

IRRIGATION WATER MANAGEMENT

FOR DROUGHT MITIGATION

SET TIMES, APPLICATION RATES, AND SYSTEM EFFICIENCY

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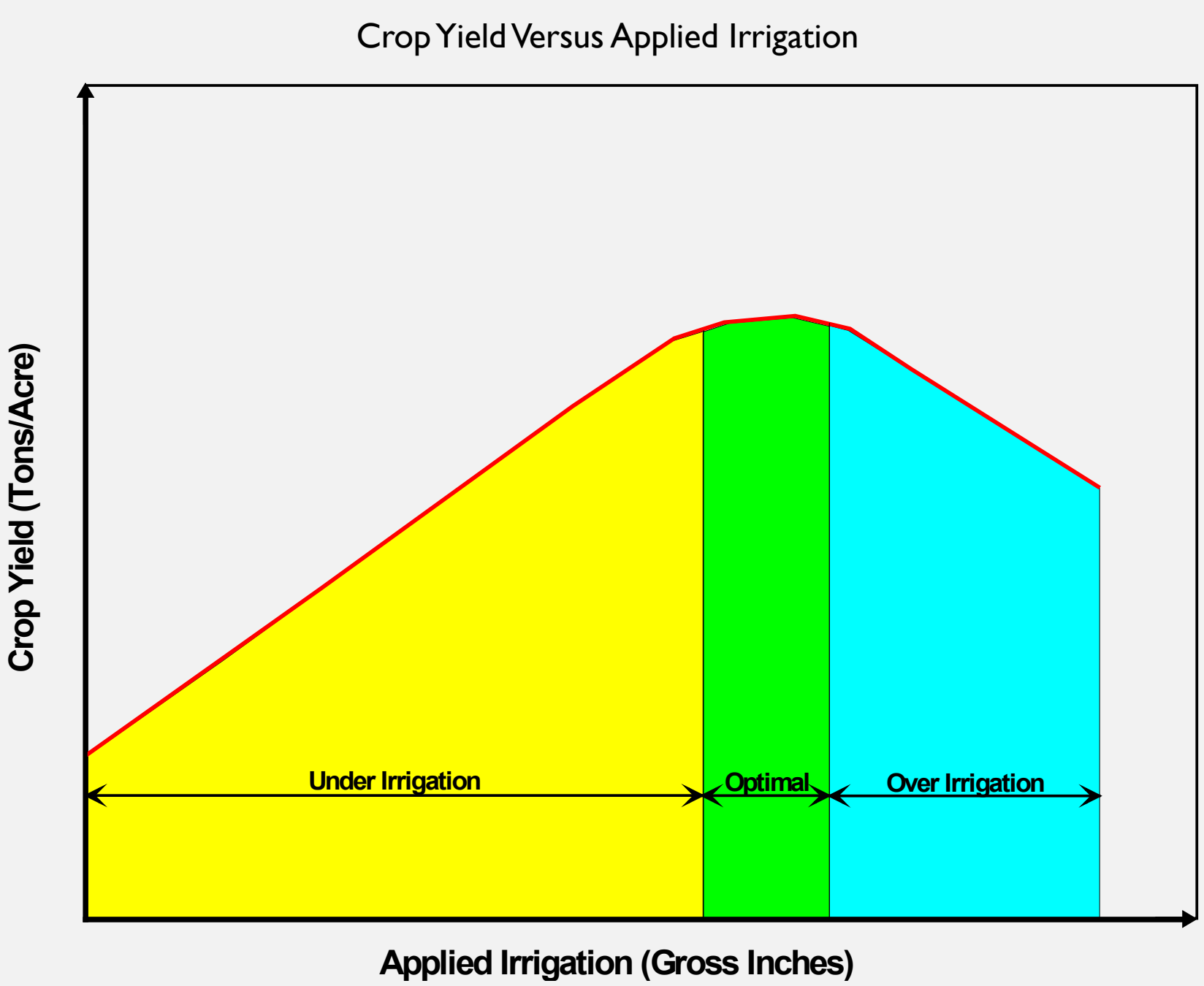
NRCS


Crop Yield Versus Applied Irrigation
Crop Yield (Tons/Acre)
Under Irrigation
Optimal
Over Irrigation
Applied Irrigation (Gross Inches)

