

The Power of Crop Rotations

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UNITED STATES OF AMERICA



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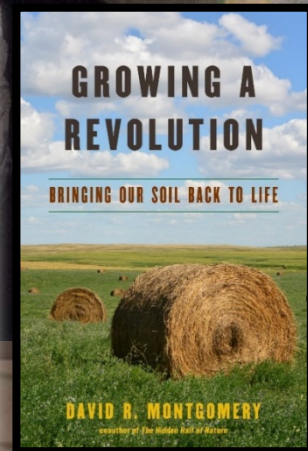
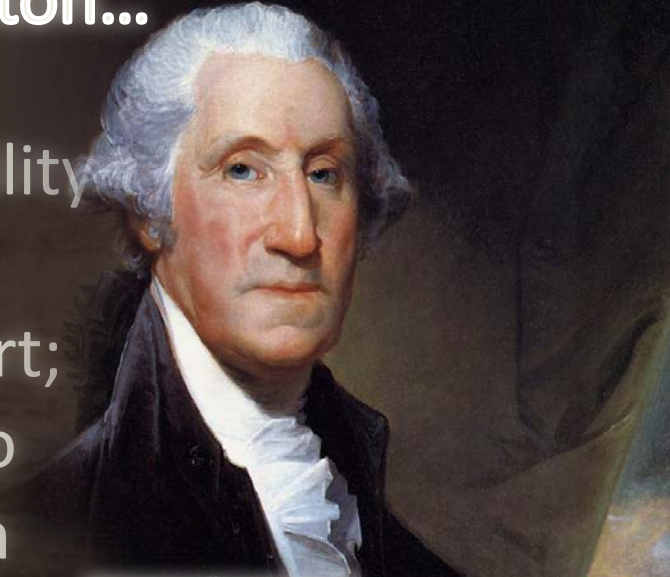


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In a 1796 letter to Alexander Hamilton...

A few years more of increased sterility will drive the Inhabitants of the Atlantic States westward for support; whereas if they were taught how to improve the old, instead of going in pursuit of new and productive soils, they would make these acres which now scarcely yield them any thing, turn out beneficial to themselves.

- George Washington



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Dakota Lakes Research Farm

- **Owned and directed by farmers.**
- **All fixed facilities, the land, and much of the irrigation equipment is owned by the Corporation.**
- **An eleven member BOD works with the farm manager to operate the production enterprise.**
- **The research manager works with the BOD and SDSU to operate the research enterprise.**

Dakota Lakes Research Farm

- Profits from the production enterprise are used to support research and make improvements to the facilities and equipment.
- There are both irrigated and dryland areas.
- The land has been 100% low-disturbance no-till since 1990 (or longer)
- May crop rotations have also been in place for that long.

Comparison of corn, soybean, spring wheat, winter wheat, and sunflower production in the Central, North Central, and South Central crop reporting districts in South Dakota increased \$1.6 billion in 2014 as compared to what they grew in 1986 (this is based on August 12, 2015 prices at Wolsey).



This success was not achieved because we set out to improve yields. Rather the goal was to better manage ecosystem processes with natural systems as the model.

This approach is sometimes called Transformational Change.

Transformational Change employs a systems or holistic approach .



**The light bulb did not result by
incrementally making candles
better.**



**NO RUNOFF WITH
IRRIGATORS APPLYING 50
MILLIMETERS OF
WATER IN 9 MINUTES**



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- **Agriculture faces substantial challenges currently from both an environmental and economic perspective.**

- **These challenges stem from creation of systems that are linear (input/output and extractive) rather than cyclic. Natural systems are cyclic.**

- **SHORT-TERM STUDIES ARE NOT ACCURATE IN EVALUATING TREATMENTS SUCH AS TILLAGE OR ROTATIONS WHICH HAVE LONG-TERM IMPACTS.**

ECOSYSTEM PROCESSES

- **WATER CYCLE**
- **ENERGY FLOW**
- **MINERAL CYCLE**
- **COMMUNITY DYNAMICS**

- **Crop rotation has been a primary tool for managing agricultural ecosystems from the time that permanent settlement began.**

