DRAINAGE CRITERIA

On website https://www.waterlog.info/

The development of criteria for agricultural subsurface drainage incorporates the study of drainage systems and their effects on the soil and agriculture with the aim to obtain an optimal design of the system

Contents

Aspects to be covered

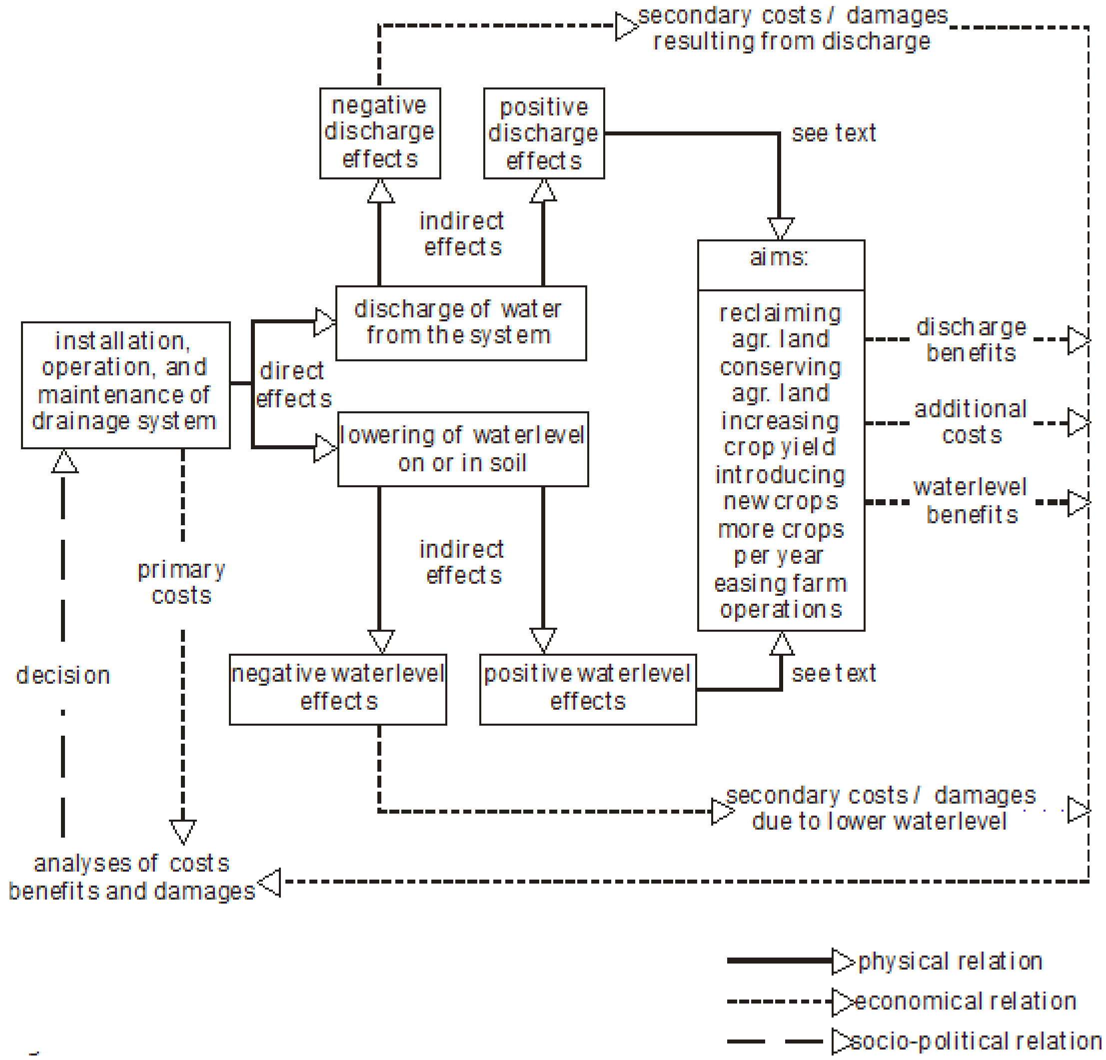


Figure 1. Effects, costs and benefits

Land drainage goes together with agricultural, environmetal, hydrologica, engineering, economics, social and socio-political aspects (Figure 1).