IWM TERMS TO KNOW

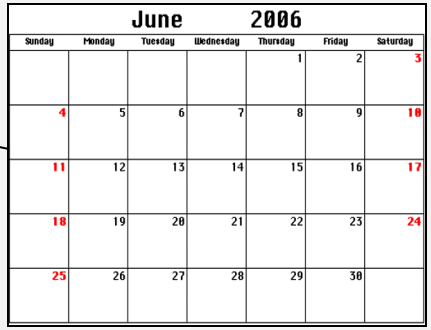
When Should I Irrigate, or How Often? = **Irrigation Interval (days)**

How Much Water Should I Apply? = **Set Time (hours)**

How Fast Should I Apply the Water? = **Type of Irrigation System (Nozzle size, etc,) (inches/hour)**

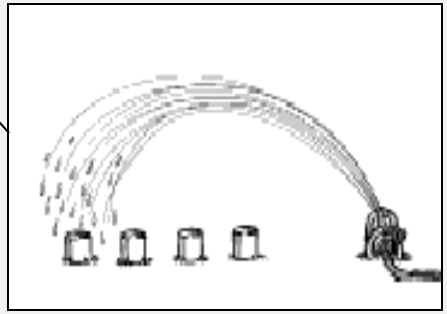
We Want to Know…

- When do I apply Irrigation Water?



- How much water do I apply?

- How fast do I apply the water?



IWM enables us to apply the right amount of water at the right time.

DETERMINING APPLICATION RATES & SET TIMES

Sprinkler Application Rate (in/hr) for 40 x 60-ft. Spacing

$$\text{Sprinkler Application Rate} = \frac{96.3\ x\ GPM}{(nozzle\ spacing\ x\ lateral\ spacing)}\ \text{in/hr}$$

Nozzle Size (in.)	40 PSI (in/hr.)	50 PSI (in/hr.)	60 PSI (in/hr.)
3/32	.06	.07	.08
7/64	.09	.10	.11
1/8	.11	.13	.14
9/64	.15	.16	.18
5/32	.18	.20	.22
11/64	.22	.25	.27
3/16	.26	.29	.32
13/64	.31	.34	.38
7/32	.36	.40	.44

Example Calculation: Sprinkler Application Rate (in/hr)

$$\text{Sprinkler Application Rate} = \frac{96.3\ x\ GPM}{(nozzle\ spacing\ x\ lateral\ spacing)}\ \text{in/hr}$$

Given:

Sprinkler Flow Rate = 5 gpm
Nozzle Spacing = 40 ft.
Lateral Spacing = 60 ft.

$$\text{Sprinkler Application Rate} = \frac{96.3\ x\ 5\ gpm}{(40\ ft.\ x\ 60\ ft.)} = \mathbf{0.2\ in/hr}$$

http://www.irrigation.wsu.edu/Content/Calculators/Sprinkler/Sprinkler-Application-Rate.php

Irrigation in the Pacific Northwest

Washington State University Extension Oregon State University Extension University of Idaho Extension

Sprinkler Application Rate

Use this first form to determine the effective application rate of sprinklers spaced at uniform distances from each other. This is particularly applicable to hand-move, or wheel-line, irrigation systems. The pressure is measured at the sprinkler nozzle. The head spacing is the distance between sprinkler heads along the water line, and the line spacing is the distance between lines in the field. If there is just one line being moved and the spray patterns overlay, as is typical for hand-move or wheel-line, then the actual application rate will be lower but the given number will be useful to determine set times.

Learn more about the units used on this page.

Nozzle Flow Rate and Effective Application Rate

Nozzle Diameter: 0.09375 in

Pressure: 40 psi

Head Spacing: 40 ft

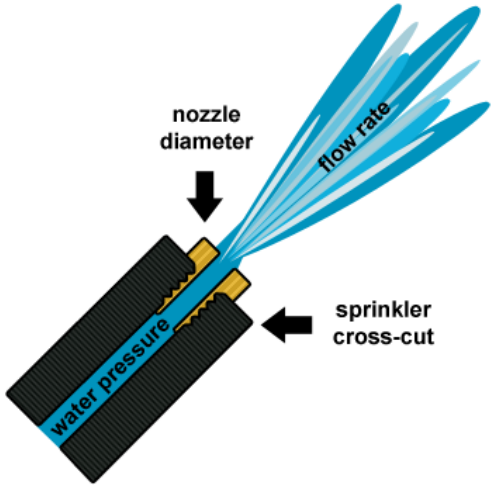
Line Spacing: 60 ft

Sprinkler Efficiency: 93 %

Calculate

Nozzle Flow Rate: 1.61 gpm

Effective Application Rate: 0.060 in/hr



Example Calculation Cont'd: Determining Set Time (hr)

