The Necessity of Soil Conservation and Soil Improvement in the World's Farmland

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1. Introduction
It has become a very important and serious problem to protect the global environment from destruction and conserve the earth with better condition. In the early 1970s, the interesting problems concerning earthly environment conservation were mainly those connected with environmental pollution such as air pollution, water pollution and waste pollution, and their damage to human life in the advanced countries. At the present time, however, many serious problems such as the collapse of ecological systems, the intensive urbanization, the disappearance of the tropical rain forest and mangrove forest, desertification, soil loss from farmland, frequent occurrences of disasters like drought, flood and so on, hunger in many regions, and various pollutions like acid rain, destruction of ozone layer by CFC gas are occurring in both the advanced and developing countries due to the main factor of world population growth. Consequently the earth has been rapidly polluted and damaged.

In this paper, the author will describe what the Land Improvement Engineer (Civil Engineer for Agriculture) can do to facilitate soil conservation and soil improvement of farmland in order to prevent the degradation of the global environment.

2. Soil Loss in the World
The investigation by artificial satelites and on-the-spot surveys in the developing countries has made clear the deadly destruction of the global environment since
the latter half of the 1970s. Above all soil loss is sharply increasing. Of course, soil is disappearing as a result of increased building, housing, pavement and road construction, etc. based on the intensive urbanization of the population. But most of soil loss is occurring in farm and forest lands. The origin of soil loss accelerated world-wide has two main components:

1. extension of farmland in both advanced and developing countries;
2. shortening of fallowing period in advanced countries and shifting cultivation patterns in developing countries.

Here shifting cultivation means slash-and-burn agriculture based on the cyclic reuse of forest resources. Standing vegetation is cut and burned to create a cleared space where crops are cultivated, and which is then abandoned after two or three years for vegetation to regenerate. It is largely confined to tropical areas, where an estimated 30% of the world’s arable land is cultivated using the slash-and-burn method, which, however, supports only 10% of the world’s people, most of them at subsistence level.

In developing countries, the main cause of soil loss is over-cutting of forest for export of timber or as fuel materials, extension of shifting cultivation and shortening of fallowing period; sometimes desertification of land or land collapse occurs because of increased population. A few examples are given as follows.

In Nigeria, forests occupied ever 60% of the country a century ago, but now it occupies only a few percent due to the above factors. Consequently soil erosion is severe and soil loss from a farm with 5% slope will reach 87 t/ha per year; thus surface soil of 15 cm depth will be lost over thirty years, and soil loss from a farm with 10% slope will reach 221 t/ha per year, which implies that all surface soil will be lost during a decade.

Ethiopia has always lacked food, and the frequent famines are due to severe soil erosion and desertification.

Nepal is a mountainous country, and its farmland consists of terraced field. The population increases at the yearly rate of 2.3%, so many new farms are reclaimed on steep mountain-sides. These farms soon collapse and destroy the lower terraced fields owing to intensive water erosion.

Next, examples from the big countries are given.

China has intensive soil erosion and desertification because of the high population pressure. The Soviet Union is suffering soil loss by wind and water erosion from over-cutting of forests and windbreak forests because of food shortages.

Soil erosion in the United States is increasing owing to decreasing fallow period and crop rotation since increment of cereals export in 1970s; for example, soil loss from maize farms in Missouri State has increased from 6.8 t/ha to 49.3 t/ha per year. It is assumed that total loss of surface soil reaches several billion tons per year in the U.S.A.

Total arable land in the worlds is about 3.2 billion ha, and the world’s forest land totals to 4.3 billion ha. Tropical rain forests make up 1.9 billion ha of the world’s forest; this area is equivalent to 6% of the global surface area, and about half of all global life lives in these forest. Tropical rain forest is decreasing at 0.1 billion ha.
per year because of over-harvesting, and loss of farmland is due to severe soil loss, land collapse, and desertification.

For example, in Thailand over the past two decades more than 12.8 million ha of forest land have been destroyed, about one half of the total. The rate of deforestation in the Philippines is somewhat lower, at an estimated 180,000 ha every year, but this is still a threat to the long term survival of forest resources.

