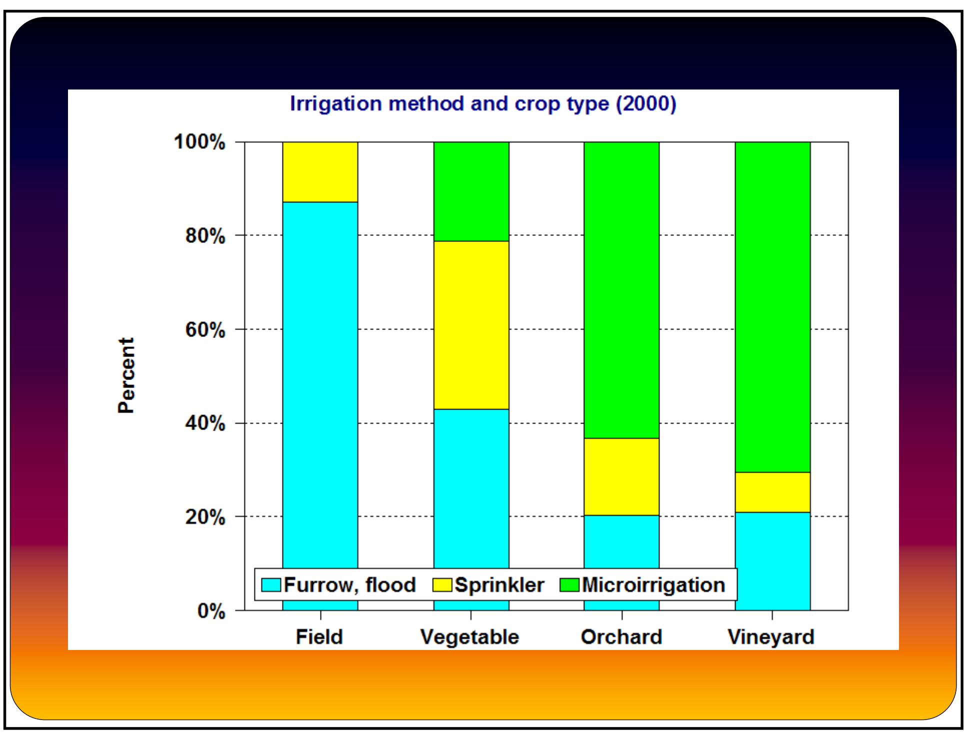
- Increased profits due to higher yields (most significant factor)
- Reduced water supplies
- High water costs
- Change in cropping patterns
- Field constraints (soil, terrain, water quality)
- Regulation

Converting from sprinkle irrigation to subsurface drip irrigation of processing tomatoes in salt affected soil (west side of the San Joaquin Valley





Irrigation method (1990 & 2000)
Percent
100%
80%
60%
40%
20%
0%
1990
2000
Gravity
Sprinkler
Microirrigation

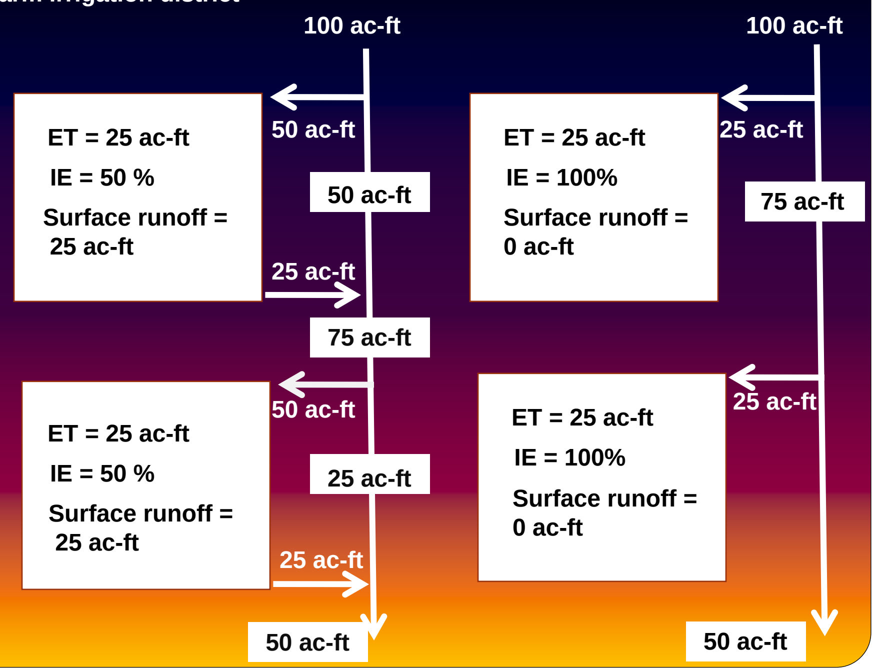


Irrigation method and crop type (2000)
Percent
100%
80%
60%
40%
20%
0%
Field
Vegetable
Orchard
Vineyard
Furrow, flood
Sprinkler
Microirrigation

Will increasing the on-farm irrigation efficiency in agriculture save water that can be used elsewhere?