$$\text{Set Time Hours} = \frac{net\ water\ application\ (in)\ x\ irrigated\ area\ (ft^2)}{(flow\ rate\ (gpm)\ x\ 96.3\ x\ system\ efficiency)}\ \text{hr}$$

Given:

Sprinkler Flow Rate = 5 gpm
Nozzle Spacing = 40 ft.
Lateral Spacing = 60 ft.
System Efficiency = 70%
You want to apply 1.08 inches (net application).

$$\text{Set Time Hours} = \frac{1.08\ in\ x\ (40\ ft\ x\ 60\ ft)}{(5\ gpm\ x\ 96.3\ x\ 0.70)} = \mathbf{7.6\ hr}$$

BASIC IWM CALCULATIONS (EXAMPLE 2)

Given:

- A soil with a water holding capacity of 1.44 in/ft at field capacity (=0.12 in/in)
- An effective root zone of 1.5 ft
- MAD of 50% before irrigation is applied
- Sprinkler Application rate of 0.2 in/hour
- Sprinkler Application Efficiency = 70%
- Average daily ET rate = 0.28 in/day

Calculate IWM Parameters:

- Soil water at field capacity = 1.44 in/ft x 1.5 ft = **2.16 in**
- Soil water at MAD = 2.16 x 50% = **1.08 in**
- Net irrigation application = 2.16 in-1.08 in = **1.08 in**
- Gross irrigation application = 1.08 in/ 70% = **1.5 in**
- Irrigation set time = 1.5 in/ 0.2 in/hour = **7.5 hours**
- Irrigation Interval = 1.08 in/0.28 in/day = **Every 3.9 days**

IRRIGATION SCHEDULING EXAMPLE 3

Sprinkler System Info:

- Nozzle = 5 gpm
- Lateral (Riser) spacing = 50 feet
- Nozzle Spacing = 40 feet
- Conversion Factor = 96.3
- System Efficiency Factor = 65%

➢ **Sprinkler Application Rate = (96.3 x 5 gpm) ÷ (50' x 40') = 0.24 in/hr**

Crop and Soil Info:

- Crop = Grass Hay
- Soil Profile Managed = 2 ft
- AWC = 1.5 in/ft of soil,
- MAD = 50%
- Manage 2 ft x 1.5 in/ft x 50% = 1.5 inches soil water = Net Irrigation Application
- ET = 0.30 in/day

➢ **Gross Application = Net Irrigation ÷ Efficiency = 1.5 in ÷ 0.65 = 2.31 in**

➢ **Set Time = Gross Application ÷ Sprinkler Application Rate = 2.31 in ÷ 0.24 in/hr = 9.6 hr set**

➢ **Irrigation Interval = Net Irrigation Application ÷ ET = 1.5 in ÷ 0.30 in/day = 5 days**

SYSTEM EFFICIENCY

Application Efficiencies for Different Irrigation Systems

System	Application Efficiency (%)
Sprinkler	
Wheel Line	65-80
Hand Line	70-80
Center Pivot	75-98
Microirrigation	
Surface/subsurface Drip	85-95
Flood	
Border Strip	65-80
Wild Flood	25-40

