THE REASONS BEHIND INADEQUATE DRAINAGE AND SOME METHODS OF SOLVING THEM

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Abstract

The most frequent problems behind unadequate drainage in Finland are the malfunctions due to soil compaction. Disrupting the compacted layer with blind inlets over the existing drains has been a successful and economical method compared to laying new drains between old drains.

The past rainy years have arisen a rather active discussion about the malfunctions in underdrainage. Because subsurface drainage is a fairly large investment even the slighfest doubt about it's reliability will easily make the farmers hesitant. In order to assist the drainage design and to make the function of drainage more reliable a research was started in 1981 at the Department of Agricultural Engineering, University of Helsinki. The object was to find out the reasons which have lead into drainage malfunctions.

Most frequent problems were compaction difficulties, iron ochre and siltation. In most cases (40,3 %) these reasons prevented water from reaching the drains.

Table 1. Percentage distribution of effects of malfunctions in underdrainage.

Water cannot flow through the outlet	3.5 %
Water does not flow in the pipe drain	22.4
Water cannot flow into the pipe drain	15.5
Water cannot reach the pipe drain	40.3
Other	18.3

The most significant problem was the soil compaction especially with clay and peat soils. Therefore in the successive research different methods of disrupting the compacted layer has been studied as an instant amendment. This procedure must be followed by suitable cultivation methods in order to avoid further compaction.

On fields where compaction problems have caused drainage problems following methods were studied:

1. Laying new drains between old minor drains
2. Laying new drains with gravel backfill up to the surface
3. Laying new drains with blind inlets made of gravel
4. Blind inlets over the old drains
5. Trenches filled with gravel

The methods of solving the drainage problems have been on trial on fairly homogeneous and level sites. The subsoil about 25 cm below the surface has most frequently been muddy or heavy clay. On the experimental fields the drainage problems have usually appeared as soon as 2-4 years after the underdrainage has been carried out. Compaction in subsoil as well as in backfill hinder water from reaching the pipe drain, which is usually in perfectly good shape. Drainage problems have always delayed the seeding, causing the crop to ripen later. Therefore harvest becomes more complicated and some of the crop will remain unharvested.

In Fig.1. is shown one of the experimental sites on which different methods of solving the drainage problem were studied. The site includes 16.7 ha which has been underdrained in the mid 1970's. The first drainage problems appeared as soon as 3 years after the drainage was carried out. The minor drain spacing was 16 m and the average depth 100 cm. In order to solve the problem in the drainage system A new minor drains were laid into every second minor drain spacing. In addition blind inlets of gravel were made in 20 meter intervals. In the system B new minor drains were laid in every spacing and blind inlets were used in 20 meter intervals as well. The new systems were carried out in such a way that it was possible to register the drain-flow in the new and old systems separately (Fig.2). In the drainage system C blind inlets of gravel were added over the old minor drains in 12 and 20 meter intervals. The blind inlets were made with an excavator digger and gravel consumption was about 1 m3 per blind inlet. In the systems D and E different sizes of blind inlets were studied. In the drainage system E inlets were laid in 10 meter intervals with the excavator digger as in the system C, in total 47 blind inlets per hectar. In the system D inlets 35 cm in diameter were laid with a tractor mounted post-hole digger. Inlets were made with 5 meter spacing about 100 inlets per hectar and gravel consumption was about 0.1 m3 per inlet. Gravel consumption per hectar was in the system D about 10 m3 and in the system E close to 50 m3.

In the drainage system F about 50 cm deep and 14 cm wide trencheswere laid in 8 meter intervals. The aim was to dig the trenches in straight angle to the old minor drains. Since the work was carried out in summer 1986 there are no results as yet available.

The efficiency of the improvements

The efficiency of the improvements have been studied so far during two growing seasons since the improvements were carried out. Accordingly these results are given by way of reserve because the bulk density in the trenches is still lower compared with surrounding subsoil. During this short period compaction in the trenches and siltation in the blind inlets is not very likely. The efficiency of the drainage systems were analysed by studing the moisture content, drainflow and carrying capacity of the fields.

Drainflows in different drainage systems were not registered continuously during the drying process and the momentarily results are consequently questionable. In an efficient drainage system the drainflow can be very high immediately after a rainfall or melting of snow. On the contrary a poorer percolation rate causes the drainflow to even out for a longer period. The soil moisture content at the seeding represents fairly well the efficiency of the drainage system provided that the soil textures have the same water storage capacity and percolation rate.

