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HERE ON
MARCH 30 1743
THE VERENDRYES
BURIED A LEAD
TABLET TO CLAIM
THIS REGION FOR
FRANCE. THIS
TABLET FOUND
ON FEB. 16 1913 IS
THE FIRST WRITTEN
RECORD OF THE
VISIT OF WHITE
MEN TO
SOUTH DAKOTA.

ERECTED BY
STATE HISTORICAL
SOCIETY
AND FT. PIERRE
COMMERCIAL CLUB
1933

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







Pick-Sloan Project

Large Main-Stem Reservoirs

4 Dams in South Dakota

500,000 acres of planned irrigation







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.**

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.**

Most present systems that are called No-till are only incrementally different from the tillage based systems they are supposed to replace.

President John Kennedy had a defined goal of placing a man on the moon by the end of the decade.

**A FARMER MANAGES ECOSYSTEMS
AND TAKES SUNLIGHT, WATER,
AND CARBON DIOXIDE AND MAKES
THEM INTO PRODUCTS TO BE SOLD.**

ECOSYSTEM PROCESSES

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

- **WATER CYCLE-Does rain feed plants and recharge groundwater or does it run off or deep percolate and cause erosion and water quality degradation? (drain tile)**





**NO RUNOFF WITH
IRRIGATORS APPLYING 2
INCHES OF
WATER IN 9 MINUTES**







**TAKE THE E OUT OF ET
(MAXIMIZE WUE IN LATE SUMMER)**

MAKE WATER ENTER THE SOIL

**MAXIMIZE THE WATER HOLDING CAPACITY OF
THE SOIL**

THIS IS A GOOD IDEA FOR IRRIGATION:

**IT IS A GREAT IDEA FOR THOSE WITHOUT
IRRIGATION.**

Ecosystems harvest sunlight energy to drive all other processes.

–Removing products from the ecosystem reduces the energy available.

- **Energy**

- **Constant or Finite**

- **Benign or Potentially Damaging**

- **Internal or External**

- **MINERAL CYCLE-Are the nutrients available for plant use and environmental services”?**

- **MINERAL CYCLE- or have they been leached, eroded, or transported from the landscape? (Sent to China or the Ocean)**

