# What's on your Soil Health Economic Score Card?

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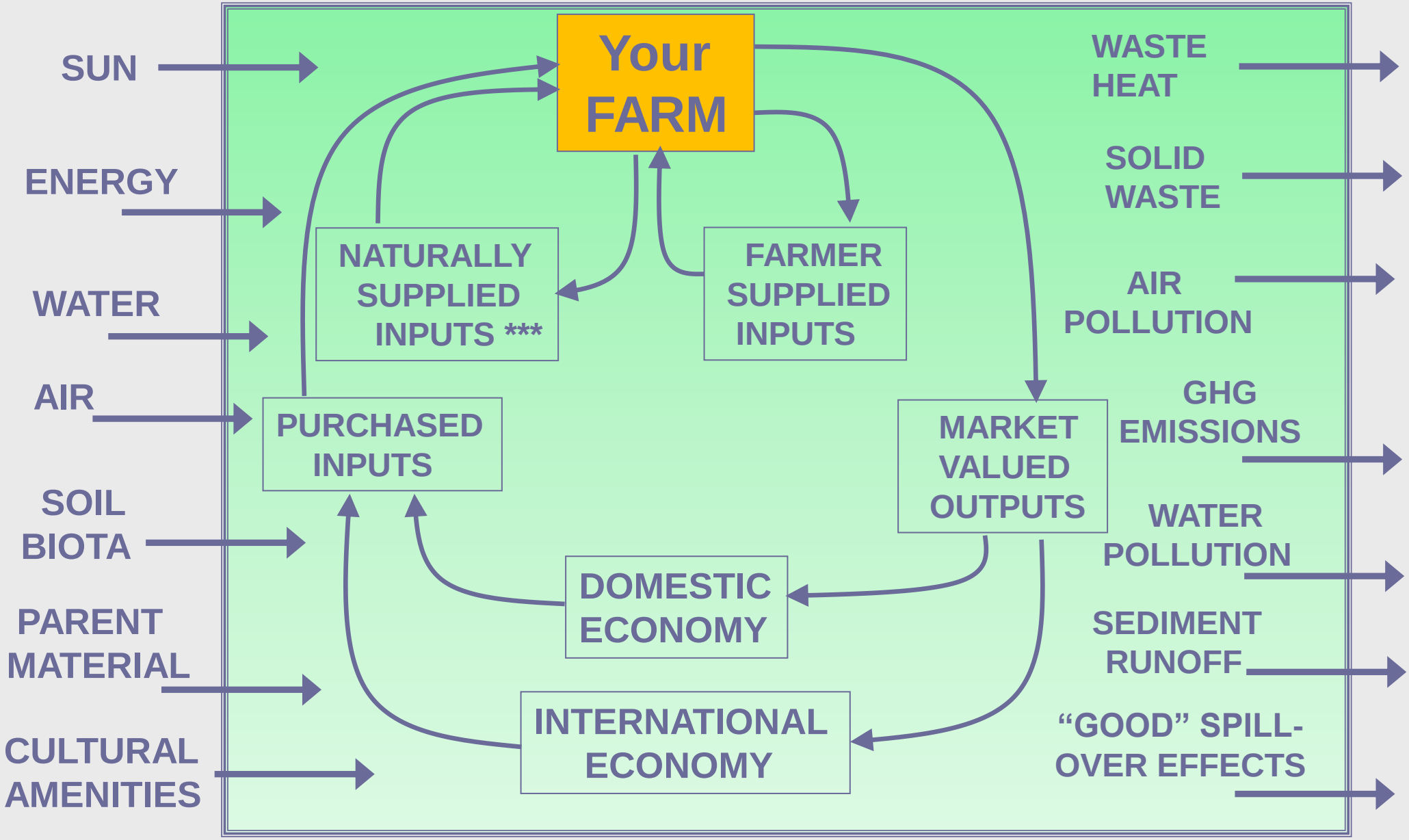
Dr. Felix Spinelli
Retired Senior Economist, NRCS
Purdue Alum

