Renewable Agriculture and Food Systems

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Securing fresh food from fertile soil, challenges to the organic and raw milk movements

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Review Article

Cite this article: Heckman JR. Securing fresh food from fertile soil, challenges to the organic and raw milk movements. *Renewable Agriculture and Food Systems* https://doi.org/10.1017/S1742170517000618

Received: 30 April 2017
Accepted: 19 October 2017

Key words:
Dairy; pasteurization; history; health; nutrition; policy; soil fertility; cooperative extension system

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Abstract

In recent decades, a diverse community of dairy farmers, consumers and nutrition advocates has campaigned amidst considerable government opposition, to secure and expand the right of individuals to produce, sell and consume fresh unprocessed milk, commonly referred to as 'raw milk'. This advocacy shares important parallels with battles fought in the organic food movement over the past century. Both the raw milk and organic food movements originated with farmers and consumers who sought to replace industrialized food production and processing practices with more traditional ones. Both movements equate the preservation of natural integrity in farming and food handling with more wholesome, nutritious food and environmental conservation. Both movements have had to work diligently to overcome a false perception that their practices are anachronistic, notably with regard to productive output of organic agriculture and the safety of fresh unprocessed milk. There is also the failure of opponents to acknowledge a growing body of scientific evidence for health benefits associated with drinking of fresh unprocessed milk. The raw milk movement has the potential to economically benefit family farmers, much as organic agriculture has done. Building soil fertility, a foundational principle of organic farming, would benefit from having numerous small pasture-based dairies spread across the land providing fresh unprocessed milk. Agricultural universities and the Cooperative Extension System could seize a real leadership opportunity by promoting and participating in this reinvention of dairy farming, and restoring the ecology of this traditional food and farming system.

Introduction

In the early years of the organic agriculture movement, Albert Howard declared 'fresh food from fertile soil' the 'birth right of humanity' (Howard, 1946). In recent decades, diverse consumer movements interested in organic and other traditional food systems have been organizing for the right of dairy farmers to produce, and consumers to have access to fresh unprocessed milk. In spite of a rapidly growing market place for organic foods, many organic dairy farmers who want to produce and sell fresh unprocessed milk are challenged by policy or discouraged by educational programs dictating food choice.

The social, political and legal challenges to this movement have been the subject of several recent books and articles (Enticott, 2003; Salatin, 2007; Gumpert, 2009, 2013; Schmid, 2009; Mincyte, 2014) and several reviews on the history of the organic agricultural movement have been published (Heckman, 2006; Youngberg and DeMuth, 2013; Saucier and Parsons, 2014). However, the broader story of the interconnections between the raw milk and organic food movements remains untold.

In the forward of *The Untold Story of Milk* (Schmid, 2009) Sally Fallon Morell briefly described the parallel between the organic and raw milk movements: 'Twenty years ago organic agriculture was a fringe movement, barely on the mainstream radar scope, a subject commentators treated with derision and politicians with scorn. Today organics is the fastest growing sector of the agricultural economy, a paradigm that garners tremendous public support, one that has proven a boon to many farmers. Raw milk today is a fringe movement, a crusade of underdogs, a pesky mouse against the entrenched lions of medicine and industry. Who would be foolish enough to propose reinstating raw milk into the American diet? Or suggest that the agricultural model of the future will be the small farm with the dairy cow as its centerpiece?'.

The similarities between the raw milk and organic food movements are numerous. One reason people have chosen to buy organic milk is their concern for the method of food production. Being a staple in many diets, and especially for children, parents are naturally particular about their source of milk. For dairy, research has shown superior nutritive food composition in organic production over conventional (Benbrook et al., 2013), a difference that can be attributed, at least in part, to the requirement that organic dairy systems must obtain a minimum 30% of dry matter intake from pasture across a grazing season lasting a minimum of 120 days.

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In addition to the method of food production, the most discriminating consumers are concerned with how the pathway from farm to table may influence nutrition, safety and quality of organic foods. The concept behind 'Know Your Farmer, Know Your Food' (USDA Program, 2012) would fit consumer interest in finding fresh unprocessed milk of the highest possible quality.

For example, the modern dairy industry requires that certified organic milk be handled separately from conventional milk, but collection and processing systems are essentially the same. It typically begins with tanker trucks collecting and commingling organic milks from individual farm bulk tanks. The organic milks obtained from many different farms are delivered to a processing plant where the milk undergoes pasteurization or often ultra-pasteurization and usually also homogenization. Typically the cream is separated from the milk and the remaining product is sold as reduced fat or skim milk. Before this milk is placed on a shelf in a grocery store, it has lost its farm identity and has been altered in many ways that would no longer qualify as a fresh whole food in the traditional sense of the word 'organic'. Yet such milk does qualify as organic under the USDA National Organic Program standards (Code of Federal Regulations, 2015).

Organic standards prohibit treatment of organic food with irradiation, but there are no other provisions to prevent organic milk from being treated differently after it leaves the farm than the conventional food system. Although there has been hope that the organic milk market would offer an economically viable alternative to the conventional food system, recent market trends with processed organic milk as a commodity is beginning to resemble the conventional dairy sector (Guptill, 2009; Whoriskey, 2017).

Once a dairy farm transitions from a confinement model to a pasture-based feeding system, a smaller further step (Heckman, 2015) is to convert the farm to organic following the required 3-yr period for transition. Often after a dairy farm becomes certified organic, consumers begin showing up at the farm gate seeking to purchase raw milk before it gets shipped for processing. This has occurred so frequently that Organic Valley Cooperative, the largest organic dairy cooperative in the United States, now prohibits its members from selling milk off the farm to any other buyer (2010).

The actual growth in demand and consumption of raw milk is, however, difficult to measure for political reasons. The legal status of raw milk sales varies greatly within the United States (Farm to Consumer Legal Defense Fund, 2016) and around the world. The hostility of the public health community and government enforcement action has frequently pushed raw milk into an underground market (Gumpert, 2013).

A 2006–2007 survey of food consumption patterns conducted by the Centers for Disease Control (2006–2007) in several states suggested that about 3% of the US population consume raw milk. Another indication of demand is that more dairy farmers are exhibiting interest in producing raw milk for this market. For example, in Pennsylvania where raw milk sales are legal, the number of permits increased from about 25 dairies in 2003 to over 150 in 2014 (Kaylegian, 2014). A high percentage of these farms is either certified organic (about 23%) or practice organic farming on pastures without certification.

Raw milk is very often purchased directly from a farmer rather than from a grocery store. This direct contact between a farmer and the families eating the food fosters a living trusting 'organic' relationship. When people visit the farm, they often come to appreciate the nature of the operation (Hassanein, 2011). People who drink fresh milk tend to place great emphasis on organic feeding practices, especially pasture, and quality of the milk (Katafiasz and Bartlett, 2012). Organizations dedicated to teaching people about fresh milk strongly urge that the milk should be produced from pasture-raised animals and not from concentrated animal feeding operations (Gumpert, 2015). Large-scale industrial or confinement operations that emphasize high levels of production per animal unit are not a recommended source for fresh milk (Shetreat-Klein, 2016). These fresh milk guidelines are aligned with USDA-NOP standards that require pasture feeding of animals. Fresh milk consumers are often satisfied with farmers following organic practices without actually attaining certification (Baars et al., 2015).

