

## SOME PROPOSAL FOR THE PERFORMANCES BETTERING OF DRENVSUBIR SOFT, USED AT THE AGRICULTURAL DRAINAGE DESIGN

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### Abstract

*The DrenVSubIR soft, used for agricultural drainage design is made out three modules, the first one for determining distance between horizontal drains, with help the Ernst – David relation, the second one for verifying the possibility of using the drainage in subirrigation and the third one for the technical and economical calculation of a hectare of equipped land.*

*Simulating the conditions from the experimental drainage fields from Diosig, Avram Iancu, Cefa și Sinnmartin, Bihor county led to the same distance between drains with the drains proposed for expansion in production.*

*The objective of this paper is to study the possibilities for the performances bettering of DrenVSubIR soft starting from the observations made up when this was tested for the conditions from experimental drainage fields from Bihor county.*

**Key words:** DrenVSubIR soft, drain tube, filtering prism, deep loosening, not permanent regime;

### INTRODUCTION

The land reclamation of the soils affected by surface and/or depth excess humidity requires the application of measures for remove of the excess moisture by surface and/or underground drainage. (Sabău et al., 2002; Man et al., 2010)

The main problem at the projection of the underground drainage with horizontal tubes is to establish the distance between the drain wires in permanently working regime and checking the results obtained for the working of the drainage in a not permanent regime. (Man, 1982)

Underground drainage with horizontal pipes designing, in the operating permanent system can be made with DrenVSubIR software, which is based on the relationship between loss of vertical, horizontal, radial hydraulic load and the entry into drain and respectively the distance between drains, established by Ernst and completed by David. (Wehry et al., 1982)

The DrenVSubIR software is a calculating program implemented by Faculty of Environmental Protection from Oradea and consists of three modules, the first one is of calculating the distance between drain wires, the second for checking the possibility of using the drainage at subirrigation and the third for the technical economical (the cost) calculus of ha, of drained field. (Bodog Marinela et al. 2007, Teușdea A.C. et al. 2008)

For calibration software DrenVSubIR was used the data obtained in the experimental drainage fields from Bihor county, establishing its particular module used for sizing the distance between absorbing drains, in the permanent regime, inclusively on heavy and compress soils, for checking reversibility of the drainage in subirrigation and respectively for the calculus of the costs of a hectare equipped land. (Sabău et al., 2008; Sabău 2009; Sabău et al., 2010)

## MATERIAL AND METHODS

The previous researches looking DrenVsubIR soft calibration, with help of the data obtained in drainage experimental fields from Diosig, Avram Iancu, Cefa and Sânmartin (Ciobanu et Domuța, 2003) has praised the its usage advantages in the drainage design but and the some deficiencies.

The DrenVsubIR software presents the advantage of automatizeing of necessary laborious calculus and especially that it takes into consideration the type and the characteristics of the type of drain tube and used filter. Also, once established the type of the drain tube, it is characteristic and the filtrating material, the total loss of pressure head remain unchangeable, which allows testing more drainage variants.

The mains deficiencies of DrenVsubIR software are:

- it considered that the soil profile is double layered and the placement of drain tubes is above the separation plan of the two layers;
- the mains required input data for the module of distance between absorbing drains is saturated hydraulic conductivities of the two layers  $K_1$  and  $K_2$  in m/day but the soil profile have more much layers with different conductivities; (Fig. 1).
- don't can be used for the design of drainage associated with drain mole or deep loosening works, specific of hard and compact soils;
- after the establish of the distance between the drains in permanent regime, these can't be verified in not permanent regime hypothesis;
- the module for "technical and economical calculus" establish the cost of a hectare equipped land using only in function of a kilometer of drain cost, without take in consideration the cost of associated works, what are reported on surface;

The objective of this paper is to study the possibilities for the performances betting of DrenVSubIR soft starting from the observations made up when this was tested for the conditions from experimental drainage fields from Bihor county.

