Irrigation Efficiency and Water Conservation

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Irrigation Efficiency and Water Conservation

What is Irrigation Efficiency?

What is Water Conservation?
What is Irrigation Efficiency?

What is Water Conservation?

Hydrologic considerations of converting from flood to center pivot irrigation
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Key Definitions

**Consumptive Use**: Water used by the crop through evapotranspiration.

**Evapotranspiration**: Loss of water from soil evaporation and transpiration of plants. i.e. plant use.

**Irrecoverable Losses**: Direct evaporation from static water, wind drift, etc.
Key Definitions

**Return Flow**: Diverted water applied to the field that seeps into ground and returns to the source.

**Seepage**: Diverted water that leaks through the bottom of the ditch.

**Tail Water**: Diverted water that is not consumed and returns to a surface source.
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Big Hole River at Wisdom (06024450)
1988-present USGS Data

Flow rate, cft

1-Apr 1-May 1-Jun 1-Jul 1-Aug 1-Sep 1-Oct
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Big Hole River at Wisdom (06024450)

1988-present USGS Data

Flow rate, cfs

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Point of Diversion

Ditch or Pipeline

Irrigated Field

Blue River
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Total Irrigation Efficiency (System): $f(\text{conveyance, on-farm})$

- System Efficiency
- Conveyance Efficiency
- On-Farm Efficiency

Blue River

Irrigated field
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Total Irrigation Efficiency (%)

System Efficiency = \( \frac{\text{Water Consumed by the Crop}}{\text{Diverted Amount}} \)
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Example: Flood Irrigation

System Efficiency = \[ \frac{\text{Water Consumed by Crop}}{\text{Diverted Amount}} \]

- Crop Consumptive Use (Evapotranspiration)
- Irrecoverable Losses (Evap)
- Surface returns (immediate)
- Groundwater Return flow (lag)

Diverted Amount

Blue River

Seepage

Montana Water Summit
System Efficiency = \( \frac{\text{Water Consumed by Crop}}{\text{Diverted Amount}} \)

For Example:

Crop consumption = 50 acre-feet
Diverted water = 100 acre-feet

System Efficiency = \( \frac{50}{100} \times 100 = 50\% \)
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Water Conservation
Water Conservation
Water Conservation

Sustainable management of water to meet current and future demands
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Water Conservation

Sustainable management of water to meet current and future demands

Preservation and Protection
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Water Conservation

Sustainable management of water to meet current and future demands

Preservation and Protection

Consuming less water
Hydrologic considerations of converting from flood to center pivot irrigation
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Why Convert?
- labor costs or loss of labor force
- financial incentives
- site limitations (soils, water availability, etc.)
- conservation

increase production
Flood Irrigation

- Diverted Amount
- Seepage
  - Blue River
- Crop Consumptive Use (Evapotranspiration)
- Irrecoverable Losses (evap)

- Diversion (conveyance)

- Gravity, requires head
- Saturates soil profile
- Provides return flows (cooler water)
- Storage?
- 20-60% system efficiency

Surface returns (immediate)

Groundwater Return flow (lag)
**Center Pivot Irrigation**

- Diverted Amount
  - Piped and pumped
  - Manages crop requirement
  - Uniform distribution of water
  - Can extend irrigation season
  - Return flows negligible
  - 60-85% system efficiencies

**Crop Consumptive Use (Evapotranspiration)**

**Seepage negligible if piped**

**Irrecoverable Losses (evap)**

**Surface and Groundwater returns**
Water use changes as a function of Flood to Sprinkler conversion
Water use changes as a function of Flood to Sprinkler conversion
Water use changes as a function of Flood to Sprinkler conversion

Water Consumed = 256 acre-feet  
1979

Water Consumed = 520 acre-feet  
2011
Increased Efficiency can lead to:
- Increased Consumptive Use
- Decreased Return Flows
- Decreased diverted amounts
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- Increased Consumptive Use
- Decreased Return Flows
- Decreased diverted amounts

\[ \text{Diverted Amount} \neq \text{Consumed Amount} \]
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Increased Efficiency can lead to:
- Increased Consumptive Use
- Decreased Return Flows
- Decreased diverted amounts

Diverted Amount ≠ Consumed Amount

Consider Objective: Temporal and Spatial implications
Alternating center pivot replaced flood field. Diversion reduced from 12 cfs to 2 cfs.

Source: Lower Poorman Creek Hydrologic Assessment, DNRC 2002
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