All those aspects can be subjects of the study of drainage criteria.

The aim of subsurface drainage is to optimize agricultural production with regard to

1. improvement of waterlogged cultivable lands
2. soil conservation
3. optimization of the crop yields
4. intensification of agricultural production
5. optimization of the agricultural operation with machanised equipment

Systems analysis

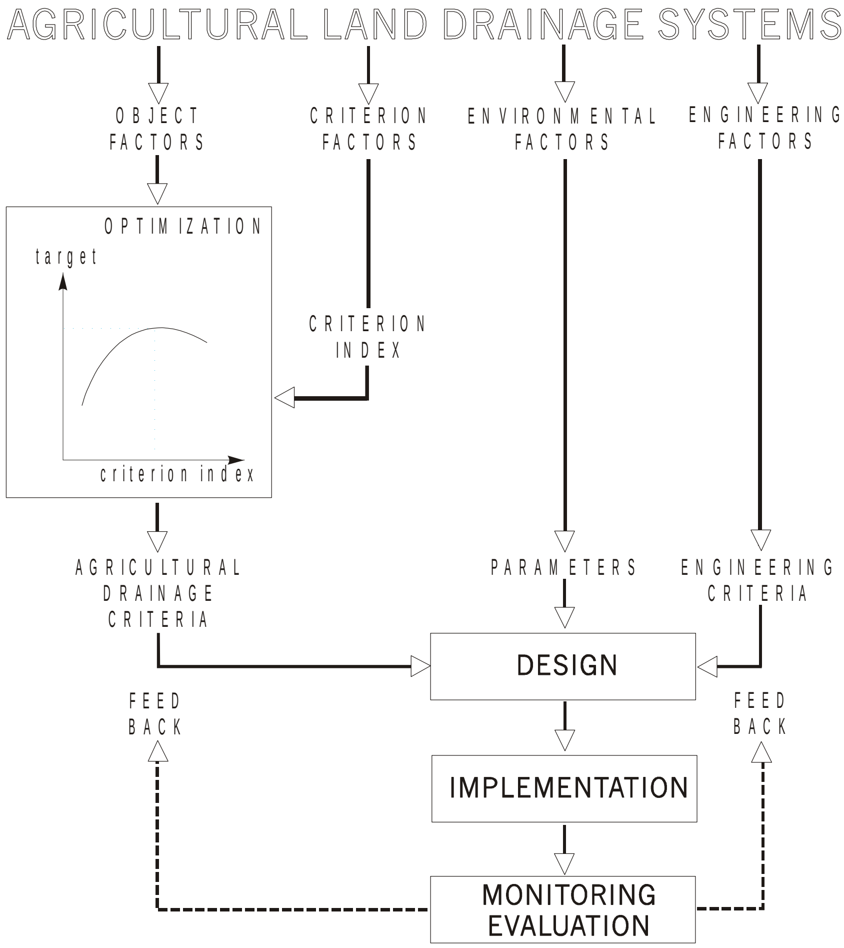


Figure 2. The role of agricultural, environmental and engineering criteria in the optimization, design, and evaluation of agricultural land drainage systems.

In figure 2 the criterion factors are influenced by drainage on the one hand and by the agricultural productivity on the other.

