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SOIL DEGRADATION AND INTEGRATED CONSERVATION POLICIES

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I. Introduction

Soil supports the growth of most of our food and fiber. The productivity of soil is a major factor in the economies of Korea and other nations. It also has much broader functions such as filtering air and water and being a site for waste disposal and recycling. Soil degradation, the wearing away of soil by water, wind, and other forces, is a natural process that can be accelerated by human activities. Soil degradation takes place in most of the agricultural land of Korea, whether through wind erosion, water erosion, acidification, or the loss of organic matter. In particular, inappropriate land use caused by unsustainable farming practices such as intensive tillage, over-fertilization and over-grazing of livestock result in soil degradation. The issues of soil degradation are of interest to policymakers because of slow reversibility (declining organic matter) or irreversibility (erosion), although the relative importance of each issue varies among countries. Thus, soil conservation practices are emerging as the key approach to curb further soil degradation problems.

Beginning in the late 1980s and continuing through the 1990s

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to the present, there have been some significant initiatives by the Korean government to remedy soil degradation problems. This paper provides a background on the sources and extent of soil degradation in Korea and the policies and programs undertaken to reduce this problem on cultivated lands. The terms related to soil degradation and the physico-chemical properties of cultivated soils in Korea are briefly explained to get a better understanding of sustainable soil management. The integrated soil conservation programs are illustrated and the authors perception of approaches and solutions suited to the Korean situation for dealing with soil degradation problems is presented.

II. Terminology and Definitions

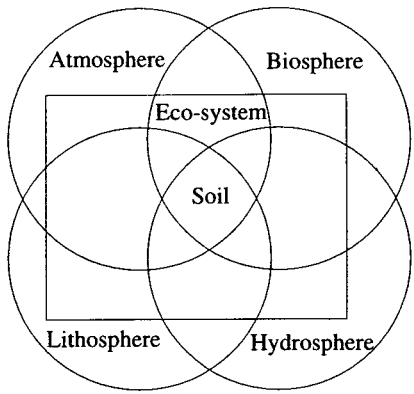
1. Concepts of Soil and Soil Quality

As an essential resource for survival, the word of soil has many meanings.[1] Agricultural scientists define soil as the natural medium for the growth of crops. Geologists perceive soil as a layer of weathered rock. Conservationists view soil as the interface between the atmosphere and the lithosphere, seeing soil as a setting for food production, water purification, and waste disposal. In the modern soil science, soil exists in a dynamic equilibrium with the rest of the ecosystem interacted with atmosphere, biosphere, lithosphere, and hydrosphere, as shown in Figure 1. Any human intervention during the course of development that affects this equilibrium will result in changes in properties and productivity of the soil.

Various physical, chemical, and biological properties of soils interact in complex ways to determine their potential fitness or capability for crop production. The integration of growth-enhancing factors that make soil productive has often been referred to assoil quality. Soil quality can be defined as the soils fitness to support crop growth without becoming degraded or otherwise harming the environment (Acton and Gregorich 1995). Thus, soil quality has

[1] The concepts of soil are extensively discussed in Donahue, Miller, and Shickluna (1977) and Klee (1991).

FIGURE 1 Interaction of the lithosphere, Atmosphere, Biosphere, Hydrosphere Eco-System, and Soils (Szalboles 1994)



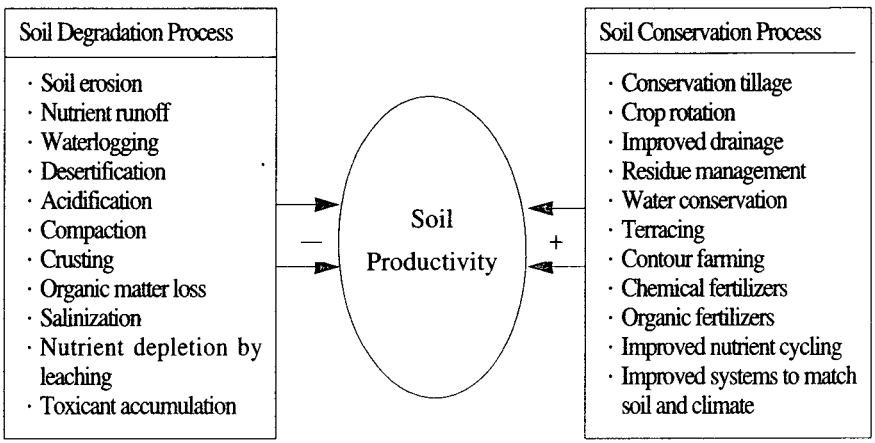
traditionally focused on, and has been equated with, soil productivity.[2] Soil quality can decline through all of the degradation processes that are discussed in the next section.