The lack of attention to the raw milk debate by historians may seem surprising given that dairy was by far the most valuable commodity produced on the US organic farms in 2014 (USDA Agricultural Census, 2015). While demand for fluid conventional milk has been steadily declining for several decades (Berry and Gee, 2012), and virtually all of the organic milk is thermally processed prior to sale, the growth in demand for permits to sell raw milk in some states has been described as 'explosive' (Beecher, 2016). This despite the fact that drinking of raw milk remains highly controversial among conventional milk producers and policy makers (Gumpert, 2015). Considering that the organic farming and food movement has a history of challenging authority and conventional wisdom (Heckman, 2006; Obach, 2015), it should not be surprising that some members of this community accept drinking raw milk as natural and normal (Organic Valley Cooperative, 2010).

The main objective of this review is to provide an historical account of the raw milk movement and its long association with the organic farming movement. A second is to provide a survey of the literature pertaining to the question of health and nutrition benefits associated with drinking fresh unprocessed milk. A third objective is to examine how food policy governing access to fresh unprocessed milk may impact soil fertility in the context of agroecosystem sustainability. Taken together, this paper will show a need for involvement by agricultural universities, the Cooperative Extension System and public health institutions. They will need to reconsider their long-standing near-universal opposition to drinking fresh unprocessed milk to one of supportive research and education.

Methodology

Personal and professional work experience in an academic setting was garnered as a result of being involved in organizing and hosting various educational programs (Table 1), and in 2008, a seminar series specifically focused on raw milk and informed consumer choice (Rutgers New Jersey Agricultural Experiment Station, News Release, 2008). Besides the four invited seminars that took place in 2007, several other speakers with differing views were invited but declined to participate in the seminar series. To manage the surrounding storm of controversy and numerous questions, an extensive search for literature was conducted. All found literature concerning scientific, historical, political and legal aspects of the raw milk issue was collected and made available for colleagues and students at the Rutgers University through electronic file sharing. Professors were invited to add any related documents to this collection that they deemed to be important for inclusion. Funds for the literature search and

Table 1. In 2008, Rutgers New Jersey Agricultural Experiment Station sponsored a seminar series to help people understand the issues and provide science-based information about raw milk. Other related educational programs included additional speakers and screenings of documentary films about raw milk. Event year, speaker and program titles are listed

Year	Speaker	Program
2006	Sally Fallon Morell, President of Weston A. Price Foundation	Seminar: Splendor from the Grass: Healthy Children, Healthy Families, Healthy Farms through Grass-Based Agriculture
2008	Mark McAfee, Organic Pastures Dairy	Seminar: Raw Milk, Mother Nature's Inconvenient Truth
2008	David G. Cox, Attorney at Law, Lane, Alton & Horst LLC	Seminar: Raw Milk Wars, Government's Attempt to Dictate What Foods We Can Consume
2008	Dr Mark Gebhart, MD, Wright State University	Seminar: Raw Milk, A Microbiology Primer
2008	Dr Don W. Schaffner, Professor of Food Science, Rutgers University	Seminar: A Risk Assessor Takes a Look at Raw Milk
2010	David Gumpert, Journalist	Seminar: The Raw Milk Revolution
2010	Michael Schmidt, Biodynamic farmer and manager of a raw milk cow share in Canada	Screening of documentary and panel discussion: Organic Hero or Bioterrorist.
2011	Dr Ted Beals, MD, member of the Michigan Fresh Unprocessed Whole Milk Workgroup	Seminar: If Raw Milk is So Dangerous Why Aren't All Our Friends and Neighbors Sick?
2011	Kristin Canty, film producer	Screening of documentary and panel discussion: Farmageddon

seminar series were provided by the Rutgers New Jersey Agricultural Experiment Station.

The (2008) seminar series and accompanying lectures and events along with the electronic sharing of raw milk files stimulated a lively and sometimes heated scholarly discussion (Alexander, 2011). Most recently, this author was invited by a USDA scientist to participate as a member of a scientific debate panel concerning raw milk risks and benefits. This debate was sponsored by the International Association of Food Protection and was held in St. Louis, Missouri on August 3, 2016 (Fallon Morell, 2016).

This review draws upon observations, experiences and an extensive collection of literature concerning milk and places it in the context of the organic farming and food movement. Previous scholarly activity on exploring the history of the organic movement (Heckman, 2006) along with service to the Organic Management Systems Community within the American Society of Agronomy (Heckman et al., 2013) and as a board member of the Northeast Organic Farming Association of New Jersey provided further background.

The whole story: fresh milk in context

A common philosophy of the early organic farming and food movement was a central focus on the concept of 'wholeness'. An organic farm functioned in its 'wholeness' as an integrated system of living organisms. Sir Walter Northbourne captured this philosophy of an organic farm saying it 'must have a biological completeness: it must be a living entity' where every 'branch of the work is interlocked with all others' (Northbourne, 1940).

Eve Balfour, founder of The Soil Association (Brander, 2003) became known as the 'Voice of the Organic Movement'. In her best-selling book *The Living Soil*, she elaborated on the wholeness philosophy by extending the concept to food as in 'whole diets' (Balfour, 1976). She wrote: 'The theory which I have endeavored to expound in this book is that the only true conception of health is one of wholeness, dependent upon both the continuity and the completeness of the cycle of life.' She further argued that, 'the health-giving property of food is dependent on the way it is grown, prepared and consumed.' In her chapter on 'whole diets' she provides a review of how ancient peoples 'preserved the wholeness of their health and that of their crops and livestock' by summarizing the observations of medical pioneers in nutrition. She draws from the works Sir Robert McCarrison (McCarrison, 1953), Weston A. Price (Price, 1950) and many others as examples of where healthy communities existed with virtually no physical or mental defects until their food culture was displaced by modern industrialized foods. While building the case for fresh whole foods sourced from fertile soils, she advocates for a 'complete and continuous transference of health from fertile soil, through plant and/or animal to man and back to the soil again'. As a leading voice in the organic farming movement, Balfour was also a vigorous opponent of compulsory pasteurization (Tinker, 2000).

In an article in Organic Gardening magazine Sir Albert Howard (Howard, 1946) wrote about 'a famine of quality' and the 'murder of our daily bread' as a result of growing food with artificial fertilizers and the use of modern processing to manufacture and denature foods. He refers to the work of Dr Weston Price as confirmation for his analysis of the problem and urges widespread distribution of Price's book *Nutrition and Physical Degeneration*. Howard recommends that schools provide nourishment to children as: 'The produce including bread and the milk should come from humus-filled soil and should be consumed fresh.'

When Walter Northbourne outlined seminal concepts of organic farming in his 1940 book *Look to the Land*, he also accurately and insightfully characterized the current situation as it pertains to milk: 'So long as people go on being fooled by advertisement (blatant or concealed) of processed foods, so long will they and the farmers be at the mercy of vast distributing concerns, whose every interest seems to be opposed to the people's real nutritional necessities. How can it be otherwise in a world of specialization and urbanization? Effective distribution seems to necessitate sterilization, which means killing, for failure to sterilize may mean infection in bulk. Hence the outcry for the pasteurizing of milk. But sterilization reduces the resistance to infection and the power of assimilation of the consumer of that which is sterilized. So yet more sterilizing seems to be necessary. A vicious circle again, of a type which should by now be familiar.'

In the United States where J.I. Rodale first popularized organic farming, he similarly drew connections between healthy soils,

healthy food and healthy people. Following in the same vein as other organic pioneers, his publications frequently discussed how commercial and industrial food processing reduced its nutritional value. Similarly, Rodale's thinking was influenced by observations on traditional farming and food systems as described by Sir Robert McCarrison and Weston Price (Rodale, 1948). Ten years later (Rodale, 1958) in an Organic Gardening and Farming magazine article entitled 'What Does Organic Mean', he explicitly staked out the organic position against pasteurization: 'It is not organic to produce milk organically, and then to pasteurize it.'

