4. Suppose that you have just started a summer internship working for a cooperative extension service, where you will collect soil samples, conduct laboratory and field tests, and make recommendations on soil conservation and agricultural practices.

   (a) Identify and describe one chemical soil test and one physical soil test that could be performed and explain how the results of these tests will allow the cooperative extension service to make specific recommendations for sustainable agriculture.

   (b) Explain one advantage and one disadvantage to using inorganic commercial fertilizers.

   (c) Describe TWO soil conservation practices that are designed to decrease soil erosion.

   (d) Identify one biome that is characterized by soil that is rich in humus. Describe how humus originated in the soils of this biome and TWO ways that humus improves soil conditions for plant growth.

END OF EXAMINATION

Question 4

(a) Identify and describe one chemical soil test and one physical soil test that could be performed and explain how the results of these tests will allow the cooperative extension service to make specific recommendations for sustainable agriculture.

(3 points)

1 point for identifying and describing a chemical soil test.

CHEMICAL TESTS:

- pH -- Measures the acidity or alkalinity or hydrogen ion concentration
- Salinity (salinization) -- Measures salt content of soil
- Organic content (humus) -- Analysis that indicates organic content
- Ion exchange capacity -- Measures ability to absorb and release cations, especially plant nutrients

On the following chemical tests the name is a sufficient descriptor of the test. (Symbols for the elements are acceptable.)

- ♦ Major elements
- ♦ Measures the amount of nitrogen, phosphorus, potassium, or sulfur in any form
- ♦ Trace elements
- ♦ Measures the amount of iron, cobalt, boron, calcium, magnesium, manganese, selenium, aluminum, mercury, etc.

1 point for identifying and describing a physical soil test.

PHYSICAL TESTS (A description of how the test is conducted is sufficient for identification of the test):

Soil Texture Ribbon test (ped test) Soil sieve test (nested sieves) Composition/make-up Sedimentation Hydrometer method Particle-size analysis	Percent/proportion of sand, silt, and clay-sized particles that make up the solid inorganic phase of soil
Water-holding capacity Porosity	Amount of water the soil can hold due to amount of pore or air space
Moisture content	Amount of water in the soil at a given time
Particle density or bulk density	How much a particular soil weighs per unit volume
Soil Structure (friability) Colloids and aggregates	How soil is held together forming small clumps of various types

Question 4 (cont'd.)

PHYSICAL TESTS (continued):

Percolation rate Soil drainage Infiltration Permeability	Speed of infiltration of water into soil
Capillarity of soil	Movement of water against the pull of gravity
Soil compaction	Degree to which soil resists pressure from wind, water, and machinery
Soil profile analysis	Determines the nature of the soil horizons (structure, depth, color – does not indicate texture)
Color	Indicates soil components or properties (e.g., iron, amount of humus, level of water table)

1 point for making specific recommendations for sustainable agriculture for either a physical or a chemical test.

APPLICATION OF TEST RESULTS TO SUSTAINABLE AGRICULTURE FROM COOPERATIVE EXTENSION SERVICE (must relate to one of the previous tests):

- Indicating suitable crops and cultivation practices
- Adding soil additives such as sand, clay, or humus to affect ion-exchange capacity as well as moisture content and water-holding capacity
- Applying lime for acid soil; applying sulfur for alkaline (basic) soil to neutralize
- Planting leguminous crops to increase nitrogen, or apply manure
- Liming or applying bone meal to improve phosphorus
- Burning crop residue to increase potassium
- Examining irrigation practices to combat salinity, erosion, and excessive water usage
- Adding lime or limestone to increase calcium and magnesium
- Applying gypsum or green sand to increase the sulfur content and water-holding capacity
- Adding organic matter (animal manure, green manure, or crop residues) to improve many of the soil's physical and chemical properties
- Increasing soil fertility by using other practices such as grassed waterways and no-till crop rotation
- Reducing the use of inorganic fertilizers
- Decreasing agricultural soil erosion by using Best Management Practices (BMP)

Question 4 (cont'd.)