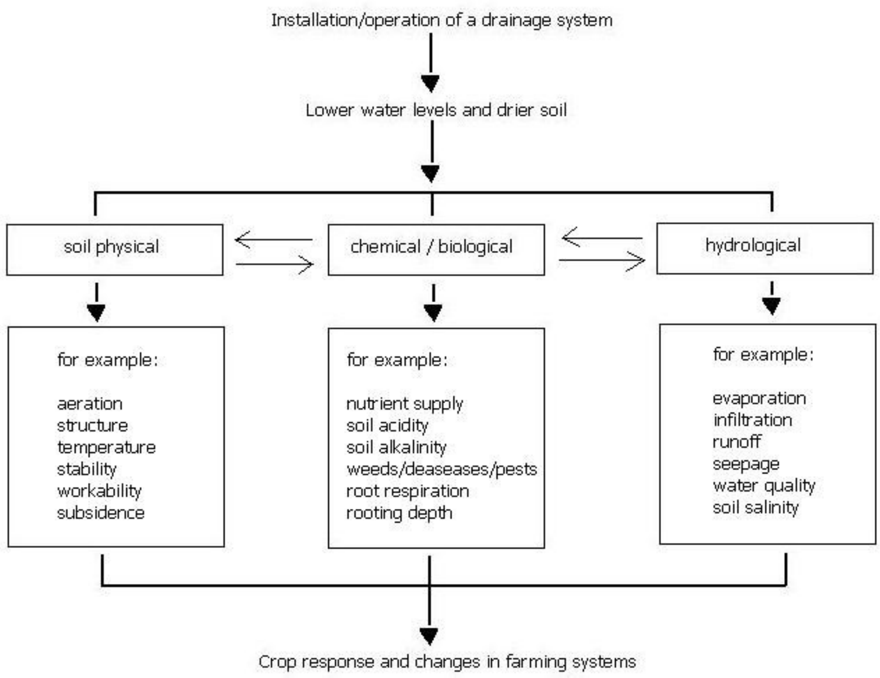
An example of a crterion factor is the depth of the water table (phreatic surface):

1. A drainage ssystem influences this depth. The relation between the design of the drainage system and the depth of the phreatic surface can be described with a drainage equation in which drainage requirement is determined by water balance of the soil.

2. The depth of the water table as a criterion factor can be translated into a numerical value that, on the one hand, represents the behaviour of the watertable and, on the other hand, can be realted to the drainage objective (for example the agricultural production).

3. The relation between the criterion index and the agricultural aim can often be optimized giving the maximium production as a final objective, while the corresponding optimal value of the criterion index can be used in the design procedure as an *agricultural subsurface drainage criterion*.

Crop response processes



Soil physical, chemical/biological, and hydrological intercations in the relations between drainage systems and crop response/farming systems

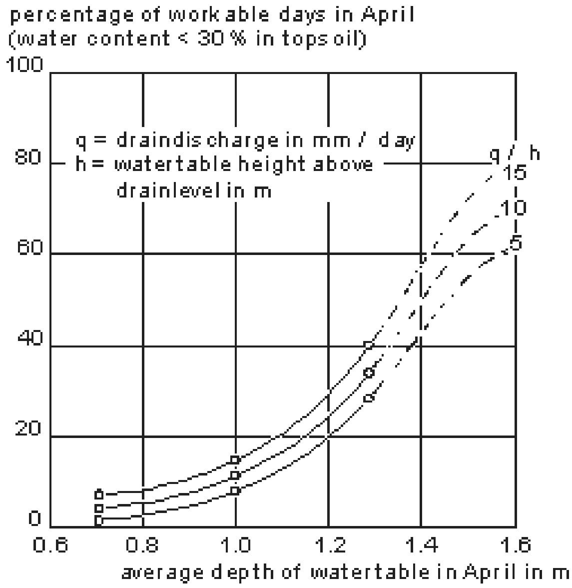
Figure 3.

