THE SOILS OF HUNGARY NEEDING AMELIORATION

by

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In an earlier publication we have already dealt with the exploitation of natural resources and classified the soils of this country from the point of view of their need for amelioration.

In the majority of cases the suitability of the soil for cultivation is basically determined by the conditions of precipitation. They also determine the quantity and quality of the crop yields. Therefore we showed the territorial distribution of the soils needing amelioration in this country in connection with the territorial distribution of precipitation.

We also described how polyelectrolytes, synthetic material foams, emulsions and true solutions preserve the already formed soil structure and how they influence the air and water economy of the soil (3).

We are going to describe the various soil types according to Stefanovits (4) or the „Methodological Manual of Genetic Soil Mapping on Cooperative Farms" (2), or „Farming on our Sodic Soils" (1).

As we have mentioned, about 50% of the total plow-land area of the country needs amelioration. The soils needing amelioration are:

1. Acid soils
2. Alkali soils
3. Sandy soils
4. Bog soils

As their chemical, physical, and biological properties – in their original state – are very different, we think it suitable to deal with them one by one.

1. Acid soils

A common feature of these soils is that the surfaces ot their colloids are unsaturated, there is much adsorbed H in them, and there is a high H ion concentration even in the liquid phase.

Unsaturated soils, if they contain many clay particles, are difficult to till, they have a bad, puddled structure.

Thus chemical, amelioration of the soil (liming) is achieved not only by neutralizing the acidity harmful to plants but also by the fact that the Ca-containing ameliorating substances replacing the exchangeable H ions bound on the soil colloids exert a favorable effect on the dispersion conditions of the latter and thus on the structure of the soil.

In addition, the effect of liming is very complex: it favors the processes of nitrification, the storage of nutrients, etc.

A considerable part of the costs of chemical soil amelioration is accounted for by the transport charges, which are particularly high in the mountainous regions. One way of reducing the costs is to extend the efficacy of amelioration to as long a time as possible. This purpose is very well served by synthetic materials, some of which can be made on the site, and combined with the ameliorating substance they surely prolong the efficacy of amelioration.

The acid soils of our country (almost 3 000 000 hectares) are made up mainly of acid, brown forest soils and acid meadow soils. The acid bog soils, sandy soils and alluvial soils cover a relatively small area.

Brown forest soils are found over large areas of the country, and as a considerable part of them are in need of amelioration we are going to deal with them in somewhat greater detail.

In a smaller area of the country there are highly acidic, non-podzolized brown forest soils formed on $CaCO_3$-free rock. The organic matter derived from the roots of the undergrowth is extremely acidic: its pH value is 3,5 – 4,0. Even the mineral layers under the „A_1" horizont are strongly acidic, their pH is 5,0 – 5,5. They have ashy crumby structure with generally poor water holding capacity.

Similary small areas are occupied by podzolized brown forest soils which have also developed on $CaCO_3$-free mother rock. It is characteristic of them that under the humified „A_1" horizon there is an ashy gray „A_2" horizon with dust structure. This is the so-called podzolic horizont which is acidic and very poor in nutrients.

The two kinds of soil described above are covered exclusively by natural or replanted forests. According to what follows amelioration with synthetic materials may be of great importance in reforestation.

The largest areas of forest soils in Hungary are clayed brown forest soils much of which has been tilled. They are soils in which the clay minerals of the eluvial horizont are washed down in unchanged from, without decay, into the „B" horizon where they accumulate. In the structure of the profile the „A_1" layer, which may be 10 – 20 cm thick, produces the humus-enriched horizon. This is usually loam with dusty, crumby structure or bound with sand. The „A_2" layer is the eluvial horizont whose humus content is much lower. This layer, when tilled, is often mixed with the „A_1" layer, and the original 5 – 8% humus content found under the forest falls to 1,5 – 2,0%. The structure of this layer is dusty, lower down occasionally plate-like, lamellar; its physical kind is loam or sand with some clay. The pH is here strongly reduced and shows the lowest value in the profile, around 5,0.

Plowlad cultivation of these soils changes not only the humus layer but also the acidity of the soil because both hydrolitic acidity and exchange acidity become reduced. At the same time the pH value of the soil grows, for while the pH value of the eluvial horizon under the forest is 5,0 – 5,5, in the profiles under plowland cultivation it is around 6,0 – 6,5. It often happens that when subjected to plowland cultivation, the „A" horizon is destroyed and the plowed layer is formed on the accumulation horizon „B".

To sum up: our primary task on these soils is to destroy the acidity of the soil and, in order to reduce erosion, to increase the water holding capacity of the surface.

Pseudogleyey brown forest soils in larger connected areas are mainly found in the western part of the country. They are characterized by very great differences between the water conductivity of the eluvial and enrichment horizons. Periodically supersaturation (stagnant water) occurs between the two horizonts in consequence of which anareobic conditions develop and a process of gleying starts in the „B" horizon.

