

# Systems Thinking and Semiarid Rotations

(United States)

## Central Great Plains – U.S.

(CO, NE, KS, WY)

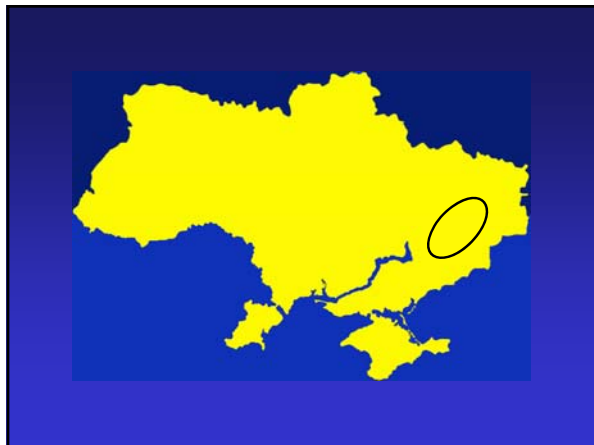
Semiarid Climate

Precipitation 350 to 450 mm/year

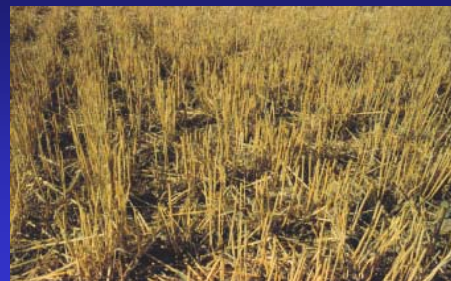
Pan Evaporation 1400 to 1650 mm/year

Winter Wheat – Fallow

*"Dust Bowl"*



## No-Till and Crop Residues



## No-Till Cropping Systems

Winter Wheat and Fallow

**Plus**

Corn (*Zea mays*)

Sunflower (*Helianthus annuus*)

Proso Millet (*Panicum miliaceum*)

Dry Peas (*Pisum arvense*)

## No-Till Cropping Systems

*Producer Goals:*

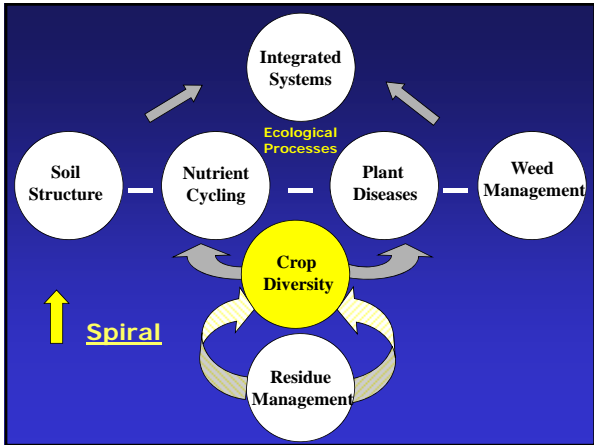
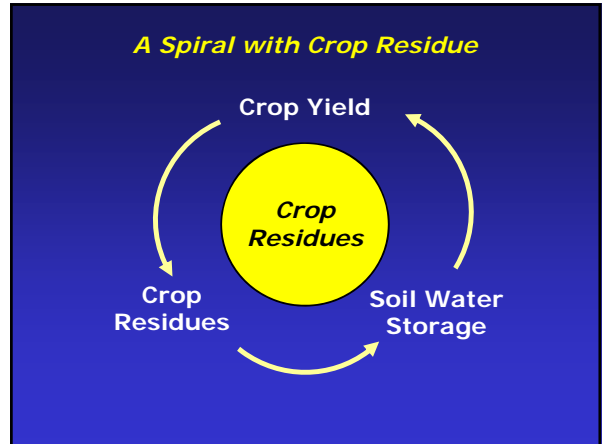
Repair Soil Damage from Dust Bowl

