DEVELOPMENTS IN DRAINAGE MACHINERY AND MATERIALS[1]

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1 INTRODUCTION

The selection of adequate materials and their proper installation and maintenance are essential for the effective and lasting performance of subsurface land drainage systems (FAO, 2000).

Although substantial developments have been made in drainage materials and installation techniques during the past two decades, there are still some important problems need to be solved.

The purpose of this paper is to highlight some issues concerning this sub-topic, to invite the drainage community to present papers to the 9th International Drainage Workshop, with the final goal of deriving appropriate conclusions after the Workshop discussions.

This discussion paper is only focused on subsurface land drainage systems.

2 DRAINAGE MATERIALS

Materials for subsurface drainage systems include drainpipes and their accessories, envelope materials and auxiliary structures.

Existing knowledge on drainage materials have been reviewed in two recent publications:

- FAO. 2000. Materials for subsurface land drainage systems, by L.C.P.M. Stuyt, W. Dierickx and J. Martínez Beltrán, *Irrigation and Drainage Paper No. 60*, Rome; and
- Vlotman, W.F., Willardson, L.S. and Dierickx, W. 2001. Envelope design for subsurface drains. *Publi. 57*, *ILRI*, Wageningen, The Netherlands.

In addition, three chapters on this subject were included in the last American Society of Agronomy publication on land drainage:

- Schwab, G.O. and Fouss, J.L. 1999. Drainage Materials. In: Agricultural Drainage. R.W. Skaggs and J. Van Schilfgaarde (eds.). *Agron. Monogr. 38*. ASA, CSSA, and SSSA, Madison, WI, United States, pp. 911-926.
- Stuyt, L.C.P.M. and Willardson, L.S. 1999. Drain Envelopes. In: Agricultural Drainage. R.W. Skaggs and J. Van Schilfgaarde (eds.). *Agron. Monogr. 38*. ASA, CSSA, and SSSA, Madison, WI, United States, pp. 927-962.
- Dierickx, W. 1999. Non-Ideal Drains. In: Agricultural Drainage. R.W. Skaggs and J. Van Schilfgaarde (eds.). *Agron. Monogr. 38*. ASA, CSSA, and SSSA, Madison, WI, United States, pp. 297-328.

In the following sections some key issues concerning drainage materials are highlighted.

2.1 Drainpipes and Their Accessories

PVC and PE are generally used as pipe materials for corrugated plastic lateral drains. Concrete pipes are used for larger collector drains. Specifications and standards for clay, concrete and corrugated plastic pipes are available in the USA and in Europe a standard for corrugated PVC pipes has been drafted.

Pipe accessories, such as end caps, couplers, pipe fittings and reducers, and rigid pipes for drain bridges and lateral outlets are also available.

Design criteria and hydraulic calculation procedures with respect to pipe diameters are well known. FAO is currently preparing simple computer programs for both single drains and multiple drains, in which the pipe diameter changes as a way to reduce material costs.

The selection of pipe material and size for a particular project depends mainly on local availability and cost. In this context the following questions can be considered:

- Are technical specifications commonly used in practice to check the quality of pipe materials used in drainage works?
- The contribution of the pipe size to the total cost of the subsurface drainage system is relevant, however, in some cases no

special attention is paid to drain diameter calculations and pipes are over-dimensioned, especially if long drains are designed.

2.2 Envelopes

Drain envelopes restrict the entrance of soil particle into the drain, improve the hydraulic conductivity at the soil-drain interface and provide structural stability around the drain. Mineral granular envelopes and prewrapped fibrous organic envelopes have been used in the past, but currently synthetic envelopes -geotextiles and loose synthetic fibres- are being used.

Specifications and standards for envelope materials are also available, as well as rules and recommendations to predict the need of an envelope and design criteria for the selected material. However:

- methods validated by field experience to assess the need for drain envelopes;
- selection criteria for the most appropriate envelope material, depending on local soil conditions, need verification;
- case studies on the evaluation of the performance of drain envelopes in the field, especially for synthetic envelopes are important; and
- research activities required to support the above issues are necessary.

2.3 Auxiliary Drain Structures

Connection structures, inlets and outlets of water and special structures, such as cleaning facilities and structures for controlled drainage and subirrigation, are common auxiliary structures of subsurface drainage systems.

In the Workshop discussion, the following issues can be covered:

- Quality control and maintenance of outlet structures.
- In composite drainage systems, junction boxes and manholes are sometimes hardly used or not used at all and may be unnecessary with GPS availability. Examples with practical data about the comparison of savings in construction costs and increments in maintenance costs may be useful for future designs.
- Designs for special structures for controlled drainage in the lateral and collector outlets are available, but examples of construction and operation of such structures are not frequent.

3 DRAINAGE MACHINERY

Special machines are used for installation and maintenance of subsurface drains. Current knowledge on this subject has been recently reviewed in the last American Society of Agronomy publication on agricultural drainage:

- Broughton, R.S. and Fouss, J.L. 1999. Subsurface Drainage Installation Machinery and Methods. In: Agricultural Drainage. R.W. Skaggs and J. Van Schilfgaarde (eds.). *Agron. Monogr. 38*. ASA, CSSA, and SSSA, Madison, WI, United States, pp. 967-1003.
- Van Zeijts, T.E.J. and Zijlstra, G. 1999. Quality Assurance and Control. In: Agricultural Drainage. R.W. Skaggs and J. Van Schilfgaarde (eds.). *Agron. Monogr. 38*. ASA, CSSA, and SSSA, Madison, WI, United States, pp. 1005-1022.

In the following sections some key issues concerning machinery for implementation and maintenance of subsurface drainage works are highlighted.

3.1 Installation Machinery

Trenchers of various types have been used in the past and still are used with success to install subsurface drains, especially for clay and concrete pipes and for granular mineral envelopes. Since the introduction of corrugated plastic pipes and prewrapped envelope materials, the installation speed has increased by using trenchless drainage machines. However, although the use of the laser grade has improved the precision of installation, the control of the work quality has become more difficult, especially as far as the grade line accuracy is concerned.

Suggested topics for papers describing new developments and for discussion may be the following:

- Installation of drains under adverse conditions, such as in wet soils and in lands with shallow water tables.
- Subsurface drainage works in unstable soils.
- Checking the quality of drainage work during installation and after the drainage system has been installed.

3.2 Maintenance Equipment

Subsurface drainage systems adequately installed with appropriate drainage materials have low maintenance requirements. Dry

rodding is sufficient to remove slight clogging, fresh ochre and roots proliferating inside the drainpipe, specially near the lateral outlet. To remove sediments and serious ochre deposits, and to clean clogged perforations jet flushing is necessary. Field experience achieved during the past years shows that medium pressure equipment is most recommended and flushing should be used only in case of dissatisfaction with or deterioration of drainage system performance.

The effective length of the flushing equipment is less than about 400 m. Therefore, this technology is effective for single drains with lengths up to 400 m and for multiple drains if manholes are constructed. However, extended laterals and composite drainage systems are sometimes installed without manholes. In these cases, are there other effective cleaning facilities or procedures?

The issues described above in this discussion paper are merely suggestions identified by the author in a call for papers. However, any paper describing case studies and other practical points concerning sub-topic 1.2, including maintenance

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