**Ecosystems that leak
nutrients turn into
deserts.**

**A 120-car train of
soybeans contains
200,000 Kg of
Phosphate.**

Saline Seep Formation

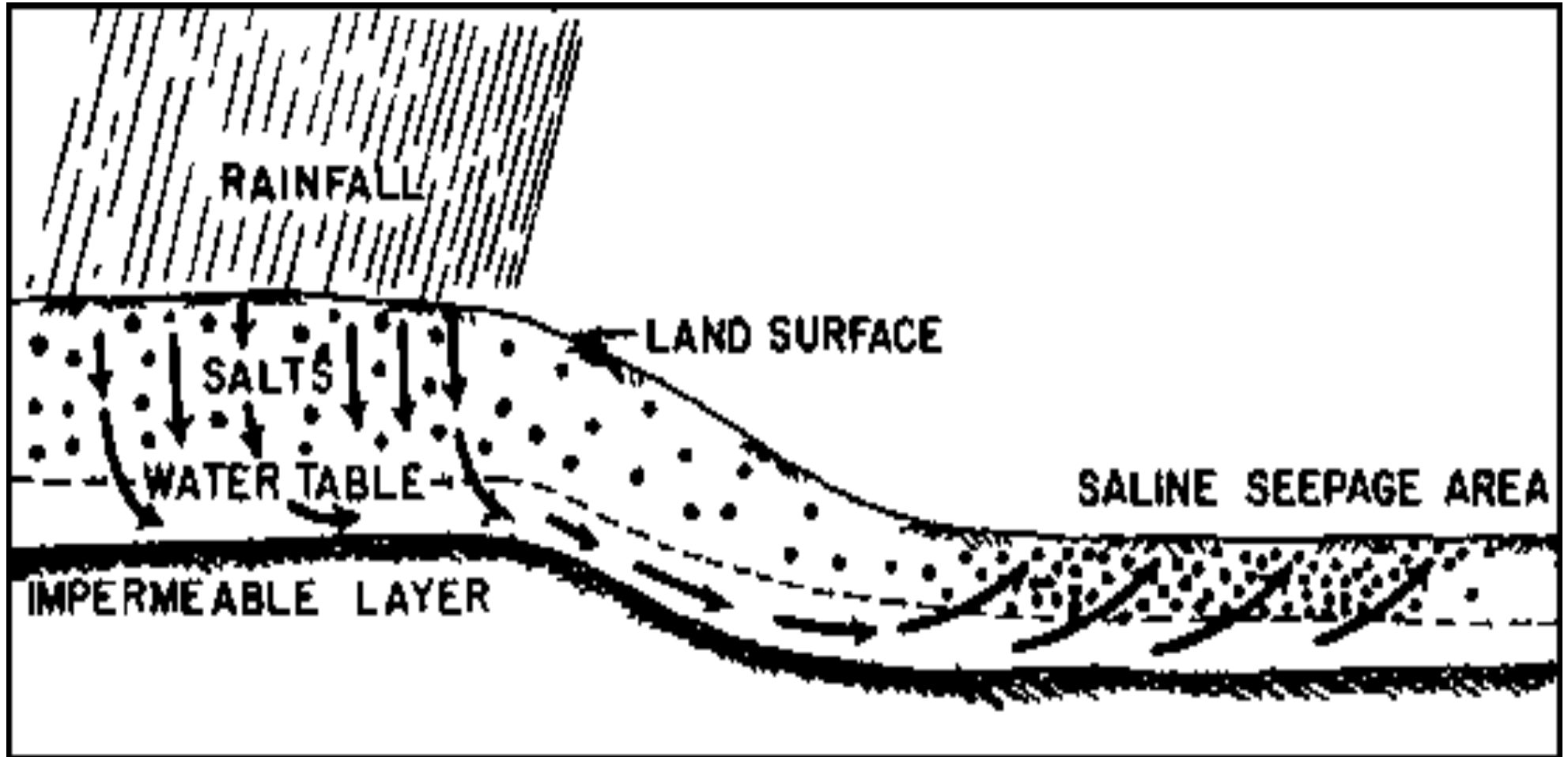


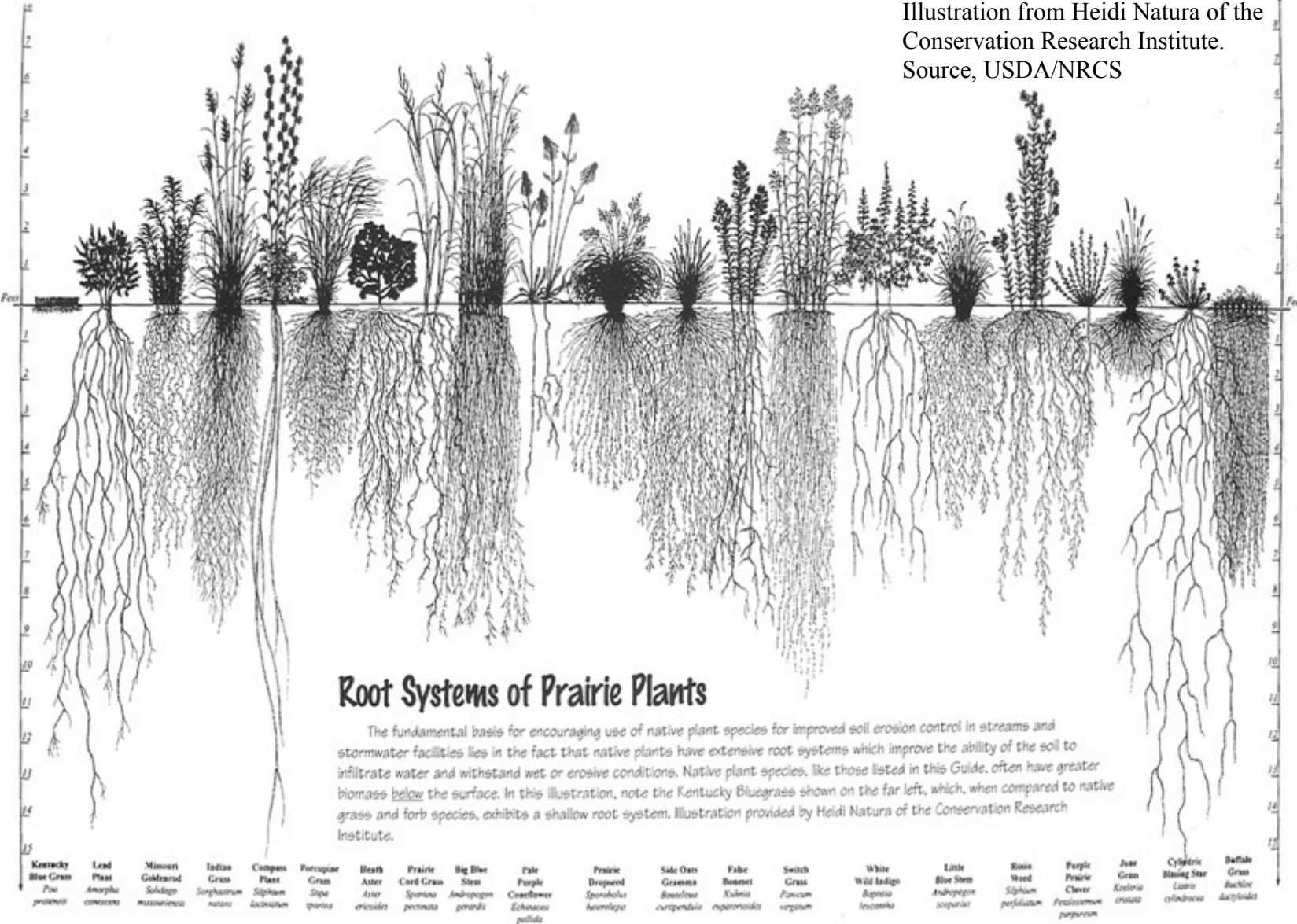








Illustration from Heidi Natura of the Conservation Research Institute.
 Source, USDA/NRCS





**CATCH AND
RELEASE
NUTRIENTS**

Fertility Management

- **Some starter P with the seed.**
- **Other nutrients placed near row at seeding or on soil surface after crop canopy.**
- **broadcast fertilizer before or at seeding encourages weeds.**
- **Three key factors**
 - 1 **Available Nutrient**
 - 2 **Moisture**
 - 3 **Roots**

ADEQUATE DIVERSITY

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

Mother Nature Is An Opportunist

If you have a problem

YOU!!!!

have provided the

OPPORTUNITY

somewhere in your system.

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

Weed or Insect Problems

PURSUIT 6 OZ

ADEQUATE DIVERSITY

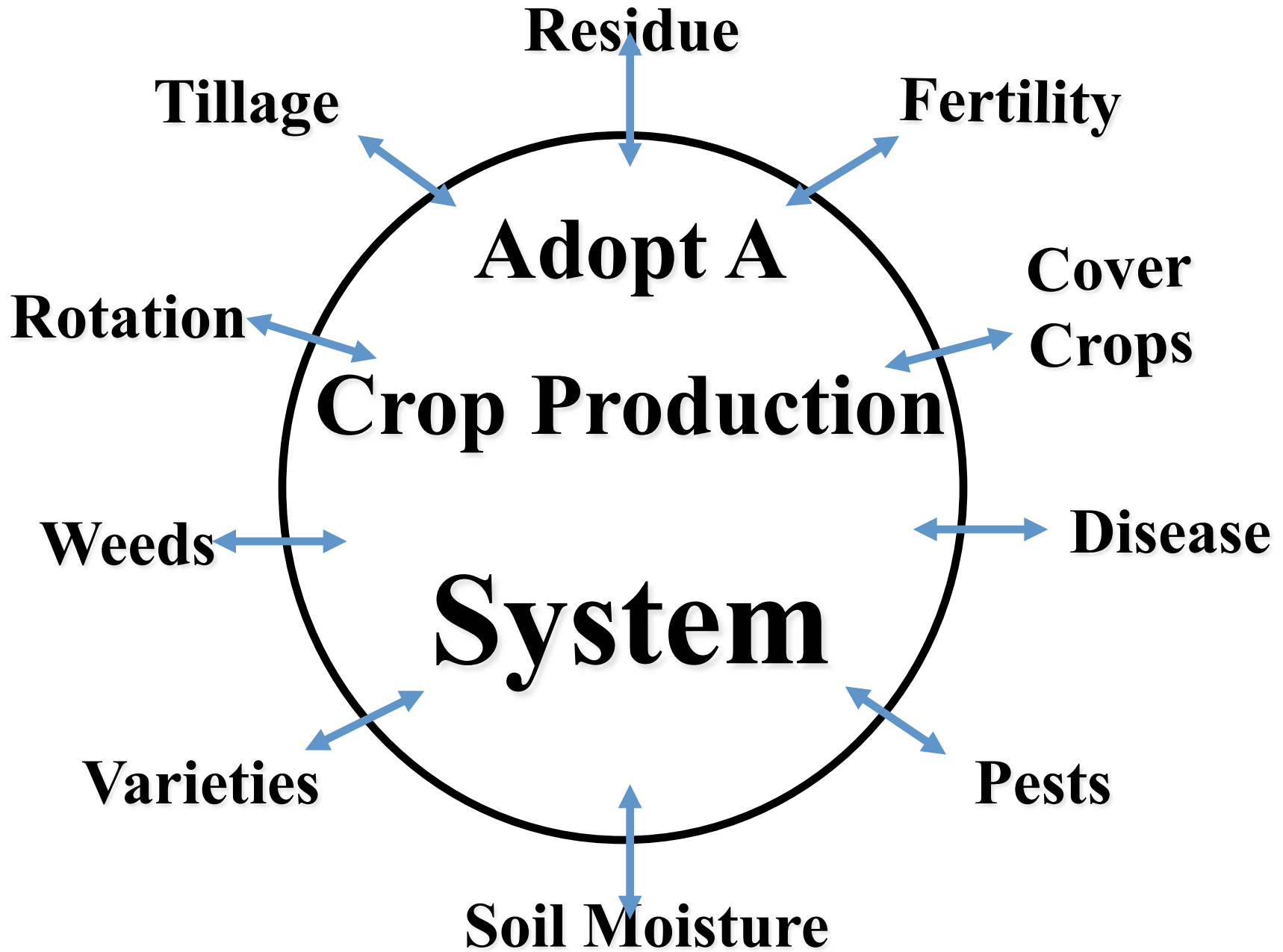
Nature's efforts to add diversity can be countered by adding beneficial diversity to the system.