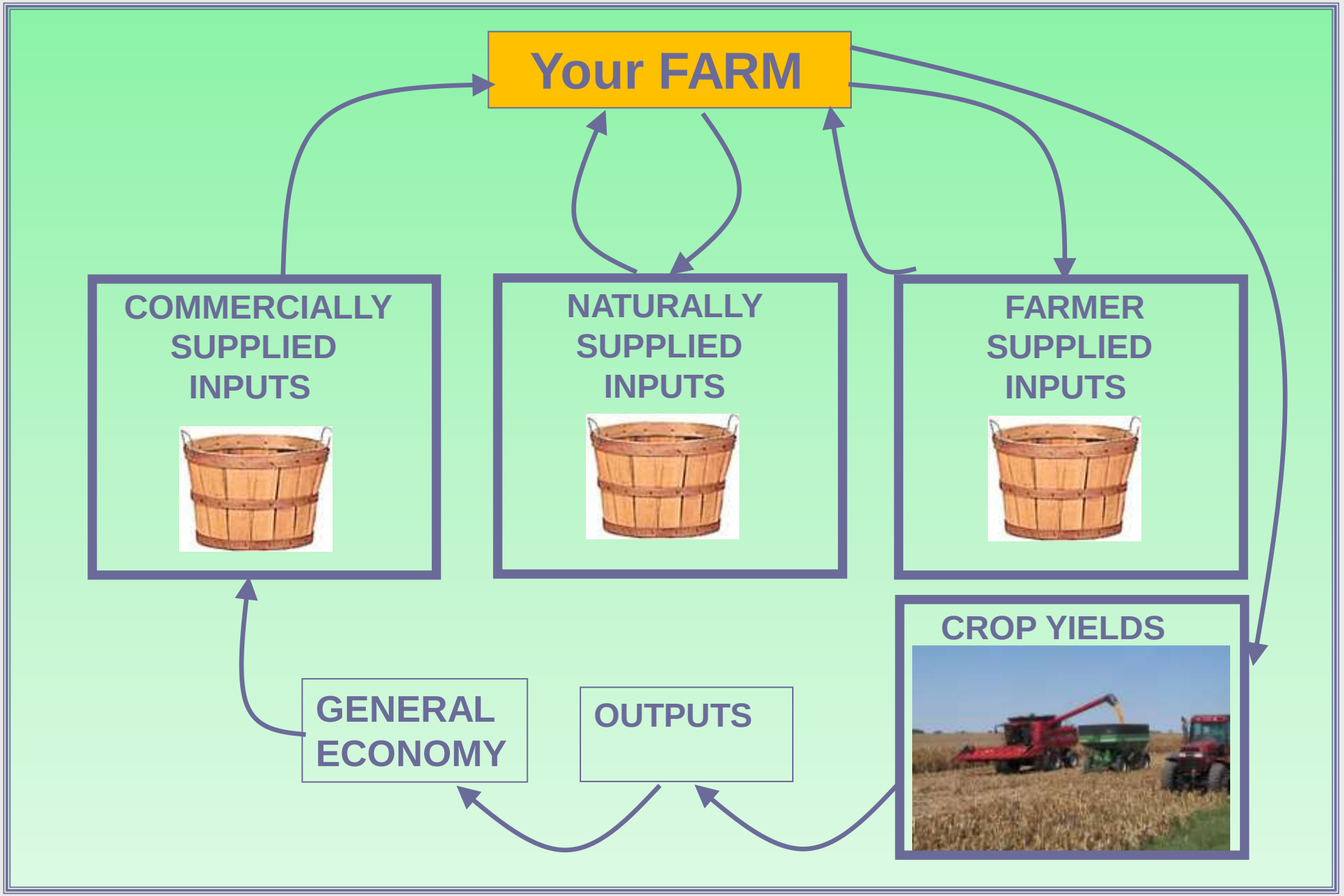
# Outline of Presentation

1. The 30,000 ft. View
2. Looking at the score card in four parts.
3. Applying the score card to your operation.
4. Relationship to agricultural sustainability.
5. Summary/Economic Implications