- **Diverse crop rotations can help mimic natural ecosystem processes.**

- **Technological developments (pesticides, fertilizers, transportation, genetics, etc.) allowed the industry to create linear (input/output) systems.**

- **Linear (input/output) systems degrade the ecosystem and prove to be unstable.**

- **Diverse crop rotations can help prevent biotype weed and insect issues while also improving productivity, ecosystem services, and soil properties.**

ADEQUATE DIVERSITY

Weeds and diseases are nature's way of adding diversity to a system that lacks diversity.

Mother Nature Is An Opportunist

If you have a problem

YOU!!!!

have provided the

OPPORTUNITY

somewhere in your system.



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- **Biological: Does this action address the weakest point in the lifecycle of the organism?**

Weed or Insect Problems



PURSUIT 6 OZ



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ADEQUATE DIVERSITY

Nature's efforts to add diversity can be countered by adding beneficial diversity to the system.

ADEQUATE DIVERSITY

AT LEAST THREE CROP TYPES. LONG INTERVALS OF 2 TO 4 YEARS ARE NEEDED TO BREAK SOME DISEASE AND WEED CYCLES.



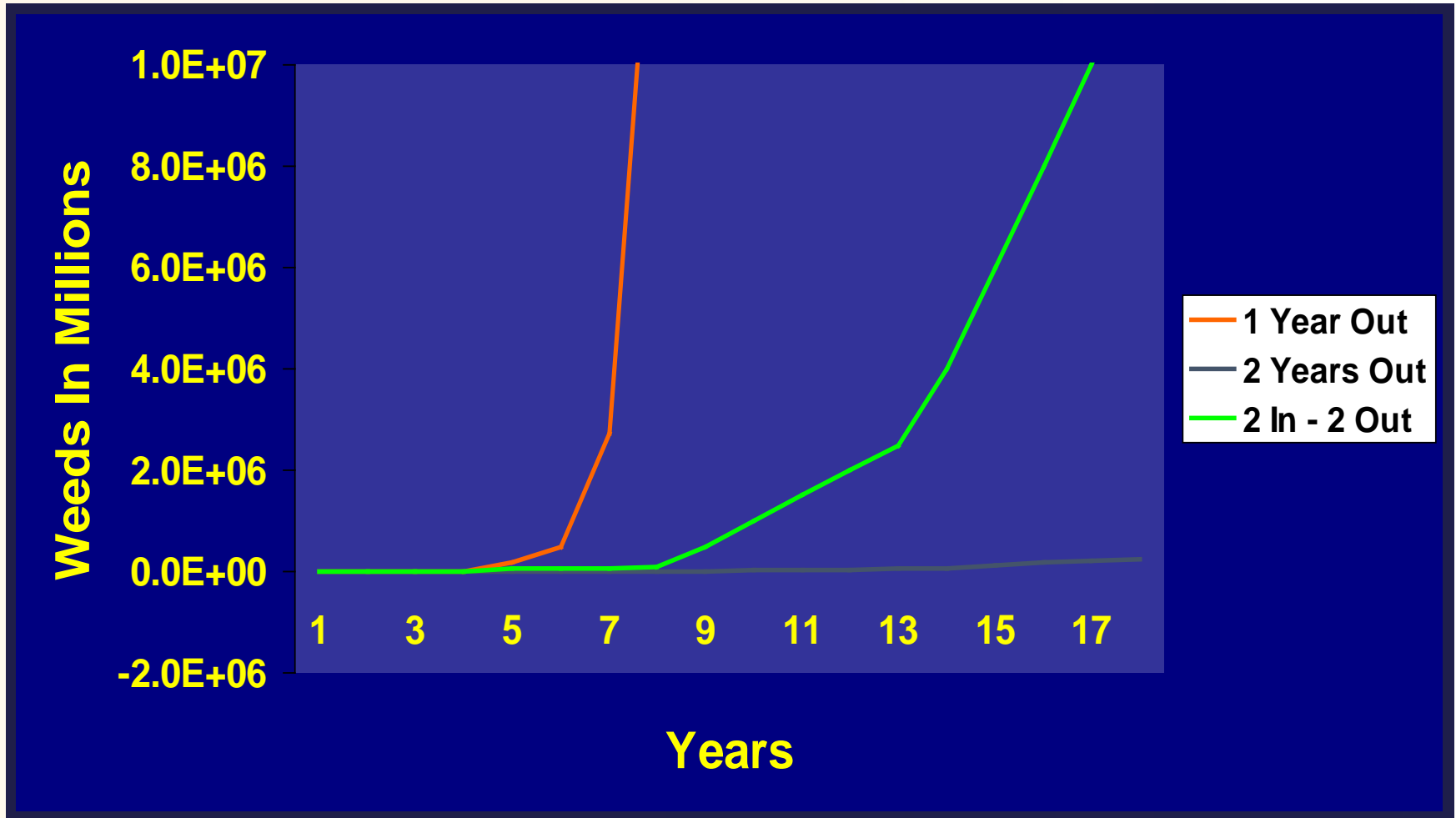
Impact of Rotation & Low Disturbance On Weed Populations