## RESULTS AND DISCUSSION

The first problem, when the drains are placed above the plan of layers separation can be resolved considering the layer above the drains, with saturated hydraulic conductivity  $K_1$  and respectively the layer under the drains,  $K_2$  and the setting of the distance until the separating line of the layers at  $D_o = 0,001$  m.

**The saturated hydraulic conductivity**, used by the DrenVsubIR software is the real saturated hydraulic conductivity  $K_R$ , determined "in situ" through the borehole method (Hooghoudt) that characterizing overall the horizons. In exchange the soil profile is created from more horizons, having different saturated hydraulic conductivities determinate in laboratory through pedological methods (cylinder method)  $K_p$  and these is a punctual characteristic.

Canarache, 1990 mentions that between the hydraulic conductivity determinate through laboratory pedological method  $K_p$  and the real hydraulic conductivity, determined through the borehole method (Hooghoudt)  $K_R$ , there are differences, the real conductivity being bigger than the pedological conductivity.

The saturated hydraulic conductivities of the horizons that create the soil profile are determined through the cylinder method and these are pedological conductivities  $K_p$ . For transforming the pedological saturated hydraulic conductivities  $K_p$  in real saturated hydraulic conductivities  $K_R$ , the polynomial correlation of second degree  $K_R = 0,2489 K_p^2 + 0,8289 K_p + 0,0519$  can be used, very significant from a statistical point of view ( $R^2 = 0,9996$ ) established after the data presented in Canarache A. 1990.

Using this relation the filtrating coefficient corresponding to each horizon, presented in table 1, can be transformed in real equivalent filtrating coefficient  $K_{Re}$ , and expressed in m/day.

Table 1.

Calculation of real equivalent hydraulic conductivity  $K_{Re}$  (m / day) for soil profile layers from experimental field Sînmartin, Bihor county

Experi- mental field	Soil type	Hori- zon	Deep (cm)	K (mm/h)	$K_P$ (m/zi)	$K_R$ (m/zi)	Layer thickness (m)	$K_{Rei}$ (m/zi)
Sînmartin	Albice stagnice luvosoil	Ap	0-22	5,5	0,132	0,166	0,90	0,090
		Eaw	22-32	1,9	0,046	0,091		
		EBtW	32-44	1,3	0,031	0,078		
		BtW	44-90	0,2	0,005	0,056		
		Cw	90-110	0,2	0,005	0,056	0,20	0,056

For this we propose the introduction of a new module named Input Data in that firstly it asks the digging depth of drains and then it asks if the real saturated hydraulic conductivity of layers from above and from bottom of drains plane are knows. If this are knows it asks the values  $K_1$  and  $K_2$  in m/day.

If the values  $K_1$  and  $K_2$  of real hydraulic conductivity are not knowing it asks: the number of soil layers, the thickness of these and their pedological saturated hydraulic conductivity,  $K_P$  in mm/ hour or in m/day.

A new module, introduced after the input Data module, can realize the obtaining of the real hydraulic conductivity values  $K_R$  of the two layers from above and from bottom of drains plane.

In case of soil profile from Sînmartin, if we taking into consideration that the impermeable layer can be found at the deepness of 1,1 m, knowing the real filtrating coefficient of every horizon and their thickness, the real hydraulic conductivities equivalent for the deepness considered homogeny of 0,9 m, can be calculating using the relation:

$$K_{Re} = \frac{\sum H_i}{\sum \frac{H_i}{K_{Ri}}}; \quad [1.]$$

The value of the real filtrating coefficient equivalent for the soil profile considered homogeny with the deepness of 0,9 m, calculated with above relation is  $K_{Re} = 0,090$  m/day.

**The drainage design on hard and compact soils** can be released when the DrenVsubIR software can calculate the hydraulic resistance coefficient  $\zeta$  (zita) for drainage with sorted ballast filter prism and take in consideration the real hydraulic conductivity of layer with deep loosening.