Reduce Use of Fallow

*Data and Trends:*

Producer Experiences

Long-Term Rotation Studies



**Crop Diversity – Semiarid Benefits**

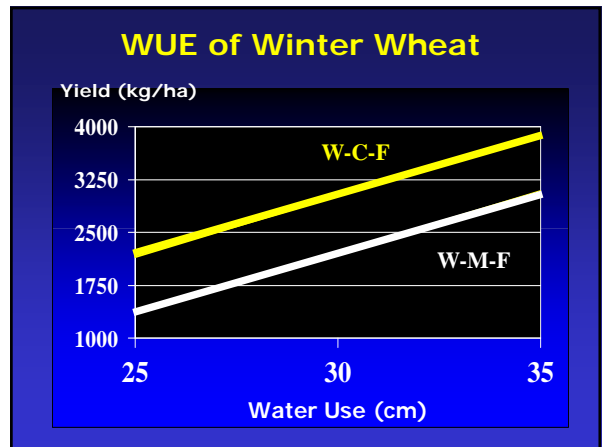
Rotation Effect  
Synergism with Water-Use-Efficiency

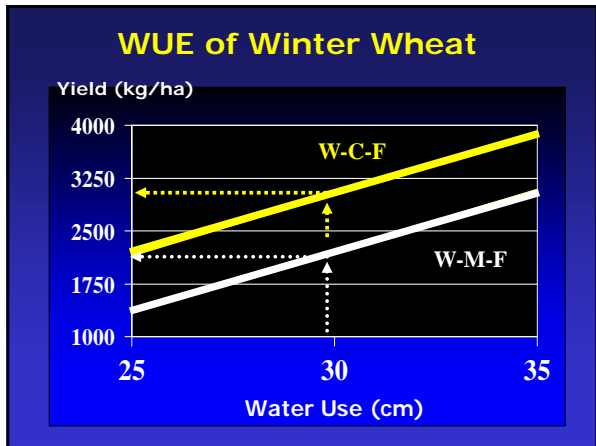
**Winter Wheat – Synergism**

Water-Use-Efficiency (WUE)

$\underline{W-C-F} < - - > \underline{W-M-F}$

6 – 8<sup>th</sup> Year of Crop Rotation Study





### Corn Synergism to Proso

4-Year Average

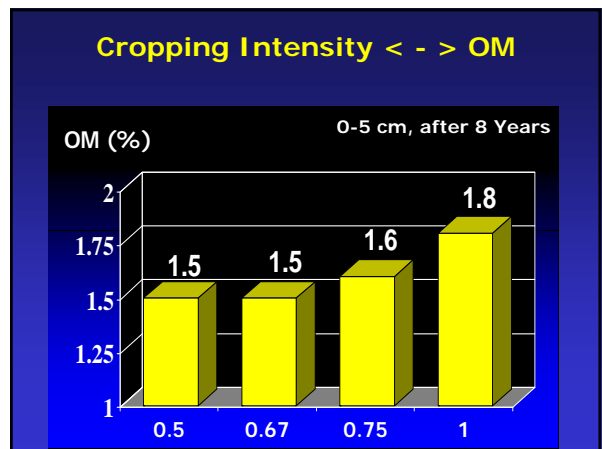
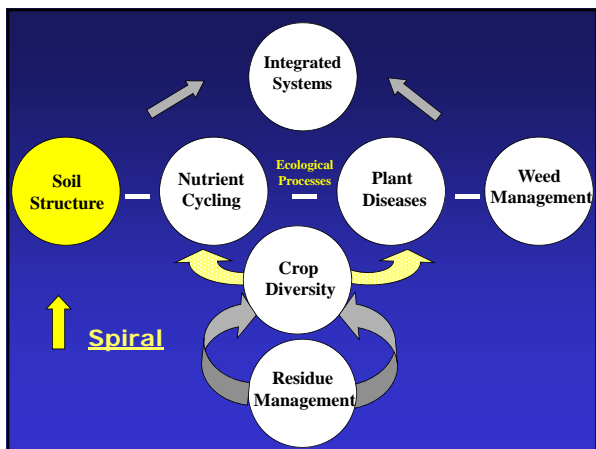
	W - M	W - C - M
Yield (kg/ha)	2020	2320*
Water Use (cm)	27	25
WUE (kg/ha/cm)	75	93*

