Recultivation Research and Its Implementation in Hungary.

Dr. Gábor Solti, February 2003

Due to the development of the Hungarian mining sector, the situation of dump sites has come into the limelight. Apart from their often enormous damaging environmental effects (dust, ground water, living water, pollution, health risks) research has also been directed to their reutilization.

Domestic research and their applications carried out independently by different institutions were summarised at a conference in October 1984 sponsored by the Plant Protection and Agricultural Chemistry Centre of the Ministry of Agriculture and Food Industry (MÉM-NAK), the Research Institute for Soil Science and Agricultural Chemistry of the Hungarian Academy of Sciences (MTA-TAKI) and the Soil Science Association of the Hungarian Society of Agricultural Science (MAE Soil Science Association). The ten lectures of the main event were published by Agroinform in a volume in 1985.

Although nearly two decades have elapsed since the conference, part of its message is still valid and useful.

Sebestyén Tóth summarised the main economic aspects of setting up dump sites and their perspective use. In his paper he emphasised that the destiny of topsoil and sedimentary rocks covering the mining site which can be made fertile had to be decided as early as the opening of the mine. He uses a model calculation to illustrate how much macro-nutrients could be saved if the layers of brown forest soil of varying thickness containing humus, were exploited and reused.

He gives international (English, Bulgarian, East-German, Soviet) examples for the utilisation of the humic topsoil.

The author emphasises the importance of the re-utilisation of the humic topsoil and draws the attention to the complex nature of setting up dump sites from an economic point of view.

György Várallyay, member of the Hungarian Academy of Sciences and his colleagues performed the land evaluation of a recultivated dump site.
When evaluating the habitats of the recultivated areas the following factors were taken into account: the microrelief of the earth's surface, amount of coarse soil particles, physical soil type – layering – water regime characteristics, measure of acidity, carbonate and humic content. Based on the authors' "land evaluation guidelines" evaluation of dump sites can be performed according to uniform standards.

János Oláh introduced recultivation technologies and the lessons learned from their implementation on the country's largest dump sites (194 hectares). The advantages of the combined rapid recultivation are the following:

1. Selective removal and laying back of the surface soil, the application of flue ash or other large bulks of materials, as well as the application of pioneering plants – prescribed for the traditional recultivation methods – are not necessary. These procedures require a lot of time and drive up costs.

2. In the first year a connected green surface has to be provided. This, at the same time, serves environmental protection needs as well i.e. protection against soil and aeolian erosion. Special technological processes and earthworks are not required.

3. In the second year – following the first stage of recultivation – an agricultural production, identical to that which based on the old growing areas can be ensured, plantations can be made on the refuse dumps of mines. In 4-5 years the opencast refuse dumps reach full productivity.

4. During the recultivation livestock manure is not used. The bioactive organic fossil products – based on lignite, brown coal, etc. – necessary for the combined recultivation can be continuously and easily manufactured, at little cost on the site, using the by-products of mining.

5. In case of traditional recultivation the quantity of material required and needed to be conveyed and arranged, etc. reaches 10,000-20,000 tons per hectare. In case of combined recultivation the material requirement, and material conveyance and arrangement, etc. requirement are:
   - 10-40 tons per hectare for non-toxic refuse soil,
   - 50-100 tons per hectare for "toxic" refuse soil.

6. The combined recultivation can be performed with traditional agricultural power machines and equipment's, it does not require novel and sophisticated machinery.

7. The combined technical and biological rapid recultivation method for refuse dumps of opencast coal mines can also be used for recultivating the refuse dumps of other opencast and underground mines, as well, and for restoring the productivity of infertile lands or lands of reduced fertility (eroded, damaged by aeolian erosion, etc.) in a fast and cost-efficient way.

József Szegi studied some of the soil science aspects of recultivation. The author gives a detailed account on biological recultivation, the formation of soil structure, the limits of more extensive application of recultivation by increasing the humus content and the role of living organisms on refuse dumps. In his summary he concluded that recultivation is a very important tool of agricultural and environmental policy. Regarding recultivation it is paramount to think in regions. Scientists and experts have to make joint efforts to preserve our natural treasures, and at the same time draw up efficient and economical recultivation methods.