A recent report (Michigan Fresh Unprocessed Whole Milk Workgroup, 2012) states: 'Milk fresh from the cow is a complete, living, functional food…the full benefits…are only realized when all of these components function as a complex interdependent and balanced process.' This contemporary view on wholeness of food systems from a panel of experts is consistent with the philosophy of the early pioneers of organic farming. The list of 'consumer preferences on production and management practices of fresh whole milk' outlined in the Workgroup report is also consistent with the cultural practices associated with organic farming.

Milk problems and solutions

Among the parallels that exist between the fresh milk and organic farming movements are responses of a concerned farming and food community to the destructive forces of a modernizing and increasingly industrialized agriculture.

One of the myths about organic farming (Heckman, 2010) is that before the widespread use of synthetic chemical fertilizers and synthetic pesticides, the farming that was being practiced was organic without the banner of the name. While this was partly true in some places in the world, such as that described by F. H. King (1911) in *Farmers of Forty Centuries or Permanent Agriculture in China, Korea, and Japan*, it was clearly not so in many places where soils were being destroyed on a massive scale by erosion. Along with the soil erosion, there was also concern over loss of native soil fertility and soil organic matter content (Heckman, 2013). These problems were described in detail in the opening chapters of *The Living Soil* (Balfour, 1976) and in *Look to the Land* (Northbourne, 1940). In these and other pioneering works, organic farming systems were proposed as a viable ecological solution to the crisis of soil destruction. In contrast, modern conventional agriculture chooses technological approaches to address soil erosion by promoting genetic engineering and chemical herbicide-no-till farming systems.

In the case of dairy farming, a serious health crisis was created in the late 1800s as a result of moving cows into crowded city feed lots and feeding them an unnatural diet (Schmid, 2009). In cities, the need for milk and the demand for whisky led to an unhealthy partnership for the mass production of both commodities. Urban centers have little pasture or forage available to feed cows. Swill, a by-product from the fermentation of grains to produce whisky, was a waste material commonly available from inner city distilleries. The feeding of swill to cows housed in deplorable and unsanitary conditions led to the production of unhealthy milk for infants and children, which in turn contributed to sickness and death.

The horrible conditions at a New York City dairy in 1842 were described by Robert Hartley (1842): 'Here, in a stagnant and empoisoned atmosphere that is saturated with the hot steam of whiskey slop, and loaded with carbonic acid gas, and other impurities arising from the excrements of hundreds of sickly cattle, they are condemned to live, or rather die on rum-slush. For the space of nine months, they are usually tied to the same spot, from which, if they live so long, they are not permitted to stir, excepting, indeed, they become so diseased as to be utterly useless for the dairy.'

In some respects, the filthy inner city dairies of the 1800s were like an early version of the modern concentrated animal feeding operation or CAFO (Imhoff, 2010). Livestock raised in CAFOs are exposed to an abundance of manure, an absence of sunny pastures and in general conditions where pathogens may flourish. The abundance of manures produced by CAFO operations are often linked to cases of food-borne illness (Erickson and Doyle, 2012). Chemical treatments, irradiation or high-pressure processing are proposed as technical solutions (National Advisory Committee on Microbiological Criteria for Foods, 2004) to food safety problems that might be avoided by changing to ecological methods of farming.

Similarly, pasteurization of milk, often described as a major public health victory, became a technological solution to a man-made problem. A century of pasteurizing milk is a relatively short history compared with the thousands of years during which humans evolved in association with consuming animal milk without pasteurization (Curry, 2013). Although not all peoples of the world became consumers of dairy, the archeology of milk suggests Europeans that did were apparently advantaged both in terms of fertility rate and a more secure food supply. In 1935, Weston A. Price, while traveling through parts of Africa, observed that the herders of cattle and goats, living primarily on dairy products, were similarly advantaged relative to non-herders (Price, 1950).

Mark McAfee refers to the modern era of dairy and the introduction of pasteurization with the phrase: 'Pasteurization was an 18th century solution to an 18th century problem' (McAfee, 2013). Out in the countryside where cows were kept on pasture, fresh milk was generally a wholesome food when consumed fresh or fermented (Schmid, 2009). The movement toward milk pasteurization did not begin in the countryside but rather in the cities where cows were housed in deplorable conditions and fed an unnatural diet. Compounding the milk problem was a lack of refrigeration and a food distribution system based on limited scientific knowledge and without standards for sanitation and hygiene (DuPuis, 2002).

This set of circumstances, where milk could be easily contaminated with pathogenic bacteria, suggested the need for a kill step such as heating to a specific temperature and time period to make the milk safe. Pasteurization, a process originally invented for preserving wine, was initially promoted by a wealthy businessman, Nathan Strauss, and eventually became widely adopted by the dairy industry (Schmid, 2009).

A completely different approach to securing clean fresh milk for infants and children was pursued by Dr Henry Coit, MD, a pediatrician from Newark, New Jersey (Rogers, 1955). A commemorative poster (Heckman, 2011) in the hallway at Beth Israel Hospital (Originally known as Babies Hospital) describes the medical and pioneering accomplishments of Dr Coit: 'A Pioneer in American Pediatrics, Henry L. Coit, MD, begins his lifelong crusade for better infant feeding and cleaner milk, following the death of his first son at age two from intestinal disease. In 1892, Dr Coit outlines a program for purification. Two years later, the world's first bottle of certified milk, handled entirely under medical supervision, is delivered. Soon Babies Hospital delivers

pure certified milk to families throughout Newark. At its peak, the program distributes 150,000 bottles per year.'

Rather than implement a kill step like pasteurization to make poorly produced milk safe, Dr Coit instituted a set of practices for better dairy stewardship. Dr Coit found that many dairy farmers of the time lacked knowledge of hygiene to produce clean milk. Being well aware of the challenges involved, Dr Coit 'devised a plan for a professional body composed of physicians, which should first educate, then encourage and finally endorse, the work of dairymen who would bring to us milk designed for the most exacting needs of physicians'. His plans also specified production practices, inspections and certification under a legal contract with the dairy farmer (Rogers, 1955). Under the leadership of Dr Coit, the first Medical Milk Commission was established in Essex Country, New Jersey in 1893. By 1896, over 60 Medical Milk Commissions were operating around the world.

In 1909, the New Jersey State Department of Health adopted the definition of certified milk that originated (Rogers, 1955) from Dr Coit: 'Certified milk is a product of dairies operated under the direction of a medical milk commission, which body is appointed for voluntary service by a medical society. The milk is designed to fulfill standards of quality, purity and safety to ensure its adaptability for clinical purposes and the feeding of infants.'

Certified milk continued to be available as a choice in New Jersey at least up until 1971 when the Walker–Gordon Farm in Plainsboro, New Jersey closed. Milk certified by the Medical Milk Commission bottled at Walker–Gordon Farm was shipped by rail to Philadelphia and New York. The dairy began its operation in Plainsboro in 1897 and provided fresh unpasteurized milk to the surrounding communities for many decades and even after1964 when New Jersey legislation made raw milk distribution illegal.

The loss of this special fresh milk is described in an excerpt from a book entitled *Walker-Gordon, One of a Kind* (Tindall and Clark, 1998): 'For those of us who grew up with the taste of fresh, really fresh, whole milk, unadulterated in any manner except to chill it ice cold, today's milk is a sad replacement.'

In the early 1900s, many medical doctors recommended pure raw milk over pasteurized milk (Anonymous, 2010). 'Certified milk' was the way Dr Coit envisioned providing infants and children with fresh pure milk without pasteurization. For several decades, people were allowed a choice to buy either certified milk or pasteurized milk. Historically, food protection associations generally agreed and allowed for an exception to mandatory pasteurization in the case of certified milk (International Association of Food Protection, 2014).