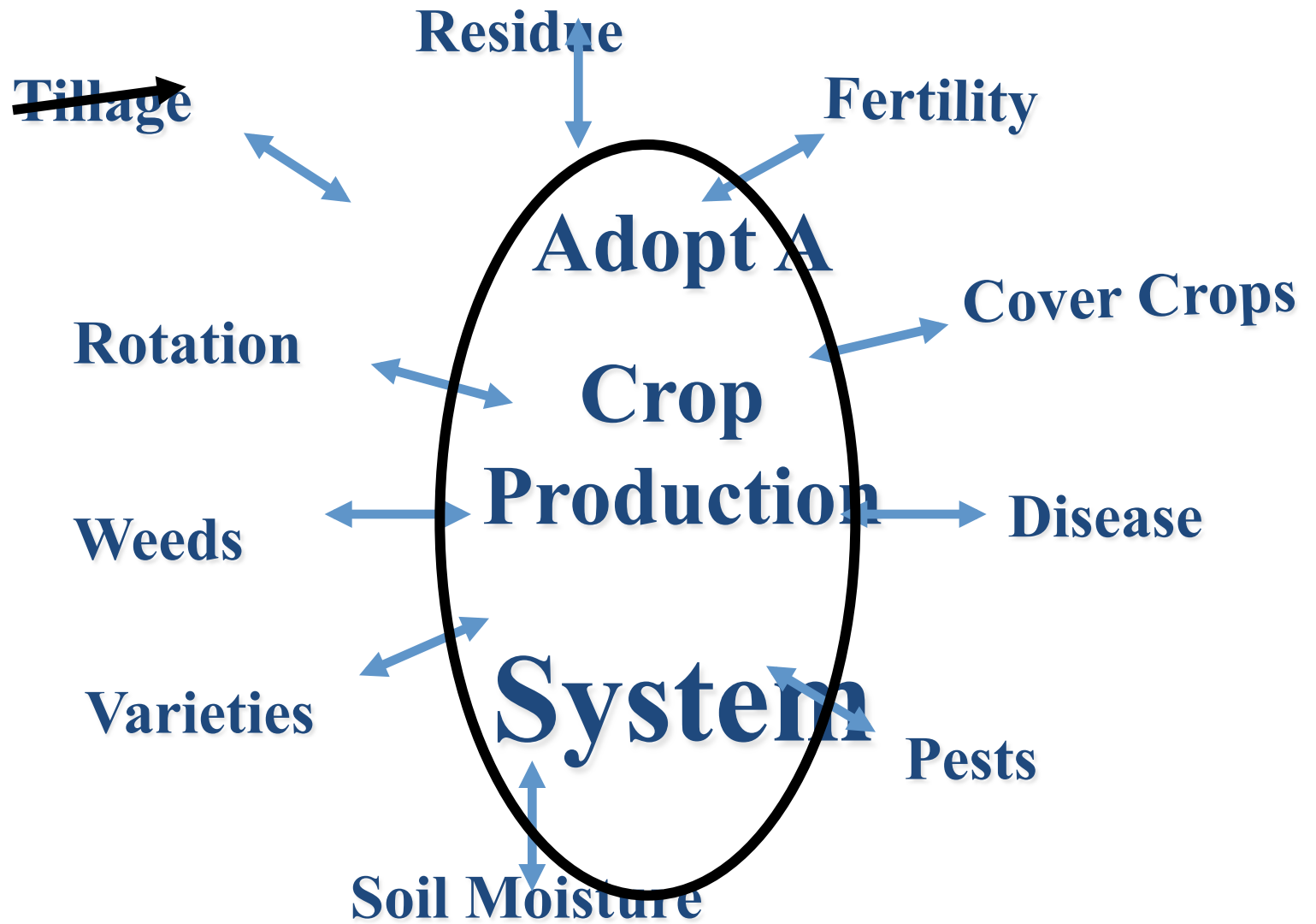
ADEQUATE DIVERSITY

**There has been no need to
apply broadcast
insecticides at Dakota
Lakes for over 17 years.**

**NO-TILL IS NOT ABOUT LACK OF
TILLAGE BUT ABOUT MANAGING
SOIL WATER, SOIL STRUCTURE, SOIL
BIOLOGY, AND CARBON
COMPOUNDS IN THE SOIL.**

**Strive to produce a crop
which is *HEALTHY*.
Not a crop which does not
get *SICK*.**





Farming System Components

- **Cultural Practices**
- **Technology**
- **Management**

CULTURAL PRACTICES

- **TILLAGE**
- **ROTATION**
- **SANITATION**
- **COMPETITION**

**IN NATURE
TILLAGE IS A
CATASTROPHIC EVENT**

**Tillage is to agriculture what
fracking is to petroleum:**

**Both increase the speed and
extent of the removal of
compounds from the
ecosystem.**

**IF YOU COULD KNOW ONLY ONE
THING ABOUT A SOIL WHAT
PARAMETER WOULD YOU WANT TO
KNOW?**

“Within all textural groups, as organic matter increased from 1 to 3%, the available water capacity approximately doubled. When organic matter content increased to 4%, it then accounted for more than 60% of total AWC“.8

IMPORTANT FACTORS

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

Wheat Health Management

Cook and Veseth

Crop rotation allows time for natural enemies to destroy the pathogens of one crop while.....unrelated crops are grown.

Crop Rotations

- **Proper Intensity**
- **Adequate Diversity**
- **Stable/Sustainable Profitability**

PROPER INTENSITY

Native vegetation is the best indicator of the range of intensities which are appropriate for a location.

PROPER INTENSITY

Most of the plant growth problems blamed on no-till are the result of inadequate diversity or improper intensity.

PROPER INTENSITY

- **Put water saved by no-till to work**
- **More high water-use crops and Cover Crops or Double Crops**
- **Proper intensity reduces risk**
 - **Plant growth, nutrients, etc.**

ADEQUATE DIVERSITY

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

Does it Work ?

