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Using vegetated buffers or setbacks to reduce fecal coliform bacteria runoff from dairy pastures

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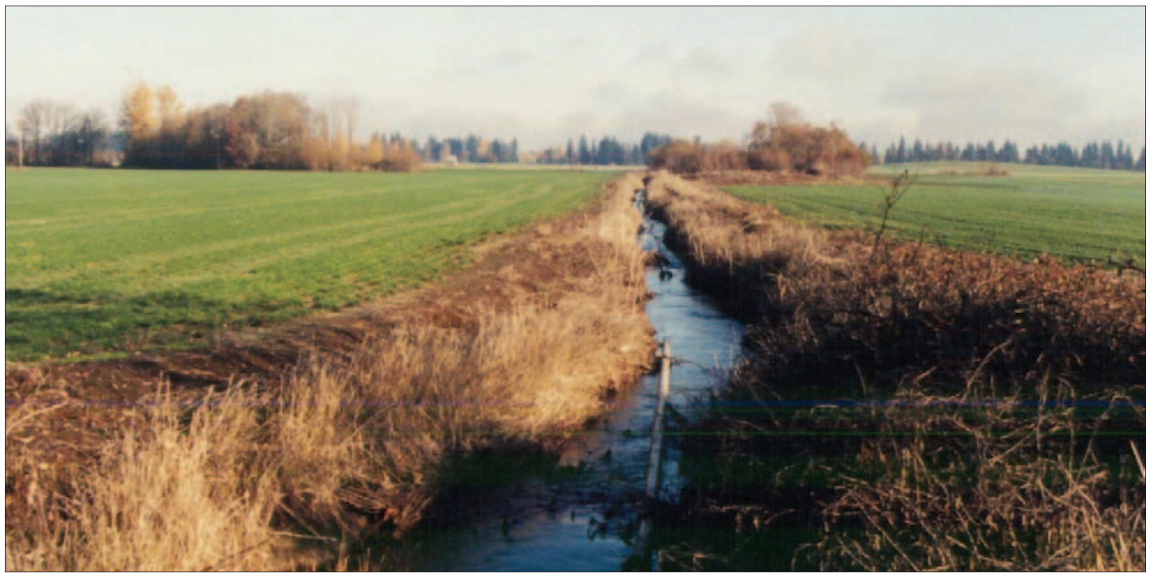

For years, producers and water quality specialists have had concerns about fecal coliform bacteria runoff from dairy pastures into rivers and estuaries. "Best Management Practices" (BMPs) have been developed to reduce the transport of bacteria after manure application to pastures. Data shows producers are making progress on reducing runoff into some rivers throughout the Pacific Northwest.

A important practice to reduce possible impacts of manure application on bacterial loading to waterways is a setback or buffer strip between the application area and a body of water. However, while this seems like an obvious recommendation to most, the distance of the setback and the benefits gained in water quality are not that clear.

A number of studies have looked at the use of vegetative buffers or setbacks to reduce bacterial movement. They show a variety of results at different distances, from 100 percent filtering to almost no improvement, depending on the study. This is further complicated by differences in bacterial loading, soil conditions, microbial die-off, rainfall intensity and amount, sunlight, and vegetation and soil organic matter.

A research project was conducted recently in Tillamook County, Oregon, to help understand the fecal coliform bacteria removal efficiencies of grass buffers of various sizes. This project involved the work and ideas of many, but was led by Dr. Tim Sullivan with E&S Environmental in cooperation with Oregon State University. The study tested the theory that for every incremental increase in buffer width, there should be a decrease in bacterial movement. Obviously, increasing buffer width reduces the land available for forage production on the farm, so there is a cost/benefit relationship to the producer and to the environment. These researchers set out to determine the edge-of-field buffer widths that would simultaneously protect water quality and require the smallest loss of forage growing area.

The study consisted of 18 treatment plots, each 45 feet wide and 100 feet long. The plots had grass growing on them and were setup to test buffer widths of 0, 3, 10, 25, 50 and 80 feet. The plots had not received manure for several years and had either a gentle slope (3.8 percent) or a moderate slope (7.0 percent). Treatment plots were isolated from one another by ditches.

At the lower end of each plot was a sampling device that captured surface runoff and shallow soil water movement through each plot. The project was conducted over nine major storm events during a two-year period. Fresh dairy manure was applied prior to a forecasted major storm event at different distances from the sampling device, simulating different manure setbacks. During the first storm no manure was applied to test the sampling devices and monitor background bacterial information.

Results from experimental treatment plots during nine rainstorms indicated that only 10 percent of the runoff samples had bacteria concentrations in excess of 200 colony forming units (cfu) per 100 ml, and the median runoff concentration for all plots was only 6 cfu/100 ml. If manure soaked into the soil, bacteria did not leave the plots, even if the buffer was only three feet wide.

The presence of a vegetated buffer of any size generally reduced the median bacteria concentration in runoff by more than 99 percent. Manure applications with no buffers averaged as high as 164,627 cfu/100 ml in the gentle slope plots. Authors con-

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cluded this result was largely due to the observed high rate of infiltration of precipitation, even during large storms. They also concluded that contamination of runoff from manure-treated pasturelands is strongly associated with specific field or management conditions, such as soils that have low water infiltration rates and generate larger volumes of runoff. Soil is highly effective at trapping and immobilizing bacteria if manure application and consequential rainfall can infiltrate the soil surface.