Soil exists only on the thin surface-layer of the earth—a crust-like skin—and all earthly life including human life is dependent upon the soil directly or indirectly. Surface soil of farmland usually has much organic matter, but its average depth is only 18 cm, and this produces all food, livestock feed, vegetable fiber, and other useful plants. Forest soil breeds trees, cultivates water resources, purifies the atmosphere, and conserves the earth. The depth of forest soil is presumed to be less than that of farmland soil. Surface soil in the earth is made by litter, the remains of plants, crops, animals, microorganisms, and organic manure, etc., after the action of rock weathering and soil formation. In the Temperate Zones, the formation of 1 cm of surface soil will take from 100 to 400 years under natural conditions.

Therefore, we have to conserve the valuable surface soil of the earth by protecting soil from erosion, land collapse, and desertification due to over-cutting of forest.

3. Methods of Soil Conservation

As mentioned above, it is very important to protect surface soil from erosion and to prevent or reduce soil loss.

In advanced countries, it is comparatively easy to perform soil conservation because these countries have the knowledge and experience. It is easy to perform soil conservation techniques such as fallow, crop rotation, breeding of windbreak forest, reclamation of terraced field, various vegetative methods, etc., after agricultural policy is changed from one of export priority to one of land conservation.

In developing countries, however, it is not so easy to use soil conservation techniques. Because most of the people of these countries are very poor and hungry, they are extending farmland, shifting cultivation, shortening the fallow period, and consequently over-cutting the forest; therefore, soil conservation technique is not appealing without the stabilization and improvement of people's livelihood.

The big countries with population pressure or food shortages, such as China and the Soviet Union, are partly performing soil conservation techniques, but those are not enough.

Most of the regions in Asia have heavy monsoon rainfall; accordingly there are many paddy fields or terraced paddy fields. Here, paddy fields at least have levees and irrigation canals. Paddy fields or terraced paddy fields prevent soil erosion; rice has higher yields than wheat, barley, and other cereals, and can be continuously harvested twice or three times in irrigable tropical regions without damage from repeated cultivation. Several developing countries have thus
reached the self-sufficiency threshold in rice production. The remarkable success of Asian agricultural development is attributed largely to their own efforts, as well as to the proper agricultural policies and also to financial and technical assistance from ODA (Official Development Assistance). Japan is also giving economic and technical assistance, and agricultural infrastructure has gradually improved in these countries.

The culture of wheat, barley, or other cereals require more farmland than the culture of rice plants, because of the requirement of fallow and crop rotation. Therefore, if a region can utilize irrigation, people must make paddy fields and culture rice plants. Consequently, it will be able to save farmland, cutless forest, produce more yield than other cereals, prevent soil erosion and soil loss, and so stabilize or improve the people’s livelihood.

Therefore, many developing countries in Africa, Asia, and Latin America with irrigable land have to reclaim or consolidate as many paddy fields as possible. Actually rice consumption in many countries in Africa is increasing, so it is possible to make paddy fields using financial and technical assistance. Also there are many terraced fields without irrigation in these countries. These terraced fields have protected soil from erosion, so this system must be kept and developed. After stabilizing the people’s livelihood, agricultural infrastructure will gradually improve and these fields will be irrigable, and consequently culture rice plants.

Japan has paddy field reclamation and cultivation techniques, so it is comparatively easy to work together with these developing countries. Next, it is necessary to introduce agro-forest technique, in which agriculture and forest coexist using various methods in developing countries. Thirdly, to prevent water erosion there are many methods of soil conservation such as vegetation system of contour strip cropping, contour grass barrier, cover crops, shelter belt, trash mulching, grassed waterways, and vegetative culture. Also, it is necessary to construct drainage system such as drainage canals, catch drains, drops, etc. For wind erosion, it is very important to breed and conserve windbreak forests.

We must adopt the adaptive method of soil conservation which fits the traditional agriculture after surveying climate, soil, customs, etc., in a region.