(Field Trial)

Long-Term Rotation Study

Cool and Warm Season Crops

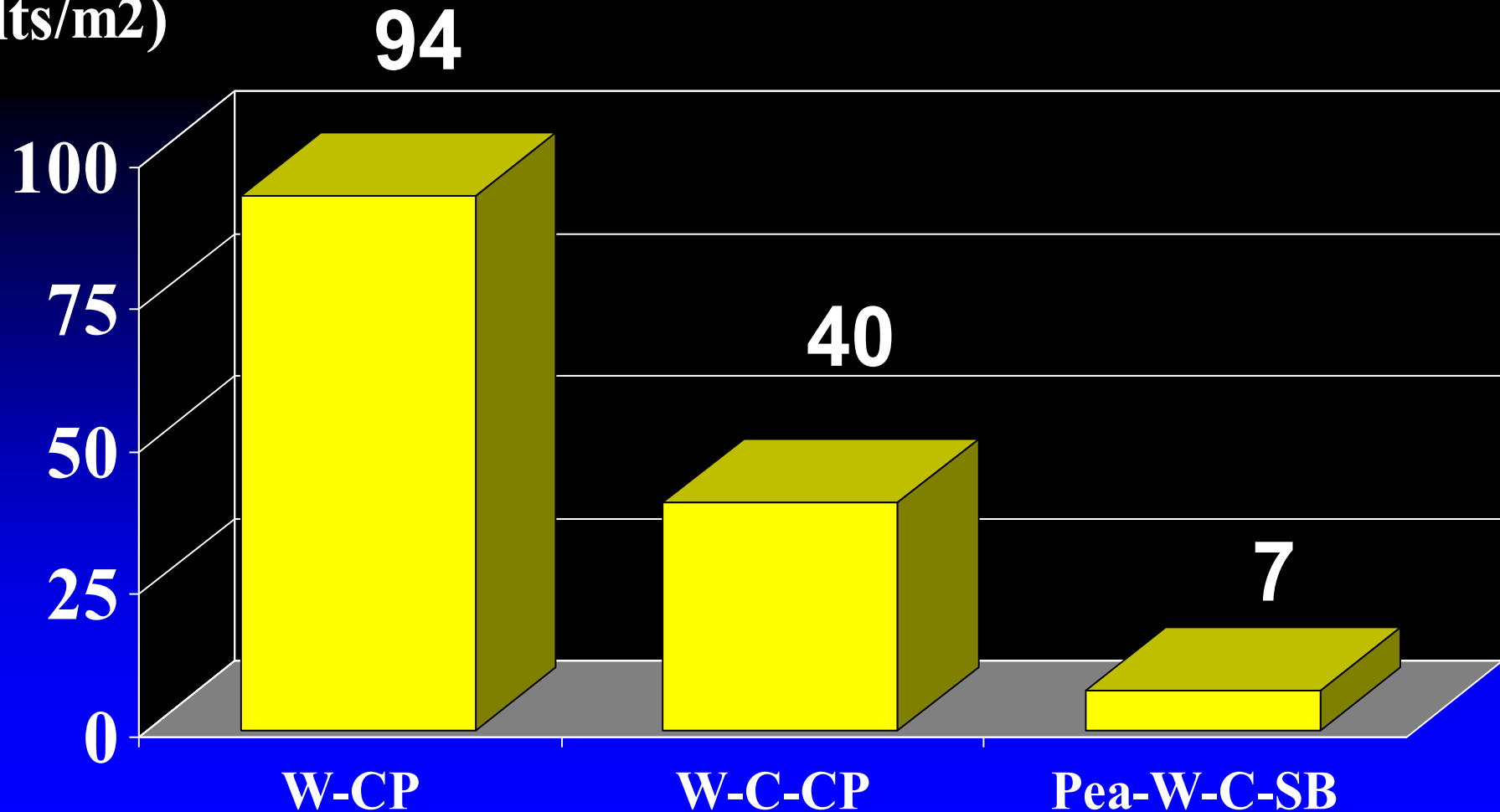
No-Till : Herbicides - Weed Control

Weed Density After 12 Years

(No Herbicides – Number of Weeds / m²)

Rotation Design < - > Weeds

Weeds
(plts/m²)



