

Complete Analysis

Benefits and Costs of a Subsurface Agricultural Drainage Water Management System



To Improve Water Quality and Increase Crop Production
In a
Public-Private Partnership

On Behalf of
Agricultural Drainage Management Coalition
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I. Introduction

Over the past decade, efforts to reduce agricultural nitrate pollution have focused on installing conservation practices, such as riparian buffers and filter strips, on or near cropland. Agricultural producers, as well as state and federal governments, however, have largely overlooked installing conservation practices to reduce pollutants from subsurface drainage water. Subsurface drainage water carries soil nutrients from the soil into streams, rivers, and lakes and some underground aquifers.

Over 50 million acres of highly productive agricultural cropland are artificially drained by underground pipes, tubes, and tile. Many of these, mostly clay tile, drainage systems have been in place for over one hundred years. Much of the Midwest gets its drinking water from rivers and streams fed by runoff and subsurface drainage from agricultural lands. Municipal and rural water systems increasingly have to use denitrification processes to lower nitrate levels to meet water quality standards. Nitrate-laden, surface waters have been identified as a major contributor to the formation of the hypoxia area in the northern part of the Gulf of Mexico.¹

In an effort to reduce nitrate runoff from agricultural lands, the agricultural community, as well as federal and state governments, have been promoting and installing a number of agricultural and environmental practices. Most are very expensive because they take valuable, productive land out of production (e.g., wetlands and buffer strips). Other plans reviewed by the President's Committee on Environment and Natural Resources (CENR) and its Hypoxia Work Group propose to limit nitrate use directly (or indirectly via taxation) with significant negative impacts on production and societal welfare. All of the strategies previously studied have significant net societal economic costs for both consumers and producers (Doering et al., 1999).

Managing agricultural drainage on 7.9 million acres can effectively reduce nitrate runoff by 128 million pounds (58 million metric tons) per year in the upper Midwest, overwhelming reductions proposed by other practices examined by the President's committee. Moreover, as this report explains, the benefits, public and private, of managed drainage far exceed the cost of installing the practice.

¹ Nitrate-nitrogen is a naturally occurring form of nitrogen and is an integral part of the nitrogen cycle in our environment. Nitrate forms from fertilizers, decaying plants, manure and other organic residues. Plants use nitrate and ammonia, but sometimes rain can move this nitrate into shallow groundwater or through subsurface drains to surface water bodies.

Drainage Water Management as a Management Practice

Drainage Water Management (NRCS Practice Standard 554) is a practice that can be cost-shared under the Environmental Quality Incentives Program (EQIP) and possibly other conservation practices administered by the U.S. Department of Agriculture. This technical practice 554 is designed to keep more nitrates and water in the soil, where they can be productively utilized by crops. Subsurface water can be retained in the soil profile of the crop fields by installing control devices that limit drainage discharge at various times of the year and to certain depths of the soil profile as needed to meet the operational needs of producers. The practice is most cost-effective on land that has very little slope (0 to 0.5 percent) because large areas can be managed by fewer control devices. Approximately 7.9 million acres in the Midwest would be classified as well-suited and cost-effective for this practice (Jaynes, 2003).

Managed drainage holds the nitrate-rich water table higher than free flowing, subsurface drain, creating a larger underground reservoir of soil water and nitrates for use by crops. This reservoir allows a greater percentage of the nitrate in the soil to be utilized productively, crops are less susceptible to short-term drought, and drainage is still managed to enable field operations and appropriate root conditions. This best management practice (BMP), as it may be defined, requires a substantial investment in new drainage control devices to retro-fit existing systems or, in most cases, installing new subsurface drainage mains and laterals. However, compared to alternative water quality practices which impair crop production by limiting nitrates, require producers to shift to lower return crops, or require producers to take valuable land out of production entirely, managed drainage is not only highly effective and cheaper, it has a high benefit-to-cost ratio.

As shown in diagram 1 below, the water table can be maintained at a programmed level above the bottom of the drain (as long as plant requirements do not exceed precipitation). Drainage pipes, tubes, or tile drains are dug deep into the soil profile in order to avoid being snagged by tillage equipment or crushed by heavy machinery. They are also laid deep in order to have some slope even in flat fields. With control devices, water level is retained until the water table rises above the "drop logs", but drains before the higher water table rises into the root zone and causes crop damage.

Diagram 1.