József Krisztián and **László Hangyel**, researchers of the Kompolt Research Institute at the Gödöllő Agricultural University published the results of the recultivation performed on the Ecséd and Visonta dump sites, situated not so far from each other. Opencast coal-cutting facilities situated on the southern spurs of the Mátra mountains and on the southern side of the Bükk mountains, respectively, damage regions with flourishing vineyards and orchards, where growing has great traditions.

Their findings proved that refuse dumps of the opencast mines in question do not contain toxic substances, therefore following the completion of technical recultivation they can be directly utilised to cultivate field crops, orchards and vineyards without the selective exploitation (removal) of the humic topsoil, and the application of the combined recultivation method. The possibility of utilization were proven by the actual growing yields and experiments performed on both the Ecséd and Visonta dump sites.

Apart from the extremely low level of nutrients and unfavourable physical characteristics refuse dumps have a useful attributes, i.e. high, up to 20% carbonate content. These characteristics have to be taken into account during the process of utilisation in order to fulfil the nutrient supply-needs of plants and other agronomic needs.

Due to the high carbonate level dump sites are most appropriate for perennial calciphilous papilionaceous plants. Seed growing is especially effective, which – apart from the high calcareous content – can be explained by the poor nitrogen

supply of the surface, and also by the fact that these areas are not contaminated by dodder and pestiferous insects.

Permanent use will result in slow improvement of physical characteristics of refuse dumps, by increasing the level of phosphorus and that of potassium.

Use of various by-products and wastes, especially public sewage sludge may contribute to the fertilisation of refuse dumps making recultivation more economical.

After the first three years of the experiment planned for six years, performed in the Visonta stone-pit with a total amount of 240 tons per hectare centrifuged dry matter it can be established that as a result of the sludge doses

- average yield, nutrient content and quality of the plants improved
- the nutrient supply in the refuse dump increased, its water regime characteristics became more favourable.

Taking also into consideration the environmental protection aspect, based on the data gained so far, the 40 tons/hectare/year dose seems to be the most suitable for practical technological implementation among the 40-80-120 tons/hectare/year dry matter treatments.

Sebestyén Tóth and his wife investigated the economic aspects of recultivation research examining opencast coal mining in the region of Northern Hungary. Within the frame of the research they analysed the yields of field crops cultivated with the utilisation of fertilisers. With the use of a total 281-536 kg/ha NPK effective fertiliser substance the average yield of cereals was 1.77-3.48 tons per hectare. In years with more favourable precipitation and nutrient supply a yield of 3.0-3.5 tons per hectare could be reached. However when less favourable nutrient supply coupled with a lower level of precipitation, the yields declined as well.

Sebestyén Tóth examined water utilisation characteristics during biological recultivation of refuse dumps. Having examined sixteen plant species (cereals, papilionaceae, vegetable plants) he ordered the plants based on water utilisation. Winter barley, setaria, the mixture of ryes and vetches, spring barley, bird’s-foot trefoil, rye and alfalfa offered the best GE result, that is 4.0 kg/mm/ha without fertilisers on the surface of refuse dumps.

Ibolya Vörös Nagy and her co-authors examined and compared recultivation methods used on the dump site in Visonta. They divided the currently used recultivation methods into two groups, on the basis of whether soil coverage with humus is applied or whether the conditions of soil formation and soil evolution are to be provided on the bare surface of the site. While in the first case minor damage is done to the microbe population, in the second both soil genesis and the formation of microbe population start from zero.

Among the overlaying rocks of the opencast lignite mine of Visonta, experiments were set up with clay, sand and flue ash, with or without surface soil coverage. Nutrient supply was provided by fertiliser, mixture of fertiliser and lignite and sewage sludge. The experiments proved that life in the soil formed and biological processes of soil formation started instantaneously in the initial phase of the recultivation, which were indicated by measurable cellulase activity.

