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Review on Significance of Organic Farming on Soil and Food Quality and Human Health

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Abstract
Agriculture is important to humankind as it produces the food on which human life depends and has been fundamental to civilization in providing the foundation from which economic activity has developed. organic agriculture is intended to produce high quality, nutritious food that contributes to preventive health care and well-being. Soil is a fundamental resource base for Agricultural production systems. Besides being the main medium for crop growth, soil functions to sustain crop productivity, maintain environmental quality, and provide for plant, animal, and human health. Sustaining and improving soil quality over the long term are frequently identified by organic farmers as their primary goals. Agro-ecosystem management can affect soil quality in the long term by modifying soil physical, chemical and biological characteristics at a rate that is largely dependent on climate conditions and farming practice. crop residues, manures, turfs, forest under story leaf falls, and compost from organic wastes have been used to increase soil organic matter (SOM) content and accordingly to improve soil physical properties in croplands. In comparison with conventional farming, organic farming has potential benefits. The health benefits and risks of organic fruits and vegetables are issues of significant importance due to the increasing popularity of organic food. Organic produce, in comparison to conventional produce, tends to contain higher levels of vitamin C and lower levels of nitrates, though more well controlled studies are necessary in order to reach any definitive conclusions. It has been definitively shown that organic produce contains fewer and lower levels of pesticides than conventional produce, though the long-term health consequences of ingestion of pesticides, and the clinical relevance of fewer and lower levels of pesticides in organic food, has yet to be determined. Organic farming methods can potentially lead to microbiological contamination, but the literature has shown that organic produce does not carry any higher risk of significant microbiological contamination than conventional produce. Taking into account the issues of nutrient content, pesticides, and microbiological safety, the reviewed literature indicated that organic produce can potentially be more beneficial, but certainly not more harmful, than conventional produce for the health of the consumer. However, very few actual benefits have been demonstrated, and at present, the best recommended diet remains as one that is balanced and rich in fruits and vegetables grown under organic management system
Keywords: Organic farming, soil quality, food quality, human health

1. Introduction

Agriculture is important to humankind as it produces the food on which human life depends and has been fundamental to civilization in providing the foundation from which economic activity has developed. Farming produces the food on which human life depends and has been fundamental to civilization in providing the foundation from which economic activity has developed. With increasing urbanization, it is extremely important for us to remember this. Majority of the world population are greatly concerned about the deterioration of the world’s land resources and our capacity to produce food for the ever-increasing world population. It is in this context that the sustainable (organic) agriculture has developed as a solution. It is a product of economically-advanced countries which have, rather belatedly, recognized the serious degradation of soils and pollution of the environment caused by chemically based farming which was widely promoted in the Green Revolution in the 1960s. Largely for this reason sustainable agriculture has sought to distance itself from the earlier imperative of achieving maximum possible production (Kimemia and Oyare, 2006).

Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved (IFOAM, 2009). Organic agriculture is a holistic way of farming: besides production of goods of high quality, an important aim is the conservation of the natural resources fertile soil, clean water and rich biodiversity. The art of organic farming is to make the best use of ecological principles and processes (UNCTAD, 2003). Organic Agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible. This principle points out that the health of individuals and communities cannot be separated from the health of ecosystems - healthy soils produce healthy crops that foster the health of animals and people. Health is the wholeness and integrity of living systems. It is

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not simply the absence of illness, but the maintenance of physical, mental, social and ecological well-being. Immunity, resilience and regeneration are key characteristics of health (IFOAM, 2009).

The role of organic agriculture, whether in farming, processing, distribution, or consumption, is to sustain and enhance the health of ecosystems and organisms from the smallest in the soil to human beings. In particular, organic agriculture is intended to produce high quality, nutritious food that contributes to preventive health care and well-being. In view of this it should avoid the use of fertilizers, pesticides, animal drugs and food additives that may have adverse health effects (IFOAM, 2009). Are organic fruits and vegetables better than conventional produce for the health of the consumer? Thus the objective of this paper is to review the scientific evidence behind the issues of organic farming on soil quality, nutritional value, pesticide contamination, and microbiological safety.