### Corn Synergism to Proso

	W - M	W - C - M
Yield (kg/ha)	2020	2320*
Water Use (cm)	27	25
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W-C-M-F

Fallow Eliminates Synergism



## Sunflower - Soil Structure

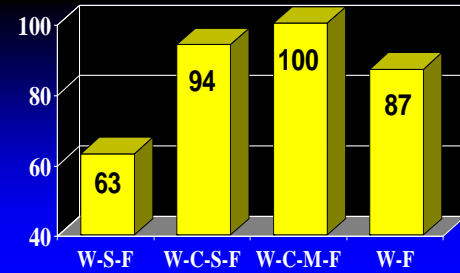
Winter Wheat

W - S - F vs. W - C - S - F



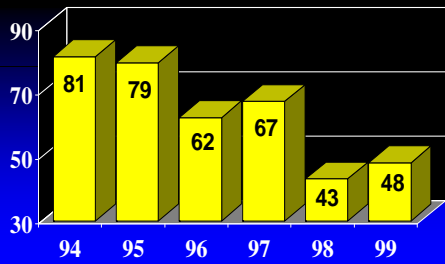
## Winter Wheat Yield

Yield (%) 6-Year Average



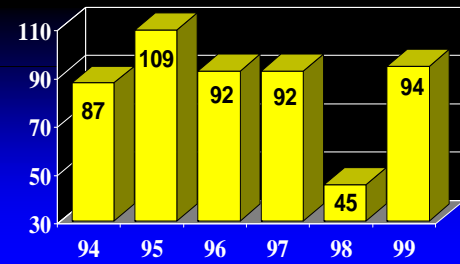
## Wheat Yield in W-S-F

Yield (%) Compared to W-C-M-F



## Wheat Yield in W-C-S-F

Yield (%) Compared to W-C-M-F



## Aggregate Stability (Wet Method)



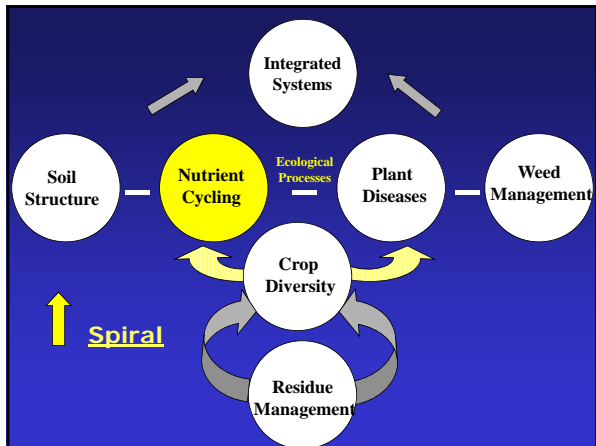
## Aggregate Stability (Wet Method)