2. Degradation and Conservation of Soil

Soil degradation refers to the process, phenomena or transformation which deteriorates soil quality. Soil degradation includes physical, chemical, and/or biological deterioration such as depletion of organic matter and associated deterioration of soil structure, water retention capacity and sorption and release of nutrients, decline in soil fertility, decline in structural condition, erosion, adverse change in salinity due to inadequate irrigation and drainage, acidity, and the effects of toxic chemicals, pollutants or excessive flooding (Hornick and Parr 1987). Soil degradation ultimately leads to poor soil productivity and poses a severe threat to food supply. The potential damage of soil degradation is endless and is self accelerating, and if continued unchecked, may

[2] The soil productivity is defined as the capability of soil for producing a specified plant or sequence of plants under a defined set of management practices. It is measured in terms of outputs or harvests in relation to the inputs of production factors for a specific kind of soil under a physically defined system of management (USDA 1957).

FIGURE 2 Relationship between Soil Degradation Processes and Soil Conservation Practices (Hornick and Parr 1987)



reach the point where it will be economically and technically irreversible.[3]

Soil conservation is defined as protection, optimum use, and reclamation of soil, within the limit of economic practicability (Donahue, Miller, and Shickluna 1977). The control of soil degradation is a major part of soil conservation. Figure 2 illustrates the relationship between soil degradation process and soil conservation practices. As soil degradation processes involving soil erosion, nutrient runoff, acidification, compaction, and organic matter loss proceed and intensify, soil productivity decrease concomitantly.

Conversely, soil conservation practices involving conservation tillage, crop rotation, improved drainage, and other soil management practices tend to slow these degradation processes and increase soil productivity. The potential productivity of a particular soil at any point in time is the result of ongoing degradation processes and applied conservation practices.

[3] It has been claimed that an inch of soil takes anywhere from 200 to 1,000 years to form; under the most erosive conditions that same soil can be swept of the land in just a few seconds (Brown et al. 1989).

III. Properties and Degraded Level of Cultivated Soils in Korea

1. Soil Formation in Korea

The development of mature soil is a complex process. Soil forming factors responsible for the kind and the extent of soil development are climate, biosphere (living organisms), topography, parent material and time during which they interact with each other to undergo the soil forming process (Donahue, Miller and Shickluna 1977).

Climate such as rainfall and temperature has a great influence on the decomposition and deposition of soil organic matter, change in moisture content, change and degradation of clay mineral, and the weathering of rocks. The climate of Korea belongs to the temperate zone with an annual average temperature of more than 11℃. The mean annual rainfall is approximately 1,300 mm and most of it is concentrated in July and August.

Biosphere includes all animals and plants from higher to lower ones which contribute markedly to the soil development. The natural vegetation in Korea consists of mixed forest, both coniferous and deciduous, and natural grass land in a poor growth condition (ASI 1985b). Concentrated heavy rainfall in the summer season together with poor vegetation causes severe soil erosion.

Parent material is the most significantly effective soil forming factor and different soil characteristics are formed under different characteristics and resistance to the weathering circumstances of the parent material. The parent materials of Korean soils are various and exhibit several different soil characteristics originating from tertiary rocks, granite gneiss, shale and sandstone, limestone and quartzite, crystalline schist, and granite (ASI 1985a). Tertiary rocks are unconsolidated sandstone, shale, and conglomerate distributed in small extent and scattered on the southern part of Koreas east coast. The soils developed from tertiary rocks are comparatively fine in texture, light in color and of shallow in depth. Granite gneiss, granite and schistose granite cover more than two-thirds of the whole of Korea, appearing mostly in the northern and south-central regions. Soils derived from these acidic crystalline rocks are mainly medium to coarse in texture and acid soil reactant. Soils developed in gently

sloping hilly areas are usually fine to medium in texture with substantial available soil depth. Steep mountainous soils are coarse in texture and result in shallow soil depth because of severe erosion.

Topography, meaning the earths surface contour or relief, influences soil erosion and soil moisture content in relation to climate and vegetation during the soil forming process. The physiography of Korea is very complex and it can be classified as mountains, foot hills, hills, rolling, fans, valleys, terraces and plains (NIAST 1992). Among them, mountains cover 65 percent of Koreas national land.[4]

2. Properties of Cultivated Soils

Cultivated soils in Korea were classified into 151 soil series in paddy soils and 125 soil series in upland soils (ASI 1985b). These many paddy and upland soil series were categorized into six types, considering similarity in the soil management, and the criteria of classification (Table 1). The total area of paddy soils was 1,268,000 ha, and 32.6 percent of these surveyed were found to be well adapted soils having a high agricultural production potential whereas 67.4 percent of paddy soils has a low agricultural production potential. The total area of upland soils was 860,000 ha, of which 41.8 percent of these were found to be well adapted soils having a relatively high agricultural production potential whereas 58.2 percent were upland soils having a relatively low agricultural production potential.