# 1. The 30,000-Foot View



## 2. Looking at the score card in four parts.




# Commercially Supplied Inputs

| Potential Impact on Commercially Supplied Input Use | Impact | |
|---|---|---|
| | Short Run | Long Run |
| Reduces fuel consumption | ++++ | ++++ |
| Lowers horsepower per acre needs | ++ | ++ |
| Reduces tractor hours per acre | ++++ | ++++ |
| Effectively extends life span of tractors with less use | ++ | ++ |
| Lowers chemical insect pest and weed control costs | + , - | ++ |
| Increases efficiency of applied fertilizer | ++ | ++ |

# Reduces fuel and machinery use

- Savings from avoided tillage operations can be significant: in Indiana (2012), custom rates for plowing to disking vary from $11 to $18 per acre.
- NRCS energy awareness tillage tool supports at least a 2 to 2.5 gallons per acre diesel fuel savings going from conventional to no-till corn production (over a 40% savings). Other studies point to a possible 50 to 65 percent reduction in fuel use in cropping operations.
- Fuel savings mostly resulting from reductions in tillage and cultivation activities associated with no-till.
- Less machinery use time, extended machine life.
- Less soil disturbance, lower horsepower needed.

# Lowers chemical insect pest/ disease and weed control costs

- Some studies suggest that no-till and cover crop systems can reduce herbicide cost by 1/3 and address early weed growth which can reduce yields by 10% in soybeans.
- By not following this system, one sustains lower yields by $50/acre (10%*50 bu/ac*$10/bu) while paying out $7 to $12 more per acre in herbicide cost.
- Reductions in costs associated with insect pest and disease repression vary by type of crop and insect.
- Molds, rusts, and insects of concern vary by site-specific conditions.

# Increases efficiency of applied fertilizer

- Dijkstra (1998) reports that corn and soybean yields have both doubled in twenty years of no-till on his Brazilian farm despite using 30% less fertilizer on corn and 50% less on soybeans.
- We will see related “spill-over effects” on nutrient efficiency brought about by CCS in the next bushel.


# Naturally Supplied Inputs

- This class of costs accrue over time as a result of better “harnessing” the power of natural systems in the soil (micro environment) in the field, across fields, and through time.
- Due mainly to improved soil health (or resiliency) crop yields are made more stable and enhanced chemical /biological processes facilitate nutrient up-take and storage. They also facilitate/reinforce the realization of the gains noted in the other two “bushels”.

# Examples of practices that could fall into Bushel 2 (as well to 1 and 3)

| Physical | Chemical | Biological |
|---|---|---|
| Tillage and Residue Mgt | Integrated Pest Mgt | Cover Crops |
| Controlled Traffic | Low-input or Organic Farming | Conservation Rotations |
| Mulch Application | Nutrient Management | Alley Cropping |
| Strip Tillage | Precision Application | Strip Cropping |

| Potential Impact on Naturally Supplied Input Use | Impact | |
|---|---|---|
| | Short Run | Long Run |
| Increases water holding capacity (WHC) and water use efficiency (WUE) | ++ | ++ |
| Maintains long-term soil productivity | NA | ++++ |
| Enhanced nutrient efficiency and storage in soil profile | ++ | ++++ |

- This “bushel” has specific costs and management demands to build soil resiliency - the core of soil health/quality and landscape systems approach.

# WHC and water use efficiency (WUE)

- Studies suggest that every one-percent increase in soil organic matter (SOM) increases the water holding capacity (WHC) of the soil by an additional one acre-inch of water.
- Increased SOM also increases water infiltration rates and soil water moisture.
- R. Gil (2006) found that increased WHC can translate into greater WUE: he found in Argentina that WUE increased yields (2X) in soybean production under double cropped systems compared with clean fallow.
- Value of increased WHC will depend on level of SOM and value of water. Some have estimated the four-percent increase in SOM can be valued at $48/acre.

