

## Chapter 1

### Introduction

Nitrogen (N) has traditionally been considered one of the most important nutrients for plants. It can increase plant growth and crop yield. Because most soils are often deficient in the type of N that plants can readily use, chemical fertilizers or organic "residuals" such as manure or biosolids are added annually to agricultural soils and are increasingly being added to forest soils.

The amount of N in biosolids is relatively high, making it an attractive fertilizer. In fact, biosolids application rates must be carefully calculated to avoid adding too much N, which can leach out of the soil in the form of nitrate and degrade the environment. Seldom have trace applications of biosolids posed problems from trace metals, such as cadmium, copper, nickel, and zinc, whereas such heavy applications will invariably cause nitrate leaching. Many studies have documented this.

Determination of proper biosolids application rates depends on a number of factors. In situations where there are small quantities of biosolids, large amounts of land available for biosolids application, and no goals for maximum crop yields, application rates can be conservative. In situations where there are large quantities of biosolids and limited available application areas, relatively minor adjustments in assumptions about the behavior of N in the environment can determine whether a potentially costly and time-consuming process must be undertaken to identify additional application sites. In situations that include maximum crop yield goals, the determination of an appropriate application rate is critical.

Other aspects of managing N from biosolids must also be considered, including the behavior of N in compost products and the management of excess N in areas where high application rates of biosolids are used in land reclamation.

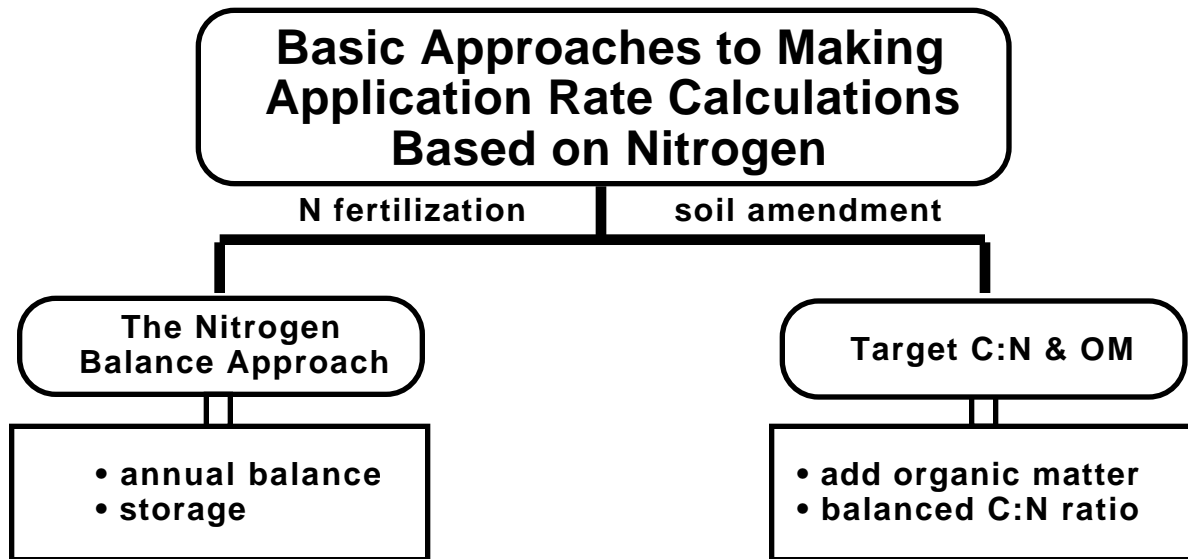
A great deal of research has focused on N management and the accurate design of biosolids application rates. The purpose of this manual is to present the most current knowledge on the behavior of N in the environment and to provide guidelines on how this knowledge can be used in biosolids application projects. Specific objectives are as follows:

- To increase the understanding of what happens to N after the land application of biosolids, so that the effects of specific biosolids types, management strategies, and site conditions can be better predicted
- To provide methods for designing site-specific biosolids application rates for agricultural, forest, and rangeland systems and for making assumptions based on local research results
- To provide a common tool to assess biosolids application and management designs for those involved in review or approval of biosolids land application projects

This manual presents two basic approaches for determining biosolids application rates (Figure 1.1). The majority of the manual (Chapters 3 through 7) focuses on the Nitrogen Balance Approach, which relies on the processes (transformations and losses) that occur in the nitrogen cycle, as described in Chapter 2. The objective of this approach is to match available N in the biosolids and the soil to the amount of N that plants need. In contrast, the Balanced Soil Amendment Approach (Chapter 8) is concerned more with the soil amendment properties of the biosolids than with their fertilizing properties. Its objective is to increase the organic matter of the soil by adding a mixture of biosolids and a carbon-rich residual (such as sawdust). The excess N added from the biosolids can be immobilized by the carbon-rich residual. Compared to the Nitrogen Balance Approach, the Balanced Soil Amendment Approach is a new concept that

requires more fine tuning in the field to verify application rates. The final chapter (Chapter 9) of this manual provides recommended methods for laboratory analysis of N in biosolids and soils.

Just as the nature of N is dynamic—it is constantly changing in form—this manual is a growing document that will change as new information emerges from continuing research.



**Figure 1.1 The Nitrogen Balance Approach and the Balanced Soil Amendment Approach for determining biosolids application rates.**