Tillage – Seed Survival

Green Foxtail

Seed Placed at 3 Depths in Soil

0, 2, and 4 *inches*

Measure Number of Live Seed Yearly

Tillage – Seed Survival

Green Foxtail

Seed Placed at 3 Depths in Soil

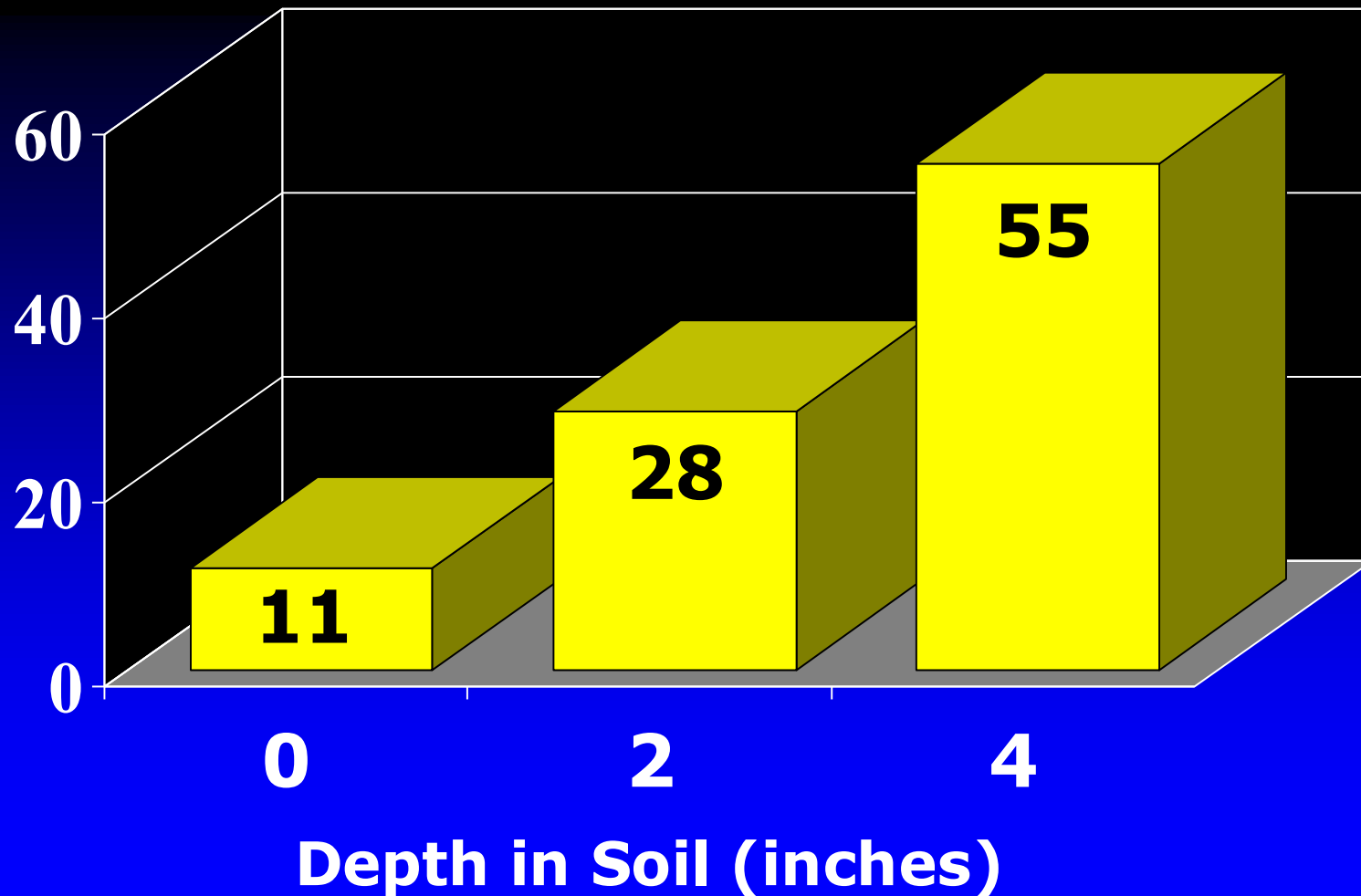
0, 2, and 4 *inches*

Measure Number of Live Seed Yearly

Green Foxtail Survival in Soil

Live Seed (%)

After 2 Years



Tillage - Weed Seedling Emergence

Weed Seed Shed: (once)

No-Till

Till (seed 1 – 3 inches deep)

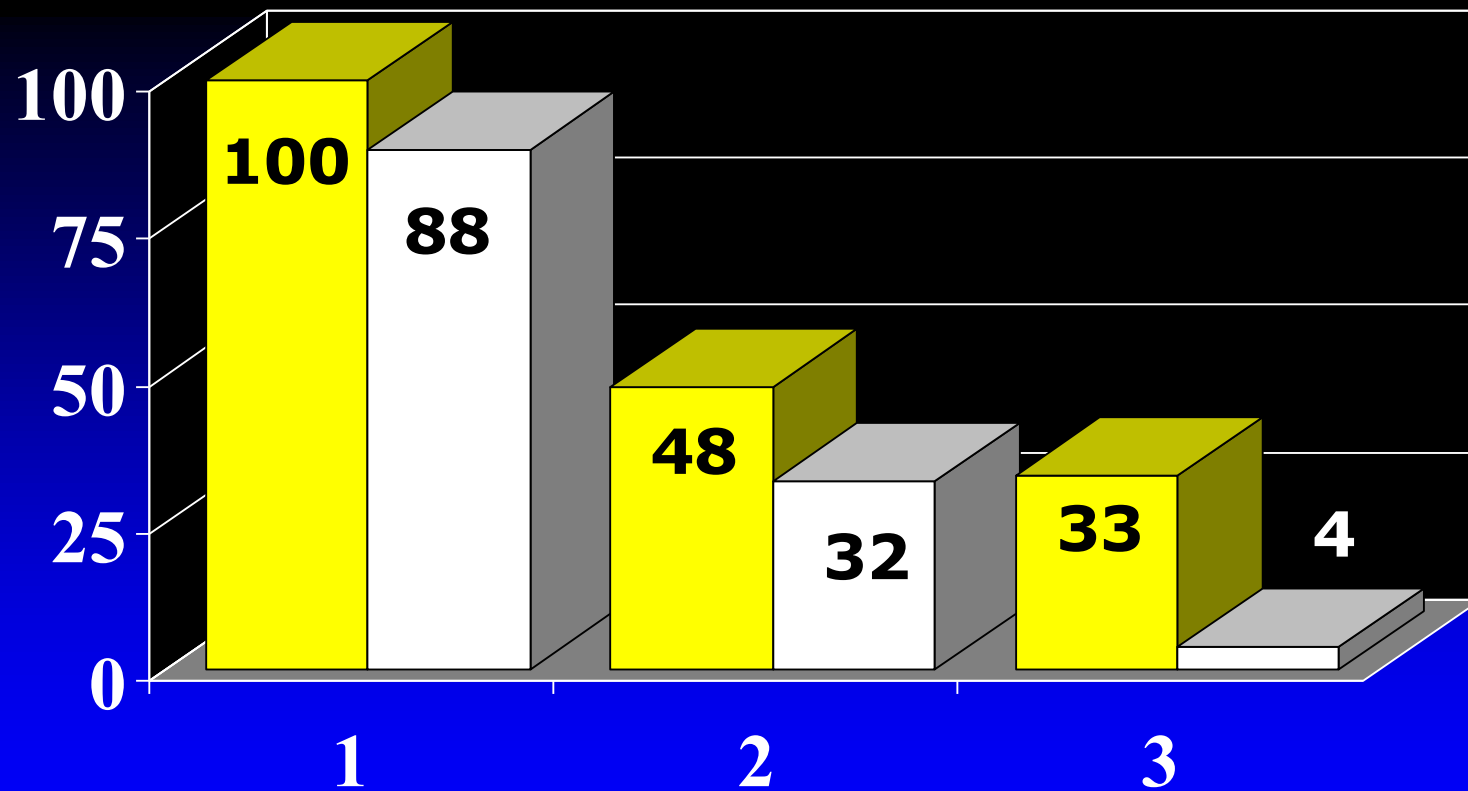
Count Seedlings Yearly, for 3 Years

Several Species, Average of 4 Sites

Seedling Emergence - Tillage

Seedlings (%)