# Long-term soil productivity

- No-till systems have shown substantial reductions in soil loss per acre over time.
- Changes in beneficial aspects of changes in physical, biological, and chemical properties take time: greater productivity potential can be viewed as an example of an optimal sustainable yield concept.
- CCS have been shown, over time, to lower pH, enhance Al saturation and increase carbon exchange capacity (CEC); all factors improve productivity.

# Impact on other nutrients and efficiency (1)

- Many past studies and presentations point to the value of SOM in terms of the nutrient content for each percent SOM in the top six inches of topsoil.
- These calculations point to a value of each one-percent SOM at around $650/one percent SOM/acre from a stock of nutrients.
- If even only 1/10 of a percent of SOM can accumulate over a growing season, that could add a $65/acre value to your operation in greater decomposed organic matter in the soil and the impact of nutrient availability due to enhanced physical, chemical, and biological soil properties.

# Impact on other nutrients and efficiency (2)

- Some highlights from the various studies and other sources:
- Increase to 80% to 90% in nitrogen efficiency with no-till and cover crops compared to 30% to 50% with conventional crop practices.
- Increase to 80% to 90% in phosphorus efficiency with no-till and cover crops compared to 50% with conventional crop practices.
- Practicing no-till and maintaining cover crops can also reduce the need to lime many soils. Could translate into lower liming costs by $7 to $11 per acre/year (Hoorman 2010).

# Three cautionary notes

- (1) There may be a need to enhance existing management understanding and skills in crop rotations, residue management;
- (2) there are costs associated with all CCS activities, such as cover crop establishment; and,
- (3) one can expect more emphasis placed on adaptive management practices **.
- This “bushel” can be viewed as finding the optimal sustainable yield within soil classes and physical environment, similar to a longer planning horizon as in grazing or forestry management plans. These outcomes are observed over time through lower realized cost outlays and greater yield stability.


# Farmer Supplied Inputs

- Farmer supplied labor, in most cases, will shift from labor-labor (i.e. less tractor time) to labor-management (i.e. adaptive practices) mainly as a result of reduced soil disturbance activities (i.e. adopting no-till).
- However, two caveats:
- Some increase in management skills in crop rotations, residue management, and related adaptive management practices can be expected and needed.
- Timing of seasonal demands, i.e. spring planting/fertilizer application in fields with cover crops, may be altered.

# The Soil Health Economic Score Card

| Potential Impact on Farmer Supplied Input Use | Impact | |
|---|---|---|
| | Short Run | Long Run |
| Reduces labor requirements | ++++ | ++++ |
| Can present challenges in field operations, due mainly to working with cover crops | + , - | + , - |

# The Bottom Line: Yields, Risk and Profitability

| Potential Impact on Profits and Risk | Impact | |
|---|---|---|
| | Short Run | Long Run |
| Maintains or increases current crop yields | + | ++ |
| More stable yields | - , + | +++ |
| Higher profits (higher yields/lower input use) | - , ++ | ++ |

# Yield Levels

- A Michigan study that found that corn and soybean yields increased by 12% when SOM increased from 3% to 4%. At 50-bushel soybean yields and 170 bushel corn yields, this could translate into a $60/acre increase for soybeans and $102 /acre for corn. If even only 1/10 of a percent of SOM can accumulate over a growing season, annual gains of $6/acre for soybean and $10/acre for corn are possible.
- Dijkstra (1998) reports that corn and soybean yields have both doubled in twenty years of no-till on his Brazilian farm despite using 30% less fertilizer on corn and 50% less on soybeans.