	Agg. St.	
W-C-M	12.6 %	109 %
W-C-M-F	12.0	104
W-F (CT)	11.6	100
W-S-F	7.4	64



< - - - >





## Nutrient Cycling

Phosphorus Use Efficiency  
by Winter Wheat

30% Greater if Continuous Cropping

*Fallow < - > Organic Phase*  
*- - > Lower Efficiency*

## Nutrient Cycling

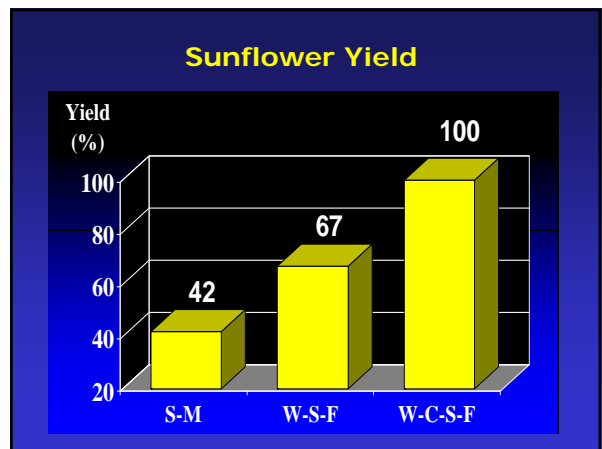
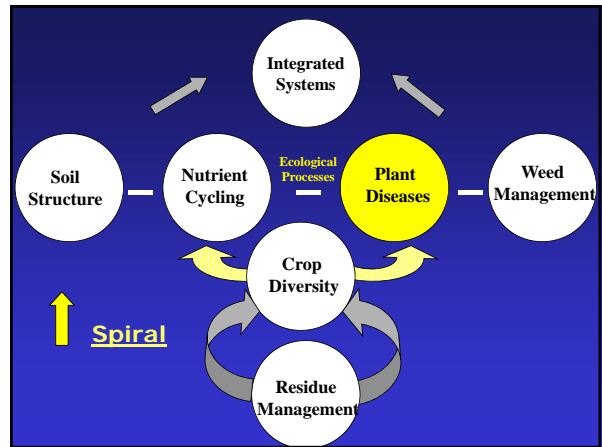
N Leaching in Soil (1990 - - > 1997)

N Buildup (50+ kg) between  
1 to 2 m depth

All Rotations With Fallow

\* Not With Continuous Cropping

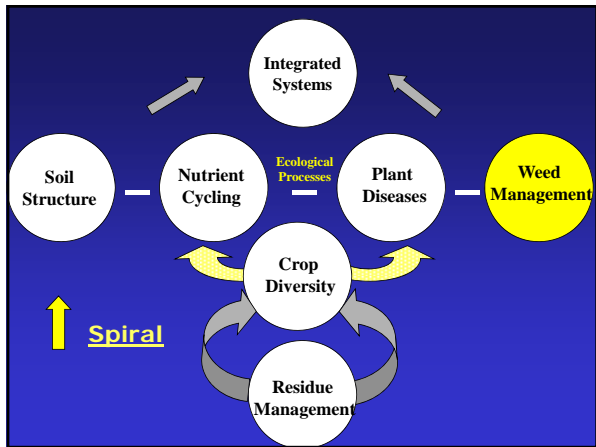
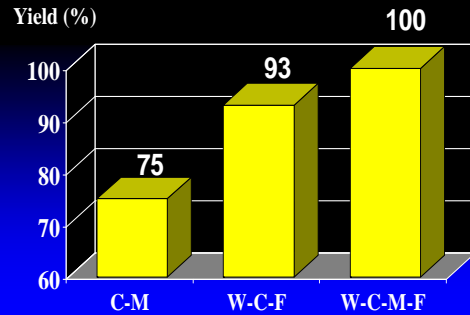
*Fallow Favors N Leaching*



*Phoma* – Fungus Disease



**Crop Frequency - Corn**



Natural Rate of Population Increase      Seed Survival in Seed Bank

**Rotations and Weed Density**

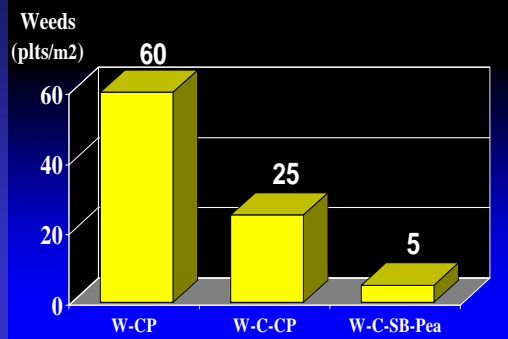
2-Year Intervals of Cool - - Warm Season Crops