As shown in Table 2, the physical properties of paddy soils were found to be shallow in plow depths and very low in infiltration rates, while those of upland soils were shallow in available depth, less than 50 cm, steep in slope, and infertile. The paddy soils were very compact, not only high in hardness and bulk density, but also low in clay content. So, available soil depth or plow depth in paddy soils were shallow compared with optimum value for crop cultivation. The physical properties of upland soils are generally high in hardness and bulk density, low in porosity and clay content, and low in nutrient or

[4] The area of whole country in South Korea is 9.9 million hectares. Of this area, mountains occupy 64.8 percent while cultivated land covers only 1.9 million hectares or 19.4 percent of the national land. Paddy land is 11.7 percent of the total, and upland 7.7 percent (Ministry of Agriculture and Forestry 1998a).

water holding capacity, and therefore poor in crop growth and great in soil loss.

Yearly changes in chemical properties of cultivated soils are given in Table 3. The contents of exchangeable potassium and available phosphorus gradually increased in both paddy and upland soils during the three decades. This is mainly due to the application of

TABLE 1 Area Distribution of Cultivated Soil Types

Unit	Well adapted	Sandy textured	Newly reclaimed	Poorly drained	Saline soils	Acid sulfate	Total
Paddy soils							
Area(thousand ha)	413	410	297	114	32	3	1,268
Ratio(percent)	32.6	32.3	23.4	9.0	2.5	0.2	100.0
Unit	Well adapted	Sandy textured	Newly reclaimed	Heavy clayed	Plateau	Volcanic ash	Total
Upland soils							
Area(thousand ha)	359	191	164	123	3	20	860
Ratio(percent)	41.7	22.2	19.1	14.3	0.3	2.4	100.0

Source: ASI (1985b).

TABLE 2 Physical Properties of Cultivated Soils

Paddy Soils	Plow depth	Percolation rate	Water holding	Hardness	Bulk density	Porosity	Clay content
	cm	mm/day	day	mm		%	%
Country mean	13	2.8	1-10	23	1.4	47	19
Optimum level	18	10	3-5	18	1.3	51	25
Upland Soils	**Av. soil depth**	**Slope**	**Plow depth**	**Hardness**	**Bulk density**	**Porosity**	**Clay content**
	cm	%	cm	mm		%	%
Country mean	20-50	0-30	11	24	1.4	48	16
Optimum level	80	0-7	20	18	1.3	51	20

Source: ASI (1985b).

TABLE 3 Changes of Chemical Properties of Cultivated Soils

Year	pH	OM	P_2O_5	K	Ca	Mg	Number of samples
	(g/kg)	(mg/kg)	----------mol+/kg ----------				
Paddy soils							
1964-68	5.5	26	60	0.23	4.5	1.8	5,130
1976-79	5.9	24	88	0.31	4.2	1.3	19,737
1980-87	5.7	23	107	0.27	3.8	1.4	612,942
1990	5.7	27	101	0.32	4.3	1.5	1,192
1995	5.6	25	128	0.32	4.0	1.2	1,168
Upland soils							
1964-68	5.7	20	114	0.32	4.2	1.2	3,661
1976-80	5.9	20	195	0.47	5.0	1.9	18,324
1985-88	5.8	19	231	0.59	4.6	1.4	65,565
1992	5.5	24	538	0.64	4.2	1.3	854
1997	5.6	24	577	0.80	4.5	1.4	854
Plastic Film House							
1964-68	5.8	22	811	1.08	6.0	2.5	215
1976-79	5.8	26	945	1.01	6.4	2.3	391
1990-95	6.1	30	876	1.11	6.5	2.7	216
1996	6.0	35	1,092	1.27	6.0	2.9	513

Source: NIAST (1998).

a large amount of chemical fertilizers and soil amendments. All the parameters surveyed in the plastic film houses were much higher than those of open field soils.

3. The Levels of Soil Degradation

The process of soil degradation in Korea results from water and wind erosion, and chemical and physical deterioration. Soil erosion is a result of both relatively unchanging physical factors, such as rainfall, slope and soil texture, and changing factors associated with crop rotation, tillage methods, and irrigation. Soil erosion on a sloped upland is particularly serious due to torrential rainfalls in the summer season. The more land is intensively cultivated, the faster it may

erode. Erosion decreases soil productivity by removing nutrients and organic matter and by thinning and modifying the soil zone where the plant roots grow. Sheet and rill erosion is the most common type of agricultural soil erosion in Korea (Shin 1995).[5] It occurs when raindrops detach soil particles from the soil surface and transport them in thin sheets of water moving across unprotected slopes. The wind erosion process is distinct from water erosion. Wind and water erosion have two major types of impact, namely on-site impacts at the source of the eroded soil and off-site impacts where water deposits eroded soil. The major on-site effect is erosion'simpact on soil productivity. When soil is not deep enough, subsurface material limits plant roots, impairing productivity. Field studies have confirmed differences in crop yields between the eroded and uneroded phases of the same soils (NIAST 1998).