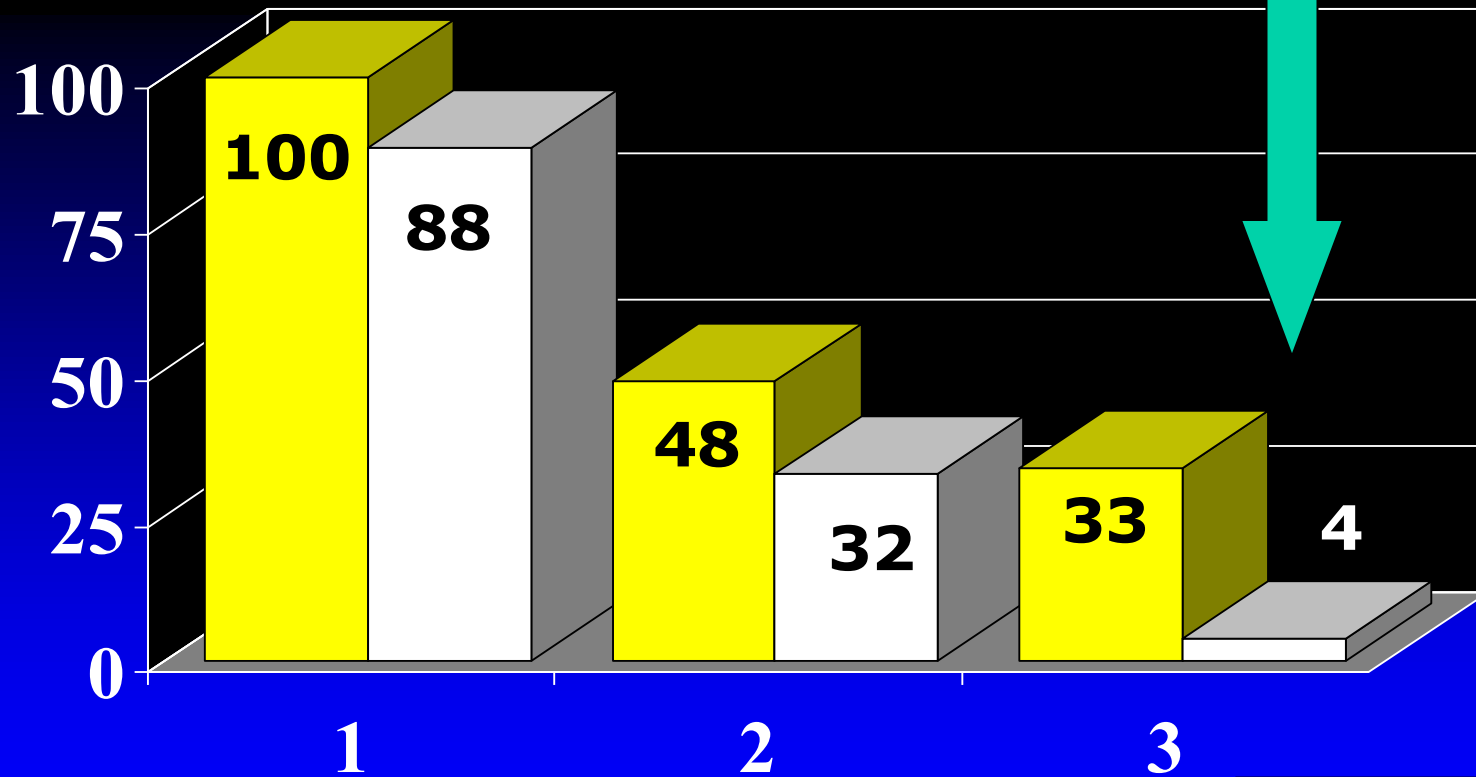
■ Till ■ No-Till



Seedlings Within a Year

Corn → **Pea** → **WW** → **Corn**

Seedlings (%)

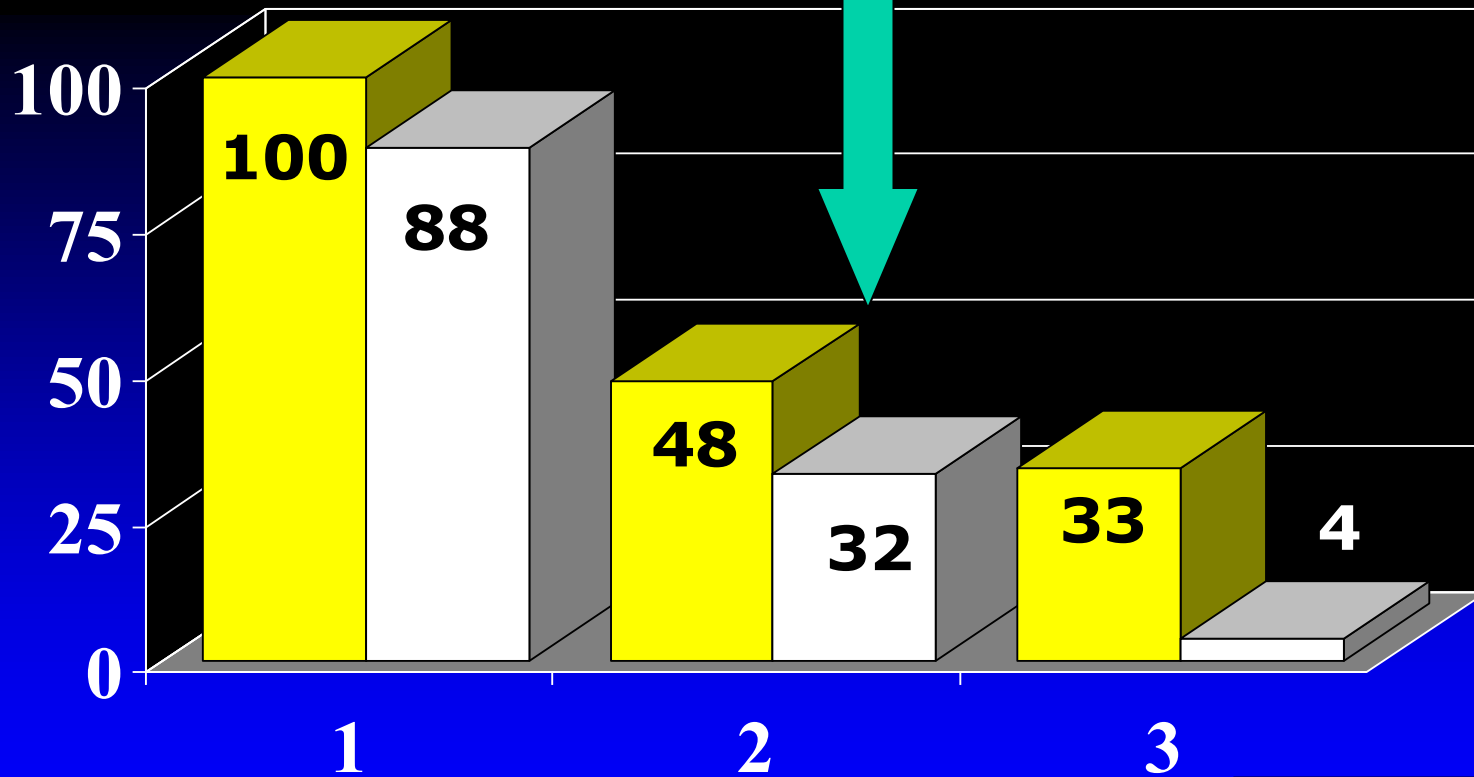


Seedlings Within a Year

■ Till ■ No-Till

Corn → **Pea** → **Corn**

Seedlings (%)