Weed of Interest: Waterhemp

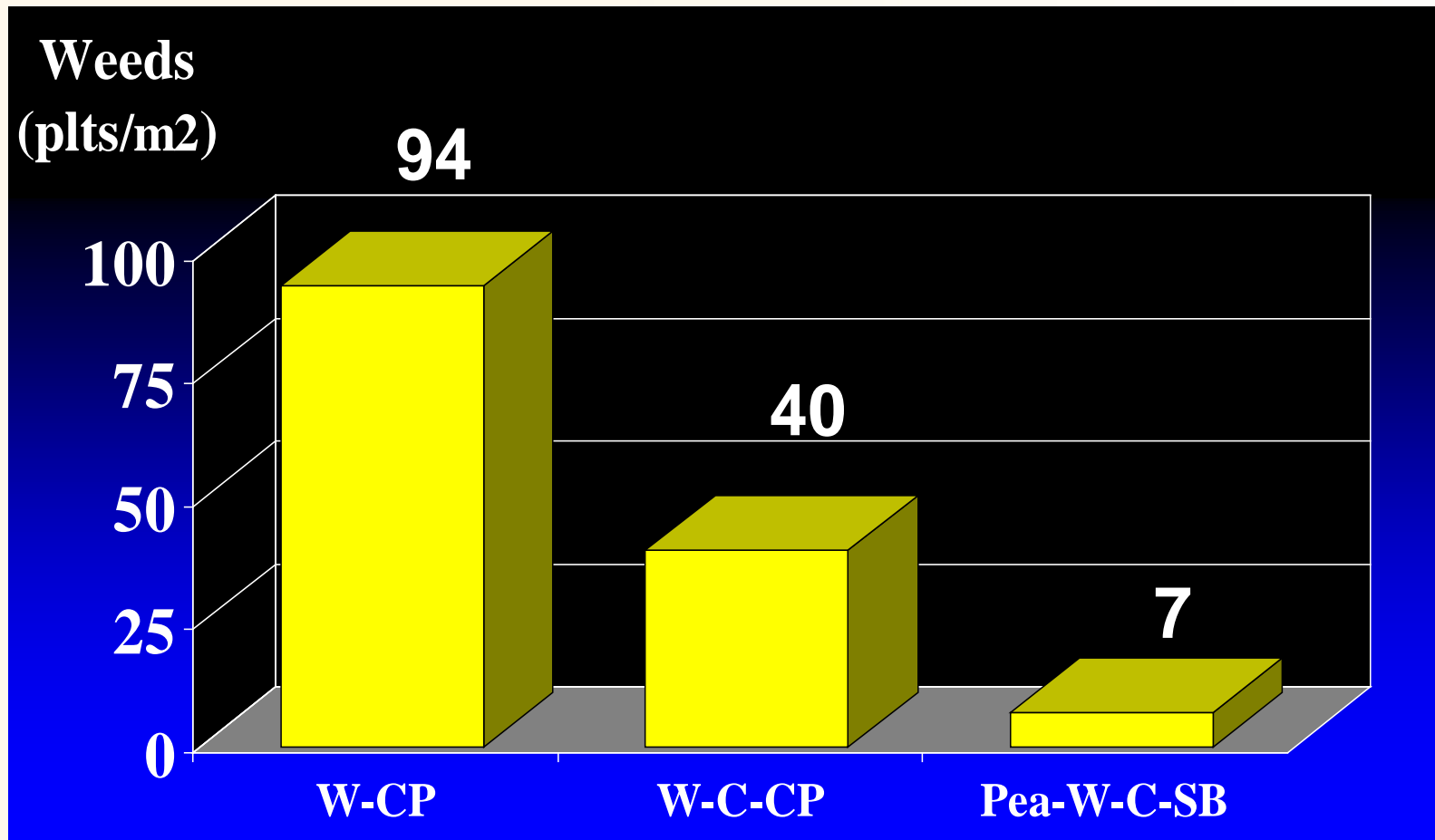
Number of Weeds Previous: 10

Number of Seeds Per Weed: 100

Rotation Interval Vs. Weeds



Rotation Design < - > Weeds



Tillage - Weed Seedling Emergence

Weed Seed Shed: (once)

No-Till

Till (seed 1 – 3 inches deep)