Table 2. Average soil moisture content in the studied drainage systems

Date	System	Moist.cont. %	Deviation	Freq.
23.5.1985	A topsoil	32,91 *	2,23	12
	subsoil	33,19 *	0,95 *	12
	B topsoil	31,68	0,49	8
	subsoil	32,61	1,33	8
	C topsoil	30,25 *	1,25	8
	subsoil	30,90 *	1,86 *	8
24.9.1985	A subsoil	35,80 *	2,13	8
	B subsoil	35,71 *	1,69	8
	C subsoil	33,25 **	1,57	8

Soil moisture content in the drainage system D, where only blind inlets were added, was lower than in the systems A and B with new minor drains (Table 2). The difference was statis-

tically significant both in spring and autumn measurements. On the contrary new minor drains did not seem to have any effect on the average soil moisture content. In the system B the moisture content was however more uniform than in the system A (deviations in Table 2.)
Observations made of the drying process in the spring confirmed the results of the measurements. At the harvesting time the carrying capasity of the field A was lowest between minor drains where no new minor drains were laid. Since the blind inlets in the systems D and E were made in early summer, no reliable results are available. These systems will be studied starting summer 1986 in order to confirm the effects of the improvements during a longer period.

Of the improvements, the new complete drainage system with the blind inlets in short intervals seems to be quite reliable when working with mineral soils. Almost as effective are the blind inlets of gravel over the existing drainage system. Twenty meter spacing seems to be adequate since no difference was discovered between 10 and 20 meter spacing. Adding blind inlets of gravel in the existing system will cost about 50 % less than laying a new, complete drainage system. New experiences of gravel filled trenches may rander an even cheaper method for solving less effective drainage systems.

