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Materials and Methods Used for Subsurface Drainage of Agricultural Lands

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Subsurface drainage was developed mainly in the temperate climatic zones (Europe, North America, Russia) to control water table level, and today, it is used in semi-arid and arid zones as an integral part of the irrigated agriculture system. The proper and lasting performance of subsurface drainage systems requires selection of appropriate materials (i.e., pipes and envelopes), adequate installation and their maintenance. Past technologies and practices can be a useful guide towards future designs. During the 1950s and thereafter, there were rapid developments both in installation techniques and materials. These developments have been interdependent in that new materials prompted the development of new installation techniques, and vice versa. The high speed mechanicalinstallation of subsurface drains by modern specialized machines, the development of new drainage materials, the increase in installation capacities, the reduction in installation costs and the graduated evolution from a practice based on local experience into an art with more general applicability contributed to the development of the agricultural land drainage all over the world.

For a successful subsurface drainage design, the knowledge of drain materials (drainage conveyance conduit) and installation techniques of the drains (including selection of envelope materials with respect to soil bedding) is a crucial element for achieving sustainable development of both irrigated and rainfed agriculture. For centuries, engineers and inventors tried to develop rapid and low cost techniques for subsurface drainage. Though many ideas were considered, only a few found widespread applications. The selection of the appropriate drainage materials (i.e., pipes and envelopes) depends mainly on their availability, durability, and cost. Over time, new drainage materials, installation techniques and modernized equipment developed continuously to take advantage of technological advances provided through research and development, while the planning and organization of the implementation process were improved.

A great variety of methods and materials have been used in the drainage of agricultural lands during different times, many of them were effective and all of them aiding to demonstrate drainage usefulness in agriculture. As we go forward to the future, it is important to consider what is, in the present day, the situation of the materials used for drainage of agricultural lands and how it has evolved, since past technologies and practices can be a useful guide towards future designs.

However, an extended presentation of the history and annotation of the evolution of subsurface drainage materials and installation techniques is quite broad; consequently, our focus is restricted to the main times in which these were developed for the speedy extension of agricultural drainage worldwide. We note that the literature cited and taken into account herein is not considered to be exhaustive; however, we try to recognize key scientific articles whenever possible.

The purpose of this article is to provide a succinct review and discussion of the evolution of key achievements in the development of drainage materials and installation techniques from antiquity to present times, with specific reference to subsurface drainage, considering the major materials used and lessons learned from the past. As such, our hypothesis is that a careful review and consideration of the past developments in drainage systems underscore their importance to agricultural production in many parts of the world, and moreover, that failure to adequately consider possible drainage issues when developing agricultural production may lead to its eventual demise and damage to the local ecosystem.

This review study is organized as follows: Section 1 is an introductory one; Sections 2–4 present the evolution of drainpipe materials, envelope technology, and installation technology through the centuries; Section 5 refers to the drainage system design/installation effects on drain-water quality; Section 6 addresses the alternative drainage technique to control waterlogging and salinity and in particular, biodrainage; finally, Section 7 deals with the general observations about how drainage has evolved and its importance to agricultural production.

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