Certified milk was at a disadvantage in a market place due to the added expense of producing clean fresh milk. In some instances, the production of pasteurized milk was subsidized. Eventually pasteurization became the dominant process as it allowed dairy farming and milk processing to industrialize on a massive scale (Schmid, 2009).

Like certified organic farming, certified milk production adhered to a set of standards to guide food production even if for different reasons. In the case of organic farming, certification directs ecological stewardship of soils, crops and livestock without the use of most conventional chemical inputs of questionable safety. With certified milk, the emphasis was on better dairy farming practices and careful milk handling to produce clean milk. Inspections are part of both certification systems. The good hygiene required to produce certified milk played a part in raising the standards for the entire dairy industry including that of raw milk intended for pasteurization (Rogers, 1955).

The sanitary handling procedures and standards for milk production intended for processing are codified in the US Food and Drug Administration (FDA) regulations as outlined in the Pasteurized Milk Ordinance (PMO). The PMO standards do not apply nor are they appropriate for dairy farms producing raw milk that will be consumed as fresh unprocessed milk. Individual states that permit raw milk sales or distribution vary widely in standards and regulation.

The absence of national standards for production of unpasteurized milk for direct human consumption inspired the founding of the Raw Milk Institute (RAWMI) by an organic dairy farmer (McAfee, 2011). Established in 2011, RAWMI mentors and trains producers of fresh unpasteurized milk. As described on its website, it 'facilitates best practices in the raw milk industry through the evaluation of research findings' and farm experience to create individualized food safety plans. Dairy farms that work with RAWMI adopt a set of standards; develop a risk assessment and management plan and safe operating procedures that are customized to the unique environment of the farm.

In some respects, the writing of this plan for an individual farm is analogous to writing an organic farm plan for organic certification. As with certified milk, the RAWMI emphasizes training and carefulness of the production. Producing a clean high-quality fresh unprocessed food within a system of farming and verifying the integrity of that system is not unlike goals for organic certification (Johnston, 2014).

The economic disadvantage of regulated and permitted raw milk arises from the special procedures for minimizing risk, which results in a food with higher production costs than pasteurized milk. Producing certified organic foods may be economically disadvantaged for similar reasons. However, premiums that consumers are willing to pay for organic food tend to improve the profitability of organic farming (Kantor, 2015).

Quality, hygiene and food safety

The legacy of Dr Coit serves to draw a distinction between the health impacts of carefully produced legitimate food-quality fresh milk intended for direct human consumption and processor-quality raw milk, which is produced knowing that pasteurization will follow. Dr Coit and the Medical Milk Commission were very concerned about both the benefits of the milk for their patients and the public health effects of dirty milk. This crucial distinction is often ignored in public discourse. Thus, when public health officials issue warnings about raw milk consumption or cite illness or outbreak statistics, they typically make no distinction or give little consideration to how milk is produced. It is simply labeled 'raw'.

For example, it is useful to examine statements issued by the Centers for Disease Control (CDC) and other food safety officials:

'Raw milk is milk from cows, goats, sheep, or other animals that has not been pasteurized.'

'No matter what precautions farmers take, and even if their raw milk tests come back negative, they cannot guarantee that their milk, or the products made from their milk, are free of harmful germs.'

'Dairying methods have improved over the years but are still no substitute for pasteurization in ensuring that milk is safe to drink. Raw milk supplied by "certified," "organic," or "local" dairies has no guarantee of being safe.'

While these statements from the CDC may be partly true, they seem to imply that not only is pasteurization the only safe option, but that it 'guarantees' safety. They also set up an impossible standard for any food to achieve.

The CDC is not alone. Some food scientists (Lally, 2011) accept the fact that 'there is no way to guarantee the safety of any food'. However, other scientists (Claeys et al., 2013) write about how milk is 'heat treated' to 'guarantee its microbial safety'.

A careful look in the historical record for pasteurization shows that it does not guarantee food safety. Any food, including raw or pasteurized milk, can be associated with food-borne illness (Real Raw Milk Facts, 2005–2017). Although dairy in general is among the safest of foods, a few notable examples of well-documented illness and deaths linked to pasteurized milk show that pasteurization does not guarantee safety. Very rarely do news stories that highlight the risks associated with raw milk drinking ever acknowledge the reality of illnesses or deaths linked to pasteurized milk. Thus, it is essential for a balanced discussion to at least present some of the food-borne illness data linked to pasteurized milk. In 1985, it was estimated that more than 168,000 people were sickened with *Salmonella* from pasteurized milk (Ryan et al., 1987). In 2007, *Listeria* from pasteurized milk was linked to three deaths. Furthermore, according to this report on these deaths linked to *Listeria*, 'records indicate that pasteurization methods at the dairy were adequate' (CDC, 2008). A more recent analysis (Stasiewicz et al., 2014) indicated that on average 18 deaths occur annually from consuming pasteurized milk and that increased risk is related to increasing temperatures used for pasteurization.

Consumption of fresh milk, as with any food, is associated with some level of risk. People unwisely sometimes drink commodity raw milk intended for pasteurization or they may drink raw milk from a black market source. Amateurs can get involved in raw milk production without adequate training and provide an unsafe product; but without drawing a distinction between legitimate food-quality fresh milk carefully produced from healthy cows and commodity raw milk produced under PMO standards (which do not require testing for pathogens, and allows commingling of milks from many farm bulk tanks intended for pasteurization), the level of actual risk of drinking carefully produced fresh milk remains impossible to accurately quantify.

The three main pathogens of public health concern with unpasteurized milk are *Campylobacter jejuni*, the shiga-producing strains of *Escherichia coli* and *Salmonella*. These pathogens are commonly found in bulk tank commodity raw milk intended for pasteurization; but in carefully produced fresh unprocessed milk, they are found only on rare occasion (Baars et al., 2015). The Real Raw Milk Facts website, which reports illnesses and deaths attributed to either raw milk or pasteurized milk, makes no distinction between commodity raw milk intended for pasteurization and carefully produced clean raw milk produced for fresh consumption.

Several recent studies conclude that raw milk is a high-risk food, which poses a risk for outbreaks 150 times greater than pasteurized milk (Langer et al., 2012). Critics have challenged these studies' underlying assumptions, the confusion between outbreaks *vs* number of illnesses per outbreak, the estimated population size of raw milk consumers and the time frame for data inclusion or exclusion (Kresser, 2012; Weston A. Price Foundation, 2012).

When outbreaks attributed to raw milk occur, they are generally associated with a small number of illnesses per outbreak. The illnesses are generally traceable back to or linked to a single dairy farm that serves a small community of customers from a relatively small herd of dairy animals.

In contrast, pasteurized milk is usually obtained by pooling milk from numerous farm bulk tanks, and when outbreaks do occur, they can be very large. For example, the earlier cited outbreak from salmonellosis traced to pasteurized milk was described as 'massive' and made it the largest ever identified outbreak in the United States (Ryan et al., 1987).

Proponents argue that where raw milk sales are legal, regulated and widely available, the number of illnesses associated with raw milk drinking is self-limited and manageable, as much as it can be with other foods (Weston A. Price Foundation, 2012). Cooperation from public health agencies and training of fresh milk producers in best practices could conceivably further improve its safety.

The current situation also raises questions: Why is less than perfectly safe a manageable risk for every kind of food except in the case of fresh unpasteurized milk? Why are no other foods held to the impossible standard of a perfect safety record?