Based on results of the study, current manure application recommendations are:

1. Make manure application schedules that account for cropping needs and site specific field characteristics.
2. Fields with poorly drained soils (lower infiltration rate), and fields prone to flooding should be scheduled for multiple manure applications early in the growing season during dry weather.
3. Fields that have higher infiltration rates, and fields that are farther away from waterways should be used for manure application during months with the potential for higher rainfall.
4. Lighter, more frequently applications to fields with enough air space in the soil for the application to move into the soil profile is most desirable.
5. Maintain some vegetation in the setback area; it will improve infiltration rate.

A copy of the complete study report can be downloaded at: http://www.esenvironmental.com/download_site.htm

Whole farm nutrient management

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Whole farm nutrient management (WFNM) includes the consideration of import of nutrients to the farm, movement and transformation (including losses) of nutrients within the farm operation, and export of milk, meat, crops, or manure.

In order to understand WFNM, it is necessary to consider all sources of nutrients, their movement within the farm, and how they might move to the environment. On most dairies, feed represents the largest import of nutrients, with fertilizer as the second largest import of nutrients. Feed Management practices currently exist to reduce imports of nutrients (particularly nitrogen and phosphorus) or decrease their excretion. Many of these specific practices and management considerations will be outlined in two assessment tools (see fact sheets- Opportunity Checklist and Feed Management Plan Checklist) as part of the implementation process of the Feed Management 592 Practice Standard.

Nutrient utilization by the dairy cow

Nitrogen (N) is used for milk production in the dairy cow with an efficiency of ~ 25 to 35 percent. The remaining 65 to 75 percent of nitrogen consumed by the dairy cow remains in the initial manure (feces and urine). However, N is lost to the atmosphere via volatilization.

Phosphorus utilization by species varies from approximately 20 to 50 percent. The 50 to 80 percent not utilized is excreted in manure. A dairy cow uses approximately 27 percent of dietary P for milk production, thus approximately 73 percent of dietary P is not exported as milk from the farm.

Whole farm nutrient balance

The goal of whole farm nutrient management is to achieve "zero farm balance" through the adoption of a variety of management practices, including Feed Management. The practices and the relative positive or negative balance (balance = anything that remains or is left over) will be unique to each farm.

It is important to acknowledge that due to biological processes, there will be losses to the environment even when all the best management practices are adopted. Therefore, "zero balance" is difficult to achieve while maintaining high crop productivity.

The concept of whole farm nutrient balance has been described in different ways progressing from simple to more complex approaches. First consider approaches using nitrogen as the nutrient of interest.

1st Approach. The first approach is to estimate Mass-Balance, which uses the concepts of import and export of managed resources at the farm boundary. This approach measures only those nutrients that cross the boundary of the farm and does not directly track nutrients flows within the farm or nutrient losses from the farm. The difference between inputs and managed outputs can be used to calculate a positive or negative balance. This positive balance represents nutrients that will be lost to the environment by both air and water pathways as well as those nutrients that accumulate on the farm (e.g. increased soil nitrogen levels). The positive balance provides an estimate of environmental risk.

2nd Approach. The second approach takes into consideration the import-export of nutrients as well as losses due to volatilization of nitrogen from manure during collection, handling, storage, and application. This approach would include the Mass-Balance approach, plus estimates of volatile nitrogen losses, and is commonly used for development of Nutrient Management Plans and Comprehensive Nutrient Management Plans in many states.

3rd Approach. The third approach takes into consideration the losses of volatile nitrogen as well as leached nitrogen. This approach is also common to NMPs and CNMPs when leaching index tools and soil nitrogen indices are utilized in NM planning.

In contrast to nitrogen, phosphorus (P) is not lost to the atmosphere and therefore, what is not exported from the farm remains within the farmstead or possibly lost due to transport. Thus, the 1st approach (mass-balance) and 3rd approach (mass-balance plus surface and leaching loss) are the approaches that are more common for P based nutrient management planning.

Checklist tools

The "Opportunity Checklist and Feed Management Plan Checklist" summarize the common Feed Management practices that can be adopted to assist with reducing the import of nutrients to the farm in the form of feedstuffs or reduce the excretion of nutrients in manure. The opportunity checklist includes Feed Management practices or concepts that usually have the greatest initial impact. These include but are not limited to:

1) formulation of diets to meet animal requirements
2) grouping animals according to nutrient needs
3) determining dry matter routinely and adjusting rations accordingly, and
4) analyzing diet ingredients routinely

Additional feed management practices and strategies that can further assist with reducing the importation of nutrients to the farm are outlined in the feed management plan checklist.

Spreadsheet-based whole farm nutrient management tools

Several spreadsheet-based tools are available to estimate the nutrient balance at the whole farm level. The name of these tools and where a copy can be obtained are:

- Whole Farm Balance Nutrient Education Tool (Washington State University) http://www.puyallup.wsu.edu/dairy/joeharrison/software.asp
- Whole Farm Nutrient Balance (University of Nebraska) http://cnmp.unl.edu/cnmpsoftware2.html#WholeFarmNutrientBalance
- Whole Farm Nutrient Balance Spreadsheet (Cornell University) http://nmsp.css.cornell.edu/projects/massbalance.asp

Summary

Whole farm nutrient management should include the consideration of import of nutrients to the farm, movement and transformation (including losses) of nutrients within the farm operation, and export of milk, meat, crops, or manure.

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