Count Seedlings Yearly, for 3 Years

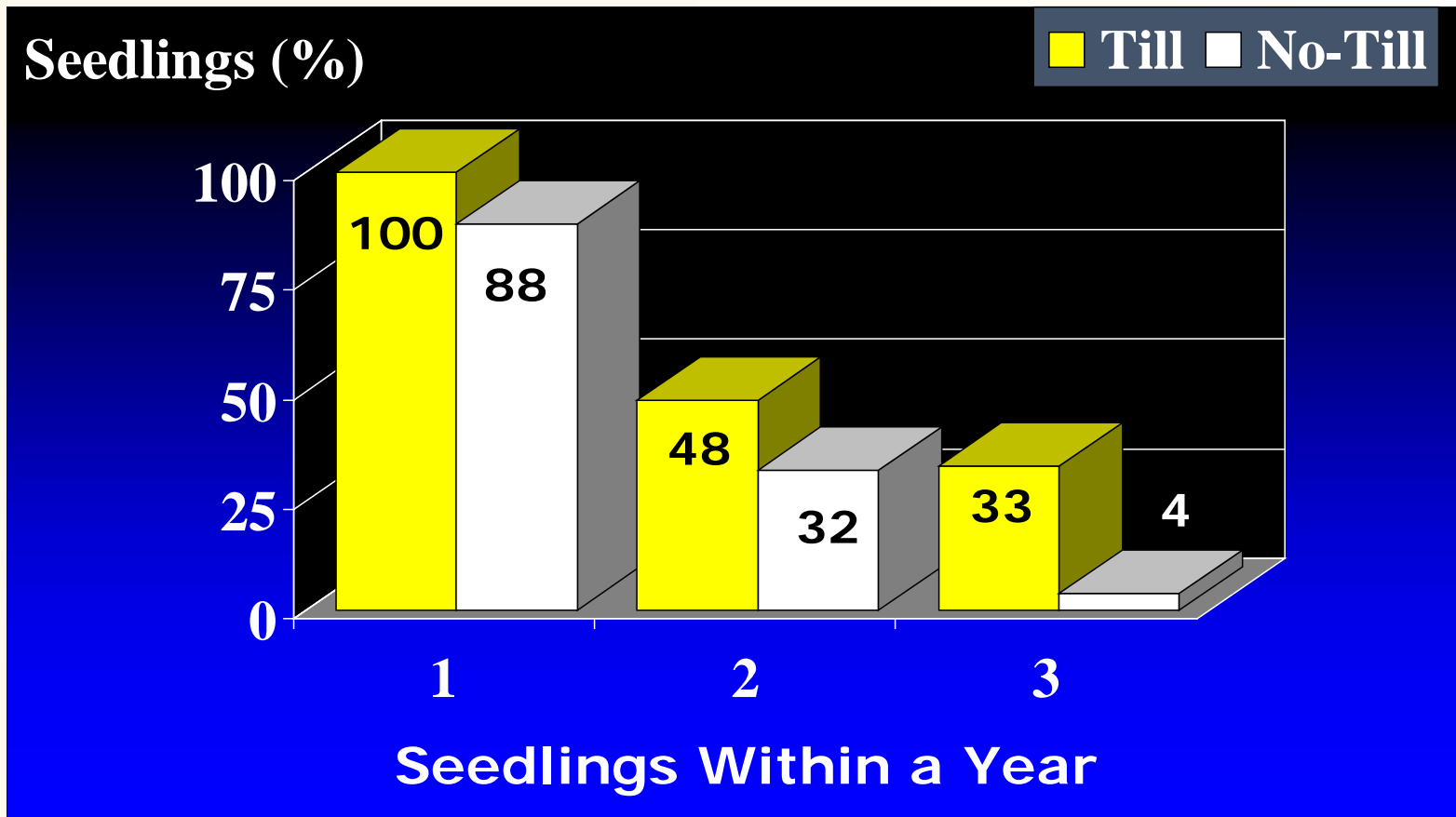
Several Species, Average

R. Anderson on 4 Sites