The underlying processes in the optimization are manifold. The processes can be grouped into mutually dependent soil physical, soil chemical/biological, and hydreological processes (Figure 3):

- The soil physical processes include soil aeration, soil structure, soil stability, and soil temperature.
- The chemical processes include soil salinity, soil acidity and soil alkalinity.
- The hydrological processes include evaporation and runoff

Examples of processes can be found in: *Agricultural Drainage Criteria*. Chapter 17 in: H.P.Ritzema (ed., 1994), Drainage Principles and Applications, Publication 16, p.635-690. International Institute for Land Reclamation and Improvement (ILRI), Wageningen, The Netherlands. ISBN 90-70754-33-9. Download from: https://www.waterlof.info/pdf/chap17.pdf

Example of a soil physical effect:

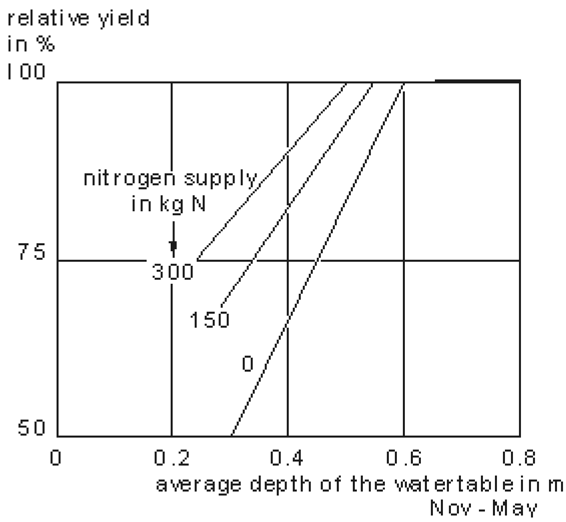


In this figure, the following holds:

1. Vertical: % of workable days for soil tillage, month of April, The Netherlands
2. Horizontal: average depth of the water table in April (m)
3. q/h = intensity of the drainage system: relation between the discharge (q in mm/day) and the elevation of the watertable (h in m) above the drainlevel. The smaller h with the same q, the smaller is the drainage intensity (or capacity).

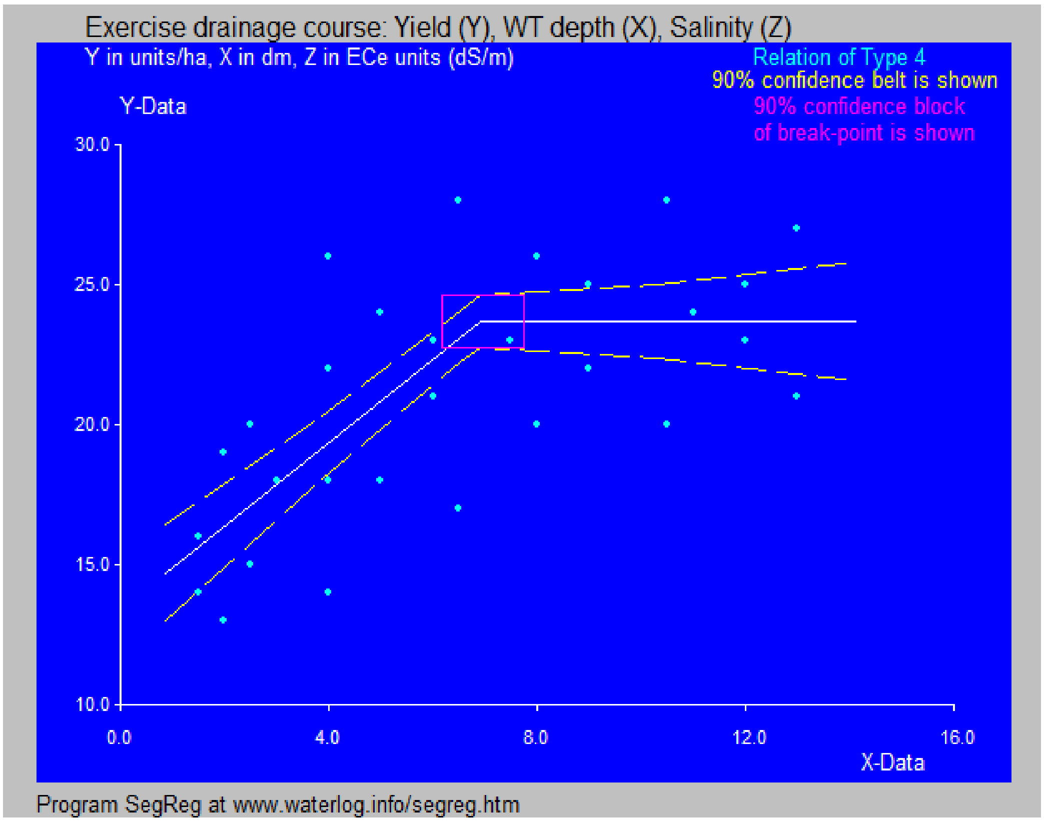
It may be noted that the average depth plays a more important role than the intensity.

