The development of drainage in Hungary

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1 Historical evolution

The history of drainage in Hungary goes back to the last century, when it was closely linked to those immense works of river regulation and flood protection which have transformed the Hungarian Plains from wetland to a fertile agricultural area. The proprietors of land that was no longer exposed to flooding, formed polder societies for the construction of drainage systems in order to remove also excess precipitation from local origin. This was necessary since the natural drainage of these areas through dead river branches and channels was cut off by the construction of dykes, so that canal networks had to be dug and their collected water to be lead, or lifted into the rivers. As potential evapotranspiration in these plains largely exceeds precipitation, and the supply of external water from the flooding rivers had been excluded, the groundwater table has generally sunk well below the root zone. The constructed drainage canals did not therefore serve in the long run for groundwater level regulation, but rather for relieving the arable land of logging surface waters originating, mainly in the spring period, from unfavourable infiltration conditions of the upper soil layer. This defined for about a century the objectives of drainage which was exclusively performed by open canals.

With increasing demands from agriculture for reducing, both in extent and in duration, harmful waterlogging, denser networks (expressed in km/km^2 values) of larger canals with greater capacity pumping installation (expressed in l/sec/ha values) have successively been realized.

However, this intensification of the drainage capacity reached its own limitations, when the large scale mechanization and chemicalization of agriculture in the last two to three decades presented qualitatively new demands on drainage. Large scale farming requires that the plots of large size should show uniformly favourable conditions with regard to timely cultivation with heavy machinery, i.e. no waterlogged or soaked soil patches could be tolerated. This means on the one hand that the drainage of heavy soils today has to secure, besides the removal of surface waters, a favourable regime of soil water throughout the root zone. On the other hand, it became evident that since the given sizes of large plots the density of the open canal network was limited, and no further increase of the l/sec/ha drainage capacity would solve this problem.

The requirement of forming big plots with uniformly favourable soil water conditions has drawn attention to the idea of providing subsurface drainage for the logging surface waters. This has lead to the introduction of pipe drainage, primarily for soil water regulation and aeration, and only at very few places for groundwater level lowering as the latter lies generally deep enough. Pipe drainage, as a required supplement in certain areas to the country's generally intensive surface drainage systems, has thus gained space and its further development can be expected.

The development of the country's drainage systems in the last decades is shown by the data of Table 1, and the development of pipe drained areas within the same in Table 2.

Table 1 The development of the country's drainage systems in the period 1960-1980

Year	Total length of drainage canals (km)	Total capacity of drainage pumping stations (m^3/sec)	Specific drainage capacity (l/sec/ha)	Drainage water storage capacity (million m^3)
1960	24 900	443	0,16	150
1965	27 700	503	0,22	180
1970	32 800	618	0,24	232
1975	36 000	645	0,26	260
1980	42 000	690	0,29	300

Table 2 The development of pipe drained areas within the country's drainage systems in the period 1977-84

Year	Area (ha)
1977	4 452
1978	5 427
1979	7 078
1980	6 393
1981	10 635
1982	14 117
1983	19 559
1984	21 184

2 Drainage criteria in relation to various types of land use

As can be seen from the foregoing, the fundamental reason for drainage in Hungary is the harmful saturation of the root zone that occurs temporarily under certain meteorological conditions, and has in general no direct relation with the rather deep groundwater table. This also defines the drainage criteria in relation to land use: in agricultural areas the plant's tolerances to excess waterlogging on the surface and/or saturating the root zone, define the drainage criteria. This recognition has lead to practical research on the matter, performed primarily by VITUKI, the Research Centre for Water Resources Development, in the Mirhó-Gyolcs experimental basin, which resulted in tables giving percentage losses for various crops exposed in different months of the year during different periods to excess water.

Knowledge of the tolerance of crops to excess waterlogging on the surface or saturating the rooting zone, has provided the planners of drainage facilities with sufficient information for their work.

On account of this information, the drainage criteria have been expressed by the number of days within which excess water should be eliminated. Under the prevailing hydrological conditions this has lead to a required drainage capacity around 0.3-0.4 l/sec/ha, a value that has by and large been attained in the country's flat areas. However, to render this drainage capacity effective in all parts of the large plots used in present day farming, supplementary pipe drainage proves useful, as explained above, and a decision for the latter is based on the characteristics of the soil.

3 Machines and materials used in constructing drainage systems

The open canal drainage systems of the country are the results of historical development. The bulk of the canals were dug by manual labour in the past, but their extension in the past decades was realized with various types of hydraulic excavators.

For the pipe drain systems that gain increasing importance, exploratory work helped to find effective and economic solutions. Pipe drainage that serves for soil water control and aeration, requires loose backfill material above the pipes; additional subsoiling and/or mole drains are also required.

After an initial period in which tile drains were used, the use of polyethylene pipes with proper filtering has gained increasing importance. With regard to backfill material, various experiments on mixing sand, ash, perlit, organic remains, etc. with the earth used for backfill have shown good results. Concerning the material for pipe drainage, considerable literature as well as officially established standards are available in the country.