# Yield Variability

- Some Illinois corn data show that only 82 bu/acre yields under conventional tillage were possible with 2.3 in. of rain. No-till systems yielded 42 bushels more; no-till with annual rye grass, 55 bushels more.
- A recent (September 2012) Iowa State study compared labor, input use, yield, and other factors across 2-year conventional corn-soybean, 3-year rotation (corn, soybean, small grain + clover), and a 4-year rotation (corn, soybean, small grain, alfalfa). Results found that more diverse systems had similar or greater yields than conventional rotations despite reductions in agrichemical inputs.

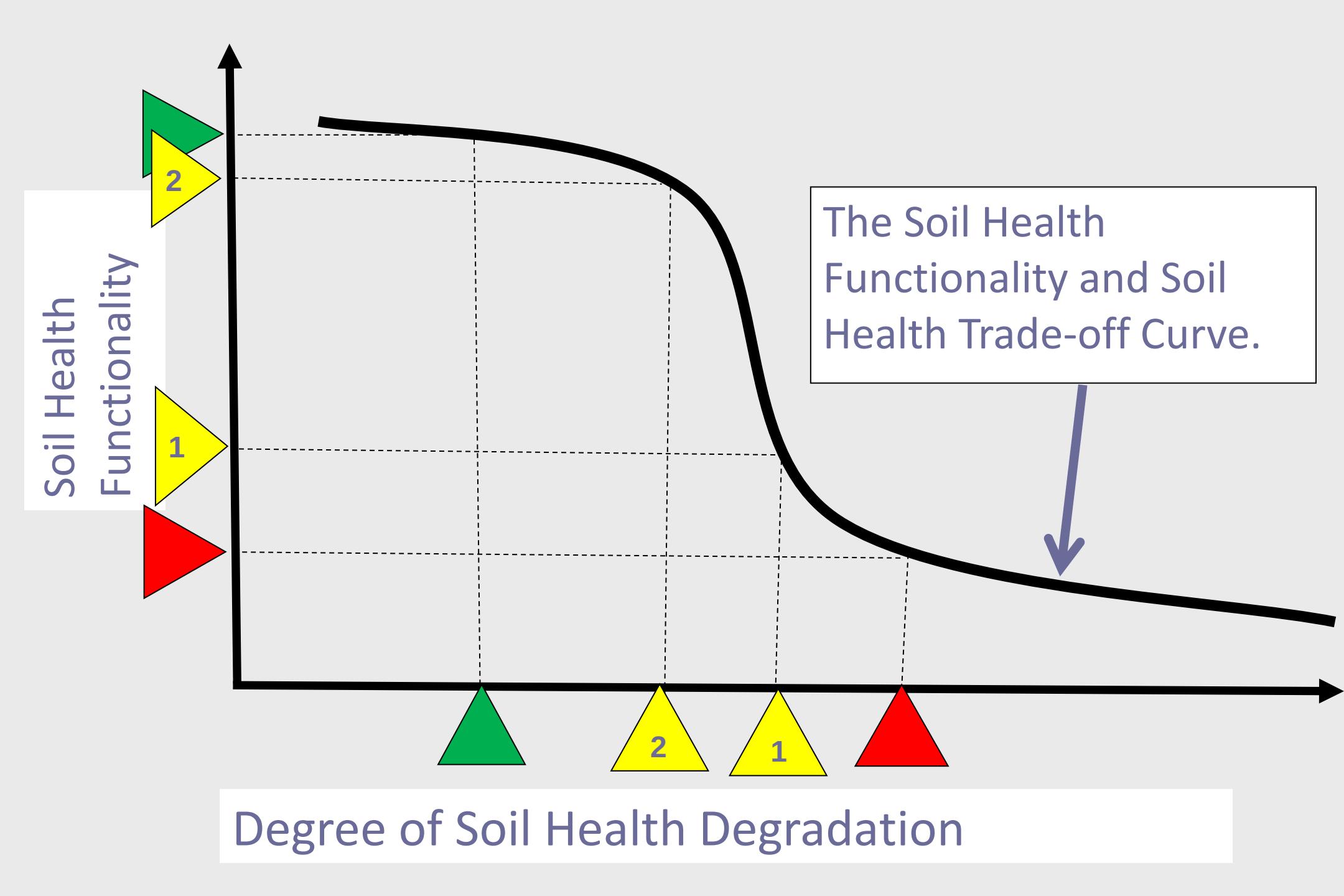
# Short- and Long-term profitability

- We have already touched on long-term productivity, but profitability is another matter.
- The impact of many past reductions in soil productivity have been masked by improvements in crop yields, increased use of inputs, and other technological advances.
- Can we depend on such developments in the future or do we need to concentrate on enhancement of natural capital?

# 3. Applying the score card to your operation.

Long run considerations are fine, but you need to operate and thrive today in a highly competitive world.

