

Role of Agricultural Geology in Sustainable Soil and Crop Management

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Abstract: Agricultural Geology examines how geological materials, processes, and landforms influence soil formation, fertility, and agricultural productivity. By studying parent rocks, minerals, weathering, groundwater, and landscape stability, it provides essential insights for sustainable farming. This field connects geology with agriculture to determine soil suitability, manage water resources, identify erosion-prone areas, and promote eco-friendly soil enrichment. Agricultural Geology supports long-term agricultural planning, soil conservation, and sustainable food production.

Keywords: *Agricultural geology; Soil formation; Parent rock; Groundwater; Fertility; Soil conservation.*

Introduction to Agricultural Geology

Agricultural Geology is an interdisciplinary field that links geological science with agricultural development. It focuses on understanding how geological processes—such as rock weathering, erosion, sedimentation, and groundwater movement—shape the physical and chemical properties of soils. This knowledge helps explain regional variations in soil fertility and agricultural potential. Since soil is the foundation of agriculture, understanding its geological origins is crucial for improving crop productivity and promoting sustainable land management practices.

Role of Parent Material in Soil Formation

Parent rock is one of the most influential factors governing soil characteristics. Rocks weather under physical, chemical, and biological processes to form soils with unique textures, nutrient compositions, and structures. For example, basalt produces nutrient-rich clayey soils, whereas granite yields coarse, sandy soils with lower nutrient availability. The mineral composition of parent materials controls soil pH, cation exchange capacity, drainage, and the availability of essential nutrients such as calcium, potassium, magnesium, and iron. This relationship helps farmers select suitable crops and understand soil limitations.

Geological Processes and Soil Fertility

Geological processes continuously influence soil fertility and agricultural productivity. Chemical weathering releases minerals essential for plant growth, while erosion and deposition create fertile river valleys and alluvial plains. Volcanic activity contributes mineral-rich ash, improving soil structure and nutrient content. Understanding these processes helps identify fertile regions, degraded lands, and areas that require soil amendment. Geological knowledge also assists in assessing nutrient depletion and recommending natural fertilizers such as rock phosphate, gypsum, and limestone.

Groundwater, Landforms, and Agricultural Suitability

Groundwater availability is directly influenced by geological formations, aquifer characteristics, and subsurface structures. Agricultural Geology plays a key role in identifying reliable groundwater sources for irrigation, determining recharge zones, and assessing water quality. Likewise, landforms—such as terraces, valleys, plains, and slopes—affect soil depth, moisture retention, erosion risk, and land-use suitability. Mapping geological and geomorphological features help farmers, planners, and policymakers make informed decisions about irrigation, crop selection, and agricultural land expansion.

Soil Conservation and Sustainable Farming

Agricultural Geology contributes significantly to soil conservation by identifying regions prone to landslides, soil erosion, and sedimentation. Understanding slope stability, drainage patterns, and sediment transport enables the design of effective conservation practices such as terracing, contour farming, retaining structures, and controlled grazing. Geological knowledge also supports sustainable agriculture by encouraging the use of natural minerals for soil enrichment, reducing

reliance on chemical fertilizers, and promoting eco-friendly farming techniques.

Conclusion

Agricultural Geology offers a scientific foundation for efficient soil and water resource management. By integrating geological knowledge into agricultural planning, it enhances soil health, improves crop productivity, and supports long-term environmental sustainability. This field ensures that agricultural development is both productive and ecologically balanced, benefiting present and future generations.