
# NUTRIENTS IN SOIL AND NUTRIENTS FOR FOOD PRODUCTION

BY ADRIAN M. JOHNSTON

Have you ever considered the link between human nutrition and soil fertility? While most people are aware of the need to conserve the soil resource, there is growing concern that many are not aware of the role that fertile soils play in producing high quality food. The crop products we are consuming today meet our nutritional needs as a result of nutrients applied to soils as fertilizer, livestock manure, or crop residues.

While the philosophy of farmers may differ on managing soil fertility, they are well aware of the impact that past soil management has on current production, and the implications of soil fertility decline on a sustainable future for agriculture.

Fortunately, plants do not discriminate among nutrient sources in the soil, taking them up as plant-available inorganic forms regardless of their origin. Commercial fertilizers have played a large role in the success of today's farms–directly with those that apply them, and indirectly with the few that don't.

Resource scientists confirm that one of the greatest advantages held by North American farmers in the competitive world of food production is the quality of their soil resource. Native soil fertility in vast regions of North America still allows the production of high crop yields in the absence of nutrient additions. The practice of summer fallowing, or letting the land rest (that is leaving it uncropped) for a period of time when crops normally would be grown allows the soil to replenish stored moisture and build up plant-available nutrients as they are released from the soil's organic matter. Spring wheat grain yield trends from a semiarid research site in western Canada illustrate the inherent productivity of many grassland soils (**Figure 1**). In the absence of phosphorus fertilizer additions, yield averaged about 84% of the fertilized wheat for over 30 years. However, in the mid 1990s the spread between fertilized and unfertilized wheat yield started to increase, reflecting a reduced nutrient supply in the fallowed land in the absence of phosphorus replacement with fertilizer use.

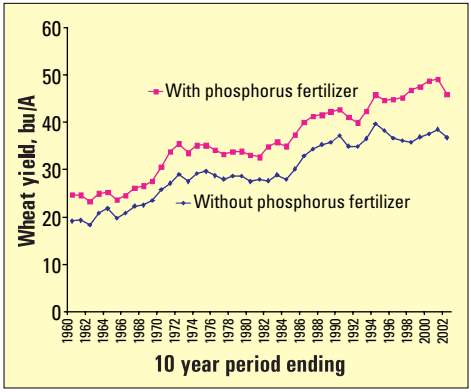


**Figure 1.** Yield of spring wheat grown on summer fallow with and without fertilizer phosphorus additions.

A small proportion of North American farmers have opted to use organic crop production methods, a practice that removes the use of certain external inputs, in particular most commercial fertilizers and pesticides. Fortunately, past fertilizer use on lands converted to organic production continues to provide residual crop responses for a number of years into the future (**Figure 2**). Additions of phosphorus and potassium to soils improves their inherent fertility for future production. Certain legume crops–such as alfalfa, clovers, and soybeans–can fix their own nitrogen from the air. However, soil reserves of plant-available phosphorus and potassium

are finite and annual removals deplete soil supply in the absence of some form of addition.

Sole reliance on nutrients which are generated on-farm limits productivity. A recent survey of organic farms in the northeast Great Plains found crops produced organically yielded only 44 to 75% of those produced conventionally (**Table 1**). An evaluation of soil nutrient status with soil testing was carried out on these same survey farms. Soil nitrogen levels were average to high on most farms, reflecting the use of forage and grain legume crops to restore nitrogen fertility through nitrogen fixation. However, the survey found low levels of phosphorus and sulfur in many of the fields sampled. Deficiencies in phosphorus and sulfur could limit future nitrogen fixation by legumes. However, the imbalance of high nitrogen with low phosphorus and sulfur is more likely to reduce crop yield by inefficient use of soil-available nitrogen. For organic farms to continue to produce good yields per acre, this often means bringing in nutrients from off the farm.