It is evident from the foregoing that properly prepared backfill material plays a crucial role in soil water regulation and aeration. The execution of drainage systems will consist of opening trenches, laying down the filtered pipes and filling back the properly mixed earth above them. This implies that machines which can be practically used in these operations, various types of trench opening and pipe laying-machines, earth mixing and refilling machines, as well as those required for complementary mole drainage and subsoiling are important for pipe drainage in Hungary. Trenchless drain laying machines can effectively be applied in the country only at those relatively rare places where the harmful saturation of the rooting zone is caused by seepage. In areas with waterlogging due to inundations, trencher machines can be used.

The greater part of the used machinery has been imported, and only some of the complementary equipment is manufactured in the country. Imports came from the Soviet Union, the U.S.A., the GDR and, more important, the FRG with Hoes Super Gigant-523, Gigant-585 and Super-Dränpflug 783 and the Netherlands with Draientie D 16 as the main types of imported machines. Connections with the Dutch Steenbergen company gained importance in the past years and widened the range of available drainage machines.

4 Cost development of drainage

When drainage activities in Hungary were started, mainly in the 19th century, it was a necessity to convert marshlands to agricultural areas, and cost was hardly taken into account. Such considerations came up in the 1950's, when the level of drainage had become high enough to raise questions of economy. Then a method was elaborated for determining the 'economic specific drainage value' of drainage systems expressed as q in l/sec/ha. On the one hand all the drainage facilities such as canals, their pertaining structures and pumping station, were dimensioned with $q_1, q_2, \ldots q_n$ specific values and the involved costs were calculated. On the other hand, detailed investigations were made as to the damages due to waterlogging which would still occur for the same q values. Cost-benefit calculations performed for the $q_1, q_2, \ldots q_n$ values have finally determined the optimum degree of development. The consulting engineering firm VIZITERV, specialized in hydraulic design, is applying in its practice a method based on the same principles.

In order to lower the cost of pipe drainage, the aim is to utilize the imported machines as much as possible to render their purchase profitable. Owing to the character of drainage problems in the Hungarian Plains, it is important to provide aerating-type pipe drainage to those areas only where significant amelioration of the farming conditions can be expected. The 'benefit' side of the cost-benefit investigations should therefore be studied with great care, in order to avoid misleading results concerning the economy.

5 Project organization and management

In Hungary drainage activities are considered as a part of the complex amelioration measures to secure optimum farming conditions. These measures include, besides drainage, physical planning, soil improvement and soil protection. Drainage itself is interpreted in the broad sense described above, including open canal systems, pipe drainage, mole drainage and subsoiling. These works belong to the competence of OVH, the National Water Authority for the water side and MEM, the Ministry of Agriculture and Food Industry for the farming side, whose close co-operation for the implementation is foreseen.

Effective organization and management of drainage projects is executed on three levels. The state is providing the main drainage systems, the system of main canals with their structures and pumping stations, for which the responsibility belongs to the National Water Authority, and the Regional Water Authorities under it. The second level consists of the polder societies, constituted by the interested parties such as state farms, agricultural co-operatives, etc. of the subregion or polder. They are responsible for inter-farm drainage facilities, secondary canals with their structures and stationary or mobile pumping equipment, and for works requiring greater investment, like the purchase of machines and the execution of pipe drainage. The third level are the land owners such as state farms, agricultural co-operatives, etc., who must secure the drainage of their individual plots by constructing the tertiary canals, subsoiling, etc. in co-operation with the polder society. A higher level in this hierarchy also means supervision of the work done at a lower level. The Ministry of Agriculture and Food Industry is also closely linked to these works, mainly to help in planning farm activities by its specialized agency responsible for plant protection and agrochemistry (MEM-NAK).

The costs of works at each level are borne by the same level, the state, the polder societies, and the land owners. However, state subsidies can also be granted to lower levels, if their own funds are inadequate to complete vital works. Subsidizing is generally planned to stimulate own initiatives and to supplement own investments at lower levels.

6 Maintenance of drainage projects

Since the responsibility for drainage activities is distributed among three levels, the maintenance of the installations also remains their task. The maintenance requires at all levels an annual budget and proper machinery for implementation. As for the state level, the Regional Water Authorities are provided with the required funds to buy dredging machines, ditch cleaning machines, etc. and to secure by regular maintenance the proper functioning of the main drainage systems. The polder societies, which procure in increasing numbers machines of their own and together with the farm level who look after the tertiary installations, provide for the maintenance of the canals, structures, etc. that join the main drainage systems.

The machinery used for maintenance includes special complementary equipment for application with universal tractors such as grading, dredging, mowing, cultivating, etc. and with hydraulic dredging machines. Further, special floating machines are used for mowing the vegetation in canals, others for removing silt from the canal bottom by hydromechanization. Some of these machines are imported from the Netherlands, Poland, etc. but many of them are manufactured in workshops belonging to the National Water Authority.

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