What is best food? How is it grown and produced?

Ross Vintiner explains the ideas behind Kete Ora Trust's exciting funding venture with Plant & Food Research *Rangahau Ahumara Kai*.

Are we eating the best food for our health? What do consumers think of the link between growing systems and the food they eat?

We are really excited to have initiated this evidence-based, world-leading research project to find answers to these questions, and grateful to Plant and Food Research for their support and enthusiasm. The project involves a comparative study of the nutrient density of food produced from biodynamic, organic, and non-organic production systems, and consumer perceptions of such food in Aotearoa New Zealand.

Why do we need this research?
Surprisingly, there are few studies that compare the nutrient density and phytochemical properties of food from biodynamic, organic, and non-organic production systems, and even fewer studies comparing consumer preference for, and experience of nutrient dense food produced from each system.
We want to provide the evidence that shows how healthy living soil enhances nutrient density in crops, and how different land use systems produce varying soil quality, which in turn yields crops with different levels of the phytochemicals, vitamins, and minerals that are relevant to human health.

Phytochemicals?
Phytochemicals are compounds produced by plants, generally to help them resist infections and consumption by insects and other animals. When consumed, phytochemicals strengthen the human immune system, reduce inflammation, prevent DNA damage, promote DNA repair and slow cancer cell growth.

What does existing research tell us about different production systems' ability to produce healthy living soil?

Production studies
There have been several "production" studies comparing biodynamic, organic, and non-organic systems and practices. In New Zealand, these have included field trials:

- *Soil Quality and Financial Performance of Biodynamic and Conventional Farms in New Zealand,* Science, 16 April 1993, Vol. 260, pp. 344-349.
- *Organic Farming Enhances Soil Fertility and Biodiversity*, FiBLDOSSIER, Nr 1, August 2000.

Both studies demonstrate biodynamic and organic soils have higher biological and physical quality compared to non-organic practices. Physical quality includes soil organic matter, microbial activity,

soil structure and root symbiosis, permeability, topsoil, diversity. In addition, biodynamic and organic farms use less inputs and energy, and produce less erosion and pollution.
These and other studies have shown that organic production systems (biodynamic and organic) produce crops with variable nutrient content, although organic crops have higher nutrient content the majority of the time, compared with non-organic production.

Nutrient density comparison studies
There is encouraging recent research that compares regenerative (including organic) and non-organic production systems producing nutrient dense food, although not directly comparing biodynamic, organic, and non-organic systems. It is important to know the difference since other research shows that each of these production systems produce variable levels of soil quality, soil life, and crop nutrients. Here's an example:

"Soil health and nutrient density: preliminary comparison of regenerative and conventional farming." Montgomery DR, Biklé A, Archuleta R, Brown P, Jordan J. 2022. *PeerJ* 10:e12848
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Abstract:

Several independent comparisons indicate regenerative farming practices enhance the nutritional profiles of crops and livestock. Measurements from paired farms across the United States indicate differences in soil health and crop nutrient density between fields worked with conventional (synthetically-fertilized and herbicide-treated) or regenerative practices for 5 to 10 years. Specifically, regenerative farms that combined no-till, cover crops, and diverse rotations—a system known as Conservation Agriculture—produced crops with higher soil organic matter levels, soil health scores, and levels of certain vitamins, minerals, and phytochemicals. In addition, crops from two regenerative no-till vegetable farms, one in California and the other in Connecticut, had higher levels of phytochemicals than values reported previously from New York supermarkets. Moreover, a comparison of wheat from adjacent regenerative and conventional no-till fields in northern Oregon found a higher density of mineral micronutrients in the regenerative crop. Finally, a comparison of the unsaturated fatty acid profile of beef and pork raised on one of the regenerative farms to a regional health-promoting brand and conventional meat from local supermarkets, found higher levels of omega-3 fats and a more health-beneficial ratio of omega-6 to omega-3 fats. Despite small sample sizes, all three crop comparisons show differences in micronutrient and phytochemical concentrations that suggest soil health is an underappreciated influence on nutrient density, particularly for phytochemicals not conventionally considered nutrients but nonetheless relevant to chronic disease prevention. Likewise, regenerative grazing practices produced meat with a better fatty acid profile than conventional and regional health-promoting brands. Together these comparisons offer preliminary support for the conclusion that regenerative soil-building farming practices can enhance the nutritional profile of conventionally grown plant and animal foods.

Main article text
Introduction

Reported declines in the nutrient density of crops (Mayer, 1997; Davis, Epp & Riordan, 2004; White & Broadley, 2005; Ekholm et al., 2007; Davis, 2009) are typically attributed to crop breeders having focused almost exclusively on increasing yields (Morris & Sands, 2006; Marles, 2017). However, studies demonstrating that fertilization regimes and soil life affect mineral uptake by crops (*e.g.*, Lambert, Baker & Cole, 1979; Marschner & Dell, 1994; Miller, 2000; Jansa, Wiemken & Frossard, 2006; Ryan et al., 2008; White & Broadley, 2009; Zhang et al., 2012; Lehmann et al., 2014; Adak et al., 2016; Konecny et al., 2019) suggest that conventional farming practices of intensive tillage, nitrogen fertilization, and synthetic pesticide applications may have contributed to declining nutrient density through disrupting crop symbioses with soil life (Montgomery & Biklé, 2016, 2022). While a number of previous assessments compared differences in the nutritional quality of foods grown with conventional and organic production practices (Svec, Thoroughgood & Mok, 1976; Smith, 1993; Worthington, 2001; Brandt et al., 2011; Hunter et al., 2011; Smith-Spangler et al., 2012; Baranski et al., 2014), few have considered directly the influence of soil health—as reflected in soil organic matter and soil life—on nutrient density (see Hepperly, Omondi & Seidel (2018) for a notable exception).

Although proponents of farming practices that rebuild soil organic matter and soil health (which we collectively term "regenerative") contend that such practices result in more nutrient-dense food, such claims remain little tested. Here we compare the effect of regenerative farming on soil health and crop nutrient density from a cohort of paired farm trials across the United States. Along with evidence from several other paired farm and plot studies this comparison indicates that regenerative agricultural practices employing no-till, cover crops, and diverse crop rotations enhance soil health and the micronutrient and phytochemical density of various crops. We also compare the fatty-acid profile of beef and pork raised on one of the regenerative farms to a regional health-promoting brand and conventionally raised meat purchased at a local grocery store. Our results suggest that farming practices that affect soil organic matter and microbial communities are under-appreciated influences on crop nutrient density, particularly for micronutrients and phytochemicals relevant to plant health and chronic disease prevention in humans. These preliminary results point to soil health as a more pertinent metric for assessing the impact of farming practices on the nutrient composition of crops than the usual distinction of organic and conventional practices (Montgomery & Biklé, 2021).