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).

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.

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.

A primary symptom is directly related (in appearance) to the cause.

Example: Tabled roots are a primary symptom of soil compaction
A secondary symptom is indirectly related (in appearance) to the primary cause.

Example: Purple leaves on a young corn plant could be a primary symptom indicative of soil Phosphorous deficiency. However, this would be a secondary symptom where root growth has been restricted by soil
compaction (the Phosphorous deficiency indicated by purple leaves is really a reflection of poor root access to soil phosphorous). Tabled roots would be the primary symptom of soil compaction.

6 pts 5. 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 prior subdivision, crop rotation, yield level, etc.

Once a field's soils map, yield map, and soil test map are established, similarly productive areas with a history of equivalent soil test levels and yields can be consolidated for representative sampling as units.

4 pts. b) Soils should be sampled to a depth of 8 inches for routine P and K soil test levels. Split samples (i.e. top 4 inches vs. bottom 4 inches may be collected as needed to follow up on surface pH or other stratification issues in no-till production systems.

4 pts 6. a) 15 ppm

4 pts b) \( (15 \text{ ppm} - 11 \text{ ppm}) \times 5 = 20 \text{ pounds P}_2\text{O}_5 / \text{acre} \)

4 pts 7. a) \( 75 + (2.5 \times 18) = 75 + 45 = 120 \text{ ppm} \)

4 pts b) \( (120 - 100) \times [1 + (0.05 \times 18)] = (20) \times 1.9 = 38 \text{ pounds K}_2\text{O} / \text{acre} \)

7 pts 8. 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.

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
10. **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.

11. No-till systems will typically demonstrate higher bulk density (initial tillage lessens bulk density for the first few weeks of the season), lower temperature (insulating blanket of residue, residue reflects warming sunlight away), and higher moisture (less evaporative loss under residue - also cooler when damp) near the surface (where young roots are forming) vs. a conventionally-tilled system.

Because of these prevailing conditions, no-till systems generally produce less total root growth and a more shallow placement of root growth when compared with a conventional tillage/planting system.

12. All are inter-related as they influence soil temperature and thereby early season crop growth. Any factor which results in low soil temperature during germination and establishment can result in slow crop development and a reduction in crop yield potential. Such factors would include: heavy crop residue (e.g. corn), poor drainage, nearly level soils, and location at northern latitudes. Combinations of these factors can determine the fit or adaptation of a tillage system in a given environment (e.g. no-till is poorly adapted to poorly-drained soils in continuous corn at a northern location).

13. 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, strain
gauge or a knife

j) Surface crusting indicates shallow compaction resulting from heavy
rainfall

6 pts 14. a) Cultural Control: Example - Row Width (narrow rows mean more rapid
leaf canopy closure and greater control of annual weeds if they are
suppressed until the canopy can close).

b) Mechanical: Example - Row Cultivation (effective against annual
weeds prior to leaf canopy closure).

The combination of Cultural and Mechanical weed control strategies
along with Chemical control strategies (e.g. Post Emergence herbicide
application as needed) leads to the greatest cost effectiveness in weed control
for crop production systems.

4 pts 15. a) PPI herbicide incorporation is to be uniform in the top 1 to 3 inches of the
soil.

b) Herbicide incorporation is generally one-half to two-thirds of the depth of
tillage with a tandem disc (e.g. tillage at 4 inch depth results in herbicide
incorporation to a depth of 2 to 2.8 inches).

5 pts BONUS
Bray P1 Maintenance Plateau = 15 ppm wide.
Exchangeable K Maintenance Plateau = 30 ppm wide.
Bray P1 Drawdown Plateau = 10 ppm wide.
Exchangeable K Drawdown Plateau = 20 ppm wide.