Chemical deterioration consists of the loss of soil nutrients and organic matter, and accumulation of heavy metals and other toxic elements, leading to salinization, acidification, and toxic contamination, while physical damage includes soil compaction and waterlogging. Soil contamination from heavy metals and other toxic elements can also be generated from non-agricultural sectors, for example, the mining industry.

To varying degrees chemical and physical deterioration of soil stem from natural processes, inappropriate irrigation and soil management practices, land clearing, excessive use of chemical inputs, and the misuse of heavy agricultural machinery.

The major degradation problems in Korea are erosion, the loss of soil organic matter, and acidification. Water erosion is the dominant component although wind erosion is significant on the sandy soils of Kangwon and Kyeongbook provinces. Unfortunately, no national data are yet available estimating the size of soil degradation, although data collection efforts are beginning.

According to the studies on the runoff of rainwater and loss of soil via erosion under different land use in a watershed, it was found

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[5] Sheet erosion means removal of a fairly uniform layer of soil from the land surface by runoff water. Rill erosion occurs when the surface flow of water establishes paths called rills, and flowing water readily detaches soil particles from their sides and bottoms (Acton and Gregorich 1995).

that annual cropping has the highest soil loss while the forest has the least, as shown in Table 4.

Soil degradation of agricultural land in Korea does not pose an immediate threat to the nations agricultural production capabilities. However, soil degradation is impairing long-term soil productivity in the alpine or hillslope areas. Intensive crop cultivation in the alpine areas lead not only to inefficient use of water but also to loss of soil. According to the studies on soil loss in an alpine area, it was found that terracing and stone waterways were most effective, followed by grass band and grass waterways, as shown in Table 5. Contour cultivation was least effective in reducing soil loss via erosion. A large part of the cultivated land in Korea is occupied by sloping lands where traditional farming systems have evolved. Sloping land agriculture on small plot sizes and poorly consolidated farms are susceptible to soil erosion. Annual soil loss from 15 percent sloping upland fields are about 30 tons per hectare. Soil loss is higher on steep areas with poor soil properties. A typical example is the alpine vegetable areas located 850 meters above sea level. The soils in these areas are poor, with shallow soil depth and a high content of gravel or stones and are barren except for short plant growing periods. Most topsoil was lost due to improper soil management during the heavy rainfall seasons, and hence, parent materials are often exposed to the surface.

TABLE 4 The Runoff of Rainwater and Loss of Soil via Erosion under Different Land Use in a Watershed

Land use	Forest	Grassland	Mulberry	Annual Crop
Runoff (kl/ha)	329	684	2,590	3,195
Runoff ratio (%)	2.5	3.5	19.7	24.3
Soil loss (ton/ha)	1.8	1.5	5.3	19.5

Source: NIAST (1997).

TABLE 5 Effect of Different Land Surface Management on the Loss of Soil via Erosion on a Sloping Land in an Alpine Area

Treatment	Contour	Grass band	Grass waterway	Stone waterway	Terracing
Soil loss (ton/ha)	66.5	11.1	0.9	8.7	8.3

Note: The period of observation was June 1 through August 13, 1995. Rainfall during the observation was 466 mm.
Source: NIAST (1997).

IV. Integrated Soil Conservation Policies and Strategies

Soil conservation programs throughout the country have greatly increased due to the heightened awareness of degradation. Issues that are currently important in dealing with the problem of soil degradation include soil conservation planning and rehabilitation of degraded soils. The integrated soil conservation programs in Korea use one or more of the following policy tools:

(1) Monitoring change of soil quality in agricultural land
(2) Providing subsidies for soil amendments
(3) Cost-sharing assistance for practice installation
(4) On-farm technical assistance and extension education
(5) Technology development and research cooperation aimed at evaluating and improving soil conservation practices.

Representative soil conservation programs include a detailed soil survey project and an integrated soil improvement project.

1. Detailed Soil Survey Project

With social concerns requiring increased production of stable food during a period of chronic deficit of food in the 1950s, the Korean government began to survey cultivated soils for fertility improvement with the goal of food self-sufficiency for the nation.[6] Soil survey was increasingly necessary and frequently requested for long-term planning of agricultural development.