4. Soil Improvement

Here soil improvement means that surface soil and/or subsoil are improved chemically, physically, or both to sustain a high level of land productivity for a long time.

In order to control extension of farmland and shifting cultivation, it is necessary to improve soils and raise land productivity of the actual farmlands.

There are many wastelands and poor crop-growing lands with acid soils and alkaline salty soils in the world. For example, acid soils in Cerrados of central Brazil spread over 1.8 hundred million ha. This area is equivalent to five times the area of Japan. Arable lands in Cerrados are fifty million ha. In Brazil there are many farmers without farmland, and they are moving to the Amazon
region in order to have farmland and raise their livelihood; they are engaged in shifting cultivation, and so much valuable tropical rain forest is now disappearing. However, presently six million ha of Cerrados have been changed to farmlands with high productivity. Soil improvement of Cerrados is being undertaken by the cooperative work of Japan and Brazil. Accordingly, Japanese Land Improvement Engineers also must contribute in this work. After soil improvement in Cerrados has advanced, it is expected that the destruction of the Amazon will cease or decrease. Likewise, if poor farmland is changed to rich farmland, it is useful to protect soil from erosion and prevent over-cutting of forest. That is a better way than extension of farmland and shifting cultivation.

Another problem is soil compaction. Recently soil compaction has become a problem of worldwide concern because of (1) larger tractors, tillage, and harvesting equipment; (2) increase in intensive cropping practices; and (3) new lands being brought into cultivation, particularly in the tropics. It is reported that the average weight of tractors increased from 2.7 to 4.5 t between 1948 and 1968, and the average is 6.8 t, with larger units weighing more than 22.4 t at present.

Current research has shown that with larger, heavier field equipment and wider wheels, compaction of soil has increased at depths of approximately 20 cm below the usual tilled zone. This is of particular concern because it is difficult and costly to loosen the soil at these greater depths. Annual loss in the United States from soil compaction is estimated at 1.18 billion U.S. dollars. This loss results from decreased yields and energy cost during field tillage. It is supposed that similar phenomena are occurring in many other countries.

Excessive compaction of soil reduces plant root growth and lowers the rate of movement of water and air through the soil. Because of root restriction, the amount of water and nutrients available to a crop are often decreased. Slower internal drainage impedes water redistribution and drain performance, prolongs the time when the soil is too wet for tillage, and decreases crop production.

Therefore, it is a matter of urgency to improve the degeneration of soil physical properties caused by excessive soil compaction.

Hard pan or hard subsoil layer caused by excessive soil compaction must be softened or loosened by using subsoil tillage equipment or subsoil breaker such as pan-breaker; better still, the softened subsoil can be packed with organic matter. These methods are not suitable for all regions, because the duration of the softening effect is differs with soil type; accordingly, a better way must be sought after various tests.

Also, there are several methods of soil improvement such as soil dressing, tillage mixing, deep plowing, upside-down plowing, etc., which are performed in advanced countries. If these methods are suitable in a region of a developing country, adoption of this method must be pushed forward by financial and technical assistance. Last, the agriculture of many advanced countries is managed with much fertilizer, agricultural chemicals, and mono-culture; consequently farmland soil of these countries is greatly degenerated and polluted. Therefore, we must improve the soil through such methods as soil dressing, upside-down
plowing, crop rotation, etc., to recover land productivity and supply safe foods. Presently the stable supply of the world's food depends mainly upon the advanced countries; accordingly we have to maintain this responsibility, as well as to raise farmland productivity in developing countries by financial and technical assistance.

As mentioned above, soil conservation and improvement must be performed in all regions of the world; however, there are many types of traditional agriculture with various climates and soil types; in addition, soil survey and classification are not performed enough, particularly in developing countries.

Soil conservation and soil improvement must be performed by a suitable method which suits actual traditional agriculture after surveying climate, soil type, and so on with the aim of stabilization and improvement of people's livelihood.

5. Conclusion

Many old civilizations were ruined by deforestation and desertification of land; therefore, we must conserve and improve earth's soils, and so contribute to the survival of the earth and of human being.

References

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