2. Significance of Organic Farming on Soil Quality

Soil is a fundamental resource base for Agricultural production systems. Besides being the main medium for crop growth, soil functions to sustain crop productivity, maintain environmental quality, and provide for plant, animal, and human health. The terms soil quality and soil health describes the soil's ability to perform these critical functions. Soil quality or health is generally seen as the foundation of successful crop production systems. Sustaining and improving soil quality over the long term are frequently identified by organic farmers as their primary goals. Agro-ecosystem management can affect soil quality in the long term by modifying soil physical, chemical and biological characteristics at a rate that is largely dependent on climate conditions and farming practice (Franzubbers and Haney, 2006)

According to one of the most widely accepted definitions, soil quality is ‘‘the capacity of a soil to function within ecosystem boundaries to sustain biological productivity, maintain environmental quality and promote plant and animal health’’ (Doran and Parkin, 1994 in Franzubbers and Haney, 2006). Soil quality cannot be measured directly but can be assessed through the measurements of changes of some of its attributes which are considered as indicators which are soil physical, chemical and biological properties. On this basis, in the last decade, a number of studies aimed at detecting changes in soil quality and fertility by using selected soil parameters have been carried out (Schloter *et al*., 2005; Happerly *et al*., 2006; Melero *et al*., 2006; Mueller *et al.*, 2006; Porter *et al*., 2006; Van Diepeningen *et al*., 2006 cited in Franzubbers and Haney, 2006).

2.1. Soil physical properties

Soil management systems influence soil physical fertility, it is important to determine the effect of long-term organic and inorganic fertilizer amendments on soil physical properties such as aggregation, porosity and water-holding capacity. It has been shown that addition of organic matter improved soil physical properties such as aggregation, water-holding capacity, hydraulic conductivity, bulk density, the degree of compaction, fertility and resistance to water and wind erosion. Generally, crop residues, manures, turfs, forest under story leaf falls, and compost from organic wastes have been used to increase soil organic matter (SOM) content and accordingly to improve soil physical properties in croplands (Stratton *et al*., 1995).

At the end of 40-47 years of dairy farm management in Denmark, organically managed soil had greater fragment size, aggregate stability in water, and microbial biomass carbon than conventionally managed soil (Schjonning *et al*., 2002). Glover *et al*. (2000) reported, at the end of 4 years of management of an apple orchard in Washington, soil bulk density, water-filled pore space, and Nitrate-N were lower under organic than conventional management.

According to Liu *et al.* (2007), there were significant differences in soil bulk density, porosity and water content among soils from the three different farming systems in each year (Table 1). Soil bulk density was significantly higher in soils from conventional than organic or sustainable farms (Table 1). However, soil porosity and soil water content were highest in soils from organic farms (Table 1). In 2 of 3 years' soil humic matter was significantly higher in soils from organic than conventional farms.

Table 1. Soil physical properties in organic, sustainable and conventional farms.

Soil physical property	2001	2002	2003
Bulk Density (g/cm^3)			
Organic	1.07	0.94	1.08
Sustainable	1.10	0.92	1.07
Conventional	1.23	1.35	1.43
p-value	0.0005**	<0.0001**	<0.0001**
Soil porosity (%)			
Organic	0.61	0.64	0.63
Sustainable	0.55	0.60	0.53
Conventional	0.45	0.48	0.46
p-value	<0.0001**	<0.0001**	<0.0001**
Soil Water Content (%)			
Organic	15.53	27.21	18.40
Sustainable	14.78	20.97	19.18
Conventional	11.07	9.97	11.03
p-value	<0.0001**	<0.0001**	<0.0001**
Humic Matter (g/100cm^3)			
Organic	1.10	0.80	0.60
Sustainable	0.70	0.30	0.50
Conventional	0.90	0.60	0.70
p-value	0.0118*	0.0048*	0.1868

