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SOIL CONSERVATION AS A CONCEPT TO IMPROVE KUWAIT ENVIRONMENT

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Kuwait's soil is very fragile, composed mostly of sand, not fully developed, and the top horizon is a very thin layer that is easily eroded with slight movement of wind. People who inhabited desert areas over the years understood the concept of soil conservation and maintained their own environment. Native desert plants have been crucial for the survival and sustenance of mankind through animal grazing and range land utilization. Oil discovery brought a significant amount of resources to the Gulf region. The population of Kuwait multiplied over the years, and machinery and vehicles increased, resulting a high demand for agricultural commodities and construction materials for new cities. Natural resources were over-exploited. Thus, the environmental balance between people and their surroundings in Kuwait deteriorated, mostly due to human activities. Increased activities and development work adversely affected soil properties of Kuwait during the last 40 years. Top horizons of most soils of Kuwait were eroded, native plants disappeared, sandstorms extraordinarily increased, and the surrounding environment significantly changed. Soil conservation is an old concept started in the western part of the US to combat and decrease human activities and to save the natural environment for better living and improved environmental conditions. This paper addresses the soil conservation approach to alleviate environmental constraints.

Keywords: Soil conservation; Environment; Desert plants; Range land; Kuwait and sandstorms

INTRODUCTION

The decade of the 1960s produced the term "green revolution" and this led to the evolution of different farming systems in the 1970s. In contrast the decade of the 1990s will be remembered as an era of "sustainable agriculture". The emphasis on agricultural sustainability emanates from the increasing awareness about the finite and nonrenewable nature of arable land resources, rapidly deteriorating quality of our environment, greenhouse effects, widespread soil degradation, need for preserving soil resources for long-term use rather than over-exploitation for short-term gains, and excessive reliance on nonrenewable resources of our agricultural systems. The ever-increasing pressure on natural resources has led to progressive desertification. Until recently, desertification was considered to be the primary result of prolonged drought, but it has now become apparent that it is the direct result of human mismanagement of land resources through practices such as over-grazing, tree-cutting, improper tillage practices, poor water management, and over-exploitation of productive capacity of the soils leading

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to degradation. This has heightened the concerns about proper management of natural resources, particularly soil and water, all over the world.

The climate of Kuwait makes the development of a viable agricultural production sector relatively more expensive and difficult. Kuwait is characterized by its very hot dry summers and cool to mild rainy winters. The average temperature ranges from 45°C in July–August to 13°C in January. The absolute minimum and maximum temperatures are around 49°C in July and as low as −4°C in January. The rainfall pattern of Kuwait follows that of arid climates, where rainfall is both scanty and inconsistent to create a reliable source of irrigation water. The country receives a mean annual average rainfall of approximately 120 mm mostly between November to May, although occasional showers may fall in October and less commonly in September. Because of extremely high temperatures and strong prevailing winds during summer, the mean evapotranspiration rates can reach as high as 25 mm/d. The daily mean evapotranspiration rates during winter drops to around 5 mm. Sandstorms are of common occurrence during spring, summer and fall. The high velocity winds are usually laden with sand and salt particles, especially in the coastal urban areas (Halwagy and Halwagy, 1974).

Additionally, Kuwait's soils are developed mostly from whitish calcareous sandstone or gravely sand that is cemented and consolidated with lime. That is why the top horizon of soil has a sandy or sandy loam texture and is of dominantly single grain structure. Low levels of organic matter, low nutrient and water retention capacity, higher levels of salts, and poor soil forming reaction to alter the parent material also characterize it. Hardpans are of frequent occurrence, and sometimes outcrop on the surface. The groundwater is also limited in quantity and is highly brackish in quality.

Soil Conservation: Principles and Concept

Arid and semi-arid lands account for nearly one-third of the total surface area of the earth. The increased pressure on already limited natural resources in these countries has led to desertification of some areas. Desertification is occasionally due to prolonged drought or decrease in precipitation, but the basic processes are related to human misuse or mismanagement of arable land resources. Dregne (1989) suggests that ignorance; poverty and greed are the indirect causes of desertification. The balance between the natural demand that a community of plants or animals makes on the environment and the ability of nature to fulfill those demands is not in static equilibrium. Mismanagement, neglect and exploitation have ruined the fragile resource base and have become a threat to human survival. The principal processes contributing to desertification are: (1) degradation of vegetative cover; (2) water and wind erosion; (3) salanization/alkanization; (4) soil crusting and compaction; (5) depletion of soil organic matter and nutrient imbalance; (6) anaerobiosis; and (7) excessive toxic substances in the soil. This simply means that desertification is another word for land degradation.

