7 pts 1. A producer can monitor input use efficiency by following the cost of production per bushel. Maximum economic yield (maximum profit) is associated with the position where cost per bushel is minimized. A producer is justified in adding further inputs as long as the cost per bushel is continuing downward. The maximum profit position is attained when inputs are added up to the point where marginal cost equals marginal revenue (the last dollar of input cost returns only one dollar in additional revenue).

7 pts 2. Yes. Over the long run, a producer who is watching their input costs as noted in question 1 above, will be adding optimal input levels and avoiding excessive input levels or abusive practices which may prove harmful to the environment or to the long term productive potential of the soil. In addition, effective management of productive fields leaves other, less productive areas out of production and in alternative uses for which they are better suited (e.g. pasture, wildlife refuge, etc.). Example: efficient utilization of applied N fertilizer (as influenced by the timing and rate of application) also means low levels of nitrate leaching into the groundwater. In addition, other less productive acres which would require greater inputs per bushel produced, may then be left out of production.

5 pts. 3. Any interaction in which response to one input is aided by the addition of sufficient levels of another input.

Examples:

a) Nitrogen response at increasing corn population levels.

b) Potassium response when N and P levels are sufficient.

c) Soybean narrow row response in yield when adequate weed control is accomplished and lodging resistance is obtained through variety selection.

d) Planting date response when soil N, P, and K levels are sufficient for corn.

e) Corn plant population response when irrigation is added.
5 pts 4. A passive symptom is one in which the cause does not involve participation by the plant.

Examples: Hail damage removes leaf tissue.
Insect feeding removes silk tissue from corn ears.

An active symptom involves the plant in symptom development.

Examples: Tabled roots form as soil compaction presents resistance to penetration by roots.
Corn brace roots grow together in response to the application of a growth regulating herbicide.

8 pts 5. **GPS** is an acronym for "Global Position Systems" and commonly refers to the use of satellites and differential correction using signals emanating from transmitting towers whose global position and altitude are known.

**GIS** is an acronym for "Geographic Information Systems" and refers to the acquisition and spatial mapping of information referenced to accurate global position.

**VRT** is an acronym for "Variable Rate Technology" and refers to the application of variable rates of a crop input as determined by accurately-mapped spatial data (such as change in soil type within a field).

**Example:** GPS may be used to determine the position of a combine as it moves through a field. GIS could include the monitoring and mapping of yield data relative to discrete positions within the field. VRT could be used to vary the amount of N applied site-specifically within the field to reflect differing historical yield levels.

4 pts 6. a) **Soil type** (as denoted on soils maps and visually by color, texture, slope, drainage).

**Prior management.** Records are used to indicate prior management differences within a field. These might include differences in performance such as are represented in a yield map or differences in previously imposed management such as prior ownership, crop rotation, supplemental drainage, etc.

Once a field's yield and soil test level histories are established, areas of similarly productive soils with a history of equivalent soil test levels and yields can be consolidated for representative sampling as units).
4 pts  b) Sample to a depth of 8 inches to determine soil P and K levels for routine recommendations of P and K for corn and soybean crops.

3 pts  7.  a) 15 ppm

2 pts.  b) 30 ppm

4 pts  c) \((15 \text{ ppm} - 12 \text{ ppm}) \times 5\) = 15 pounds P\textsubscript{205} / acre

3 pts  8.  a) \(75 + (2.5 \times 16) = 75 + 40 = 115 \text{ ppm}\)

2 pts.  b) 145 ppm

4 pts  c) \((115 - 80) \times [1 + (0.05 \times 16)] = (35) \times 1.8 = 63 \text{ pounds K}_{20} / \text{ acre}\)

5 pts  9.  a) Shallow rooting and poor root uptake of mineral nutrition

b) Increased soil compaction potential

c) Delayed planting

d) Delayed harvest

e) Late-season drought stress

f) Non-uniform herbicide incorporation

g) Potential delay in field access for post-emergence herbicide application

h) Greater N losses to denitrification

4 pts  10. The line transect method measures percent surface cover (by residue).