Figure 1. The layout of underdrainage system at the experimental site in Urjala

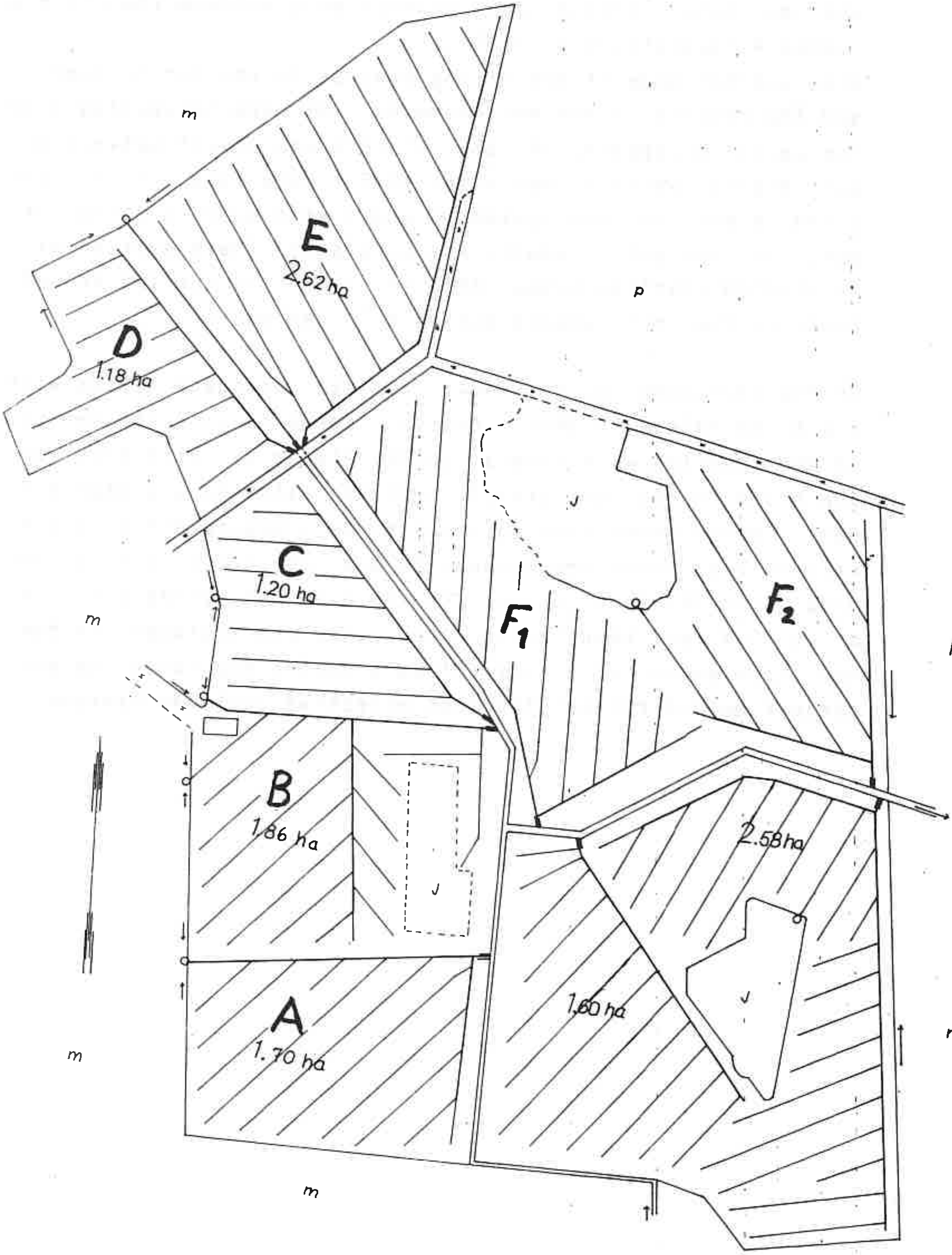
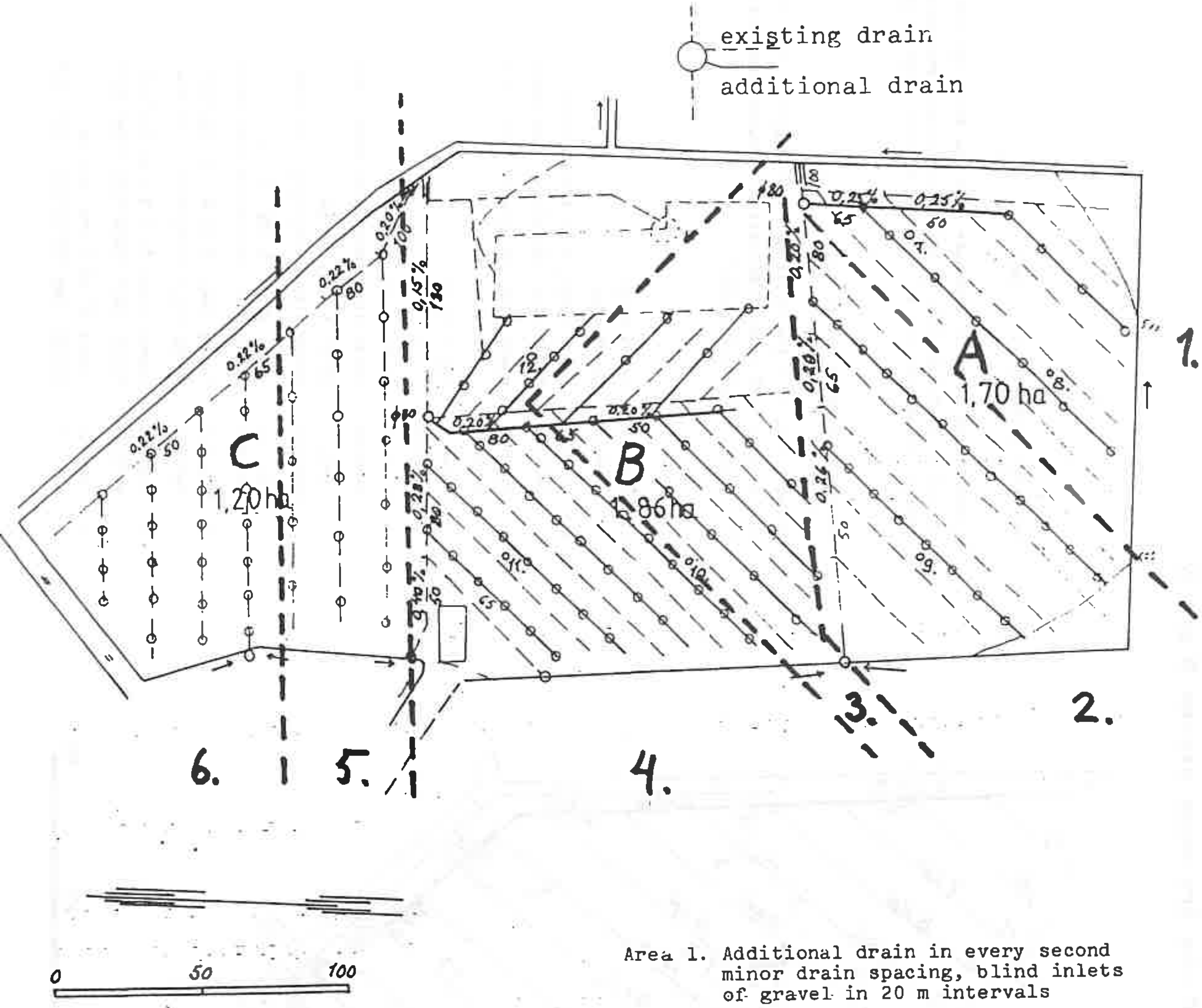