(b) Explain one advantage and one disadvantage to using inorganic commercial fertilizers.

(2 points)

1 point for advantage
1 point for disadvantage

ADVANTAGES	DISADVANTAGES
Easily obtained, transported, stored, and applied	Adds no humus or organic matter to soil/decreases water- holding capacity
If both have to be purchased, they are more economical than organic fertilizers	Lowers oxygen content of soil and keeps nutrients from being taken up as efficiently
Nutrients are concentrated and only small amounts must be applied	Does not completely supply all micronutrients
Computerized applications can release specific minerals needed by plants	Requires large amounts of energy for production, transportation, and application
Nutrients are immediately available to the crop	Releases nitrous oxide (N_2O) a greenhouse gas
Increase soil fertility	Over-application may harm plant
Have guaranteed/specific nutrient analysis	Aquatic pollution resulting from runoff in surface or groundwater is detrimental to humans or ecosystems
Increases crop yield	Can be very expensive to obtain and apply as compared to unpurchased organic fertilizer (if this is available)
Speeds up the growing process	

(c) Describe two soil conservation practices that are designed to decrease soil erosion.

(2 points)

1 point each for identification of agricultural conservation practice and explanation of how it decreases soil erosion (practice must be linked to how it decreases erosion). If student describes three or more practices, only the first two will be scored.

Question 4 (cont'd.)

PRACTICE	HOW IT DECREASES EROSION
Conservation tillage	Disturb the soil as little as possible when planting crops
No-till	Inject seeds into slits or holes in the soil by machine – minimum soil disturbance
Minimum tillage/reduced tillage	Decrease the number of times the soil is disturbed – maintains crop residue
Terracing or division terrace	Shape land to create level shelves of earth to decrease soil and water runoff

PRACTICE	HOW IT DECREASES EROSION
Contour farming or planting	Plow in rows with the contour of gently sloped land to slow water runoff
Strip cropping/intercropping/polyculture	Plant different crops in alternating strips to reduce water runoff and wind erosion
Alley cropping /agroforestry	Plant crops in strips between trees and shrubs to reduce wind and water erosion
Windbreaks or shelterbelts of trees	Reduce wind erosion
Rotation of crops with a ground cover	Plant back-to-back (multicropping) to prevent erosion
Grassed waterways	Decreases gully erosion
Plant cover crops/native grasses	Prevents erosion when main crops cannot be planted
Protect riparian zones (buffer strips)	Prevents soil erosion into rivers and streams
Mulching	Prevents raindrop impact and runoff
Land leveling	Recontour land in order to prevent soil loss
Leave land fallow with cover crop	Leave land undisturbed or ungrazed for a period of time
Gully reclamation (arroyo)	Reclaim steep slopes from gully erosion
Modified irrigation methods	Decreases water's ability to act as an erosion agent (run-off)
Sustainable grazing	Regulates stocking rates to sustain cover
Land Classification (NRCS; SCS)	Decreases utilization of easily erodible marginal land

Question 4 (cont'd.)

(d) Identify one biome that is characterized by soil that is rich in humus. Describe how humus originated in the soils of this biome, and TWO ways that humus improves soil conditions for plant growth.

(4 points, maximum 3 points for this part)

1 point for correctly naming biome.
1 point for explaining how the humus originated in that biome.
2 points for explaining how humus improves soil conditions (1 point for each explanation).

BIOME	HOW HUMUS ORIGINATED
Deciduous forest: • tropical/seasonal (not tropical rainforest) • temperate	Plant and animal materials decompose
Grasslands (temperate and tropical) • prairie • savannah • steppes • pampas	Grasses form a large amount of organic matter that decomposes
Temperate rainforest	Needles/leaves decompose to form a layer of humus

How humus improves soil conditions:

- Provides nutrients/fertility for plants and soil organisms
- Helps topsoil hold water (water-holding capacity)
- Makes root growth easier
- Improves soil aeration
- Improves habitats for soil organisms
- Improves buffering capacity, which stabilizes pH
- Promotes development of mycorrhizae
- Prevents erosion
- Improves soil structure
- Improves porosity