Proponents argue that when compared with many other foods, the number of illnesses associated with fresh milk consumption is comparatively small. For example, at the International Association of Food Protection, Raw Milk Debate in 2016, it was shown that leafy greens are at the top of the list for most risky food. Even when compared at the same level of consumption, leafy greens are several times more risky than raw milk. Some further argue that there are health implications from prohibiting access to raw milk because doing so removes the potential for people to receive the health benefits (discussed below) uniquely associated with drinking fresh milk.

For the last several decades public health officials and food safety scientists have almost exclusively focused on warning and educating people against consuming fresh milk by highlighting safety concerns. Documentary films *Farmageddon*, *Organic Hero or Bioterrorist* and *Milk War* have provided graphic illustration of clashes over raw milk between government agencies on one side and dairy farmers and consumers on the other.

A psychiatric physician attending one of the raw milk seminars at the Rutgers University (Schwartzman, 2010) and well-versed in the dynamics of mass psychology spoke up about how the battle over legal access to raw milk was about much more than just food safety. In his blog (Government *vs* Raw Milk) he defines and explains a social phenomenon called the emotional plague as originally outlined by Dr Wilhelm Reich. Schwartzman explained: 'I contend no matter how much proof of safety is presented or what additional information is provided, the government authorities will never relent in their efforts to end sales of unpasteurized milk…The safety of unpasteurized milk and the best interest of the public are not the sole or even primary reason for the government's attack… In their minds they must stop 'dangerous' activities and behaviors, never realizing their prohibitive actions are not really for good of others but rather to make themselves feel better by putting an end to the behavior that makes them intensely anxious. Controlling others makes plague-ridden individuals feel better, at least temporarily.'

Antagonistic campaigns against a farming system are another parallel between the raw milk and organic farming and food movements. When the USDA Secretary of Agriculture, Earl Butz declared 'Before we go back to organic agriculture, somebody is going to have to decide what 50 million people are we going to let starve', he dismissed organic as a viable system of farming. Similarly, John F. Sheehan (2005) of the FDA declares that,

'Raw milk is inherently dangerous' and that, 'Drinking raw milk or eating raw milk products is like playing Russian roulette with your health.' Such statements appear intended to frighten people away from consuming unpasteurized dairy regardless of the carefulness of production.

In spite of such pronouncements from public officials and the interests of agricultural industries and food manufactures, as with certified organic production, farmers and consumers are making personal choices toward a new food movement. Educational campaigns against access to raw milk may be seen as a failure given that demand for pasteurized fluid milk has been steadily declining (Berry and Gee, 2012), whereas the growth in demand for permits to sell raw milk has been described as 'explosive'. Research and support from the Cooperative Extension System for careful production of raw milk needs to catch up with the educational resources available for the organic system of farming. Publication of the book on *Producing Fresh Milk, The Cow Edition* (Baars et al., 2015) and *Producing Fresh Milk, The Goat Edition* (Baars et al., 2017) are examples of educational efforts in this direction.

Policy toward raw milk availability varies widely among countries. In the United States, there are as many different policies and different levels of availability of raw milk to consumers as there are states (Farm to Consumer Legal Defense Fund, 2016). In spite of the FDA policy prohibiting transport of raw milk across state borders by farmers, consumers frequently cross borders to procure raw milk. In Canada, raw milk is completely prohibited with the exception of the unsettled gray area of the law where consumers buy into ownership of the dairy farm. In India, Bangladesh and Pakistan, fluid milk is widely available for consumption without processing. Australia strongly prohibits raw milk distribution, while New Zealand permits raw milk sales at the farm. In many European countries, raw milk is widely available as retail sales or directly from dairy farms with the help of raw milk vending machines (Brasch, 2014). What these different levels of restriction or access appear to illustrate is that consuming regulated raw milk does not lead to an overwhelming number of food-related illnesses.

Mainstream attention, policy changes and the role of leadership

Organizations dedicated to teaching people about fresh milk strongly urge that the milk should be produced from pasture-fed animals and not raised in continuous confinement (Gumpert, 2015; Shetreat-Klein, 2016). Large-scale industrial or confinement operations that emphasize high levels of production per animal unit are not perceived to be a good source for fresh milk due to concerns over animal welfare and sustainability. These guidelines are aligned with the USDA-NOP standards that require pasture feeding of animals (Code of Federal Regulations, 2015) and the traditional philosophy of organic dairy farmers to accept less intensive inputs described as a 'refusing to push the cows' (Saucier and Parsons, 2014). That fresh milk be produced by a certified organic operation is not necessarily the point, but rather that the dairy uses many organic production practices that serve to enhance milk quality and ensure animal welfare (Baars et al., 2015). Such production practices are assumed to reduce risk but their value and effectiveness need research for validation or further improvement.

Until recently, and after several decades of hostility, agricultural universities and the Cooperative Extension System gave little research support to the organic system of farming (Lipson, 1997). Currently virtually every agricultural university exhibits some level of support for organic farming. In some cases, there are now professors at major agricultural universities dedicated full time to research and educational programs on organic farming.

Yet in more than 100 yr of the Cooperative Extension System, there has been very little effort dedicated to research or training of dairy farmers in the careful production of fresh milk to be consumed without pasteurization. Despite the fact that fresh milk is a legal beverage in all states (at least from a family cow or goat) and can be legally sold from the farm or retail in many states, the Cooperative Extension System has not met its responsibility to be truly transformational in its educational programing by serving fresh milk dairy producers and consumers (Heckman, 2007). Contrary to helping fresh milk dairy farms produce a safer product, with few exceptions (Hoenig, 2014), the focus of the Cooperative Extension System has been warning people of the dangers of drinking unpasteurized milk and driving people away from their personal food choice (Schutz and Ferree, 2012).

Recently, Raw Milk Workshops (2014, 2015) were held at the Penn State University and at the State University of New York–Cobleskill. These notable exceptions may be a sign of some specialists within the Cooperative Extension System accepting a role in the training of raw milk dairy farmers. The workshops objectives were designed to teach science-based food safety principles to help create a secure foundation for the growing raw milk movement. Speakers included veterinarians and experienced raw milk dairy farmers.

As with success in organic farming, innovations with fresh milk production and safety have been associated with working farms, which historically received little to no assistance from agricultural universities and the Cooperative Extension System. One might assume that people will never stop a 10,000-year-old tradition of producing and drinking fresh milk. If anything the number of people choosing fresh whole unprocessed milk appears to be rising in spite of public health agencies discouraging fresh milk drinking.

Other organizations have stepped in to serve farmers and consumers when the Cooperative Extension System fails to provide a necessary service. The historic guidance for the production of Certified Milk by Medical Milk Commissions, the more recent establishment of the RAWMI and educational efforts of the Farm-To-Consumer Foundation, were initiated by actors almost entirely outside of universities and the Cooperative Extension System. In the case of the RAWMI, it was established by Mark McAfee, the owner of the largest organic raw milk dairy in North America.

Agricultural universities and the Cooperative Extension System typically follow the lead of federal authorities. Federal agencies strongly opposed to allowing people to choose fresh milk could potentially reverse direction under new leadership. Such was the case when the Secretary of USDA Bob Bergland decided to take a look at organic agriculture in the 1970s. It was an 'across the fence conversation' with a neighboring organic farmer that sparked the talks and surveys between USDA and the organic community (Youngberg and DeMuth, 2013). In 1980, the USDA published its Report and Recommendations on Organic Farming (USDA, 1980).

In the forward of that USDA document, Bob Bergland writes about gaining an understanding of organic farming systems and the need for research, education and communication.