Apart from this characteristic their properties agree with those of the clayey brown forest soils.

A considerable part of the soils of Őrség in western Transdanubia belong here. Their det:rioraticn is first of all due to the climatic and relief conditions, secondly to unfavoruable physical and chemical properties of the soils.
here. Their deterioration is first of all due to the climatic and relief conditions, secondly to unfavorable physical and chemical properties of the soils.

The unfavorable physical and chemical properties can be eliminated by liming and the harmful superfluous water by drainage.

In Transdanubia and the North Hungarian Highlands Ramann's brown forest soils cover large areas. They were usually formed on $CaCO_3$ – containing native rock. Acidulation of the profile is only slight, its pH is rarely less than 6,5. The upper layer consists of small crumbs, contains no $CaCO_3$, and is loam-adhesive.

An important subtype of it is the *rusty brown forest soil of Ramann* formed on sandy basement rock; accordingly its structure in the „A" horizon is loose sand and in the „B" horizon slightly packed sand.

Flow of sand is frequent on these soils and so protection against deflation is very important.

Among the acidic sandy soils of Nyírség and Somogy wider stretches of iron incrustation brown forest soils can be found which have been formed on $CaCO_3$-free sand owing to the influence of forests. This type has got its name from the zigzag ferrous stripes deep in the profile. In these there is no connected „B" horizont in the eluvial layer but parallel compact acidic, colloidal layers at 10–25 cm from each other.

The iron incrustation brown forest soils are, owing to their better water economy, generally more fertile than the sandy soils. As a result of their light mechanical structure, deflation is frequent on them, especially in spring when the plowlands are mostly barren of vegetation and the green crops do not contribute to protection.

In the case of these soils it is of prime importance to make the water economy more favorable and to provide protection against deflation.

The meadow soils have been formed under varied natural conditions and thus there are sometimes very great differences between the different types. They are generally found in the alluvia of rivers, first of all of the rivers of the lowlands (the Tisza, the Kőrös rivers, the Maros), and to a smaller extent of the Danube and other rivers, in depressions between sand dunes as well as in the valleys of the hilly and mountainous regions. They are soils formed owing to the influence of the nearness of the ground water table and they are either $CaCO_3$-containing or $CaCO_3$-free. The chemical properties of the profiles are very varied according to the soil-forming rock. There are profiles that are limy already from their upper layer on, but more often the „A" horizon occasionally part of the

„B" horizont is noncalcic. In such cases the chemical reaction of the upper layers is slightly acidic which does not exclude the possibility that in the case of heavy clay adhesiveness the hydrolytic acidity may be greater than 10. From the point of view of pedological conditions or soil amelioration the alluvial soils are judged similarly. Their amelioration consits in structure development by artificial materials.

From the point of view of amelioration *bog soils* under plowland cultivation fall in the same category. They are formed in the presence of an abundance of humidity. The chemical reaction of moss moor soils (moss peat saturated with water) is highly acidic, around pH 4,0. The *low moor soils* (depressions filled up by organic matter are less acidic, their pH value is rarely below 5,5–6,0. In the case of bog soils hyrolytic acidity may be very great (around 100) owing to the great degree of cation replaceability of humic matter.

2. Alkali soils

About 1 million hectares of the arable land of the country can be qualified as alkali soil. (Of this about 1/2 million acres are non-calcic, acid, and nearly neutral alkali soil).

By alkali soils generally soils are understood in the formation and character of which waters-soluble salts, namely sodium salts, play a decisive role.

Alkali soils are of several types and subtypes with very many varieties. The degree of alkalization, the accumulation of salts, the thickness of the „A" horiton, the position of the „B" horizon, etc., all play a decisive role from the point of view of alkalization and agricultural utilization. They agree more or less in that they are hard to till, they are compact; if they contain many clay particles they become crevassed when dry and dissolve and disperse when wet. Their water economy is very unfavorable, stagnant water pools are common on them.

Their amelioration — depending on their character — can be effected in several ways:

a) Non-calcic, acid, and near — neutral alkali soils: A common feature of the soils belonging in this category is that to a smaller or greater depth they do not contain $CaCO_3$. Their pH value is below 7,5. From the acid alkali soils with less unfavorable properties both the salts and the Na of the absorbing complex have begun to be eluted, thus the upper layer has become asid, i. e. unsaturated. In the absorption complex of the near-neutral alkali soils the accumulated Na ions play an important part.

b) Non-calcic, alkalescent alkali soils:
Here belong the non-calcic alkali soils whose Na-saturation is so great that heir pH is above 7,5. The salinity of the soil profile in the plow layer varies between 0,1–0,2% and increases toward the subsoil. On such alkali soils it is necessary to add also acid amelioratiors to facilitate the solubilization of lime.

c) Basic and/or limy sodic alkali soils:
Limy alkali soils are highly basic (alkaline their pH being higher than 8,2–8,3 often reaching or exceeding 9,0. In these soils Na is clearly predominant in the soil solution. Applying the above-mentioned facts to *genetic soil types:* liming and loessial subsoil spreading can be used for the amelioration of solonetz-like meadov soils, medium and deep solonetz meadow soils.