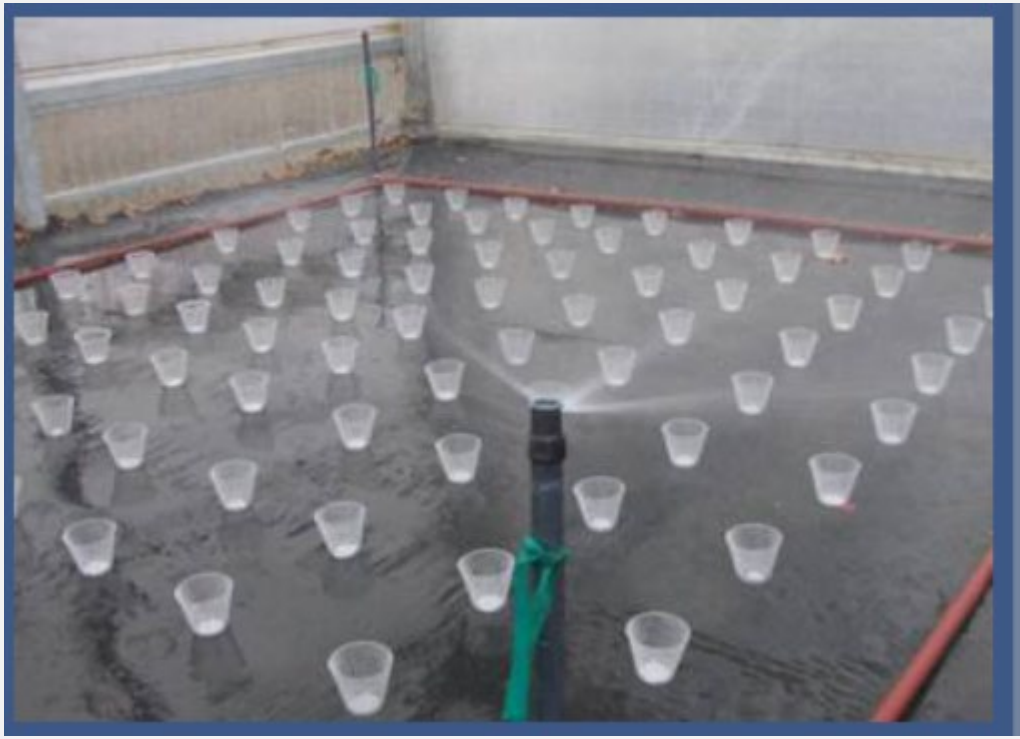
Application Efficiency Factors

Conditions	Center Pivot	Hand Move Side Roll Solid Set	Big Gun
Day Time Wind <10 mph	0.9	0.8	0.7
Day Time Wind >10 mph	0.8	0.7	0.6

Distribution Uniformity

An irrigation system's water distribution is affected by:

- Wind speed and direction
- Water pressure
- Sprinkler spacing and height
- Nozzle selection
- Slope of the land



A grid of catch-cans is a simple, practical way to test the water application uniformity of a sprinkler system.

Photo by J. Kowalski.