What would happen to the fresh/raw milk movement with a similar change in attitude of government officials?

Several years after passage of the Federal Organic Food Production Act of 1990, the Organic Farming Research Foundation surveyed the USDA's Current Research Information System for pertinence to organic farming. The findings from that survey were summarized in 'Searching for the O-Word' (Lipson, 1997). By revealing a lack of USDA commitment to organic farming research, the report became a catalyst for increasing levels of financial and institutional investment in such work.

The uneven legal status of fresh milk sales within the states and FDA policy may be an even greater hurdle to getting USDA support for research and the Cooperative Extension System teaching on production and safety. Recent trends toward legalization or administrative policies among numerous states are allowing increased access to fresh/raw milk (Kennedy, 2016). Currently there also appears to be a relaxing of restrictions against dairy farmers providing fresh milk. Even more important than research support is the desire among raw milk dairy farmers and the people who want access to fresh milk to simply be left alone and to have their food choice respected (Gumpert, 2013).

Health outcomes, subjective experience and the 'great subject'

The holistic view of health and nourishment concerning soils, plants, animals and people sets the traditional organic system of farming apart from conventional agriculture. This broad ecological perspective was expressed by Albert Howard (1943) when he wrote about 'the whole problem of health in soil, plant, animal and man as one great subject'.

Eating food serves numerous health functions, not the least of which is pleasure and satisfaction. In the case of full fat unprocessed fresh milk many people claim to have a different drinking experience (Katafiasz and Bartlett, 2012). Commodity pasteurized and homogenized milk is usually comingled with many farms and processed for consistent flavor throughout the year. In contrast, people consuming fresh milk directly from specific farms can experience the flavors as they vary with the quality of pasture or feed, growing season, geography, animal breed and carefulness of the milking operation (Gumpert, 2015). People who drink and appreciate the flavors and mouth feel of quality fresh milks are every bit as much connoisseurs as those who consume fine wine. The satisfying value and pleasurable experience with artisanal foods such as fresh milk are too often undervalued or ignored by the proponents of industrialized agriculture (Mincyte, 2014). Health benefits are also similarly dismissed and ignored.

When a food is deconstructed and its chemical constituents measured in an analytical laboratory, the nutrient concentrations are itemized but not functionally understood. Studies comparing nutritional composition of organically grown food and conventional food usually stop short of investigating how the food objectively functions in a living organism (Carr et al., 2012), let alone how it subjectively functions. In the case of fresh *vs* pasteurized milk, nutrient content reports usually acknowledge that pasteurized milk results in some loss of a few nutritional components, such as vitamin C. They may go further and say that milk is not a significant source of such nutrients anyway.

Although nutrient content data can be useful, it does not tell the full story. For example, it does not tell us much of anything about the eating experience and the role that qualitative factors play in health and satisfaction. Surveys have shown that the number one motivation for drinking fresh unprocessed milk is taste (Katafiasz and Bartlett, 2012). This is very important because dietary health benefits can only come from foods people are willing to eat.

Often the personal experiences of health outcomes expressed by people switching from drinking pasteurized milk to fresh milk are not taken seriously. Rather than viewed as preliminary lines of evidence for formulation of hypothesis and follow-up research, the potential health benefits of drinking fresh milk are too quickly dismissed as anecdotal and not worthy of further investigation.

The values of the numerous biologically active factors in fresh milk that are diminished or inactivated by the heating process of pasteurization are reviewed in the report by Michigan Fresh Unprocessed Whole Milk Workgroup (2012). Besides nutrient bioavailability, this report recognizes the valuable role of bacteria in providing prebiotic and probiotic functions, and active enzyme systems that assist digestion. The report also cites studies indicating that drinking fresh milk protects against allergies and asthma. It further notes some people who are not able to drink pasteurized milk have tolerance for drinking fresh milk. Unlike most reviews, this report is unusual in that it acknowledges these special attributes of fresh milk.

Any evidence for health outcomes uniquely associated with consuming fresh unpasteurized milk is typically dismissed with blanket pronouncements. For example, the CDC (Raw Milk Question and Answers, 2017): 'There are no health benefits from drinking raw milk that cannot be obtained from drinking pasteurized milk that is free of disease-causing bacteria.'

The US FDA similarly plays up the risks and dismisses the benefits. How some public health organizations, community of health professionals and food scientists can ignore the accumulated published evidence on health benefits appears biased or a willful failure of scholarship.

However, it appears that as the scientific literature (showing that raw milk offers unique protection from allergies, asthma and respiratory infections) is made easily available, it can no longer be so blatantly ignored. As an example, in response to political pressure from the state of Maryland, the legislature called upon public health professionals at the Johns Hopkins University for an opinion on raw milk. A published report entitled: A Literature Review of the Risks and Benefits of Consuming Raw and Pasteurized Cow's Milk (Davis et al., 2014) concluded that 'there is no scientific evidence supporting the claim that the benefits of raw milk outweigh any health risk.' While this review did not entirely please the proponents for legalizing access to fresh milk in Maryland, it did review and acknowledge some evidence for health benefits from fresh milk consumption at least for its association with reduced allergies. As may be expected from mainstream sources, the report also strongly discouraged the drinking of fresh milk.

There are many other examples of this narrative that magnifies risks while ignoring, downplaying or dismissing the benefits. While it is extremely difficult to change an establishment position, one approach to shifting the debate is to study a subject in depth and to challenge the experts by exposing the contradictions of their words (Martin, 1996). A few well-informed and vocal critics can spur a movement and sometimes make an enormous difference.

People concerned with making food choices have several options: (1) place their trust in the pronouncements of the 'experts', (2) ask a trusted health care professional, (3) read and review published literature and arrive at their own interpretation

and assessment, or (4) become knowledgeable about their food choices from real-world experience.

The fourth option is not unlike what farmers and gardeners experience when they decide to implement organic practices on their land. When a farmer transitions away from commercial chemicals to the organic system, they observe the unique qualitative changes in soil properties that result from switching to a biologically based soil fertility system. The special soil properties achieved and the benefits to plants of feeding the soil with complex organic nutrient sources are now well documented and cannot be dismissed as simply anecdotal (Rodale Farming System Trial, 2016). The increases in soil organic matter content, ease of tillage, water infiltration, biological activity, drought tolerance and disease suppression are expressions of soil health typically observed when organic farming is compared with conventional chemical farming (Carr et al., 2012).

The analogy of feeding soil or feeding people with naturally occurring whole biologically active substances is a concept very much in tune with the philosophy of the organic farming movement. The observations on soil health or human health that follow from it may be considered subjective and therefore subject to criticism from the scientific establishment; but for individuals with positive experiences with organic systems nothing matters more or is more convincing than these personal experiences (Padel, 2001). Nevertheless, the organic community also welcomes scientific studies that can provide objective validation for their subjective experiences.

When considering food choice, the third option is the most difficult and time consuming and therefore the least likely path taken. Nevertheless, in service to the stated goal of informed consumer choice, Table 2 outlines the newer as well as the older published literature on health properties and nutritive values associated with fresh unprocessed milk in contrast to pasteurized milk. This listing includes studies and literature references (drawn from the extensive collection described in the Methods section) that include both human milk as well as that of other lactating animals.

The body of scientific literature comparing fresh milk *vs* heat-processed milk suggests that health outcomes are often different (Table 2). The evidence is based on animal as well as human feeding trials using cow milk or human breast milk. It generally shows that when milk is heated, some of the nutritive qualities are diminished; weight gains and growth are often less with heat-treated milk. The more recent studies indicate that consuming fresh milk helps protect children from allergies, asthma and respiratory infections (Waser et al., 2007; Braum-Fahrlander and von Mutius, 2010; Loss et al., 2011). The literature also notes that unpasteurized milk has immunologic factors and antimicrobial properties that decrease when heat treated (Loss et al., 2015; McCarthy et al., 2015).