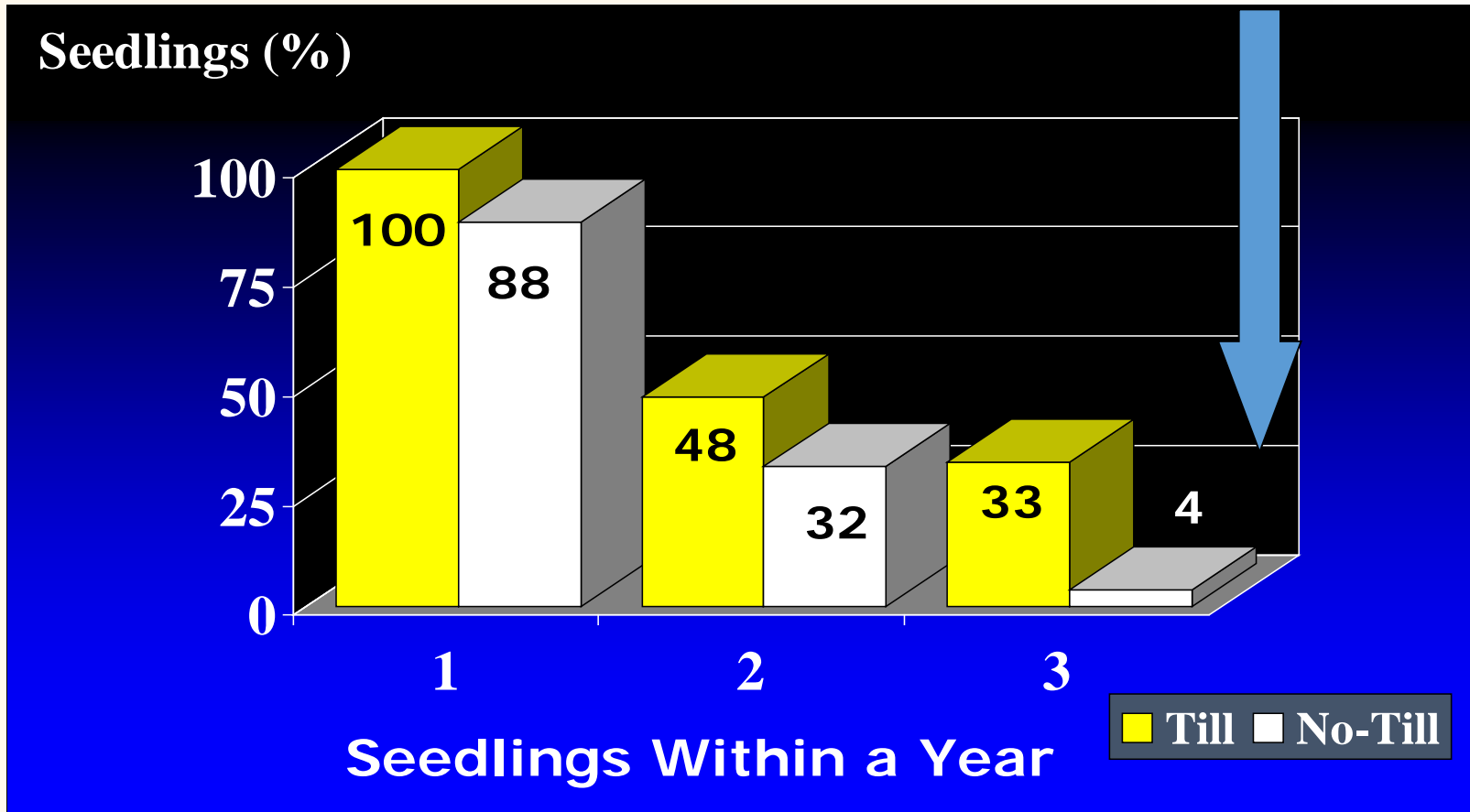


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Seedling Emergence - Tillage