Table 6 presents the evolutionary process of soil survey in Korea. A modernized reconnaissance soil survey covering 9.8 million ha of the whole country, which was conducted as the project of the Korean Soil Survey by the UNDP special fund, was continued from 1964 to 1967. The reconnaissance soil maps were published in 438 pieces of mapping on scale of 1:50,000 for nine provinces. The reconnaissance soil survey designed for national land development planning, however, was not satisfactory for agricultural purposes, because the large number of soil classifications and the least mapping unit was too large at 6.25 hectares (Shin and Park 1998). These shortcomings made it necessary to obtain more detailed soil information. So, a detailed soil survey was performed from 1966 to 1990 by the Agricultural Science Institute of Rural Development Administration. The Institute finished a detailed soil survey for cultivated land throughout the country and part of reclaimable hillside areas by 1976, and completed the whole country including the mountainous areas by 1990. Detailed soil surveys were conducted to find representative values of physico-chemical properties in Korean soils and to serve as the basic information for improving the soil properties for enhancing of soil productivity. The results were published with 1,559 pieces of detailed maps covering the entire country of approximately 9.6 million hectares on a scale of 1 : 25,000 for 137 counties. During the period of the detailed soil survey, the highly detailed survey for every farm parcel of paddy was conducted from 1980 to 1989 by the Agricultural Science Institute to provide for the basic information on the paddy soil management. This soil survey was carried out on the paddy soils covering approximately 1.4 million hectares and soil testing was done on 617,000 samples.

Recently, a five-year project of a super detailed soil survey for lands used for upland cropping was initiated in 1995 to be continued up to 1999. This project aims to reappraise soil resources in view of their capability to support the sustainability of agriculture and the

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[6] Soil surveys are the systematic mapping, classification, and description of the soils and soil characteristics in a geographic area. Soil survey in Korea originated in 1936 by the Department of Agriculture and Forestry and the Agricultural Experiment Stations and used the method recommended by the Japanese Society of Agriculture. For more detailed exposition on the history of Korean soil survey, see ASI (1985b).

TABLE 6 Soil Survey Projects in Korea

Type of Soil Survey	Duration	Major Contents
· Reconnaissance soil survey	1964-67	· Survey for soil genesis · Covering 9,848,000 ha of land · Publishing reconnaissance soil maps (438 pieces of 1:50,000 scale)
· Detailed soil survey	1966-90	· Survey for soil characteristics, slope, erosion, and drainage · Covering 9,578,000 ha of land · Publishing detailed soil maps (1,559 pieces of 1:25,000 scale)
· Detailed paddy soil survey	1980-89	· Covering 1,391,000 ha of paddy · Soil testing for 617,000 samples · Analyzing physico-chemical properties of soils
· Super-detailed upland soil survey	1995-99	· Covering 583,000 ha of upland · Soil testing for 1,166,000 samples · Making a super-detailed soil map (1:5,000 scale)
· Soil fertility survey	1990-	· Covering paddy, upland, orchard, plastic film houses · Monitoring soil fertility, pesticide, heavy metal, NO_3, BOD

Source: NIAST (1992; 1997; 1998).

health of the ecosystem. The survey involves the classification of landscape and analysis of physico-chemical properties of soils to identify the factors that limit the productivity of soils. This project is conducted by several public institutions.[7] In particular, the participating rural county extension offices specifically conduct the intensive soil testing of every piece of land for the recommendation of soil fertility management based on the chemical properties of soils.

[7] One of the special features of the super-detailed project is the fact that various relevant institutions participated, such as the National Institute of Agricultural Science and Technology, Honam Agricultural Experiment Station, Yungnam Experiment Station, all of the Provincial Rural Development Administrations, and Rural County Extension Offices throughout the country (NIAST 1997).

Farmers are given information on fertilizer recommendation with reports on soil quality, salt accumulation, improvement techniques, and the required quantity of soil amendments. In addition, the available nutrients content, heavy metal contents, and other soil characteristics of cultivated soils have been monitored in fixed plots at a four-year interval since 1990.

In order to make the database of cultivated soil information readily accessible to various users, the reconnaissance soil map (1 : 50,000 scale) of the entire country and detailed soil map (1 : 25,000 scale) for several provinces are being digitalized in image form. Information on soil characteristics such as soil texture, drainage, soil depth, and clay contents of the soil with different mapping units were computerized using the geographical information system (GIS).[8] These bits of computerized soil survey information would be used for the identification of soil characteristics of specific site.

2. Integrated Soil Improvement Project

An integrated system approach to soil conservation planning addresses degradation problems along with other aspects of soil quality, including productivity, and environmental and economic issues. Integrated soil conservation is an outcome of complex interactions involving farmers, scientists, extension workers, and policy-makers. The Korean government set up the Integrated Soil Improvement Project in 1996 in order to foster an environment-friendly agriculture by national improvement of cultivated soils.[9] Figure 3 presents the key components of the integrated soil conservation process in Korea. Based on the analytical results of the Detailed Soil Survey, the major components of the project consists of nutrient management, soil management, and farm management. The interactions involving farmers, agricultural scientists, extension