There are also some studies reporting no meaningful differences when comparing raw *vs* pasteurized milk for lactose tolerance (Mummah et al., 2014), protein quality or mineral availability (Weeks and King, 1985, and Zurera-Cosano et al., 1994). On balance, however, many studies provide evidence of health benefits associated with milk consumed fresh.

In spite of the acknowledged evidence for improved health outcomes from consuming raw milk, authors of such studies apparently feel compelled to incorporate a personal opinion against drinking fresh milk due to the potential presence of pathogens (Waser et al., 2007; Loss et al., 2015). They also call for further research on finding, isolating or preserving the protective components of fresh milk (Perkin, 2007; Waser et al., 2007). This approach would seem to be at odds with the whole natural foods philosophy of traditional organic food systems. What is missing from their recommendations is a pursuit of research and education for dairy farmers on how to improve the quality of fresh milk and its production practices.

Until recently, the organic farming systems received only very limited research and educational support from agricultural universities. The increasing abundance of organic food in the market place shows that organic farming can function as a viable system of food production with or without the help of institutional support. In a similar fashion, researching ways to reduce risks and improving production practices may enable more people to consume wholesome fresh milk without pasteurization and receive accompanying health benefits.

Published scientific literature is always open to interpretation and continuous reinterpretation in the context of current science. From the summary (Table 2) and reference list, 'citizen scientists' willing to make the effort can more quickly find pertinent literature and read and interpret it for themselves for the purpose of making an informed food choice.

Policy impacts on soil fertility, sustainability and health

The pioneers of the organic farming movement placed great emphasis on health in connection with soil fertility. Howard (1943), for example, wrote of a 'great linkage between the soil, the plant and the animal.' and furthermore declared that 'Soil fertility is the basis of the public health system of the future' (Howard, 1972). The authors (Baars et al., 2015) of the book on *Producing Fresh Milk, The Cow Edition* would agree with the organic farming concept that mineral-rich fertile soils are one of a large number of factors promoting healthy dairy animals and enhanced quality fresh unprocessed whole milk.

Albert Howard (1972) was also very much cognizant of the function of livestock on soil fertility when he wrote that 'Mother nature never farms without live stock….' Cows as part of the farm ecosystem are effective transformers of relatively low nutrient density forages into nutrient-rich foods with fat-soluble vitamins, proteins and energy-dense fats (Heckman, 2015). On dairy farms, there is a flow of soil fertility through the cow (Bear, et al., 1946). Although cows do extract a fraction of the minerals from their feed to make milk, the larger fraction of the minerals contained in feeds and forages are recycled back to the land through manure application.

Pasture-based dairy farming systems are one of the most effective ways to build soil organic matter content and soil fertility in general (Heckman, 2015). This organic fraction of the soil is a valuable storehouse for carbon, nitrogen, phosphorus, sulfur and other plant nutrients. Pastures under organic management are ideally a mixed stand of legumes and grasses. This diverse mix enables a farm to be self-sufficient in nitrogen. This biologically captured nitrogen as part of a well-designed crop rotation is supportive of an entire organic farming operation. In this way, pasture and perennial forage crops are foundational attributes of an effective organic farm plan.

Whether organic milk from a dairy farm is provided directly to consumers as fresh milk or as pasteurized milk makes little difference in terms of how soil fertility functions on the farm. However, milk policy can have a huge influence on the number, size and distribution of dairy farms and thereby sustainable soil fertility.

Table 2. Literature summary on health and nutritional responses associated with raw or heat treatment of animal milk and human milk. The listed studies generally refer to bovine milk unless indicated to be human milk

Hess (1917)	A study (Hess, 1917) on infantile scurvy examined to influence of heating milk and its freshness. The author concludes: 'One of the several factors in the pathogenesis of infantile scurvy is faulty diet. Pasteurized milk was found to be a contributing cause if it was not fresh––if given twenty-four to forty-eight hours after pasteurization'
Kramer et al. (1928)	A study conducted at the Kansas Agricultural Experiment Station compared availability of minerals to children from various forms of bovine milk. They found that 'Pasteurized milk…gave less favorable calcium balances than did fresh' (raw) milk. The effect on phosphorus availability followed a similar trend
Scott and Erf (1931)	(3) A study conducted at the Ohio State University compared the feeding of rates on bovine milk as either raw or pasteurized. They observed that rats fed with raw milk had 'sleek', smooth coat, were in good flesh, their eyes were clear, their dispositions good and they seemed to enjoy being petted; while those receiving the pasteurized milk showed a roughened coat, they were dull, listless and huddled together in the cage, their eyes lacked luster and they became quite irritable and showed a tendency to bite upon being handled. The weight curves in these groups also showed differences. Raw 'certified milk showed an average gain of 57 g; those receiving the pasteurized milk indicated and average gain of 33 g'
Mattrick et al. (1931)	A study at the National Institute for Research in Dairying, University of Reading, was conducted on the relative nutritional value of raw and heated milk. They report on 5 yr of research using various species of animals that 'some dietetic factors are destroyed when milk is sterilized, and to a definite but lesser degree when it is pasteurized'. In a detailed study with rats fed either raw or pasteurized bovine milk along with a 'biscuit' made with white flour and water, they found that 'The appearance of the rats on raw milk was excellent, those on pasteurized milk, although generally well grown, had rather staring coats, while the coats of the group on sterilized milk were very staring and their general condition was very poor'
Fisher and Bartlett (1931)	A report issued by the Department of Health for Scotland on 'Milk Tests in Lanarkshire Schools' concluded 'the effects raw and pasteurized milk on growth in weight and height are, so far as we can judge, equal'. Fisher and Bartlett (1931) writing in Nature re-examine the data and conclude that the school children grew better in response to raw milk than to pasteurized milk
Krauss et al. (1933)	A report from the Ohio Agricultural Experiment Station reviews the literature on the nutritive properties of raw and pasteurized milk. After a lengthily discussion over a mix of previous findings, some in favor of raw milk and some in favor of pasteurized, they describe new experiments with the feeding of laboratory rats and found no significant difference in the growth when exclusively fed raw or pasteurized milk over a 12-week period. They also reported that heating the milk destroyed 'at least 25% of the vitamin B originally present'
Elvehjem et al. (1934)	A study conducted at the University of Wisconsin compared the nutritional value of raw *vs* pasteurized bovine milks fed to rats, each supplemented with minerals iron, copper and manganese. They conclude that 'The kind of feed ingested by the cow has a greater effect upon the nutritive value of milk than does pasteurization.' And that 'Pasteurization has practically no detrimental effect, as measured with rats, upon the nutritive value of a milk of high nutritive quality but may further decrease the value of a milk of low nutritive quality'
Woessner et al. (1939)	A study conducted at the University of Wisconsin measured ascorbic acid content of commercial milks. They found that pasteurized milks contained on average only about half as much ascorbic acid as commercial raw and certified milks. Homogenization also has a destructive effect on ascorbic acid
Wulzen and Bahrs (1941)	A study conducted at the Oregon State College compared guinea pigs fed rations of whole raw milk, pasteurized whole milk, raw skim milk and pasteurized skim milk. They reported: 'Animals fed raw whole milk grew excellently and at autopsy showed no abnormality of any kind. Those on the pasteurized milk rations did not grow as well and developed a definite syndrome, the first sign of which was wrist stiffness'
Tomarelli et al. (1955)	A study conducted at the Wyeth Laboratories evaluated the biological availability of vitamin B_6 as a result of heating milk. They reported: 'Heat sterilization of liquid milk products results in a loss of vitamin B6'
Gregory (1962)	A study conducted at the University of Florida set out to characterize the influence of pasteurization on folacin bioavailability from milk. This study confirmed previous research showing that milk loses 'its ability to enhance folacin absorption after pasteurization'
Bjorksten et al. (1980)	A review and study of processes for collecting, banking and feeding human breast milk was conducted at the University Hospital, Sweden. They conclude that 'raw human milk is better than heat-processed milk for infant nutrition and defense against infection.' They also report that pasteurization 'affects the nutritional properties of milk'
Narayanan et al. (1984)	A study compared raw and pasteurized human milk on incidence of neonatal infection was conducted at the Lady Hardinge Medical College, New Delhi, India. They reported that heating expressed human milk reduces its protective effect against infection
Schanler et al. (2005)	A trial feeding premature infants concluded that 'beneficial short-term outcomes for extremely premature infants are not supported by substitution of pasteurized donor milk for mothers milk.' Furthermore: 'the process of pasteurization reduces the content and function of several host defense proteins and cellular elements'
Waser et al. (2007)	A study conducted across several European countries examined the association between consumption of farm and shop-purchased pasteurized milk on the incidence of asthma and allergy. 'Farm milk' was not clearly defined as raw milk because sometimes it might have been boiled. However, it is very common on family dairy farms to consume fresh milk in its raw form. The primary objective was to compare farm-produced *vs* shop-purchased products and their effect on allergic disease. Among the foods considered, consumption of farm milk offered the most 'protection against asthma and allergy'