Seedlings Within a Year

■ Till ■ No-Till



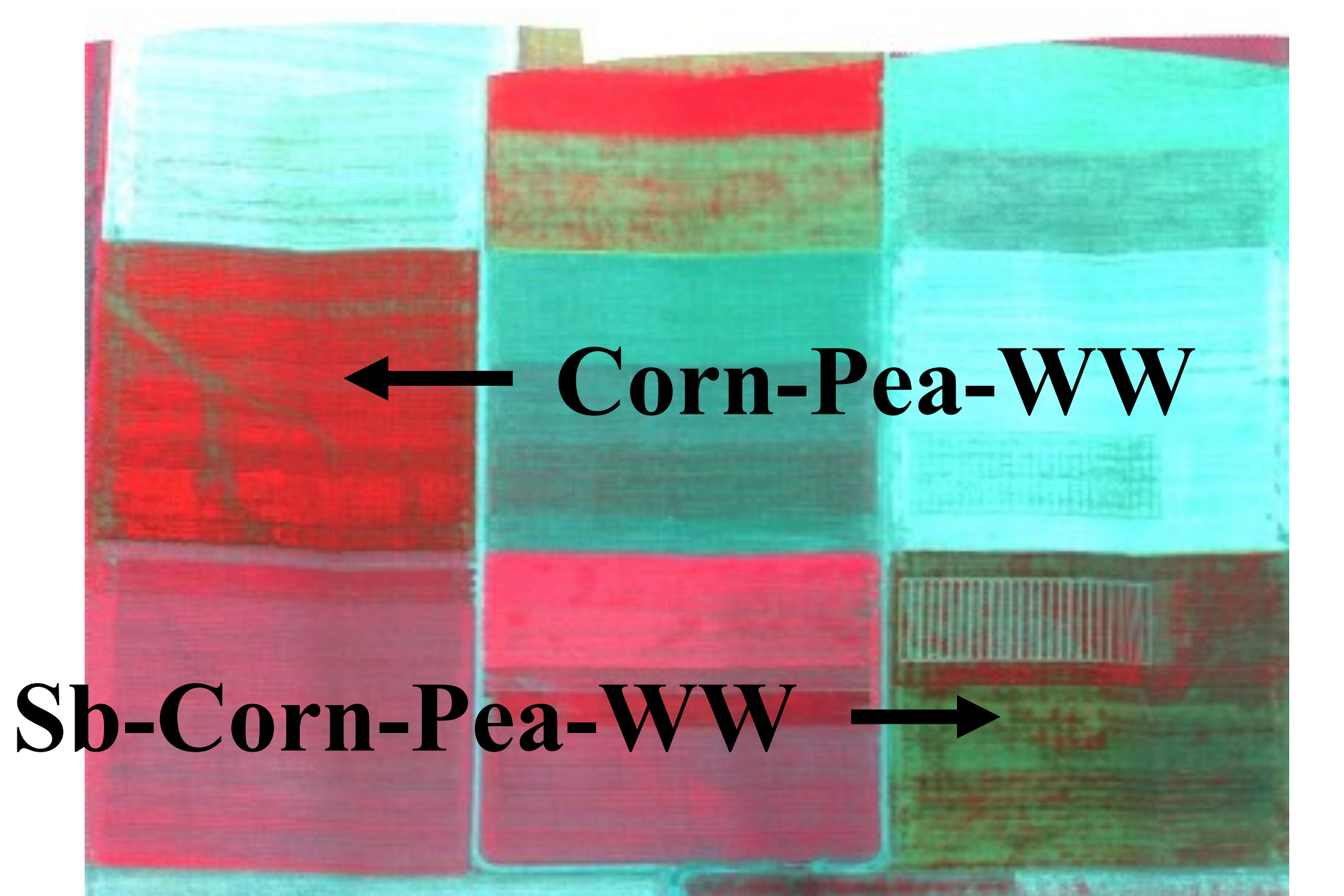
**Organic Matter
Makes a Difference**

Rotation Impact on W.Wheat Dakota Lakes Research Farm

Rotation	Yield	Precip*
Corn-Pea-WW 2006	60	7.9
SB-Corn-Pea-WW 2006	29	
Corn-Pea-WW 2005	92	23.7
Sb-Corn-Pea-WW 2005	57	
Corn-Pea-WW 2002	56	6.4
SB-Corn-Pea-WW 2002	28	







← Corn-Pea-WW

Sb-Corn-Pea-WW →

2016 Rotation Impact on W.Wheat Dakota Lakes Research Farm

Rotation	Yield	Protein
Corn-Pea-WW	95	13.4
SB-Corn-Pea-WW	80	14.6
SB-Corn-Carinata-WW	60	14.7
WW-WW-Sorg-Corn-Pea	95	13.2
WW-Sorg-Corn-Pea-WW	87	13.4

Field Scale Yield Data

Dakota Lakes Research Farm

- **C – SB rotation (Cover Crops historically increases soybean yield 7.3 bu/a on average vs no CC in this rotation).**
- **Soybean with WW CC 62.9 bu/a. We would have expected around 55.6 bu/a without CC.**

Field Scale Yield Data

Dakota Lakes Research Farm

- **C – C – SB – Wheat - SB rotation**
- **1st year SB yield - NO cover crop = 76.3 bu/ac**
- **2nd SB yield – Cover Crop = 81.2 bu/ac**

Field Scale Yield Data

Dakota Lakes Research Farm

- **Cover crop increased SB yield (7.3 bu/ac), but more importantly crop diversity increased SB yield by 15.9 bu/ac.**

C – SB rotation = 62.9

C – C – SB – Wheat – SB = 78.8 bu/ac

Field Scale Yield Data

Dakota Lakes Research Farm

- **CONTINUOUS CORN**
 - 203 bu/a
- **CORN-SOYBEAN**
 - 217 bu/a
- **C-C-SB-W-SB**
 - 235 Corn

DIVERSITY IMPACT IF 5,000 ACRES

- **CONTINUOUS CORN**
 - 1,015,000 corn, 0 soybean, 0 wheat
- **CORN-SOYBEAN**
 - 542,500 Corn, 157,250, 0 Wheat
- **C-C-SB-W-SB**
 - 470,000 Corn, 157,600, 120,000 Wheat

DIVERSITY IMPACT IF 5,000 ACRES

- **CONTINUOUS CORN**

- 1,015,000 corn, 0 soybean, 0 wheat

- **CORN-SOYBEAN**

- 542,500 Corn, 157,250, 0 Wheat

- **C-C-SB-W-SB**

- 470,000 Corn, 157,600, 120,000 Wheat

- **Does it make sense to trade 72,500 bushels of corn for 120,000 bushels of wheat and 350 bushels of soybean. With less pest issues.**

As citizens of North America 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.