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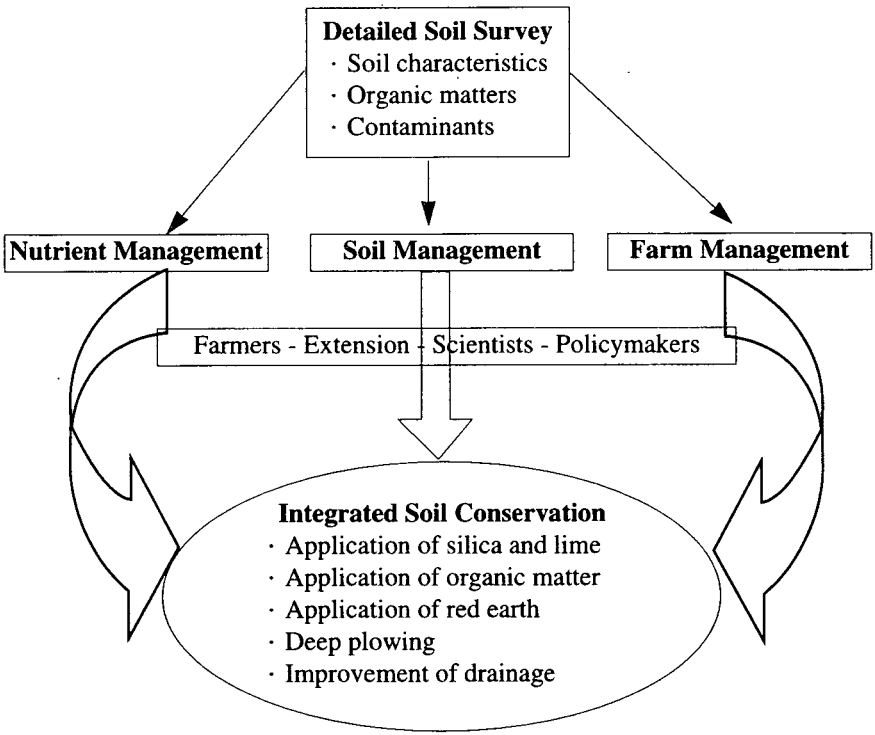
[8] The GIS is a computer-based system for the input, storage, retrieval, analysis and display of geographic data. The GIS database is usually composed of map-like spatial representation on a number of attributes including land evaluation, land use, land ownership, crop yield, and soil nutrient levels (National Research Council 1997).

[9] For more detailed description about the integrated soil improvement project, see MAF (1997b; 1998b).

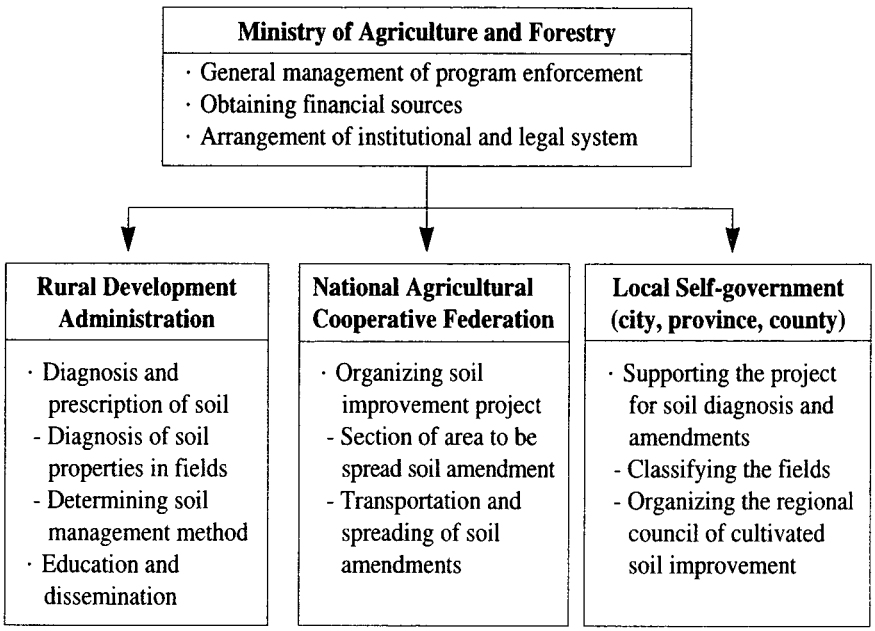
FIGURE 3 Key Components of the Integrated Soil Conservation Process



workers, and policymakers are important in conducting the integrated soil conservation program to be integrated into sustainable agricultural strategies. The challenge of this project is to develop the most effective field methods for applying soil amendments (e.g., lime, silica, and red earth) and organic matter, at variable rates that match the soils need.[10] The Agricultural Land Act which was established on December 22, 1994, supports the integrated soil improvement project for developing sustainable agriculture. As shown in Figure 4,

[10] Application of red earth not only improves the nutrient holding capacity of soils but also prevents nutrients from leaching by reducing percolation rate (ASI 1985).