(*Continued*)

Table 2. (*Continued.*)

Andersson et al. (2007)	A study compared raw and pasteurized human milk on preterm infants at the Queen Silvia Children's Hospital, Gothenburg. They concluded that 'Feeding preterm infants pasteurized as compared to raw own mother's milk reduced fat adsorption. When the infants were fed raw milk, they gained more in knee-heel length compared to when they were fed pasteurized milk'
Perkin (2007)	An editorial published in Clinical and Experimental Allergy, based on relevant literature noted that there is a 'small but growing body of evidence that consumption of unpasteurized milk is another factor mediating a protective effect on allergic disorders'
Braum-Fahrlander and von Mutius (2010)	An opinion published in Clinical and Experimental Allergy, summarizes ten epidemiological studies. In their review: 'there is a growing body of epidemiological evidence suggesting that consumption of unprocessed cow's milk does not increase but rather decreases the risk of asthma, hay fever and atopic sensitization'
Akinbi et al. (2010)	A study at the Cincinnati Children's Hospital assessed the impact of pasteurization or prolonged frozen storage on the immunologic properties of human milk. They concluded: 'immunomodulatory proteins in human milk are reduced by pasteurization and, to a lesser extent, by frozen storage, resulting in decreased antibacterial capability'
Ewaschuk et al. (2011)	A review discussed the effect of pasteurization on the immune components of human milk. They report that pasteurization results in a partial or total loss of immune and bioactive milk components
Montjaux-Regis et al. (2011)	A study on feeding preterm infants compared raw and pasteurized human milk. They found that mother's own raw milk improved weight gain better than donor milk that was pasteurized
Loss et al. (2011)	A study investigated the effect of farm milk on asthma and atopy. Results of this large epidemiologic study found that drinking 'unboiled farm milk was consistently inversely associated with asthma, hay fever, and atopy in both exclusive and mixed farm milk drinkers.' They also found that 'boiled farm milk was not associated with any health outcome'
McCarthy et al. (2015)	A study of the immunological consequences of pasteurization concluded: 'that the immunomodulatory potential of farm (raw) milk is significantly altered following pasteurization. Changes in gene expression profiles relating to the innate immune response suggest that raw milk consumption could play a role in alteration of allergy incidence'
Loss et al. (2015)	A study investigated the 'effects of raw and processed cow's milk on common infections in infants'. They reported: 'raw milk consumption was inversely associated with occurrence of rhinitis.' They conclude: 'Early life consumption of raw cow's milk reduced the risk of manifest respiratory infections and fever by about 30%. If the health hazards of raw milk could be overcome, the public health impact of minimally processed but pathogen-free milk might be enormous'
Lalles (2016)	Alkaline phosphatase, an enzyme present in raw milk but deactivated by pasteurization, is hypothesized to have health-protective effects on consumers of raw dairy
Abbring et al. (2017)	The findings of study, using mice as a model organism compared raw and heated milk, suggested that raw milk was protective against asthma and that the protective effect was abolished by heat treatment

Dairy farms in the business of providing fresh milk directly to consumers are typically smaller operations with a local community of patrons. These dairy operations employ many organic farming practices. This is in large part due to the preferences of fresh milk consumers for organic production systems, especially pasture feeding. A recent study (van Asselt et al., 2015) on dairy farming in the Netherlands concluded that 'raw organic milk is more sustainable than pasteurized organic milk' and furthermore that 'it is also more sustainable than pasteurized conventional milk due to a higher revenue'. Where policy supports production and trade in fresh milk, more farmers are likely to enter the business of producing fresh milk. Thus, more pasture-based dairy farms would contribute to more land area under sustainable soil fertility management.

As a case study, the state of New Jersey illustrates the impact of food policy on soil fertility. By law New Jersey currently prohibits distribution of raw milk by dairy farmers. However, there is no law against sales of raw vegetables directly from farms. Consequently, New Jersey has numerous small vegetable farms; but for dairy farming, there is no practical legal avenue for direct marketing of fresh milk. Consequently, fresh milk drinkers source this special food choice from neighboring states where sales are permitted. An estimated $95 million in revenue leaves New Jersey annually, which goes to support out-of-state fresh milk dairy farms (Heckman, 2014) rather than local farms.

Where New Jersey once had thousands of small dairy farms spread across the Garden State, <70 remain. Among states in the Northeast USA, New Jersey obtains a relatively small (12%) percentage of its agricultural revenue from livestock. Thus, looking at New Jersey as an example, it may be argued that the legal status of milk policy nearly precludes the viability of small dairy operations and the sustainability of local well-distributed soil fertility ecosystems that would naturally follow the dairy cow.

Summary

The raw milk movement has been associated with the organic farming movement since its inception. Walter Northbourne, the first person to write about organic as a system of farming, correctly characterized the emerging problems not only of agriculture, but of fresh food systems. He explained that just as industrialization of farming lead to erosion and destruction of soil on a massive scale, the 'vast distributing concerns', 'specialization' and the phenomenon of 'infection in bulk' created the need for milk pasteurization, and that this heat process degraded the quality of a fresh whole food.

The organic dairy farming community in 'refusing to push the cows' is pursuing natural alternatives to industrial confinement production by emphasizing the feeding of dairy animals outside, in sunshine and on pastures grown on fertile soils. In this system, organic farmers are willing to accept lower productivity for healthier cows, higher quality milk, economic sustainability and happy feedback from fresh milk consumers. Agricultural

universities and the Cooperative Extension System reluctantly joined in with research and teaching of organic food and farming systems as they slowly became accepted and moved into the mainstream. These same institutions have an opportunity to become a positive force in reinventing dairy farming and restoring the ecology of this traditional food and farming system.

Acknowledgements. The research reported in this publication was supported by the Rutgers New Jersey Agricultural Experiment Station. The author thanks Mark Keating for valuable suggestions and Theresa Lam for organizing the literature search.

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