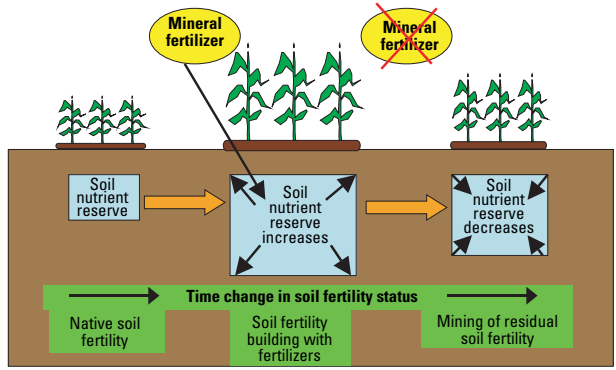


**Figure 2.** Role of past fertilizer additions in future crop production.

**TABLE 1.** Yield of selected cereal, oilseed, and pulse crops grown using organic and conventional production practices in Manitoba.

| | Organic | Conventional[1] | Organic as % of conventional |
|---|---|---|---|
| | Yield, bu/A | | |
| Wheat (hard red spring) | 25.3 | 35.2 | 72 |
| Barley | 45.7 | 60.9 | 75 |
| Oats | 45.9 | 64.8 | 71 |
| Flax | 11.8 | 22.0 | 54 |
| Canola | 12.9 | 29.5 | 44 |
| Field pea | 18.7 | 34.5 | 54 |

[1]Conventional yield source was Manitoba Crop Insurance Corporation data from southwestern Manitoba.

**Addressing the net export of nutrients from organic farms will become a major challenge in the future.** Some growers obtain organic nutrients from neighboring farms to balance their nutrient needs. Composts, crop residues, and animal manures all contain nutrients derived in part from commercial fertilizer, either directly applied or from past application. And even after many years of transition to organic farming, soils still contain phosphorus and potassium built up by previous fertilizer use (**Figure 2**). So, organic farmers also benefit from North America's long history of applying commercial fertilizers.

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Suggested changes in organic certification criteria are making it more difficult to source nutrients and crop production inputs for organic farms. It has been suggested that manures and composts only come from livestock managed on certified organic farms. The same applies to new seed grain cultivars introduced to capture improvements in yield, quality, and pest resistance. These restrictions are bound to increase the interdependence between organic farms and limit the possibilities to manage nutrients and maintain productive soils.

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**Without fertilizer to maintain productivity on North American farms, more of the world's fragile lands would have to be converted to growing food. Fertilizers increase yield potential of farmland, so that other land can be used for other purposes.**

Correcting the trends toward lower soil tests will help farmers and our national food security by:

- Maintaining our low-cost food supply through increasing yields and reduced cost per unit of production.
- Increasing potential to produce low-cost feedstuffs for industrial uses.
- Enhancing competitiveness of agriculturally-derived energy products.
- Ensuring continued independence for our most basic food and fiber needs.

Our future food/fiber/energy security depends on responsible attention to nutrient management today...on all fields. Correcting current trends requires better attention to soil testing and fertilizer application to address deficiencies and avoid excesses. Techniques are being refined, such as site-specific nutrient management systems. Scientifically sound, balanced nutrition in farm fields leads to more balanced diets for animal and human consumption, and supports our national independence in food, fiber, and, perhaps someday, energy. BC

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**Commercial fertilizers supply nutrients in the inorganic form–the form that plants actually absorb–to boost the growth of plants.** Using these nutrients, plants produce the organic materials critical to building soil structure and to supporting the soil organisms essential to nutrient cycling. Thus, inorganic nutrients play a vital role in the biology and health of the soil ecosystem.

Across North America, crops currently remove 77% of the nitrogen supplied in fertilizers, manures, and by legumes. The figure for phosphorus is 95%. Some losses occur, but growers have made progress over the past two or three decades in reducing them. Soil potassium, however, is currently being depleted. Crops remove 43% more potassium than is supplied in fertilizers and recoverable manure.

Agriculture has, and continues to be, oriented toward producing healthy food for all consumers. Managing the Earth's large reserves of inorganic nutrients is imperative to sustain an agriculture that produces healthy food for all. BC

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