Example of a chemical effect



There is no effect of the N fertilization at a water table depth greater than 0.6 m, while at shallower depth N application compensates the poor drainage to some extent.

Field data



The seasonal average depth of the water table (X in dm) and crop production (Y)

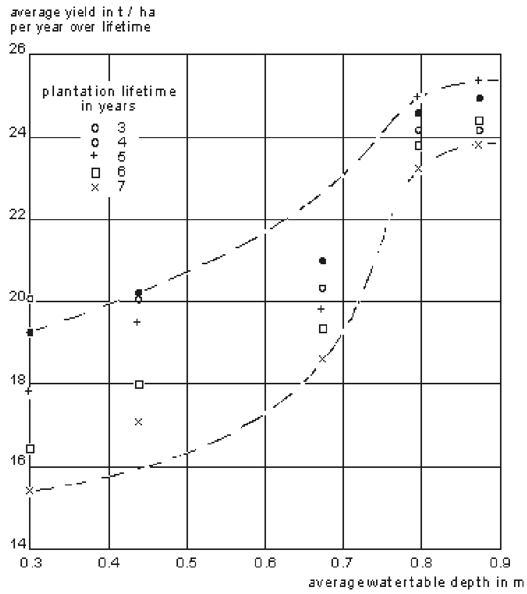
The graph has been made with the SegReg program for segmented regression

For the investigations of agricultural alnd drainage, field data are important.

Dealing with field data a considerable spatial random variation is to be expected owing to the large number of natural processes involved and the large variation in the plant and soil charcateristics as well as the hydrologic phenomena.

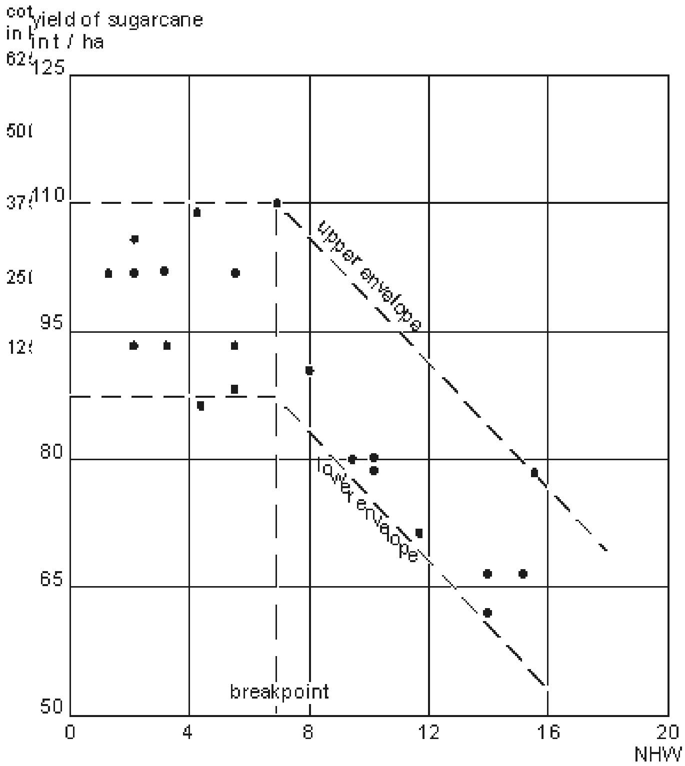
While nalyzing field data with random variation, the adequate application of statistical principles is indispensible, both the regression analysis and the frequency analysis.