*, Significantly different at p=0.05 **, significantly different at p=0.01

Source; adopted from Liu *et al.* (2007)

All the soil (0-20 cm depth) physical properties like bulk density, water holding capacity, porosity, and soil temperature were found to be significantly influenced by organic nutrition (Table 2). In all the cases, vermi-compost application (Full recommended dose as Vermi compost and Full recommended dose as Vermi compost + P solubilizing microorganism) has been found to be superior. According to Brady (1996 in Bhaskaran and Krishna, 2009), organic matter is the major component that stimulates the formation and stabilization of granular and crumb type of aggregates. As organic residue decomposes organic acids, sugars, mucilaginous substances, and other viscous microbial by products are evolved. Which, along with associated fungi and bacteria, encourage the crumb formation and net effect of these activities will decrease bulk density and increase porosity as reported by Loganathan (1990). Higher organic matter addition could increase organic carbon content of the soil which resulted in an increased water holding capacity of the soil. The humus can absorb water two to six times its own weight. Soil organic matter is responsible to a great extent, directly or indirectly for making the physical environment of the soil suitable for the growth of crops. It exerted this benefit largely through its effect on improving soil aggregation and porosity, which in turn influenced soil structure, water infiltration, moisture conservation, drainage, aeration, temperature, and microbial activities.

Table 2 Effect of organic farming practices on soil physical properties.

Treatments	Bulk density (Mg m^{-3})	WHC %	Temperature ^{0}C	Porosity %
T_1 (20 kg N ha^{-1}, 30 kg P_2O_5 ha^{-1} and 10 kg K_2O ha^{-1} with 20 t FYM ha^{-1})	1.41	35.84	31.26	44.00
T_2(Full recommended dose as farm yard manure)	1.35	36.54	30.13	44.70
T_3 (Full recommended dose as farm yard manure)	1.34	35.83	30.33	44.87
T4 (Full recommended dose as vermi compos	1.32	41.70	29.40	48.00
T_5 (Vermi compost + P solubilizing micro organisms)	1.31	42.3	28.86	48.42
T_6 Full recommended dose as poultry manur	1.34	37.30	30.53	45.30
T_7 (Full recommended dose as poultry manure + PSM	1.33	37.43	30.43	44.97
T_8 (Inorganic alone (20 kg N ha^{-1}, 30 kg P_2O_5 ha^{-1} and 10 kg K_2O ha^{-1}).	1.48	30.13	32.73	41.13
SE	0.01	0.59	0.15	0.32
CD (0.05)	0.03	1.79	0.47	0.98

T1: Full recommended dose as per package of practices recommendation (20 kg N ha^{-1}, 30 kg P_2O_5 ha^{-1} and 10 kg K_2O ha^{-1} with 20 t FYM ha^{-1}); **T2**: Full recommended dose as farm yard manure; **T3**: Full recommended dose as FYM + P solubilizing microorganisms; **T4:** Full recommended dose as Vermi compost; **T5:** Full recommended dose as Vermi compost + P solubilizing micro organisms;**T6:** Full recommended dose as poultry manure; **T7:** Full recommended dose as poultry manure + PSM; **T8:** Inorganic alone (20 kg N ha^{-1}, 30 kg P_2O_5 ha^{-1} and 10 kg K_2O ha^{-1}).
Source; (Bhaskaran and Krishna, 2009)

2.2. Soil chemical properties

A few comparative studies have been conducted to look at soil quality under conventional and organic agricultural systems. At the Rodale Institute in Pennsylvania, organically managed soil had greater soil organic carbon and total nitrogen and lower nitrate leaching loss than conventionally managed soil (Drinkwater *et al.*, 1998).