Ways to Improve Uniformity and Efficiency of Sprinkler Systems

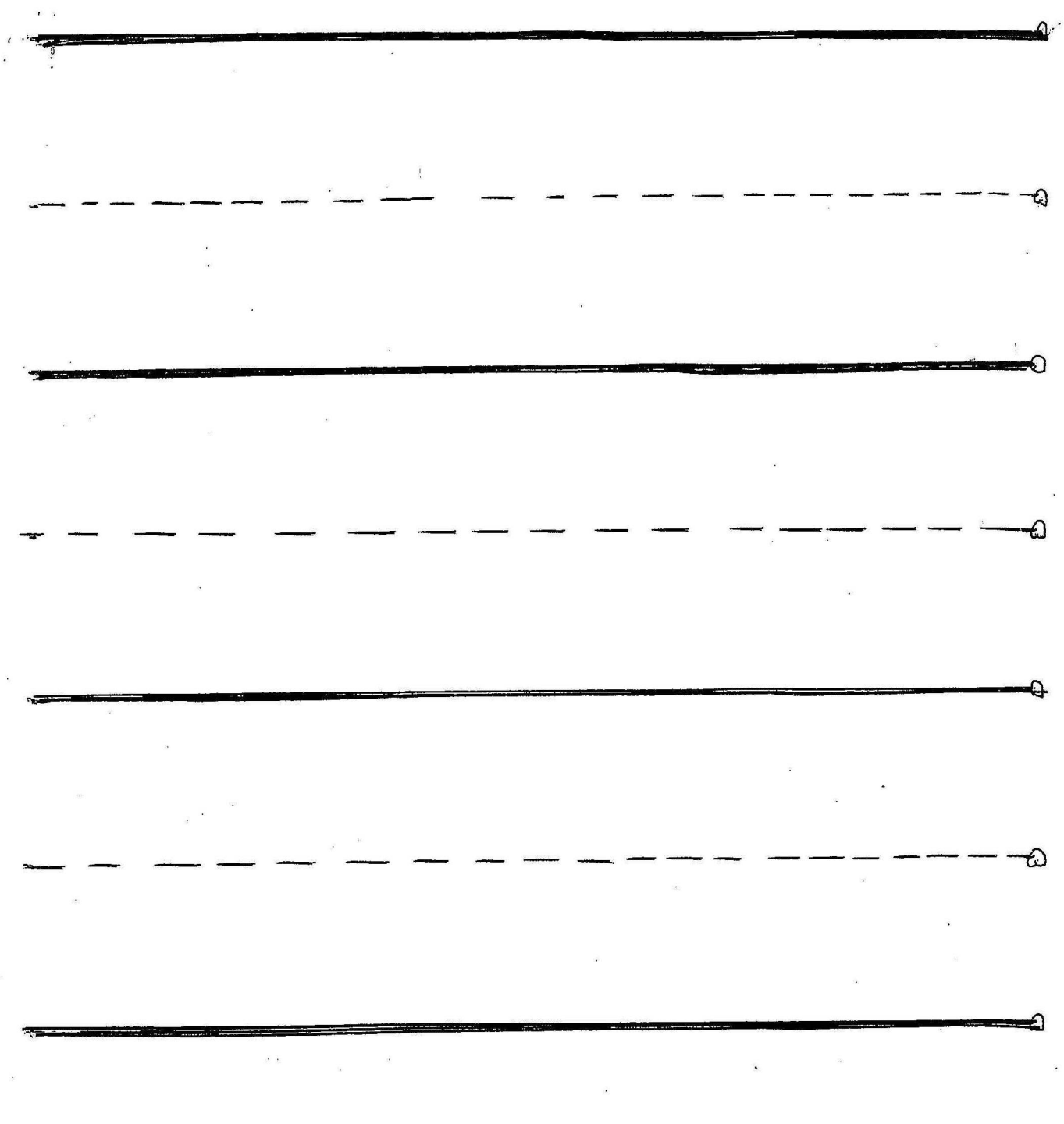
- **Determine the application rate and average depth of water applied.**
- **Irrigate during low wind periods when feasible. (The uniformity of irrigation is greatly reduced at wind speeds greater than 10 mph).**
- **Use flow control nozzles when the pressure variation between the first and last nozzle exceeds 20%.**

Increase Irrigation Efficiency (Improve Yield and Quality)

- **Irrigation systems were designed to have 50% overlap; many systems were not constructed this way.**
- **Different existing systems have 40, 50, & 60 feet between risers on main line.**
- **“Never” skip-set Irrigate. Always straight-set irrigate. (Exception may be: irrigating with hand lines or very short time periods between first and last irrigation to get across the field)**

Increase Irrigation Efficiency (Improve Yield and Quality)

- **Always Off-Set Irrigate if you can**
  - **1st irrigation is on the riser, then split the difference the best you can between risers to apply water on 2nd irrigation. Then irrigate on the riser, then the next time between risers… (you will need a longer swing tube to connect from riser to the irrigation line)**