The measurement is conducted by observing the percent of regularly spaced points (e.g. the foot interval marks on a measuring tape or evenly spaced knots on a knotted rope) which are in direct visual contact with surface residue on a line laid on the soil surface at a 45 degree angle to the previous crop's row direction.

4 pts.  11.  a) Greater surface residue improves infiltration by serving as a barrier to runoff and thereby lessens soil erosion.

(Greater surface residue also breaks the impact of raindrops, thereby protecting against the dislodgment of soil particles and lessening soil erosion potential.)
b) **Improved soil structure** is preserved in a no-till system as there is no plow pan (compacted layer at plow depth) established and the structure of undisturbed soil improves over time (e.g. root growth and decomposition, soil shrink/swell associated with soil wetting and drying, and earthworm activity). Improved soil structure enhances infiltration and thereby lessens.

10 pts 12. a) No-till systems will typically demonstrate **higher early-season bulk density, lower temperature, and higher moisture** near the surface vs. a conventionally-tilled system. All of these factors result in less total root growth and a more shallow placement of root growth in the no-till system.

b) No-till systems will typically demonstrate higher bulk density since pre-plant tillage lessens bulk density for the first few weeks of the season.

Lower temperature results in no-till systems when an **insulating blanket of residue** remains which also reflects warming sunlight.

Higher surface moisture is preserved early in a no-till system as there is **less evaporative loss from cool soils** under residue. Also, higher bulk density slows evaporation from sin no till systems. All of these factors result in less total root growth and a more shallow placement of root growth in the no-till system.

10 pts 13. Latitude, previous crop residue, and soil drainage, all influence soil temperature which is critical in determining early season Corn crop growth rate. Any one or combination of these which results in cool conditions would slow growth and lower yield potential.

**Latitude** has direct influence as Northern locations have an abbreviated season including more persistent cool conditions early during crop establishment.

**Previous Crop species** (e.g. Soybean vs. Corn and Wheat: less mass and fragile vs. massive and non fragile or less massive and non-fragile) as well as previous crop yield level (e.g. 185 Bu/Acre Corn vs. 85 Bu/ Acre Corn) directly affect the amount of surface residue present as the subsequent growing season begins. Heavy residue cover;
a) Reflects away incoming long wave (infrared) radiation which warms the soil
b) Serves as an insulating blanket which slows soil drying and warming
c) Slows runoff which produces a more moist and therefore cool soil

**Soil Drainage** influences warming directly as wet soils first require incoming light (long wave portion) to evaporate the moisture and then to warm the soil. Drier soils promote more rapid crop establishment as less heat is used to evaporate soil moisture and more is used to warm the soil.

Interactions produce a range of crop establishment rates and thereby determine how well adapted a tillage system is going to be in a given environment.

Example: No-till Corn can be more effectively produced on a northern poorly drained soil when rotated with soybean (less massive and fragile reside) and where the row environment is tilled an cleared of surface residue.

4 pts 14.a) Reduced yield  
   b) Decreased height  
   c) Delayed maturity  
   d) Tabled (horizontal) roots  
   e) Visible nutrient deficiency symptoms  
   f) Heightened drought stress  
   g) Increased sensitivity to herbicide injury  
   h) Slowed infiltration of water (surface ponding, evidence of poor drainage such as mottled color or slow crop residue decomposition)  
   i) High bulk density as reflected by resistance to soil probe or knife  
   j) Surface crusting indicates shallow compaction resulting from heavy rainfall

5 pts 15. A soil "mottled" in the top 18 inches of its profile has both oxidized (rust-colored) iron and reduced (gray-colored) iron present. The gray (reduced) iron is evidence of prolonged water-logged conditions. This appearance in the top 13 to 18 inches indicates poor drainage critically-high in the root zone. Poor drainage is a likely restriction on yield in that environment.
5 pts BONUS Economic goals by definition are intended to optimize economic return. As such these goals factor in the potential for other crop system variables such as climate, weed control, insect pest pressure, etc. to be more limiting to yield than is soil fertility in a given year.