FIGURE 4 Institutional Roles in Conducting the Integrated Soil Conservation Program



organizations conducting the project are local self-governing bodies and the National Agricultural Cooperative Federation under the control of the Ministry of Agriculture and Forestry. Technical and extension supporting organizations are the Rural Development Administration, the National Institute of Agricultural Science and Technology, the Institute of Honam and Yeongnam Crop Experiment Station, the Provincial Office of the Rural Development Administration and the Office of Rural Guidance. This project covers 2,651,000 ha including paddy fields, uplands, orchards, mulberry uplands, reclaimed hillside uplands, and saline soils throughout the country. The outline of the project implementation includes selecting the fields requiring soil improvement every year, determining the soil types with a spot soil survey, assessing the soil fertility unit (about 2 ha) in the soil map referring to cultivation history, extracting a composite soil sample per unit, conducting a detailed soil analysis, determining the amount of soil amendments and NPK fertilizers according to soil analysis data, and issuing prescription slips for soil

TABLE 7 Budgetary Outlay of Integrated Soil Management Project

Items	1996	1997	1998
	---------- million won----------		
Supplying soil amendments	17,640	22,502	30,353
Lime fertilizer	6,712	10,944	12,960
Silica fertilizer	10,928	11,558	17,393
Red earth application	20,000	25,953	28,184
Supporting soil testing equipment	-	-	3,800
Total	37,640	48,455	62,337

Source: Ministry of Agriculture and Forestry (1997a).

improvement to the farmer. The prescription slips arepromptly and precisely prepared by a computerized system. The rural extension offices are operating soil testing laboratories for soil samples collected from cultivated fields. Reports about soil quality including information on fertilizer recommendations, salt accumulation, amelioration techniques, and the required quantity of amendments are given to the farmers.

As shown in Table 7, the budgetary requirement of the integrated soil management project in 1998 was 62,337 million won with the portion of 30,353 million won for supplying soil amendments, 28,144 million won for red earth application, and 3,800 million won for supporting soil testing equipment in 1998. The investment for soil conservation projects has increased 28 percent every year since 1996. This trend will be continued since the current agricultural policy regime is based on the development of sustainable agriculture.

3. Effective Methods and Research Priority for Soil Conservation

The policy objective for soil conservation is to optimize the appropriate functioning of soil as a limited resource for sustainable agricultural production in ways that are environmentally safe, economically viable, and socially acceptable. An effective response to soil degradation calls for improving the incentives for farmers to care for their cultivated soils and improving their access to the knowledge and inputs required for proper care. Based on lessons learned from

past success and failure in managing soil degradation in Korea, the following policy actions should be considered:

(1) Promote soil quality improvement investments through technical assistance and new financing arrangements suitable for systematic and integrated soil conservation programs.

(2) Increase research, and technology developed elsewhere should be tailored according to local condition.

(3) Improve the spread of information through widely linked, user-friendly information systems for farmers.

In particular, the following research for soil conservation should be given high priority by agricultural scientists and extension workers in Korea:

(1) Conduct research on sustainable farming systems using a holistic or an interdisciplinary approach. A holistic approach may require the development of new methods and technologies related to chemical, physical, and biological interactions with soil fertility, crop productivity, and environmental quality.

(2) Estimate consequences of integrated soil conservation projects including risk and profitability associated with existing technology. This should be done on a whole farm basis. Such data are absolutely essential to credibility for on-farm soil management.[11]

(3) Develop more effective methods for transferring best management practices of soil conservation. One of the best means to transfer technological information is through farmers organizations and networks.

(4) Identify and quantify reliable indicators of soil quality that can be used to predict the effect of management practices on soil productivity and how they relate to the long-run sustainability of a farming system.

(5) Identify barriers and constraints that limit the development and adoption of new and innovative methods and technologies for soil conservation practices.

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[11] For more detailed description of economic model framework of soil conservation, see Clark and Furtan (1983) and Taylor and Young (1985).

V. Concluding Remarks

Soil is the most important natural resource for human life assuming water is available. Soil supports living residences and gives food which is the driving force of life for mankind. This means that a countrys development is measured entirely by how it treats its invaluable soil resources and how it utilizes them.

Soil degradation of cultivated land in Korea does not pose an immediate threat to the nation's agricultural production capabilities. However, soil degradation is impairing long-term soil productivity in some critically vulnerable areas like alpine and hillslope upland. Thus, the problem of soil degradation is the most serious threat to sustainable agricultural policy in the long run. This statement does not diminish the facts of the current economic crisis in some sectors of agriculture, but economic problems are cyclical in nature, and it is to be hoped that the present problems will be managed satisfactorily in the near future. On the other hand, the problem of soil degradation is with us today, and will be with us tomorrow, next year, and forever. Unless we are vigilant, we will lose the competitiveness of our agricultural industry which depends on both the quality and the health of the soil. These necessities illustrate the need for high level policies and programs that encourage long term soil conservation. Public institutions serving the agricultural sector need to know why degradation happens so that they may be able to influence the policy and law reform processes and/or direct research and development efforts in order to discover more effective farm management solutions and disseminate information to support national longevity and self dependence.