According to Arau´ jo *et al.* (2008), as shown on table 3, chemical properties of soil in conventional and organic management systems. Soil pH was not significantly different between conventional and organic management systems. Soil salinity, evaluated by electrical conductivity (EC), was greater in organic management system (ORG24) than the others. Organic management system (ORG24) had a higher soil P and Ca content than conventional management system (CNV).

Table 3. Soil chemical properties (0–10 cm) on different soil management systems (Arau´ jo *et al*., 2008)

Management system	pH	EC (dSm^{-1})	P (g kg^{-1})	K (cmolc kg_{-1})	Ca (cmolc kg^{-1})	Mg (cmolc kg^{-1})	CEC (cmolc kg^{-1})
CNV	6.9a	0.7b	83.6b	0.255b	2.1b	1.0a	3.68c
ORG6	6.6a	0.6b	100.4b	0.10b	2.3b	0.8a	3.37c
ORG12	6.4a	0.9b	92.0b	0.5a	1.9b	1.0a	4.52b
ORG18	6.7a	1.1b	120.1b	0.5a	2.2b	1.1a	4.7b
ORG24	6.8a	1.6a	219.0a	0.6a	3.0a	1.3a	5.85a

- EC ¼ Electrical conductivity and CEC ¼ cation exchange capacity.
- Means followed by the same letter within each column are not significantly different at 5% level by Duncan's test.
- The management systems evaluated were (1) under 12 months of soil conventional management (CNV); (2) under six months of soil organic management (ORG6); (3) under 12 months of soil organic management (ORG12); (4) under 18 months of soil organic management (ORG18); and (5) under 24 months of soil organic management (ORG24).

Recent studies that compared the mineral content of soils today with soils 100 years ago found that agricultural soils in the United States have been depleted of eight-five percent of their minerals. This phenomenon was documented worldwide. Researchers found that soils in Africa have seventy-four percent less minerals, soils in Asia have seventy-six percent less minerals, soils in Europe have seventy-two percent less minerals, soils in South America have seventy-six percent less minerals and in Canada soils have eight-five percent less minerals than 100 years ago (Marler and Wallin, 2006).

The treatments with vermicompost application registered superior values for all the soil chemical properties like pH, Cation Exchange Capacity, organic carbon, and C/N ratio (Table.2). The increased level of organic carbon is a good indication of better carbon sequestration in soil by reducing the amount of CO_2 released to the atmosphere. Organic matter addition significantly enhanced the nutrient availability of the soil. Available N, P, K, Ca, Mg, Mn, Zn and Cu were increased by vermicompost application. Sulphur availability was found to be increased in poultry manure treated plots. Organic nutrition also enhanced the soil enzyme activities like dehydrogenase and phosphatase (Bhaskaran and Krishna, 2009).

Table 4. Effect of organic nutrition on soil chemical and biological properties adopted from Bhaskaran and Krishna (2009)

Treatments	pH	Organic carbon %	CEC (cmol P+ kg^{-1})	C:N ratio	Available nutrients kg ha^{-1}			Dehydrogenase (µg TPF g soil^{-1} 24hr^{-1})	Phosphatase (µg P nitro Phenol g soil^{-1}hr^{-1})
					N	P	K		
T_1	5.53	0.61	2.94	10.17	238	25	141	204.67	76.33
T_2	5.51	0.66	3.51	12.20	241	30	144	236.67	81.93
T_3	5.51	0.67	3.37	12.03	261	33	149	231.00	91.00
T_4	6.31	0.78	4.97	9.97	296	37	175	301.00	115.83
T_5	6.33	0.78	5.02	9.97	308	39	171	310.67	135.70
T_6	5.62	0.56	3.78	10.03	237	32	163	238.67	76.07
T_7	5.62	0.58	3.70	10.00	254	34	160	244.30	81.13
T_8	5.30	0.50	2.54	10.13	188	22	122	150.00	39.07
SE	0.04	0.02	0.06	1.25	7.86	0.59	3.88	10.12	3.19
CD(0.05)	0.13	0.05	0.18	0.76	23.85	1.80	11.76	30.71	9.68