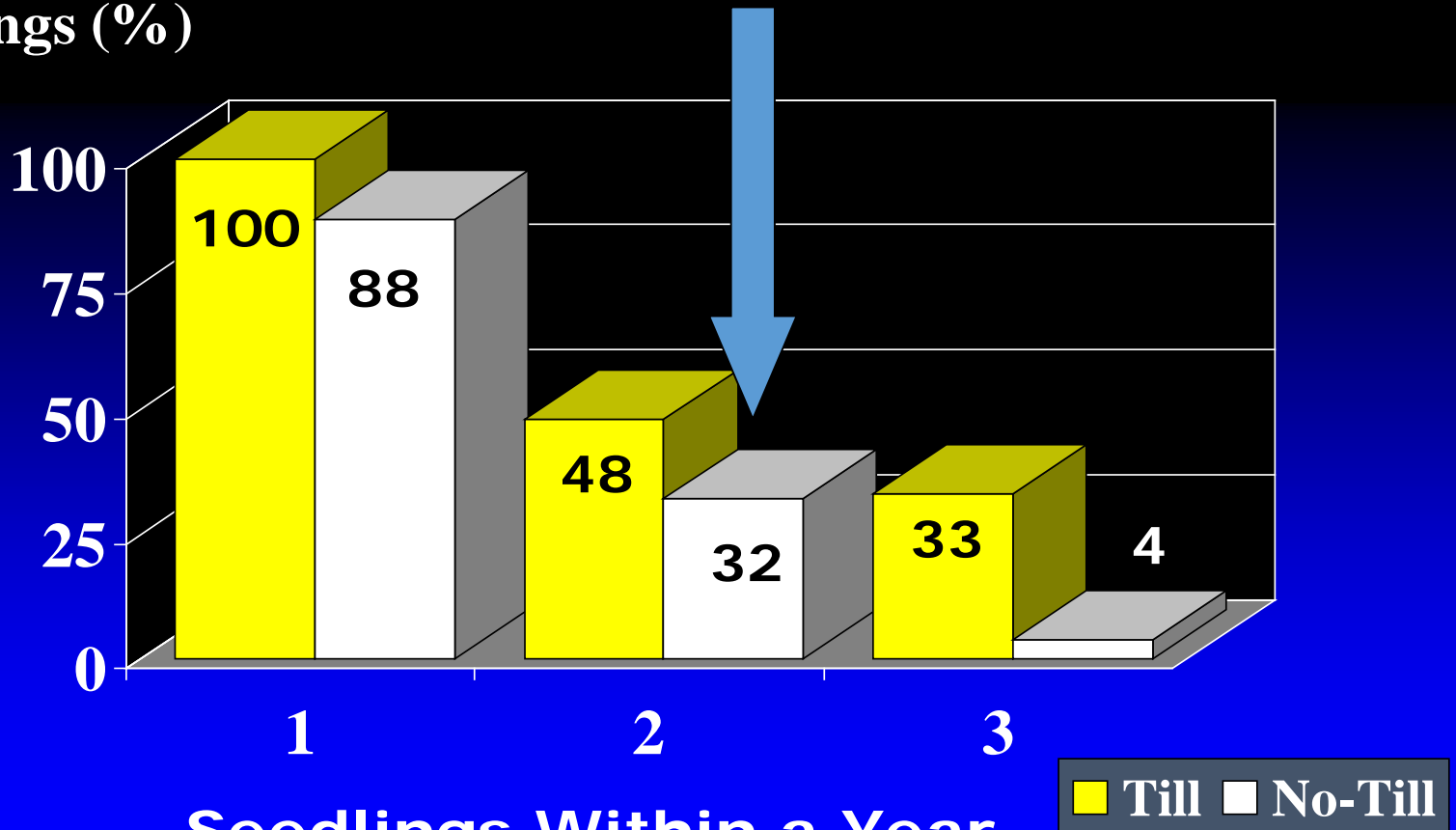


Corn → Pea → WW → Corn



Corn → Soybean → Corn

Seedlings (%)



Seedlings Within a Year

THE REAL COMPARISON

- **Tillage and Poor Rotation gives 225 weeds/m²**
- **No-till and GOOD Rotation 7 weeds/m²**
- **That is 97% weed control**

ADEQUATE DIVERSITY

**There has been no need to
apply broadcast
insecticides at Dakota
Lakes for over 16 years.**



SIMPLE ROTATIONS

- **Winter Wheat-Corn-Canola**
- **S. Wheat-Corn-Sunflower**
- **Winter Wheat-Corn-Pea**
- **Corn-Soybean**

SIMPLE ROTATIONS

Advantages

Simple-limited number of crops to manage and market.

Disadvantages

Limited-all corn behind wheat or all winter wheat into spring wheat.

Rotations With Perennial Sequences

- **C-Sb-C-Sb-C-Sb-C--Sb-Gr-Gr-Gr-Gr**
- **Many other examples**

Rotations with Perennial Sequences

Advantages

Simple-limited number of annual crops to manage and market.

Excellent place to spread manure.

Probably can produce more soil structure than annual crops (grass or grass mixtures) not removed as hay.

Removing residue can negate many of the benefits

Rotations with Perennial Sequences

Disadvantages

Difficult to manage sufficient percentage of land in a perennial crop without grazing.

(harvesting 40% of farm as forage is tough)

(using less perennial minimizes impact)

Marketing perennial crop is an issue.

COMPOUND ROTATIONS

Combination of two or more simple rotations in sequence to create a longer more diverse system.

EXAMPLE:

**S. Wheat-W. Wheat-Corn-SB-Corn-SB
(Mother-in-Law or Banker rotation)**

COMPOUND ROTATIONS

Advantages

Limited number of crops to manage.

Creates more than one sequence for some crop types.

Disadvantages

Limited ability to spread workload.

COMPLEX ROTATIONS

Rotations where crops within the same crop type vary.

EXAMPLE:

Barley-W.Wheat-Corn-Sunflower-Millet-Pea

COMPLEX ROTATIONS

Rotations where crops within the same crop type vary.

EXAMPLE:

Barley-W.Wheat-Corn-Sunflower-Millet-Pea

COMPLEX ROTATIONS

Advantages

Capable of creating a wide array of crop type x sequence combinations.