Other examples of the relation between crop yield and depth of the water table.

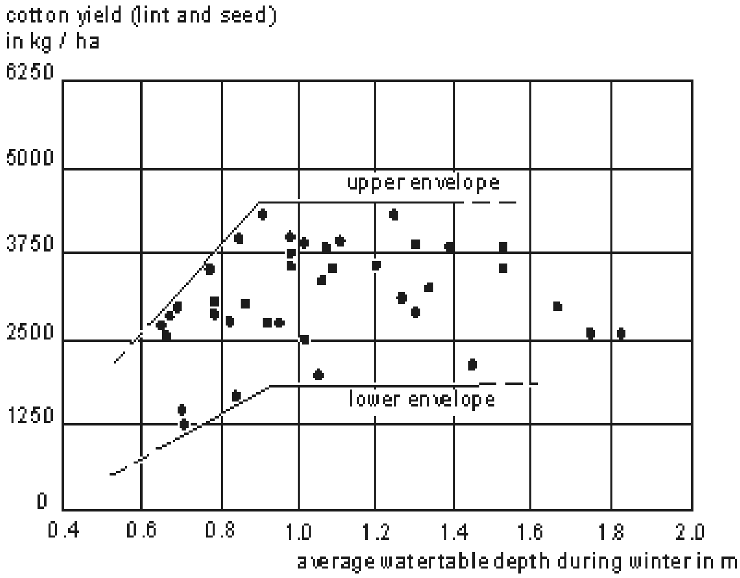


Yield of banana (t/ha), plantation age, and average depth of the water table (m) in Surinam (Lenselink, 1972).

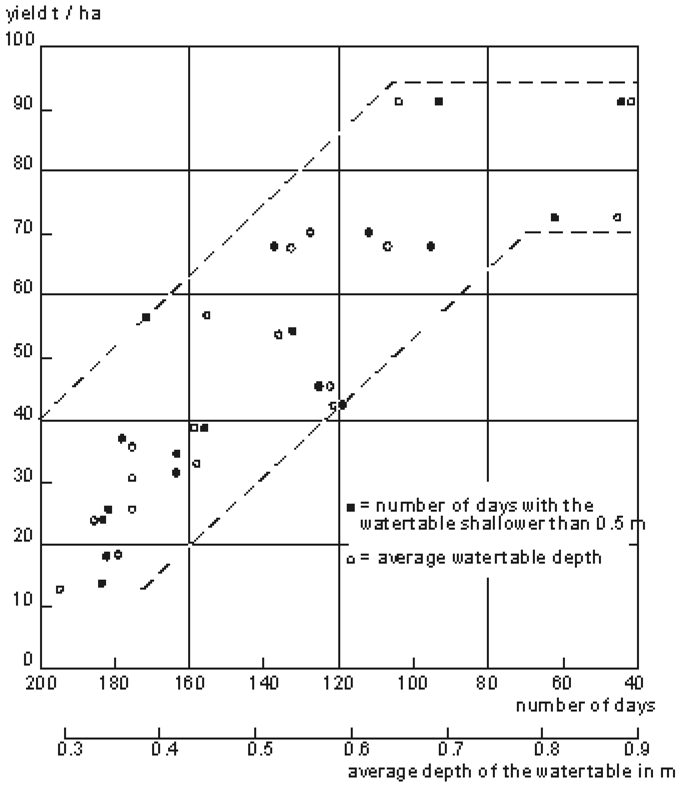
At watertables shallower than 80 cm the yield declines.