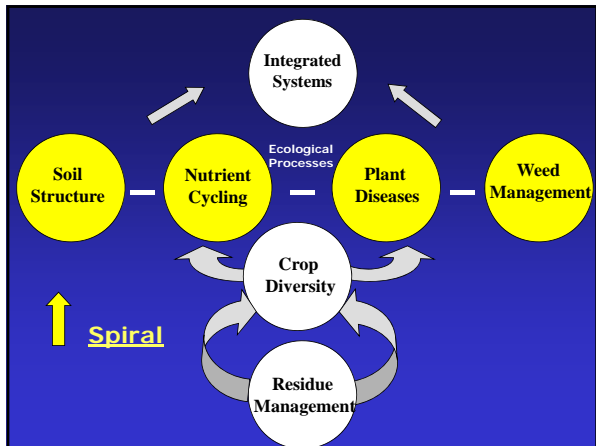
**Rotation Design -- > Weeds**

Long-Term Rotation Study

- Winter Wheat –Chickpea (W-CP)
- Wheat – Corn – Chickpea (W-C-CP)
- Wheat-Corn-Soybean-Field Pea (W-C-SB-Pea)

**Rotation Design < - > Weeds**





**Maximum Benefits –  
Cycle of Four**

**W-C-M-GF (Peas)**

Rotation Effect – Synergism  
 Soil Health and Nutrient Cycling  
 Crop Interval - - > 4  
 Interval of Cool - - **Warm Season** Crops  
 Planting Date Range

**Synergistic Rotations**

Wheat-Corn-Proso Millet-Green Fallow (Peas)

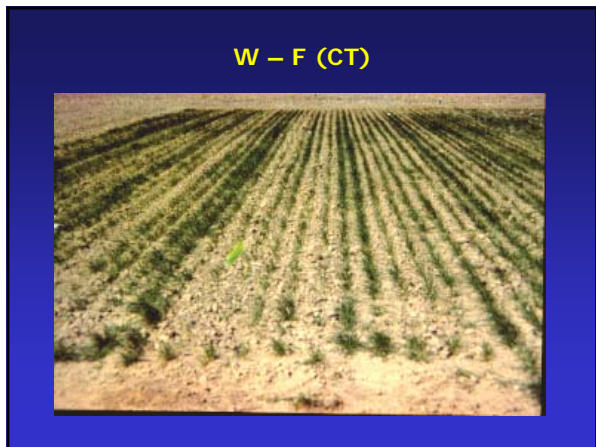
*Corn - - > WUE of Winter Wheat, Millet*  
*Peas - - > WUE, NUE, and PUE of Wheat*  
*Wheat - - > Residue and Corn Yields*  
*Proso Millet - - > Less Weeds in Peas*

**Synergistic Rotations**

Economics

W-F	25 to 30\$/ha
<b>W-C-M-GF or</b>	
<b>W-C-Sun-GF</b>	<b>100 to 110\$/ha</b>

Higher Yields  
 Lower Costs (Weed Control 50%)



## Removing a Yield Cap

W-C-M-GF (NT) vs W-M-F (CT)

Excellent Years

Winter Wheat Yield

W-C-M-GF (NT) : 5400 kg/ha

W-M-F (CT) : 2600 kg/ha

## Removing a Yield Cap

W-C-M-GF (NT) vs W-M-F (CT)

Excellent Years

Proso Millet Yield

W-C-M-GF (NT) : 4500 kg/ha

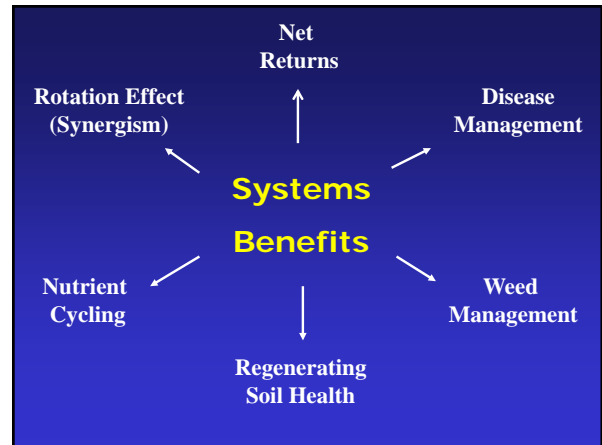
W-M-F (CT) : 2000 kg/ha

## Longer-Term Rotations

Wheat-Corn-Proso Millet-GF (Peas)



Wheat-Corn-Sunflower-GF (Oats)



## Systems Thinking

