In the western U.S.A., high soil pH values often lead to Zn and Fe deficiencies and low P availability. Rock phosphate is a commonly used organic P fertilizer; however, it does not dissolve in alkaline soils. Therefore, increasing soil P availability is an important challenge for organic farmers in this region. In addition, soils typically have low organic matter contents (0.5-1.5%), and irrigated land has a risk of salt buildup that interferes with plant growth.

Data was gathered from annual soil tests taken at Grant Family Farms (GFF), the largest organic mixed crop farm in Colorado, located in the semi-arid Great Plains (330 mm precipitation per yr). The land that now makes up GFF was purchased in the early 1970s, and sustainable agricultural practices were used until the mid-1980s when organic farming practices were implemented. Crop rotations among over twenty different vegetables and herbs are standard practice under center pivot irrigation. GFF uses dairy manure and green manures as their only fertility inputs. The dairy manure is applied in the fall once every 3 yrs. Green manures are used two out of every three years. The spring/summer green manures are usually oats or field peas, and the fall green manures normally include a vetch/rye mix or an Austrian pea/rye mix.

Our objective was to assess the soil fertility impact of the transition of GFF from a conventional to an organic farm. Soil samples were taken every fall from the 0-30 cm depth. Soil test data from twelve fields, 17 to 63 acres in size, were compiled and analyzed for changes over time in soil chemical properties for ten soil fertility components: pH, electrical conductivity (EC), soil organic matter (SOM), nitrate (NO$_3$-N), phosphorus (P), potassium (K), zinc (Zn), iron (Fe), manganese (Mn), and copper (Cu). The number of years of data per field ranges from 5 to 16 years over the period of 1985 to 2000.

Macronutrient impacts were variable. Soil NO$_3$-N did not change significantly over time in organic production in any of the observed fields. However, available P levels increased significantly over time in 11 of the fields (92%) to high (12-15 ppm AB-DTPA) and very high levels (>15 ppm AB-DTPA) for crop production. Unfortunately, we were unable to separate the impacts of the dairy and green manures on soil P or any fertility components. Levels of available K also increased significantly in eight fields (67%). Clay soils in Colorado are not prone to K deficiencies, and additions of dairy manure and green manure to the soil replace K that is depleted by crop use.

Many micronutrients can become deficient in plants grown in basic soils. Four (33%) of the GFF fields showed a significant decrease in pH. Baseline pH levels, before organic practices began, ranged from 7.9-8.1; these numbers changed to 7.6-7.9 in the last year analyzed. The four fields that showed significant decreases (p<0.05) in pH also increased significantly in available P, K, and Fe. The micronutrient content of the manure and the drop in pH are likely explanations for the significant available Zn and Fe increases in five of the fields (42%). Available soil Mn increased in only two of the fields (16%), and available Cu did not show any significant change in any of the fields.
Soil OM increases very slowly and can take several years to detect. However, in four of the fields (33%), soil testing revealed a slight increase in SOM (<0.10 % per year) in organic production.

EC increased in two fields (16%) but still remained within satisfactory levels for most field crops. However, EC reached detrimental levels in some years for sensitive vegetable crops like lettuce, onions, carrots, and beans, all of which GFF cultivates. This may be due, in part, to the salt content of the applied dairy manure.

In summary, annual soil tests revealed a significant increase (p<0.05) in P, K, SOM, Zn, and Fe and a significant decrease in pH levels in ≥ 33% of the fields. Overall, there was an observed improvement in soil fertility components over time in organic production. Therefore, organic soil fertility practices are a promising way of meeting the challenges of agriculture in the western U.S.A. Soil pH was reduced; soil OM was increased; available P, Zn, and Fe were increased; and there was little impact on soil EC.

For more information, contact Jessica Davis at Jessica.Davis@Colostate.edu