In addition to direct economic consequences related to productivity, soil degradation has severe environmental impact (Lal and Pierce, 1991; Tweeten, 1995). The widespread concern about global environmental change is linked to severe problems of soil degradation. It affects the global climates both directly (rapid increase in atmospheric carbon dioxide due to faster decomposition of organic matter) and indirectly (by reducing agricultural productivity and increasing the need for bringing more area under cultivation through deforestation, burning and cultivation of marginal lands). Scientists have recognized the dangers of global warming caused by the impact of the emission of carbon dioxide and other greenhouse gases (carbon monoxide, methane and nitrogen oxide). Soil is, therefore, a potential sink or source of carbon dioxide depending on the management system adopted. Therefore, controlling the rate of land degradation and restoring the biological productivity of degraded ecosystems may be the crucial factor in reversing the trend of greenhouse effects.

Continuous intensive farming activities in a fragile ecosystem necessitated by high demographic pressure, and accelerated soil erosion may degrade soil's life-supporting abilities irretrievably. There is an urgent need to address some of these problems. A sustainable soil and water management system should be developed; not only to curtail further degradation, but also to restore the productivity of lands already degraded due to human impact. In this context, conservation is a concept aimed at prolonging the useful life of the natural resources. The major emphasis is on the development of means and ways to satisfy human aesthetic and physical needs from land without destroying its productive capacity. This requires a more comprehensive characterization of soil resources, i.e., physically, chemically and biologically.

Soil quality has historically been closely related to soil productivity. More recently, there has been a growing recognition that the functions the soil carries out in the natural and agro ecosystems exceed promoting the growth of plants. Accordingly, the soil quality can be best defined in relation to the functions it performs in natural and agro ecosystems. This automatically means that the scientists, growers, policy-makers and governments should adopt a broader definition of soil quality.

Soil quality is best broadly defined as the capacity of a soil to: promote the growth of plants; protect water sheds by regulating the infiltration and partitioning of precipitation; and prevent water and air pollution of buffering potential pollutants such as agricultural chemicals, organic waters, and industrial chemicals. The quality of a soil is determined by a combination of physical, chemical, and biological properties such as texture, water-holding capacity, porosity organic matter content, and depth. Soil management can either improve or degrade soil quality (Fig. 1). Erosion, compaction, salinization, sodification, acidification, and pollution with toxic chemicals can and do degrade soil quality. Increasing soil protection by crop residues and plants; adding organic matter to the soil through crop rotations, manures, or crop residues; and careful management of fertilizers, pesticides, tillage equipment, and other elements of the farming system can improve soil quality (Hornick and Par, 1987).

A system that measures changes in soil quality is needed if conservation of soil quality is to become the long-term goal for management of the soil resource. A system that monitors changes in soil quality could be used for three major purposes. First, such a system can be used to track national trends in soil quality by incorporating measures of soil quality indicators into national resource surveys and assessments. Second, such a system can improve the management of soil conservation programs by establishing tolerable soil erosion standards, targeting lands that need conservation measures, and identifying lands most suitable for inclusion in a long-term easement program. Finally, a system of soil quality indicators can aid in the analysis of the sustainability of farming systems by providing a set of criteria against which farming systems can be compared. Soils, however, are difficult to inventory and assess. Soils vary greatly, with variations often occurring at distances of only a few meters. Cross differences in soil surfaces can be seen or felt and usually reflect differences in organic matter content, mineralogy, or texture. The soil characteristics below the usual depth of cultivation, however, are often not carefully observed and characterized except by soil specialists.

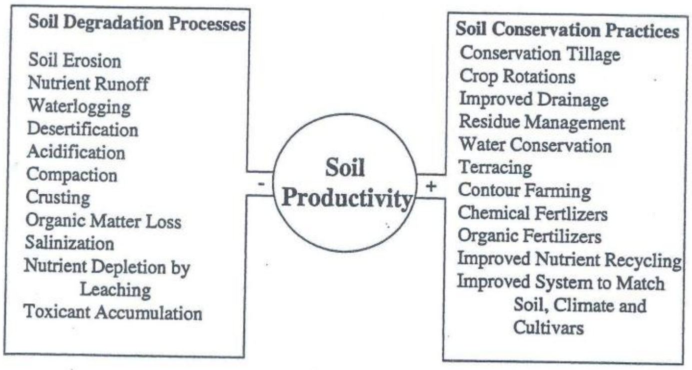

FIGURE 1 Relationship of soil productivity to soil degradation processes of soil conservation practices.