T1: Full recommended dose as per package of practices recommendation (20 kg N ha^{-1}, 30 kg P_2O_5 ha^{-1} and 10 kg K_2O ha^{-1} with 20 t FYM ha^{-1}); **T2**: Full recommended dose as farm yard manure; **T3**: Full recommended dose as FYM + P solubilizing microorganisms; **T4:** Full recommended dose as Vermi compost; **T5:** Full recommended dose as Vermi compost + P solubilising micro organisms;**T6:** Full recommended dose as poultry manure; **T7:** Full recommended dose as poultry manure + PSM; **T8:** Inorganic alone (20 kg N ha^{-1}, 30 kg P_2O_5 ha^{-1} and 10 kg K_2O ha^{-1}).

At the end of 21 years of crop rotation management in Switzerland, soil organic carbon and total nitrogen were greater under biodynamic management than conventional management, but organic management and integrated management (combination of manures, inorganic fertilizers, and herbicides) were intermediate (Fliebbach *et al*., 2006). Soil microbial biomass carbon and de-hydrogenase activity were greater under organic than under conventional management, but basal soil respiration was not different between systems. Liebig and Doran, (1999) indicated that among 5 paired farms in North Dakota and Nebraska, total and microbial carbon and nitrogen, and mineralizable carbon and nitrogen were greater under organic than under conventional management.

Soils from organic and sustainable farms had significantly higher levels of soil calcium, magnesium, sodium, manganese, and zinc than soils from conventional farms in each year (Figure 1A–E). Soils from organic farms also had higher levels of soil copper and phosphorus than soils from sustainable and conventional farms (Figure 1F and G). The level of potassium was more variable among farms and from year to year (Figure 1H). Soil pH levels, the cation exchange capacity and base saturation levels were also significantly higher in soils from organic and sustainable than conventional farms (Figure 1I, K and L). However, the level of extractable acidity was more variable between production systems and year (Figure 1J).