- Numerous studies have attempted to answer this question
  - Many researchers are not very familiar with irrigated agriculture
  - Some ignore reality
  - Questionable assumptions
  - Questionable results and conclusions
- Problem – losses from one farm frequently are used by downstream farms
  - Difficult to track where the water goes
  - Little or no real water savings
- Problem – improved irrigation efficiency may reduce losses, but increase yield and ET (little or no water savings)
- Improved water quality may be the primary benefit of increased irrigation efficiency rather than water savings

Two farm irrigation district



How do we balance the demands for water by the urban/industrial, environmental, and agricultural sectors with the water supply?

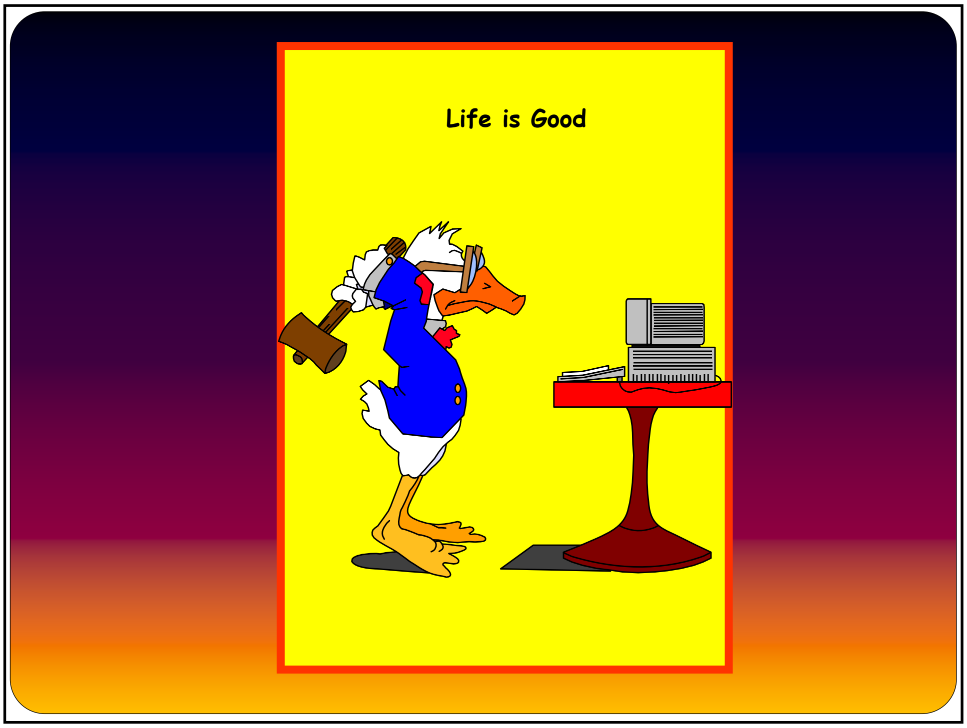
No one appears to have the answer!

Where will the water come from?

- No more dams for water storage
- Water conservation from increased irrigation efficiency?
  - UC study – 843,000 acre-feet
  - Consultant study – 1,100,000 acre-feet
- Removal of agricultural land from production – most likely source of water for satisfying the increased urban/industrial and environmental water demands
  - DWR water transfer program of fallowing land in the Sacramento Valley – unused water is transferred to the San Joaquin Valley and southern California
  - MWD program of removing alfalfa fields from production on a rotating basis in the Palo Verde Valley – water is transferred to the LA area
- Deficit irrigation of agricultural fields
  - Regulated deficit irrigation – trees and vine crops (UC Davis)
  - Mid-summer deficit irrigation - alfalfa (UC Davis)
- Reduced urban/industrial and environmental demands

Summary

- Agriculture is California's largest user of water.
- It takes a lot of water to produce a crop.
- The price that society has to pay for food is the water and land required to produce the crops needed for food. There is no other choice.
- It is unlikely that increasing irrigation efficiency will have a large impact in supplying the predicted future water needs of the urban/industrial and environmental sectors.
- Agricultural land will need to be removed from production to supply the needed water.



Life is Good