It is often difficult and laborious to obtain samples from the deeper horizons of the soil. A system to monitor changes in soil quality will require the following:

- Identification of the soil attributes that can serve as indicators of changes in soil quality.
- Standard field and laboratory methodologies that can be used to measure changes in indicators of soil quality.
- A coordinated monitoring program that can quantify changes in soil quality indicators.
- A coordinated research program designed to support, test, and confirm models that can be used to predict the impact of management practices on soil quality.

Physical degradation leads to a deterioration of soil properties that can have a serious impact on water infiltration and plant growth. Wind and water erosion is generally the dominant physical degradation process, but compaction is also a widespread concern in places where heavy machinery is commonly used. Soil degradation is a complex phenomenon driven by strong interactions among socioeconomic and biophysical factors. Soil degradation is fueled worldwide by increasing human populations, fragile economics, and misguided farm policies. The physical and chemical attributes of a soil can be protected from degradation by a number of general types of management practices.

Soil management practices in the 21st century must be formulated on the understanding of the ecosystem concept. Agriculture production ecosystems are managed ecosystems. Therefore, to understand both the potential productivity and fragility of agriculture ecosystems, we must be aware of the fundamental ecological relationships and processes that are common to all ecosystems. We must also examine the strengths and weaknesses of agriculture and natural ecosystems and then alter the energy and material flows within the agriculture production systems to flows that are based on ecological principles. These major objectives are achievable through judicious soil management options. Figure 2 depicts the basic management principle for the 21st century is to manage soils both in space and time (Pierce and Lal, 1991).

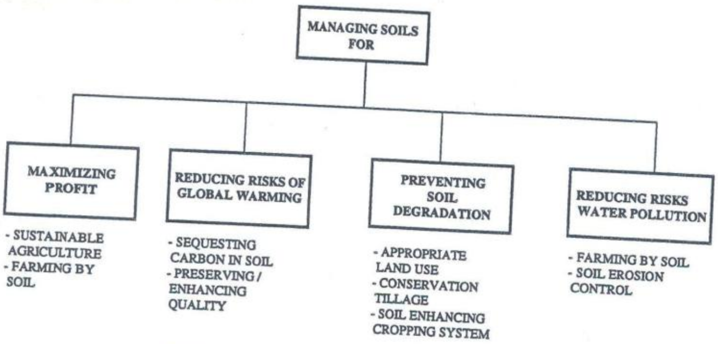

FIGURE 2 Soil management in the 21st century.

SUMMARY AND REMARKS

Protecting soil properties, like protecting air and water quality, should be a fundamental goal of national environmental policy. The quality of a soil depends on attributes such as the soil's texture, depth, permeability, biological activity, capacity to store water and nutrients, and the amount of organic matter contained in the soil. Soils are dynamic living systems that are the interface between agriculture and the environment. High-quality soils promote the growth of crops and make farming systems more productive. National policies should take advantage of opportunities to protect soil and water quality while sustaining profitable production of food and fiber. Policy-makers usually face a dilemma. People need and want the food and fiber that farmers produce. Producing food and fiber inescapably alters the environment, and various effects on soil and water quality are inevitable; however, national policy, in the short term, should take advantage of opportunities to refine the management of farming and grazing systems in ways that protect soil and water with minimal or even positive effects on profitability.

The philosophy that it is the responsibility of landowners and land users, as stewards of the land, to protect soil and water quality is a powerful ideal that is reflected in many of the traditional approaches to soil and water protection in the world. The ideal has been promoted through education, financial incentive, ethical imperatives, or legal mandates, and many landowners and users manage their lands in ways that prevent soil degradation and water pollution. The lack of clarity and consistency in the legal definition of the responsibilities as well as rights of landowners and users has impeded long-term comprehensive efforts in which publicly funded soil and water quality gains are made permanent. A policy that clearly establishes the responsibilities of landowners and land users to manage their lands in ways that protect soil and water quality would provide a consistent and uniform basis for implementing soil and water quality protection efforts on a permanent basis.

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