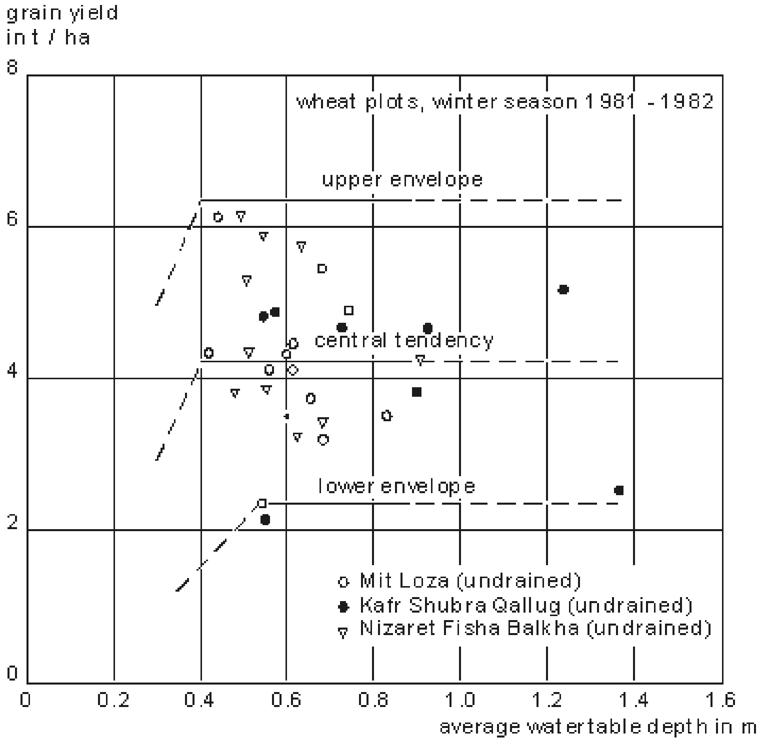
Yield of yield of sugarcane (t/ha) and number of days (NWH) with an eleveated level of the watertable (shallower than 90 cm. below soil surface) in the collector drainage system in Guyana (Naraine 1990). 7 days is a critical value beyond which the yield reduces.



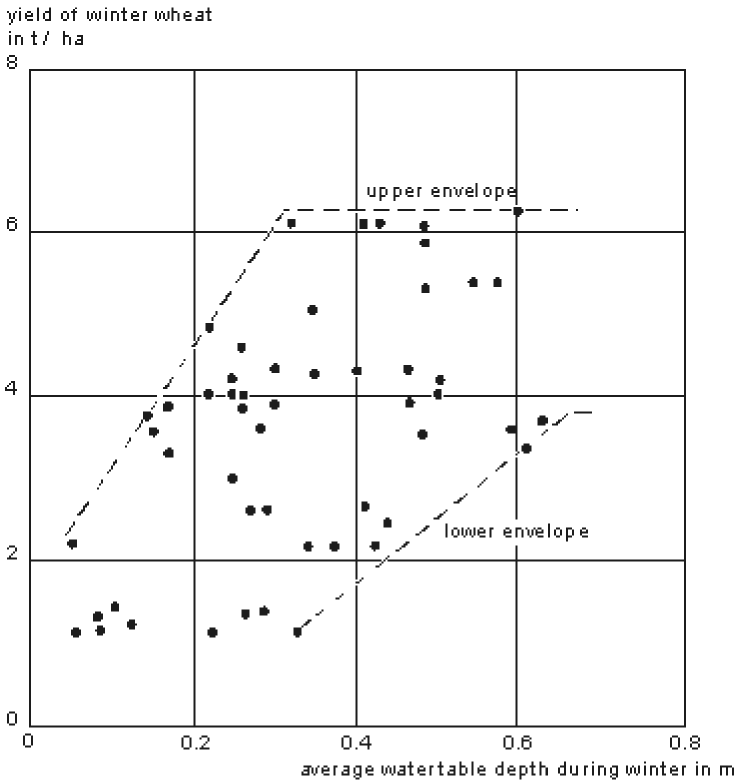
The cotton yield in Egypt is not affected by average depth of water table as long as it is deeper than 90 cm. (Nijland et al. 1984)