Jan Kostruch demonstrated soil preparation and recultivation methods used for refuse dumps of coal-fields of Czechoslovakia, and illustrated those by examples. While Hungarian recultivation examples are from refuse dumps of Pliocene lignite, coal-beds of the Ostrava-Karvina coal-field in Czechoslovakia are significantly older. During the recultivation they covered the area 0.3-2.3 meters thick with new topsoil which was had been previously removed and stored.

As a result of planting experiments performed with several tree and shrub species it was established that species growing naturally near the site as well as certain exotic species can be successfully cultivated on the dump site too. In the Ostrava-Karvina coal-field practically all trees appropriate for planting are deciduous, except the larch-tree, being the only coniferous species. This can be explained by the high level of air pollution. In order to determine the most favourable plantation method the plantation was made into pits, with a pit size of 1.0x1.0 meter.

The plantation was performed without mixing in humic surface soil, with the utilisation of 5 and 10 kg of surface soil, respectively. The following species were planted: Fraxinus excelsior, Quercus robur, Q.petraea, Acer pseudoplatanus, A. platanoides, Ulmus glabra, and as catch-crop and protective crop: Betula verrucosa, Prunis serotina, P. padus, P. avium, Crataegus monogyna, Rosa rugosa, Tilia sp.

It was established that in the third year following the construction of the refuse dump cuttings can be planted, since materials of the refuse dump decrepit rapidly in the

surface layer due to the climatic conditions. In the case of plantation into pits the mixing in of humic surface soil is not necessarily required, although by portioning 5 kilograms of humic soil the rooting percentage becomes more favourable and the development of plants are more powerful in the first year following the plantation. In the second year after plantation, however, a difference between the plants planted with and without humic soil cannot be noticed. The 5 or 10 kilograms of humic soil portioned into the planting pit did not cause differences in the growth of the plants over the long run.

For planting the most suitable are the 3 or 4 year-old nursery propagating materials, and 2 year-old in the case of oak and alder. The saplings to be planted should have well-developed root structure and they cannot be longer than 75 centimetres. Excellent results were reported for the Oregon alder, but the examinations remained in an experimental phase due to the lack of seed. This method could be applied successfully in case of other tree species too.

Care of the planted trees and shrubs is provided by grass cutting and loosening of the soil twice a year, to be performed on the forested area during two years. In order to prevent damage done by game trees are coated by a protective substance. Beginning from the second year a fertiliser dose of 250 grams should be dispersed per year and per tree. The afforested areas are usually handed over to the state forestry authority that ensures further handling of the plantation.

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Tree plantations with starter have been going on since 1977 using alginite, the algal rock discovered in Hungary in 1973. (Solti G. 1987: Tree plantation experiments with alginite starter. – Manuscript).

During the recultivation of a dolomite stone-pit an experiment with alginite and the mixture of alginite and bentonite was set up. The walls of the closed stone-pits on the main tourist areas of the Balaton Uplands are very sloping, therefore they are exposed to erosion, and due to the lack of nutrients the vegetation cannot start at all, or only after a long while.

In general the efficiency of the artificial plantation is insufficient as well, the settlings are imperfect and die out later due to lack of nutrients. In order to eliminate this deficiency we set up an experiment where we wished to use alginite and bentonite partly as a starter, and partly as a material seeping into the soil to provide the appropriate nutrient supply during the development phase of the roots.

For the implementation of the experiment we chose the exploited stone-pit of Gyenesdiás. The area is explicitly dolomitic, its nutrient content is minimal. As regards its location it can be found in a basin, therefore the temperature and the heat due to the light-reflecting effect of the dolomite are increasingly felt due to the deterioration of air.

When planting the pine samplings alginite, a mixture of alginite and basalt bentonite, the suspensions of these and fertilisers were used as starters.

The detailed evaluation of the experiment was completed with abundant photo illustrations. Due to the extremely dry weather the experiment did not provide good results, however, it could be established that in the case of alginite and basalt bentonite treatments the samplings were apparently more developed than in the case of alginite treatment.

During the recultivation of this dolomite stone-pit extremely exposed to erosion and weather conditions it was proved that using alginite as starter for tree planting provides favourable results.