**Step 1.** Do you have a window where soil health can be improved in a cost-effective manner while maintaining or improving my yields?  Do actions offer significant gains in soil functionality?


Soil Health Functionality
2
1
The Soil Health Functionality and Soil Health Trade-off Curve.
2
1
Degree of Soil Health Degradation

# **Step 2.** Look at instances where disturbances are occurring.

## A natural or human induced stress

**Examples for agricultural systems include:**

- **Heavy traffic load**
- **Tillage**
- **Fertilizers**
- **Pesticides**
- **Monoculture**
- **Pollutants**
- **Saline irrigation water**
- **Grazing pressure**
- **Weeds**
- **Climate**

# **Step 3.** Develop a conservation plan with a focus on addressing disturbance.

## What are the expected outcomes?

**Will my costs decrease? Will they increase? What about my crop yields?**

- **Commercially supplied Inputs**
- **Naturally supplied inputs**
- **Farmer supplied inputs**
- **Yields**

- **Net impact on input use/demands**
- **Yield effect**
- **Profitability**
- **Sustainability**

# 4. Relationship to agricultural sustainability.

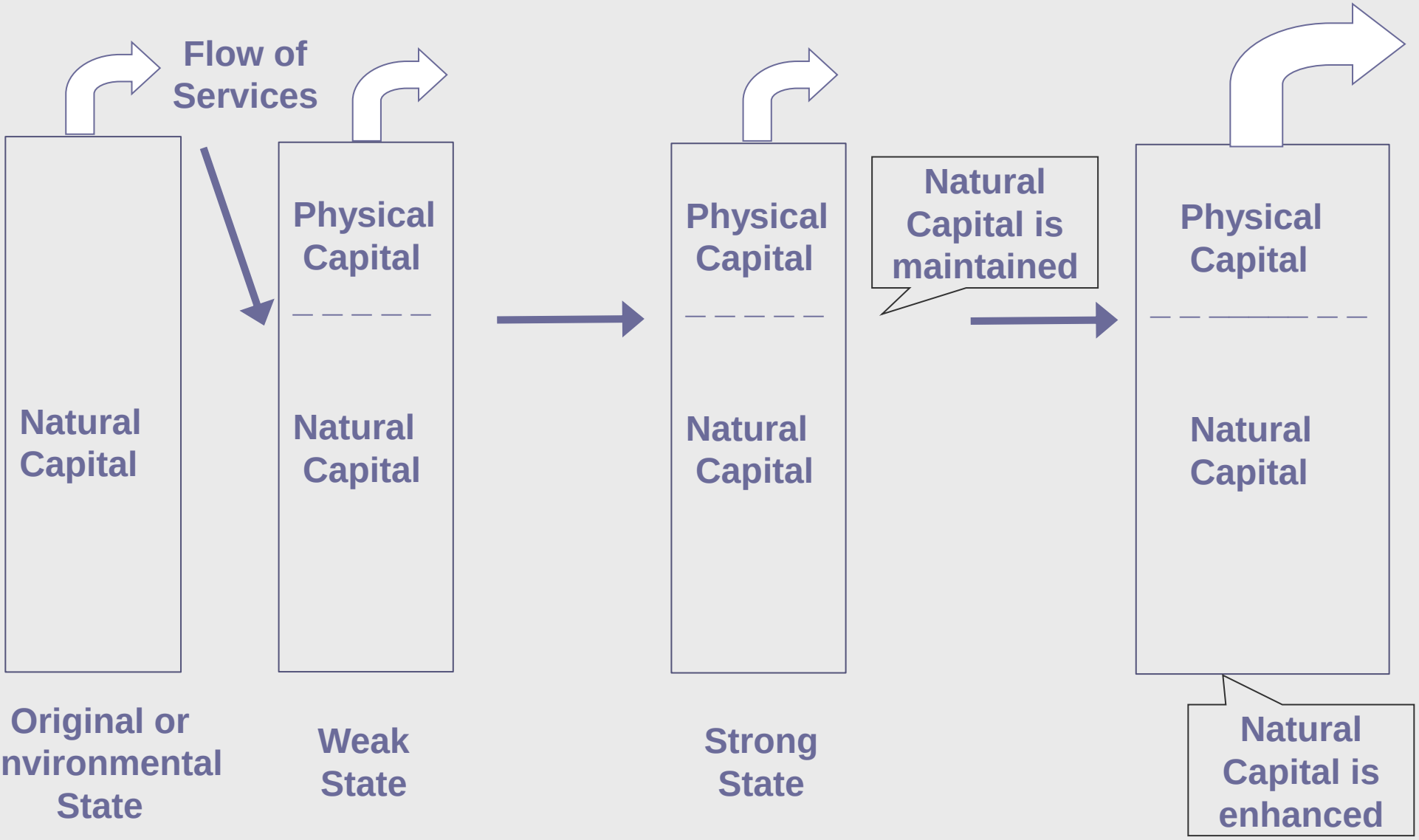
Sustainability can be a vague term.