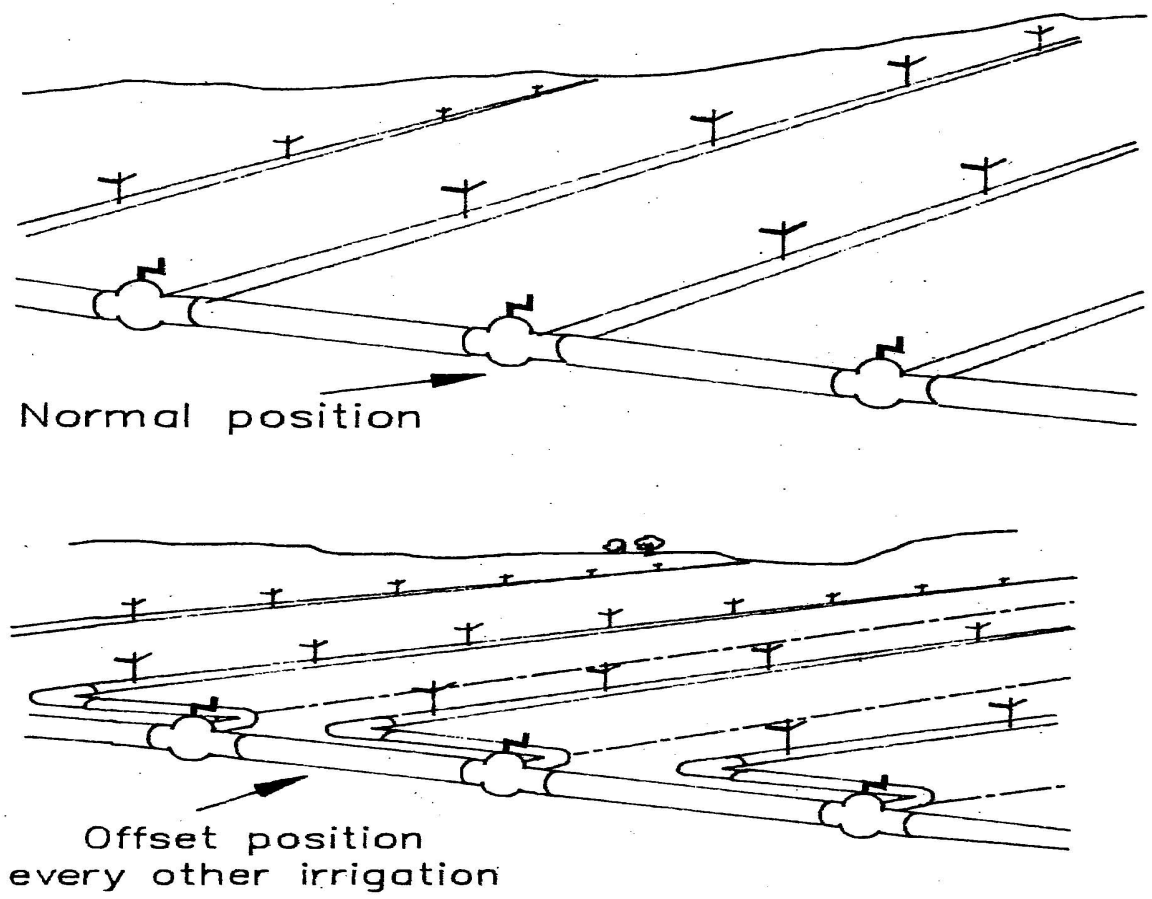


Figure 1.—An offset program alternates positioning of the lateral during every other irrigation. The total of two successive irrigations gives a more uniform distribution of water on the field.