REFERENCES

Acton, D.F. and L.J. Gregorich (eds.). 1995. *The Health of Our Soils: Toward Sustainable Agriculture in Canada.* Agriculture and Agri-Food Canada, Publication 1906/E.

Agricultural Sciences Institute (ASI). 1985a. *Soils of Korea.* Soil Survey Materials 11. Rural Development Administration, Suwon, Korea.

Agricultural Sciences Institute (ASI). 1986b. *Soils of Korea and Their*

Improvement. Rural Development Administration, Suwon, Korea.

Barnett, V., R. Payne and R. Steiner (ed.). 1995. *Agricultural Sustainability*. New York: John Wiley & Sons.

Brown, L.R. et al. 1989. *State of the World: A Worldwatch Institute Report in Progress toward a Sustainable Society*. Worldwatch Institute.

Clark, J.S. and W.H. Furtan. 1983. "An Economic Model of Soil Conservation/Depletion." *Journal of Environmental Economics and Management* 10: 356-370.

Donahue, Roy L., Raymond W. Miller and John C. Shickluna. 1977. *Soils: An Introduction to Soils and Plant Growth*. 4th ed. Englewood Cliffs, New Jersey: Prentice-Hall, Inc.

Hornick, S.B. and J.F. Parr. 1987. "Restoring the Productivity of Marginal Soils with Organic Amendments." *American Journal of Alternative Agriculture* 2: 64-68.

Hur, Bong-Koo et al. 1984. "Representative Physical and Chemical Properties of Korean Soils by the Results from Detailed Soil Survey." *Journal of Korean Society of Soil Science and Fertilizer*. 17(4): 330-336.

Jo, In-Sang. 1990. "Hillslope Farming in Korea." in W.C. Moldenhauer et al. (eds.). *Development of Conservation Farming on Hilllslopes*. Soil and Water Conservation Society, Iowa, U.S.A.

Jung, Beung-Gan et al. 1990. "Chemical Properties of the Horticultural Soils in the Plastic Film Houses in Korea." *Journal of Korean Society of Soil Science and Fertilizer* 31(1): 9-15.

Ministry of Agriculture and Forestry (MAF). 1997a. *Guidelines for 1997 Agricultural Investment Projects*.

————. 1997b. Information for Agro-Environment Affairs, Department of Sustainable Agriculture.

————. 1998a. *Statistical Yearbook of Agriculture & Forestry*.

————. 1998b. *Policies for Environment-Friendly Agriculture Development*. Department of Sustainable Agriculture.

Moore, W.B. and B.A. McCarl. 1987. "Off-Site Costs of Soil Erosion: A Case Study in the Willamette Valley." *Western Journal of Agricultural Economics* 12: 42-49.

National Institute of Agricultural Science and Technology (NIAST). 1992. *General Description of Korean Soil*. Soil Survey Materials 13.

———— 1997. *Research Highlights of 1995 and Research Emphasis in 1996*, Rural Development Administration, Suwon, Korea.

———. 1998. Results of Monitoring Soil Quality. unpublished manuscript. Rural Development Administration, Suwon, Korea.

National Research Council. 1997. *Precision Agriculture in the 21st Century: Geospatial and Information Technologies in Crop Management.* Washington, D.C.: National Academy Press.

Oh, Wang-Keun, Ryu In-Soo and An Yun-Woo. 1990. "Soil Conservation and Maintenance of Fertility on Upland Soils." *Journal of Korean Society of Soil Science and Fertilizers* 6(1): 53-60.

Owen, Oliver S. 1985. *Natural Resource Conservation: An Ecological Approach.* 4th ed., New York: Macmillian Publishing Co.

Szalbolcs, I. 1994. "Soils and Salinization." in M. Pessaraki (ed.). *Handbook of Plant and Crop Stress*, New York: Marcel Dekker Inc.

Shin, Jae-Sung. 1995. "Soil Conservation Management." in proceedings of 1995 Agricultural Science: 25-38.

Shin, Jae-Sung and Park Moo-Eon. 1997. "Korea: Sustainable Soil Management by Farm Parcel." in *Helsinki Seminar on Environmental Benefits from Agriculture Country Case Studies.* OCDE/GD(97)110, Organization for Economic Co-operation and Development.

Taylor, D.B. and D.L. Young. 1985. "The Influence of Technological Progress on the Long Run Farm Level Economics of Soil Conservation." *Western Journal of Agricultural Economics* 10: 63-76.

U.S. Department of Agriculture. 1957. *Soil-Yearbook of Agriculture.* Washington, D.C.: U.S. Government Printing Office.

World Resource Institute. 1992. *World Resources 1992-93.* New York: Oxford University Press.