The necessary input data for to calculate the hydraulic resistance coefficient zita are the characteristic data of the drain tube of riflated PVC: diameter (m), the number of port rows on generators  $n$ , the width of rectangular slots  $l$  (m), the length of the slots orientated after generators  $b$  (m) and the characteristic data of the filter, filter diameter  $df$  (m) and respectively hydraulic conductivity of the clogged filter  $K_{fc}$  (m/day). Therefore, the DrenVsubIR soft works with wrapped up filters that have circular form.

In order to DrenVsubIR program to utilize the filter prism is required to ask at the input module of characteristic filter data if the filter is circular or prismatic. If the filter is prismatic the program demands the breadth and the width in meter of these. Having these values, before of the module for the calculus of the hydraulic resistance coefficient zita, can be introduced a calculus stage of equivalent diameter  $df$ , for the case of prismatic filter, using the relationship:

$$df = 2r = U/\pi; \quad [2.]$$

where  $U$  is the perimeter of the filter prism.

In the drainage experimental field from Cefa was utilized small, sorted ballast filter prism with the breadth of 0,15 m and the width of 0,10 m and high, sorted ballast filter prism with the same breadth and the width of 0,20 m. For small filter prism, the perimeter

is  $U = 2 \times 0.15 + 2 \times 0.10 = 0.50$  m and equivalent diameter of the filter is  $df = 0.159$  m, and respectively for high filter prism, the perimeter is  $U = 2 \times 0.15 + 2 \times 0.2 = 0.70$  m, resulting equivalent diameter of the filter  $df = 0.223$  m.

For hydraulic conductivity of clogged ballast filter prism was considered that the value closest to reality is that experimentally determined by Man, 1982 respectively  $K_{fc} = 12.4$  m/day.

Module to calculate the distance between the drains of the DrenVSubIR program present the advantage that once established drain tube type, its characteristics and filtering material, the total hydraulic load losses remain unchanged, which allows testing by testing several types of drainage.

Using the known characteristics of the soils of drainage fields, for the same drain tubes and filtering prisms have tried several values of equivalent hydraulic conductivity  $K_{Re1}$  above the drain lines aiming to obtain the distance between drains  $L = 30$  m. (Table 2.)

Table 2.

Actual hydraulic conductivity of the first soil layer, the drainage variant  $L = 30$  m + Fi + Sc, from the experimental drainage fields of Bihor county

Variant	Experimental field	$K_2$ (m/zi)	df (m)	$K_{fc}$ (m/zi)	$K_{Re1}$ (m/zi)	$K_{Rsc}$ (m/zi)
L = 30 m, Fi + Sc	Diosig	0,054	0,223	12,4	6,529	4,852
	Sânmartin	0,056	0,223	12,4	6,495	4,808
	Cefa	0,066	0,223	12,4	6,447	4,746
	Avram Iancu	0,076	0,223	12,4	6,478	4,786
Average						$4,798 \pm 0,044$

Equivalent actual hydraulic conductivity  $K_{Re}$  of upper layer of horizontal siting plane of drain tubes are very close, being between 6.447 m/day at Cefa and 6529 m/day at Diosig. Given that these values cumulative the effect of hydraulic conductivity of high prism of graded ballast,  $K_{fc} = 12.4$  m/day and knowing the scarifying depth and filter height can estimate the effect of deep loosening through scarifying.

Actual hydraulic conductivity values of deep loose layer by scarifying are also very close, between 4.746 m/day at Cefa and 4.852 m/day at Diosig, with an average standard deviation of  $\pm 0.044$  m/day. Knowing these value,  $K_{Re} = 4.8$  m/day, it can use the software DrenVSubIR to design the drainage associated with works of deep loosening through scarifying.