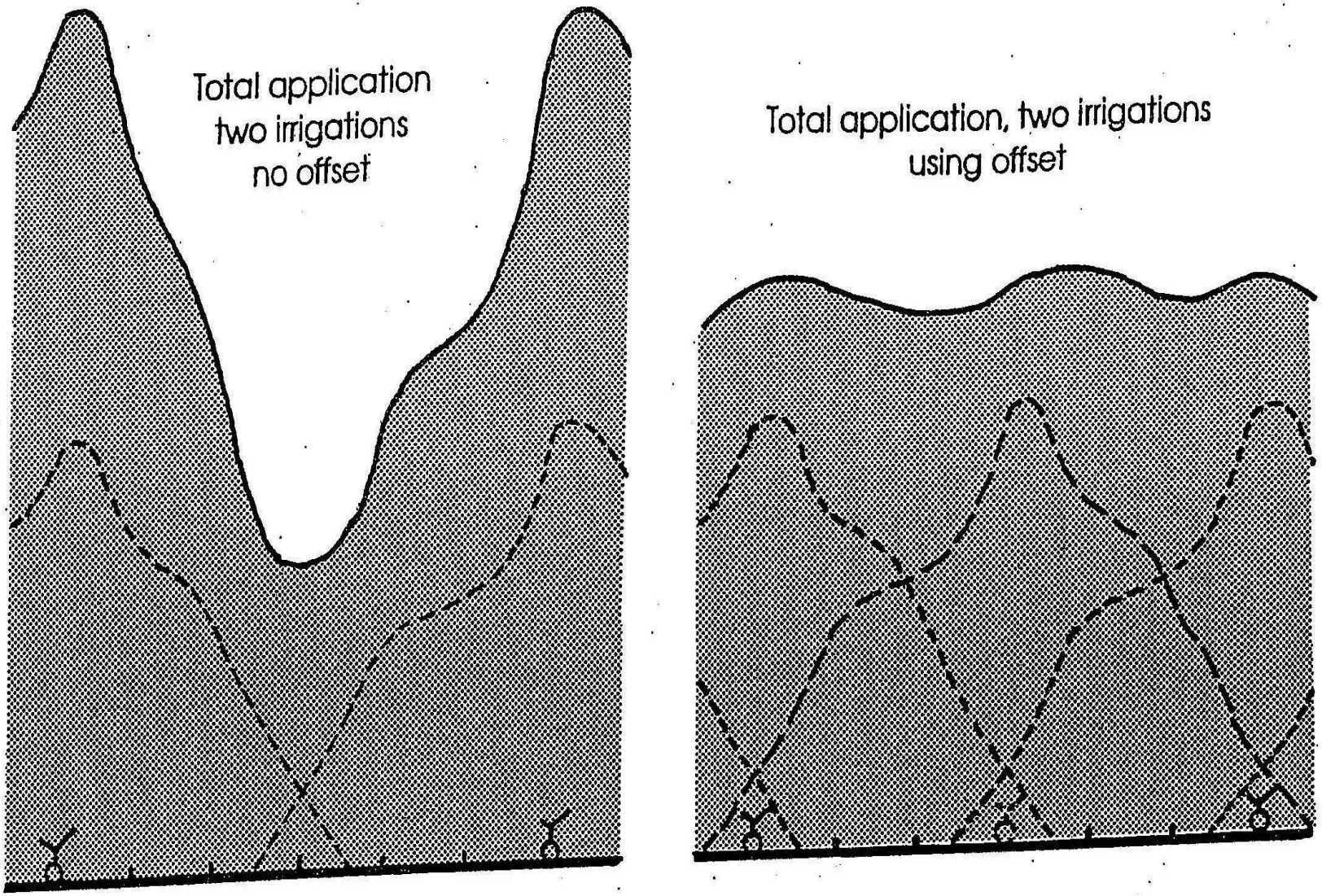


Figure 2. Use of lateral offset on alternate irrigations improves uniformity of total water application.

Ways to Improve Uniformity and Efficiency of Sprinkler Systems

- Repair leaks and malfunctioning nozzles.
- Use the same nozzle size on each line.
- Use closer spacing, boom mounted nozzles, and/or rotating-type nozzles for center pivot systems.

Ways to Improve Uniformity and Efficiency of Sprinkler Systems

- Maintain adequate pressure (50-60 psi) by
  - Adjusting the pump impeller of semi- open impellers,
  - Repairing or replacing worn pump, or
  - Reducing the number of laterals operating

Sprinkler Heads, Nozzle Size and Wear

- Use a drill bit to determine if there is excessive wear on the nozzle to determine if replacement is needed.

- There are “New” Sprinkler Heads:
  - LEPA/LESA Pivot Sprinklers
  - Nelson Wind Fighter 2000
  - Nelson R33 (low pressure options)

- Make sure to inspect your irrigation system and check the size of the nozzles.

Irrigation Maintenance

- Nozzles tend to enlarge with constant use. As they enlarge, they allow more water to pass, resulting in poor uniformity of application.
- Rubber gaskets – these crack with age and exposure to the elements resulting in poor connections and loss of water. Store the extras in water.

IRRIGATION MAINTENANCE

- ***Broken or bent risers*** **– if broken, the geyser is very obvious and cause considerable crop damage. If bent, the sprinkler will not have the proper trajectory.**
- ***Pressure relief valves*** **– Test to ensure they are functioning properly.**
- ***Pump Impellers*** **– These tend to wear out occasionally. They should be checked annually for wear.**

Irrigation Maintenance

- **Pump Intake – Make sure it is screened and kept clean.**
- **Systems Leaks – These should be repaired as soon as possible.**
- **Proper Operating Pressure – Check pressure at the pump and at the nozzles.**
- **Sprinkler Heads – Be sure these are not damaged and that they turn freely.**

NRCS IRRIGATION ENERGY ESTIMATOR

https://ipat.sc.egov.usda.gov/


QUESTIONS?