Historical Review on Soil Improvement in Japan

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Since the 19th century, it has ben recognized that soil improvement is important and necessary to increase agricultural production and a large quantity of lime has often been applied to paddy field back in the 1890's.

While the theory of calcium-magnesium ratio was introduced by Aso and Loew (1890), the method of exchangeable acidity determination was established by Daikubara (1914), and the distribution map of acid soil was compiled. In consequence it has been widely noticed that lime application is very important to improve soil acidity.

From 1910 to the twenties, the plan to raise production of self-supplying manures has been promoted by the Japanese Government as one of the indispensable methods for preservation of soil fertility.

On the other hand, seed multiplication and cultivation techniques for some green manure crops such as genge, forage soybean and vetches were studied and investigated at Toyama Prefecture and other prefectural agricultural experiment stations.

From 1932, the setting project of seed multiplication field for leguminous crops, the distribution of cultured nodule bacteria and the increased use of compost have been planned and executed.

In 1939, a project to establish practical fertilization standard for every soil type was started to rationalize fertilizer application. In 1941 slaked lime was replaced by calcium carbonate as calcareous fertilizer. It was not until 1945 that the soil improvement program was effectively pushed by the government and a remarkable effect was obtained year by year.

Soil improvement program for low productive land

As most arable land was devastated to a great extent after World War II, the urgent increase in production of agricultural products, rice in particular, was intensively demanded because of the worst food situation. The soil survey project for low productive land was started in 1947 subsidized by the government in order to clear the limiting factors for the present low productivity of soil which lurked in the background of the unstable social and economical situation as it existed.

To launch this gigantic program, 272 soil surveyers were stationed in all the agricultural experiment stations in Japan and a national organization to conduct soil survey and soil improvement research was established.

Through this soil survey, the distribution of not only Akiochi paddy soil but also that of the volcanic ash soil, heavy metal rich soil, salted soil, extremely poorly-drained soil and droughty soil were mapped.

With the special survey conducted on Akiochi paddy soil, acid soil and Akahoya soil (vitreous volcanic ash soil), the cause and degree of low fertility in these areas were investigated. At the same time the technical and economical probability for the improvement was guaranteed, along with the experimental results in the past, and those results have be-

come the basis for establishing the Soil Amendment Project.

Soil improvement method under Soil Amendment Act

The Ministry of Agriculture and Forestry legislated the law of the Soil Amendment Act to preserve and promote soil fertility in 1952. In the program, a new method in agricultural technical administration known as the Karte system which is a subsidizing system based on the prescription from investigation results, was applied.

The new system was characterized by the cooperation rendered by the research workers and the administrative staffs so that effective results might be obtained. As a result, it became one of the driving forces in the remarkable progress witnessed in the soil improvement program. The following were undertaken for the program.

1) Improvement of Akiochi paddy soil

Generally speaking, Akiochi means that despite the healthy growth of rice in the early half of the rice growing stage, in the latter half the growth of rice plant becomes poor, lower leaves gradually die around the heading stage, and leaves and stems turn dark. Finally the yield estimated in advance is not obtainable. Such paddy soil is called Akiochi soil.

Shioiri (1943) studied the cause for Akiochi and explained that hydrogen sulphide which occurs in the soil under anaerobic condition during midsummer, overcomes the active iron content in the soil, and consequently the root of the rice plant is damaged.

Other soil characteristics as less content of silica and bases than normal, and low nutrient-holding capacity in the soil result in enforcement for degradation of rice plant growth. Akiochi easily occurs in well-drained sandy soil, especially in clayey moderately drained soil. In poorly drained soil excessively accumulated in organic matter, the redox potential of soil is lowered suddenly with the increase of soil temperature in the latter half of the rice growth. Finally Akiochi symptoms appear on the leaves and stems of the rice.

It was found from the soil survey carried out from 1947 that Akiochi soil was distributed in 700,000 ha corresponding to 24 per cent of the total paddy soil. Akiochi soils were divided into 6 groups based on the morphological characteristics, physical chemical properties of soil as organic, poorly drained, extremely well drained, shallow surface and iron deficient soil. The main countermeasures for Akiochi were recommended as follows:

a) Application of iron containing material as limonite, bauxite slag, pyrite slag and iron rich soil.

b) Dressing of clay which contains much iron and bases, and in high cation exchange capacity.

c) Deep ploughing (upside-down of subsoil in well drained soil).

d) Artificial drainage for very poorly drained soil.

e) Dressing of silica, manganese, magnesium and compost.

2) Improvement of acid soil

The cause of acidification of soil and the practical method for improvement have been already studied in 1910. However 2,756,800 ha corresponding to 52.1 per cent of the total arable land, were found to be of acid soil from the soil survey started in 1947. This means that the agricultural technical extension system did not work as expected, and calcareous matter calculated from soil acidity had not been applied. With the establishment of the Soil Amendment Act, the improvement of acidic soil was initiated as planned.

3) Improvement of allitic soil

The study on volcanic ash soil commenced by Seki (1925) and continued by other scientists clarified the progress of research that most soil was allitic, one of the special characteristics of volcanic ash soil. Allitic soil was defined by Shioiri as of high aluminium activity and of positive charge at pH 4. As a result of the survey, it was shown that 20 per cent of the total upland area were allitic and that it was necessary to apply a large quantity of calcium and phosphate to improve these

soils. The agricultural fund for soil improvement as a loan for 92,000 ha of allitic soil was founded for farmers to purchase 225 kg calcareous material and 37.5 kg phosphate fertilizer per 0.1 ha.

4) Subsoil improvement and deep ploughing

The volcanic ash soil underlying a hard pan layer which is causing inferior physical properties for plant growth is widely distributed throughout Japan. The hard pan layer impedes the growth of root and its activity, and moreover has a bad effect on the movement of soil water. The government subsidized farmers under the provisions of the law at a half amount of the price when they purchase crawler tractor and other machinery to improve these soils. Consequently the subsoil improvement project was carried out smoothly since 1960. At the same time, other big-powered agricultural machinery as a wheel tractor was introduced for agricultural mechanization. The project was a step forward in stimulating farmers to purchase 7,000 wheel tractors for a total area of 2,948,000 ha which are necessary for deep ploughing. With this reasonable measure, the situation became favorable for the rapid development of soil improvement.

Fundamental soil survey and its countermeasures project

With the execution of the soil amendment project, a cooperative research group on upland soil fertility was organized in the Ministry of Agriculture and Forestry in 1956. The members from Japan's experiment stations and institutions have conducted a cooperative research through discussions and field works. In 1961, they established a soil survey method for productive classification and proposed the productivity classification system. In 1959 based on this survey method, the fundamental soil survey for the fertility maintenance project was enacted by the Ministry in succession to the Soil Amendment Projects. The 15-year plan started in 1959 by setting the goal at the survey of 4,875,000 ha corresponding to 80 per cent of the total arable land.

The soils in the area were classified into soil series based on morphological characteristics, physical and chemical properties of soil, and into soil classes based on productivity criteria. In the survey, the pedological and edaphological characteristics of the soil, and the main hazard factors for soil productivity have been investigated.

In 1966 the countermeasure project for soil fertility maintenance was promulgated, resulting in the prefectural agricultural experiment stations being equipped with analytical instruments necessary for the project, and agricultural agent offices provided with qualitative analytical apparatus. Through the systematized cooperation of these members, more accurate and suitable countermeasures have been taken for good soil improvement and management.

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