Figure 2. The layout of the drainage systems A, B and C



Area 1. Additional drain in every second minor drain spacing, blind inlets of gravel in 20 m intervals

2. Additional drain in every second minor drain spacing, blind inlets in 12 m intervals

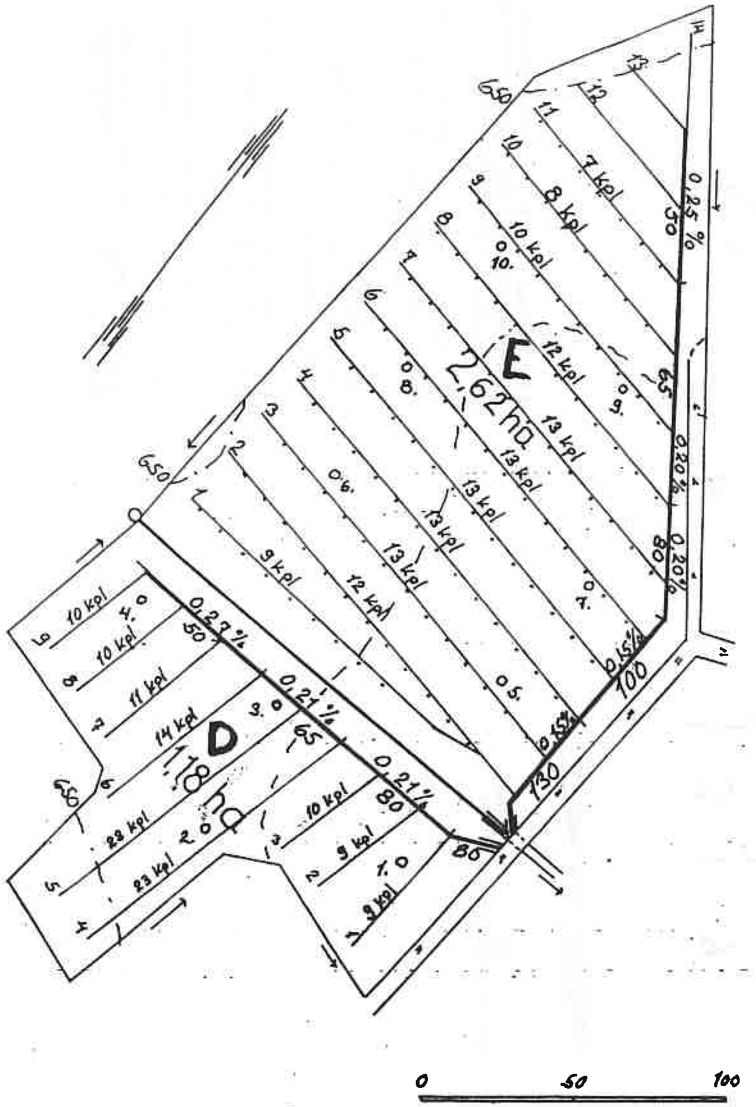
3. Additional drain in every minor drain spacing, blind inlets in 20 m intervals

4. Additional drain in every minor drain spacing, blind inlets in 12 m intervals

5. Blind inlets over the existing minor drains in 20 m intervals

6. Blind inlets over the existing minor drains in 12 m intervals

Figure 3. The layout of the drainage system D and E



DRAINAGE SYSTEM D (1.18 ha)

Blind inlets 35 cm in diameter over the existing minor drains 1 - 9 in 5-6 m intervals, 119 in total (100 inlets per hectar). Gravel consumption 0.1 m^3 / inlet. Tractor mounted post-hole digger.

DRAINAGE SYSTEM E (2.62 ha)

Blind inlets over the existing minor drains 1 - 11 in 10 m intervals, 123 in total (47 inlets per hectar). Gravel consumption 0.8-1.2 m^3 per inlet, excavator digger.

1.	Topsoil	heavy clay
	subsoil	heavy clay
2.	Topsoil	heavy clay, 6-12 % org. matter
	subsoil	muddy clay containing fine sand
3.	Topsoil	muddy clay containing fine sand
	subsoil	"
4.	Topsoil	heavy clay
	subsoil	"
5.	Topsoil	20-40 % org. matter
	subsoil	muddy clay containing fine sand
6.	Topsoil	20-40 % org. matter
	subsoil	muddy clay containing fine sand
7.	Topsoil	clay, 20-40 % org. matter
	subsoil	muddy clay containing fine sand
8.	Topsoil	heavy clay, 6-12 % org. matter
	subsoil	muddy clay containing fine sand
9.	Topsoil	heavy clay, 6-12 % org. matter
	subsoil	muddy clay containing fine sand
10.	Topsoil	clay, 20-40 % org. matter
	subsoil	muddy clay containing fine sand