Soil health concept is similar to our life-time earnings and savings goals: accumulation; preservation; and distribution.

Soil is a fundamental resource that allows crop production (creating income, accumulating savings and building up future agricultural production potential); preserves that ability in an eco-system context; and sustains us.

Think of natural and physical capital replacement.

# Weak, Strong, and Environmental Sustainability



# Soils are the Foundation Resource

**With loss of soil function air and water quality degrade**

# Soil Quality
# as a Component of Sustainability


-after Andrews et al., 1998; 2002

# 5. Summary/Economic Implications

- Results for your economic score card on soil health can be quite favorable depending on:
- Inherent soil quality;
- Current level of soil health and soil function;
- Current type, level, and range of disturbances;
- Willingness to consider greater sustainability through greater soil resiliency by:
  - Reducing physical, chemical & biological disturbances
    - To increase overall function and diversity
    - To increase system stability
    - To optimize cycling of nutrients, water and energy

# Summary (2)

- Most of the impact in the cost categories accrue mainly from the reduction in soil disturbance activities (i.e. adopting no-till), but crop management plays a critical role in crop selection, operation timing, etc.
- Short-run trade-off becomes one of weighing the costs of CCS (i.e. cover crop plantings, shift in labor use) with its benefits, but we know:
- Only some cost and yield impacts are immediate; most are gradual; built up from current “investments” generating long-term benefits over time.

# Summary (3)

- Sustainability and good cropping practices go hand in hand; is a multi-year proposition; its economics must reflect this reality and complexity.
- Economic and social sustainability is based on environmental sustainability – establishes the basis for a prosperous future just as soil health does.
- Implications for economic evaluation: Budgeting needs to done on a long-term basis, say a 10-year planning horizon, to show all the “challenges” and “opportunities” presented on your individual farm.
- This score card might help guide you in that analysis.