Sugarcane in Australia needs an average water table depth of at least 70 cm, otherwise the production goes down. (Rudd and Chardon 1977)



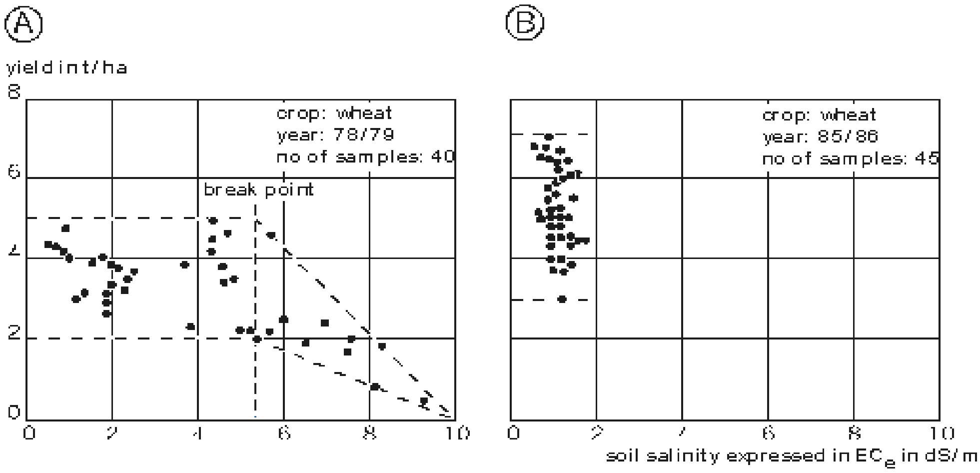
The wheat crop in Egypt is not affected when the water table is deeper than 50 cm. For shallower depths no conclusions can be drawn as the pertinent data are not available.



The winterwheat in England on a heavy clay soil needs a watertable deeper than 50 cm.

Soil salinity control

In irrigated lands, subsurface drainage may be required to leach the salts imported with the irrigation water in order to prevent soil salinization



Yield of wheat and soil salnity before (A) and after (B) the installation of a subsurface drainage system in a pilor area in the Nile Delta, Egypt

(Safwat Abdel Dayem and Ritzema 1990).

The soil salinity has come down considerably and the yields are safe.

Agro-hydro-salinity models like SaltMod can be instrumental to determine the drainage requirements and effects.

References

1. ↑ *Drainage for Agriculture: Hydrology and Water Balances*. Lecture notes, International Course on Land Drainage (ICLD), International Institute for Land Reclamation and Improvement (ILRI), Wageningen, The Netherlands. Download from: [1]
2. ↑ *Agricultural Drainage Criteria*. Chapter 17 in: H.P.Ritzema (ed., 1994), Drainage Principles and Applications, Publication 16, p.635-690. International Institute for Land Reclamation and Improvement (ILRI), Wageningen, The Netherlands. ISBN 90 70754 3 39. Download from: [2]
3. ↑ *Drainage Research in Farmers' Fields: Analysis of Data*. Part of project “Liquid Gold” of the International Institute for Land Reclamation and Improvement (ILRI), Wageningen, The Netherlands. Download from: [3]
4. ↑ *SaltMod: A tool for interweaving of irrigation and drainage for salinity control*. In: W.B.Snellen (ed., 1997), Towards integration of irrigation, and drainage management. Special report, p. 41-43, International Institute for Land Reclamation and Improvement (ILRI), Wageningen, The Netherlands. Download from: [4]

External links

- Website about subsurface drainage: [5]

- Free software for calculations of subsurface drainage: [6]
- Articles about subsurface drainage: [7]
- Frequently asked questions and answers about subsurface drainage: [8]
- Case studies about subsurface drainage: [9]