Loessial subsoil + acid upper layer and lime + gypsum spreading can be used for the amelioration of columnar, shallow, medium meadow solonetz soils. The columnar, shallow solonchak-solonetz soils can be ameliorated only in patches with acid substances.

3. Sand Soils:

Of the three extensive sandy areas of our country in the land strip between the Danube and the Tisza, Somogy, and Nyírség approximately 1,5 million hectares need amelioration.

The elevated sandy plain between the Danube and the Tisza is generally limy, the lime content decreasing from the Danube toward the Tisza while the sandy areas in Somogy and Nyírség are acid. Liming of these soils is always of doubtful value and other methods of amelioration should be considered.

It is well known that the water and nutrient economy of the sandy soils is bad, and their amelioration is a primary task because it is in this way that the conditions of successful agricultural production on them can be ensured.

Now known means are:

a) Dung (medium ripe)
b) Bentonite, fen clay, peat
c) Clay minerals, special ameliorating substances
d) Various composts
e) Deepmanurig, green manure

4. Bog soils:

About 100 000 hectares of bog soil of this country need amelioration. Amelioration of the bog soils is a very hard task and work on this project is constantly in progress.

In the case these soils first of all problems of water economy have to be solved. Besides this the anaerobic processes in the soil must be áltered favorably and the decomposition of a large amount of organic matter must be controlled and utilized. (Bog soil exploitation.)

Besides consideration of the chemical, physical, and biological properties of the needing amelioration we must deal briefly with the soil-forming factors under whose influence the soil is formed and changed.

The mother rock, climate, relief, the evolution of the landscape, its flora and fauna, together with human activity produce the physical, chemical, and biological forms of the soils and their variability in space and time.

The soil temperature, water economy, salinity conditions, and aeration are of decisive importance. Other properties are important only as far as their effects can modify the soils.

The granulometric composition of the soil is determined by the physical and chemical processes taking place in the mother rock. At the same time an interaction is demonstrable, namely the granulometric composition influences the physical and chemical processes. The effectiveness or ineffectiveness of the interactions manifests itself in the productivity. In the final analysis the necessity of amelioration is determined by the productivity.

Heavy soils are generally richer in minerals such as feldspar, mica, calcareous rock, iron and many other compounds than light sand is Solubility of the different particles in heavy soils facilitates the the supply of the requirements of plants. In sandy soils there is usually only a small amount of mineral salts. The absorbing capacity of argillaceous soils is much better than that of sand. The amount of residual soil solutions is always determined by the size of the soil particles.

Heavy soils contain considerably more dampness than sandy soils. Water adsorption in the soil is always a function of the soil structure. Heavy soils ensure the capillary rise of water better than loose sand. The water permeability and degree of aeration of heavy soils are smaller than those of sand.

The puddled structure of heavy soils may hinder the supply of oxygen as well as the development of the roots of plants. At the same time the conditions of aeration may be unfavorable for plants. Heavy soils warm up and cool off more slowly than sand soils do.

Besides the afore-mentioned properties of the soils the alteration products in the soil, play an important role. The composition, amount, and properties of humus depend on the climate and the vegetable or animal substances from which it is formed. Accordingly there are considerable quantitative and qualitative differences between the humuses of forest, meadow, and grassland soils. Humus plays an important part in the development of the soil structure; if it can ensure a durable structure in some soil, it improves in the conditions of salt supply, aeration, water and heat economy.

Structured soil is looser than structureless. Heat, water, and air penetrate into the loose soil more easly, the large pores fill with water, and after seeping down, the water nourishes the plants for a long time.

Soil water is an important ecological factor, because it is a supplementry source of humidity. But this source of humidity may be useful or harmful, depending on the climate. If the soil water contains large quantities of harmful salts, it can itself be considered a harmful factor.

The thickness of the soil as an ecological factor indicates the depth of the mother rock. The soil-forming processes are generally active in a thin layer of the mother rock, and the roots of plants penetrate deeper only occasionally. The smallest soil thickness indicates the first stage of transformation or the hindering effect of climatic conditions. The biological weathering of different kinds of rock can be observed and even artificially accelerated. Simultaneously with biological wearing away physical and chemical weathering takes place.

The chemical character of the soil is determined by its mineral composition, the chemical and granulometric composition of its organic constituents, their physical properties, and the totality of the soil-forming factors.

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