**The checking of the drainage designed for working in not permanent regime** in experimental field Diosig has been made with the relation Glover Dumm:

$$\frac{pL^2}{10KD} = \frac{t}{\ln\left(1,16 \frac{h_0}{h_i}\right)}; \quad [3.]$$

where:

p is drainable porosity in %, and can be calculated with the relation  $p = K^{1/2}$ , where hydraulic conductivity is expressed in cm/day;

L is the distance between drains in meter;

KD is the hydraulic transmissivity, in  $m^2/day$ , calculated as product of K, hydraulic conductivity, in m/day and average thickness of the moistened horizon:

$$D = D_0 + \frac{h_0 + h_i}{4}; \quad [4.]$$

$h_0$  is the initial level of water table, after the stop of rain;

$h_i$  is the final level of water table, corresponding for proposed drainage norm;

t is the time in day, necessary for lowering the water table level from the initial level  $h_0$  to the final level  $h_i$ ;

The checking of drainage working in not permanent regime of a same variants studied ( $L = 50, 35$  and  $20$  m) in experimental field Diosig shows that the time necessary for lowering the water table level from the surface of land,  $h_0 = 0,8$  m, the depth of drains to the water table level corresponding at drainage norm  $h_t = 0,4$  m is of  $29 - 4$  days (Table 3.)

Table 3.

The characteristic of the functioning in not permanent regime of the variants from the Diosig experimental field

L (m)	t/j	K (m/day)	PD (%)	D (m)	KD (m <sup>2</sup> /day)	j	t days
50	0,84	1,742	13,2	0,549	0,956	34	29
35	0,84	1,927	13,9	0,544	1,048	16	14
20	0,84	2,682	16,4	0,517	1,387	5	4

Analyzing the functioning of the drainage variants studied in not permanent regime, it can be concluded that the most efficient looking a hydraulic point of view is the drainage variants from rifled PVC tube 65 cm with filtrated prism from sorted ballast with the height 20 cm, posed to the medium deepness of 0,8 m.

The module for checking the drainage functioning in not permanent regime can be introduced at finish, forwards the module for technical and economical calculus.

**The technical and economical calculus** establishes the cost of a hectare equipped land using the distance between drains in permanent regime and the price of a kilometer of drain tube.

For the performances bettering of this module it propose the use of the distance between drains established by the module "The checking of the drainage designed for working in not permanent regime"

The required element is the cost of 1 km length drain tube posed, but we still have the associated works, with the price reported on surface unit. We propose the grouping in two categories of required elements, the first price reported on 1 km of length drain tube and the second the price reported on the surface of 1 hectare, for the associated works. In the first category it require the price of 1 km of ditch, 1 km of drain tube, 1 km length of filter and in the second category it require the cost of 1 hectare of mole drainage or 1 hectare deep loosening by scarifying. (Table 4)

Table 4.

The costs of studied drainage variants calculated with the DrainVSubIR program for the experimental field Avram Iancu, Bihor County

Variants	Price of 1 km drain					Price of 1 ha with associated works			Total costs Ron/ha
	Ditch Ron/ km	Drain tube Ron/ km	Filter Ron/ km	Unit Price Ron/ km	Total drai- nage Ron/ha	Mole drai- nage Ron/ha	Scari- fying Ron/ ha	Total assoc. works Ron/ha	
Ff	1500	7000	-	8500	23311	-	-	-	23311
Fa	1500	7000	100	8600	4938	-	-	-	4938
Fm	1500	7000	150	8650	3892	-	-	-	3892
Fi	1500	7000	300	8800	2946	-	-	-	2946
Ff + Cr	1500	7000	-	8500	16144	110	-	110	16254
Fa + Cr	1500	7000	100	8600	5198	110	-	110	5308
Fm + Cr	1500	7000	150	8650	3823	110	-	110	3933
Fi + Cr	1500	7000	300	8800	2882	110	-	110	2992
Ff + Sc	1500	7000	-	8500	11596	-	130	130	11726
Fa + Sc	1500	7000	100	8600	5509	-	130	130	5639
Fm + Sc	1500	7000	150	8650	3759	-	130	130	3889
Fi + Sc	1500	7000	300	8800	2862	-	130	130	2992

