



Phosphorus Balance

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Definition:

Balance of phosphorus (P) inputs and outputs from all sources in a specific component of an agricultural system, such as a field, an animal facility or a farm.

Accounting methods using amounts of each material and P concentrations can make simple estimates of the difference between P in the inputs such as fertilizer, feed and manure and P in the crops harvested, animals sold, manure exported or other outputs. More sophisticated computer-aided tools can also be used.

A positive balance indicates an accumulation of P, while a negative balance indicates a depletion of P.

Purpose:

To balance the P inputs and outputs so that P on the farm or in a field remains adequate to meet crop and animal requirements, but does not represent an excess that could be a potential source of P loss to the environment.

After P inputs and outputs have been balanced, land treatment practices can then be implemented in fields to control losses, without additional concern for accumulating P that

could overwhelm their effectiveness.

How Does This Practice Work?

Phosphorus pollution requires a source of the nutrient and a mechanism to transport it to a water resource. Phosphorus balance is determined by the managed material/nutrient transfers to, from and within a field, an animal facility or farm. If the flow of P in exceeds the flow of P out, a positive P imbalance will occur and nutrients will be accumulating in that component of the system, contributing to the source of P. This accumulation will often be indicated by excessive soil test levels in the farm fields.

For a farm that specializes in animal production, overall farm balance can be roughly estimated based on animal density or external

feed sources, as illustrated in the table below.

This simple classification can be used as a starting point for assessing the nutrient balance for an operation and for helping to determine the need for a more detailed P balance assessment.

Accumulation is a potential source of P that can be lost from fields to surrounding water resources through erosion, runoff and leaching. When P appears to be accumulating in an animal facility, it may be a source of P loss in runoff discharges from the facilities, or it may be part of residual “sludge” in manure storage structures that must be accounted for at some time in the future.

If the difference between P inputs and P outputs is negative, P is being depleted from that component of the agricultural

Farm Features	Farm Phosphorus Balance		
	Deficit	Balanced	Excess
Animal Density (Animal Units* per acre routinely manured)	Low <0.6	Medium 0.6 to 1.2	High >1.2
% of total feed from off-farm sources	<20	20 to 40	>40

* 1 Animal Unit = 1000 lbs live weight

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system. Where large amounts of P may have accumulated, this depletion can be beneficial. However, if not carefully monitored, it may result in low soil test levels over time and possible crop P deficiencies.

The matrix that follows can be used to assess the potential agronomic or environmental impact of nutrient balance for individual fields, groups of fields or a farm, depending on the different soil test conditions on a farm.

Soil Test Level	P Balance Annual Input – Output Status		
	-	0	+**
low	Agronomic liability		Preferred
optimum	OK*	Ideal	OK*
excessive	Preferred	OK	Potential environmental and/or biological liability

*long-term performance can cause an undesirable change in the soil test level

**extreme balances can create environmental or biological problems, especially when the nutrients are supplied in manure

The actual loss of P from farms to water resources will depend on the transport mechanisms operating on the source. By managing the flow of nutrients to maintain a balance between inputs and outputs, the contribution of the source can be minimized and the risk of P loss reduced.

Achieving nutrient balance often does not mean simply adopting a different tactical or operational approach to field, animal or farm nutrient management.

Nutrient balance at the farm level is usually determined by a farmer's strategic decisions. These decisions are based on a wide variety of factors, especially those ex-

ternal to the farm, that are quite different from the factors influencing day-to-day farm activities.

The outcomes of these strategic decisions may not be influenced by their consequences for the balance of nutrients. An example of the lack of connection between these decisions and their environmental consequences would be intensifying animal production by increasing reliance on feed from off the farm to support more animal production with little concern for the fate of the additional nutrients.

Strategic decisions not only impact the farm level balance, but also constrain the management options available to achieve balance on the fields within the farm.

Unlike most traditional Best Management Practices, implementation of a nutrient balance practice will usually require strategic changes in the farm operation.

Examples of strategic farm changes might include reducing the animal density on the farm to reduce the inputs of nutrients; securing more land for manure application, thus increasing the outputs in the form of crop removal; or moving manure off the farm as an additional output of nutrients.

Where This Practice Applies and Its Limitations:

This practice applies to all types of agricultural production. Controlling P accumulation in excess of crop utilization potential will primarily apply to situations where there are significant sources of nutrient inputs to farms that are not directly related to crop requirements. For example, this would include inputs of nutrients in feeds for intensive livestock and poultry enterprises.

Where the P inputs are closely related to crop production, economic factors often directly encourage nutrient balance.

Effectiveness:

If nutrient inputs and outputs are balanced at the farm and field scales so that nutrients are not accumulating beyond levels needed for optimum agronomic crop production, the P source dimension of the loss process will be controlled. When source control is combined with adequate transport controls, P losses should be low.

The costs to remove P from the agricultural system to achieve the P balance associated with this practice may seriously inhibit the feasibility of implementation (see below). The physical accounting for P may not be as difficult to implement as corrective management responses.

Cost of Establishing and Putting the Practice in Place:

When P is accumulating in excess of crop utilization potential, the costs associated with implementing this practice can be very high and possibly prohibitive.

The outcomes of strategic decisions that result in the positive imbalances this practice would address are usually based on optimizing the economic performance of the operation without regard for the environmental costs. These environmental costs are usually not included in the financial accounting of the farm performance, but are external to the operation. Because we do not have simple methods to define these costs, setting their exact values is difficult.

Achieving nutrient balance will likely result in a less than optimum economic outcome for the individual farm operator when those external costs become part of the farm operation.

Generally, costs of production related to water quality protection that are not reflected in the price farmers receive for their products are considered to be "sunk" costs. These costs can alter annual profitability and the feasibility

of remaining in business for the long-term.

Farms that are in a start-up phase or about to expand are best able to cover the sunk costs in their business plan, so complying with new strategic requirements, such as planning for P balance, should be an important consideration in these situations. However, these additional costs may encourage other farmers to quit farming, and encourage the remaining businesses to get larger to cover the costs.

Operation and Maintenance:

When P is accumulating in excess of crop utilization potential, this practice may require intensive, ongoing effort to maintain nutrient balance at the field and farm levels. Detailed records of inputs and outputs will be helpful at the field or farm level, depending on the outcomes of a preliminary P balance evaluation. These can be used to identify the opportunities for improving the balance and ensuring that goals are routinely achieved.

New skills and management capacity may be required for this accounting and evaluation. For example, if additional cropland is acquired to provide additional capacity for crop nutrient utilization, animal-oriented producers may have to take on greater crop production responsibilities.

Implementing this practice will likely require a much greater off-farm focus; for example, in developing and servicing off-farm markets for manure or dealing with manure importers, brokers and haulers, than the historic focus on field and farm management practices.

References:

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For Further Information:

Contact your local conservation district, USDA-NRCS or Cooperative Extension Service office.

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