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

ECOSYSTEM DEGRADATION/FOOD INSECURITY

**Never in history has ALL of
mankind KNOWINGLY faced
this type of impending
catastrophe**

**RESEARCH NEEDS TO BE
TRANSFORMATIONAL
AND
TRANSITIONAL
NOT INCREMENTAL**

**Eighty Percent of the total
input costs in agriculture
can be traced directly to
energy at the present time.**

1970

**Average Wheat Price in
1970 was \$1.37/bu.**

**The Average price of a
barrel of oil was \$3.39**

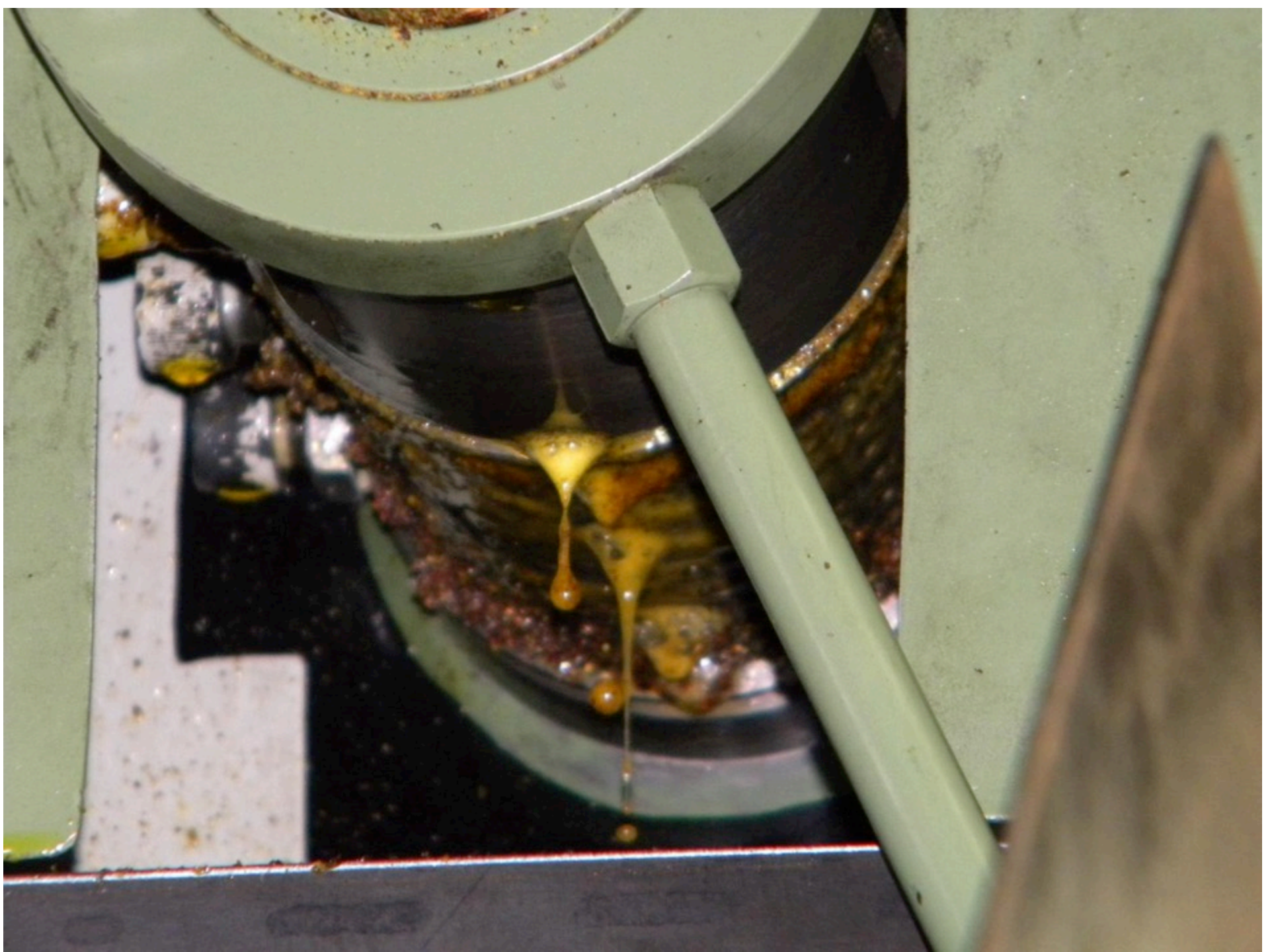
**It takes the energy of 1 gallon
of diesel fuel to manufacture,
transport and apply 5 lbs of N**

**150 lbs of N is equivalent to
30 gallons of Diesel**

**Fossil fuel input in agriculture
120 years ago was essentially
zero**

**In 120 years, it will have to be
zero again.**

**The Dakota Lakes Research
Farm will be fossil fuel
neutral by 2026**



ADDRESS THE PROBLEM

INSTEAD OF

TREATING THE SYMPTOM



**I HAVE LEARNED MORE
FROM OBSERVING
NATURE THAN BY TRYING
TO CHANGING IT.**

**MOTHER NATURE HAS BEEN
MANAGING ECOSYSTEMS BETTER
AND FOR LONGER THAN ANYONE
ELSE.**

WHAT DOES MOTHER DO?

**SHE HARVESTS THE MAXIMUM AMOUNT OF
SUNLIGHT.**

**SHE LEAKS VERY FEW NUTRIENTS
(INCLUDING CARBON DIOXIDE) FROM THE
SYSTEM (RECYCLING)**

WHAT DOES MOTHER DO?

SHE MAKES MAXIMUM USE OF WATER AND NUTRIENTS BY HAVING WEBS OF VAM AND OTHER TRICKS.

SHE USES ANIMALS (BIG AND LITTLE ONES) AS PART OF THE SYSTEM.

Soil Biology

In dry (brittle) climates soil biology slows during times of low soil moisture.

The rumen of grazing animals remains moist continuing biological processes.

Soil Biology

In cold climates soil biology slows during times of low soil temperatures.

The rumen of grazing animals remains warm continuing biological processes.

















Swath Grazing Forage

Winter Wheat stubble that will be seeded to corn in 2017: Oats, Peas, Rapeseed

Field 2-1:	Average
Biomass :	7,700 lb
Protein	18.2%
RFV	121







**40 Million More Cows, More
Goats, More Sheep....**

The world supply of minable phosphorus will be exhausted in less than 120 years.

**Use of perennial
sequences or perennial
cover-crops will probably
be necessary.**

WHAT MOTHER DOES NOT DO?

**SHE DOES NOT DO TILLAGE UNLESS IT IS A
CATASTROPHIC EVENT.**

SHE DOES NOT EXPORT NUTRIENTS.

Commonality Among Tillage Tools

- **All Tillage Tools Destroy Soil Structure.**
- **All tillage tools decrease water infiltration**
- **All tillage tools reduce organic matter**
- **All tillage tools increase weeds.**

**BUREAUCRACIES,
GOVERNMENTS, AND
CORPORATIONS ARE
OPERATED BY PEOPLE WITH
LIMITED TENURE (SHORT-
TERM GOALS)**

**SOCIETY AND
LANDOWNERS/FARMERS
DESERVE TO HAVE LONG-
TERM RESEARCH**

Looking Forward 600 Years

The climate will change but it will still be a continental climate.

Degradation of the ecosystem will have more potential impact.

**Farmers and Ranchers
harvest sunlight, carbon
dioxide, and water to
produce products we can
sell.**

Some of this is human food, we need to be aware of nutrition issues and off-site impacts.

If we want to eat beef, maybe we should concentrate on producing beef instead of corn or barley that feeds beef in feedlots.

PEAK OIL
PEAK PHOSPHOURS

PEAK SOIL

TAKE THE

E

OUT OF

ET

TAKE THE

'T

OUT OF

CAN'T

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

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