Ff – No filter prism; Fa – filter prism out of soil for acidity correction with a 0,1 m height; Fm – filter prism of sorted ballast with a height of 0,1 m; Fi – sorted ballast filter prism of 0,2 m; Cr – mole drain perpendicular on the drain direction; Sc – deep loosening through scarification, on the perpendicular direction of the drains;

The total costs of one hectare equipped represent the sum of drainage price, in Ron/ha and the price of associated works, in Ron/ha. The unit price of drainage in Ron/km represents the sum of ditch price, drain tube price and filter price. The total drainage cost is calculated in function of distance between the rains, determined by “The checking of the drainage designed for working in not permanent regime” module.

Taking in consideration the above observations the structure of DrenVsubIR software will be modified, having two new modules, the first “INPUT DATA” and last but one module “The checking of functioning in not permanent regime”. (Fig. 1.)

The module “INPUT DATA” have the required characteristics grouped in three categories: the first, “Data for the draining geometry”, in which if not know the real hydraulic conductivity of the layers it opens the window “Data for soil profile characteristics”, where it may introduced the pedological hydraulic conductivity of soil layers. The third group requires “Data for drain tube and filter characteristics” and he differentiates the circular filter and prismatic filter.

Before the module “The calculus of hydraulic pressure losses  $\zeta$  (zita)”, the program makes preparatory calculus being determined the real hydraulic conductivity  $K_R$  of the two layers from above and from bottom of drains plane and respectively the equivalent diameter of the prismatic filter  $df$ .

The module “The calculus of the distance between the drains  $L$ , in permanent regime” was bettering for the design the drainage upon the hard and compact soils using the drainage in association with deep loosening works.

After the module “The calculus of the distance between the drains  $L$ , in permanent regime” is introduced a new module “The checking of functioning in not permanent regime” that determine the time necessary for lowering the water level table from the surface of land, the depth of drains to the water level table corresponding at drainage norm.

The module “The checking of the reversibility drainage into subirrigation” is not modified but it use the distance between drains resulted after the checking of functioning in not permanent regime.

The last module “The technical and economical calculus” take in consideration the same distance between drains, established in not permanent regime and make the difference between the unit price of drain in Ron/Km length of drainage tube the price of associated works expressed in Ron/ha equipped surface.

In this new structure DrenVsubIR software shell have expanding possibilities for using and betting performances in the design of the agricultural drainage.