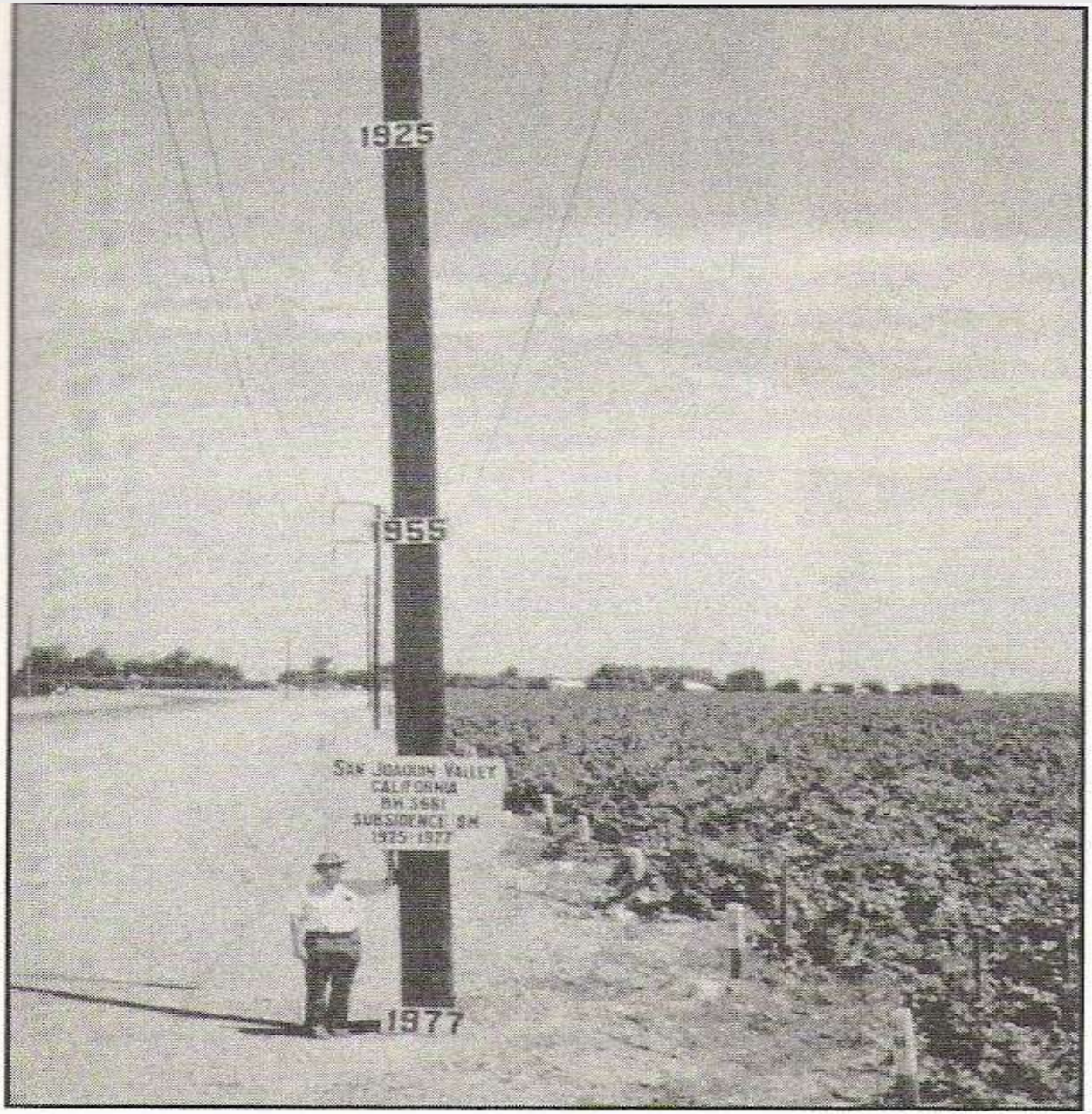



FIGURE 2.3. Land subsidence in the San Joaquin Valley of California. Signs on pole show approximate altitudes of land surface in 1925, 1955, and 1977. Photograph courtesy of the U.S. Geological Survey.