Complementarity-ie Sorghum and Corn

Disadvantages

Requires substantial crop management and marketing skill.

STACKED ROTATIONS

Rotations where crops or crops within the same crop type are grown twice in succession followed by a long break.

EXAMPLE:

Wheat-Wheat-Corn-Corn-Soybean-Soybean

Stacked Rotation Concepts

- **Attempt to keep pest populations diverse (confused). Diversity in sequences and intervals used.**
- **Mix of long and short residual herbicide programs. Reduces costs and minimizes the chance of resistance and biotype changes.**
- **Two year break between corn and wheat**

Stacked Rotation Concepts

- **The goal is to allow sufficient time for pest pressure to decline to very low levels before sequencing the crop or crop type 2 times.**

STACKED ROTATIONS

Advantages

Reduce the risk of developing of biotype resistance when properly employed.

Can reduce cost of herbicide programs.

Disadvantages

Some crop sequences may not be ideal.

The goal is to be
INCONSISTENT
in both sequence and
interval



Rotation Impact on W.Wheat Dakota Lakes Research Farm

Rotation	Yield	Precip*
Corn-Pea-WW 2006	60 (4.4)	7.9 (201)
SB-Corn-Pea-WW 2006	29 (2.0)	
Corn-Pea-WW 2005	92 (6.2)	23.7 (602)
Sb-Corn-Pea-WW 2005	57 (3.8)	
Corn-Pea-WW 2002	56 (3.8)	6.4 (163)
SB-Corn-Pea-WW 2002	28 (1.9)	

2016 Rotation Impact on W.Wheat

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Rotation	Yield	Protein
Corn-Pea-WW	95 (6.4)	13.4
SB-Corn-Pea-WW	80 (5.4)	14.6
SB-Corn-Carinata-WW	60 (4.0)	14.7
WW-WW-Sorg-Corn-Pea	95 (6.4)	13.2
WW-Sorg-Corn-Pea-WW	87 (5.9)	13.4

Field Scale Yield Data

Dakota Lakes Research Farm

- C – SB rotation – 62.9 bu/a (4.2 Mg/ha)
- C-C-Soybean-Wheat/CC-Soybean –
78.6 bu/a (5.3 Mg/ha)

Field Scale Yield Data

Dakota Lakes Research Farm

- **CONTINUOUS CORN**
 - 203 bu/a (12.8 Mg/ha)
- **CORN-SOYBEAN**
 - 217 bu/a (13.7 Mg/ha)
- **C-C-SB-W-SB**
 - 235 Corn (14.8 Mg/ha)

DIVERSITY IMPACT

IF 5,000 ACRES or 2,500 HECTARES

- **CONTINUOUS CORN**
 - 1,015,000 (63,000) corn, 0 soybean, 0 wheat
- **CORN-SOYBEAN**
 - 542,500 (37,000) Corn, 157,250 (10,600) soybean, 0 Wheat
- **C-C-SB-W-SB**
 - 470,000 (29,570) Corn, 157,600 (10,620) soybean, 120,000 (8,090) Wheat
- **Does it make sense to trade 72,500 bushels (4562 tonnes) of corn for 120,000 bushels (8,090 tonnes) of wheat and 350 (24 tonnes) of soybean. With fewer pest issues.**

The Rotation Must Fit the Ecosystem and the Operator

- There is no set recipe or “best” rotation
- Individual fields may need differing treatment due to soils, location, proximity, history, landlord, ownership.....
- Understanding the power or rotations is the key.

**As citizens of the US and the World,
you need to decide what you would
like agriculture to look like in the
future. Our present path is
troubling.**

**Use 200 years a timeline. Maybe
600 years would be better.**



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Native American culture based decisions on their potential impact on the next 7 generations. That is 280 years at 40 years/generation.



**DOING THE RIGHT THING
ENVIRONMENTALLY IS
ALMOST ALWAYS THE
CORRECT ECONOMIC
APPROACH IN THE LONG-
RUN.**



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Acknowledgements

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