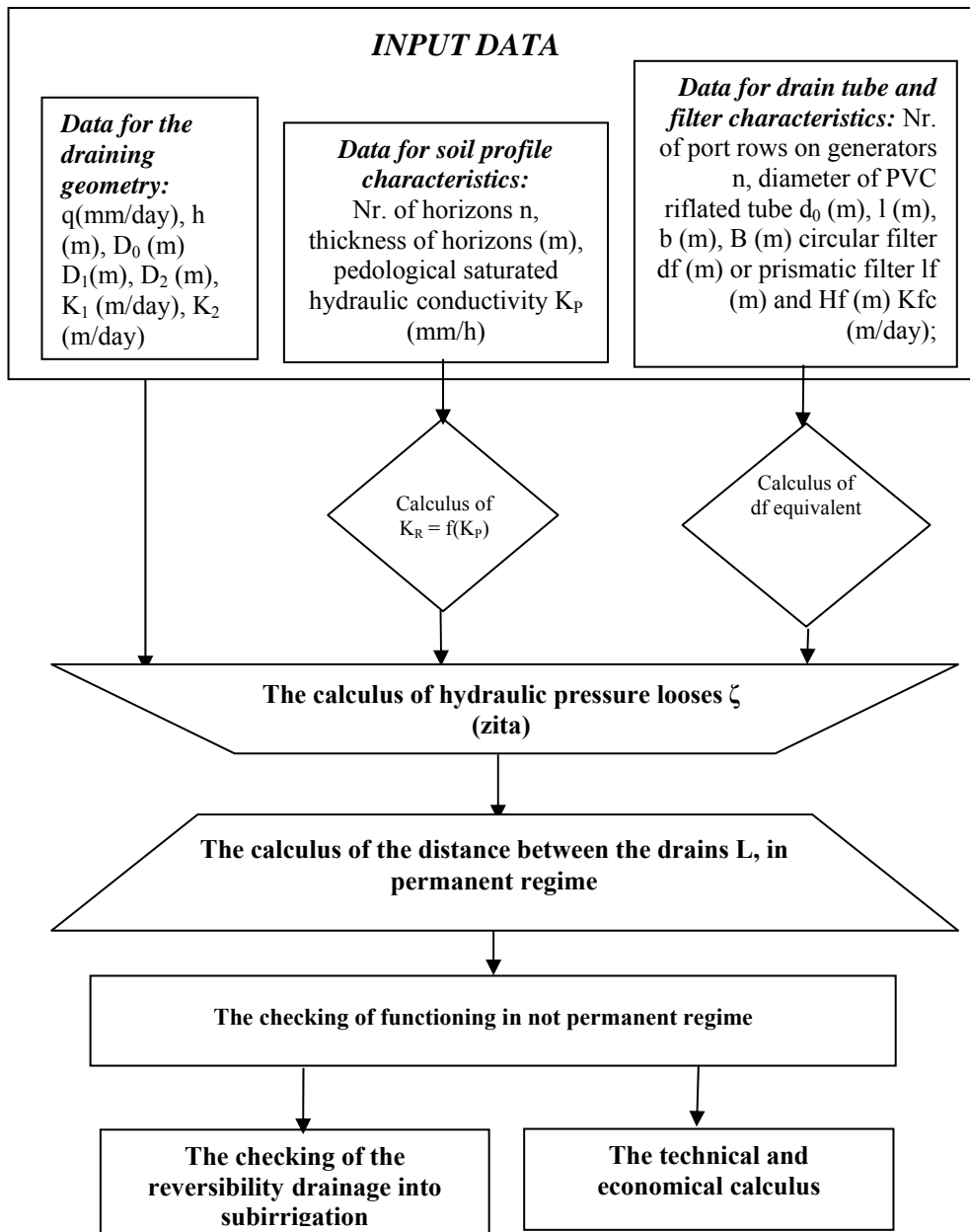


Fig. 1. The new structure of DrenVsubIR software

## CONCLUSIONS

The DrenVsubIR software presents the advantage of automatizing of necessary laborious calculus and especially that it takes into consideration the type and the characteristics of the type of drain tube and used filter. Also, once established the type of the drain tube, it is characteristic and the filtrating material, the total loss of pressure head remain unchangeable, which allows testing more drainage variants.

The objective of this paper is to study the possibilities for the performances betting of DrenVSubIR soft starting from the observations made up when this was tested for the conditions from experimental drainage fields from Bihor county.

Taking in consideration the observations from the drainage experimental fields the structure of DrenVsubIR software shell be modified, having two new modules, the first "INPUT DATA" and last but one module "The checking of functioning in not permanent regime".

The module "The calculus of the distance between the drains L, in permanent regime" was bettering for the design the drainage upon the hard and compact soils using the drainage in association with deep loosening works.

The last module "The technical and economical calculus" take in consideration the same distance between drains, established in not permanent regime and make the difference between the unit price of drain in Ron/Km length of drainage tube the price of associated works expressed in Ron/ha equipped surface.

In this new structure DrenVsubIR software shell have expanding possibilities for using and betting performances in the design of the agricultural drainage.

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