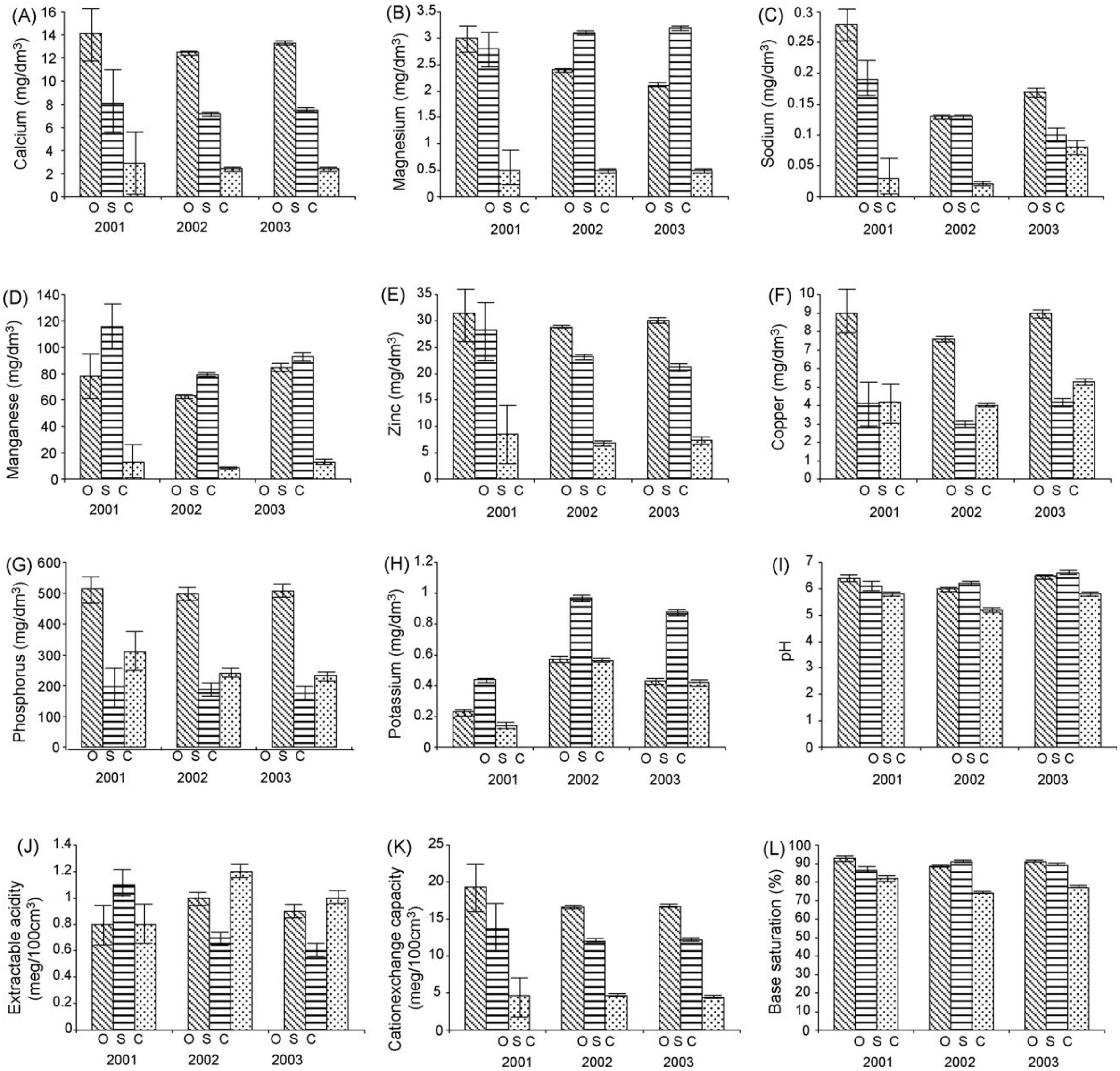

Figure 1. Chemical properties of soils from organic, sustainable and conventional farms in North Carolina in 2001 to 2003 including: (A) calcium; (B) magnesium; (C) sodium; (D) manganese; (E) zinc; (F) copper; (G) phosphorus; (H) potassium; (I) pH; (J) extractable acidity; (K) cation exchange capacity; (L) base saturation. O represents organic farms, S represents sustainable farms and C represents conventional farms (Liu *et al.,* 2007).

2.3. Soil Biological properties

In comparison with conventional farming, organic farming has potential benefits. Soils contain enormous numbers of diverse living organisms assembled in complex and varied communities. These organisms play an essential role in the sustainable function of all ecosystems, including recycling of nutrients, regulation of the soil organic matter and soil carbon sequestration, modification of soil physical structure and water regimes, enhancement of the efficiency of nutrient acquisition and plant health, suppression of undesirable organisms and detoxification of noxious chemicals (Coleman *et al*., 1978; Kennedy and Smith, 1995 in Liu *et al*., 2007). In addition, even though microbial communities are a small fraction of the soil's total organic matter content, they provide a source and sink of nutrients and control soil organic matter mineralization. Changes in microbial communities can be used to predict the effects of ecosystem perturbations by organic and conventional management practices (Bending *et al*., 2000; Poudel *et al*., 2002 and van Bruggen and Semenov, 2000 cited in Liu *et al*., 2007).

Higher Corg content observed in organic management system (ORG24) indicates that the increase in Corg, following organic practices, was statistically significant after 2 years. This increase in Corg is important for semi-arid region, as Piauı´ state, due to the low levels of organic matter observed for our soils. The high organic C is important for sustainability because of organic matter influence on soil's physical, chemical and biological properties (Arau´ jo *et al*., 2008).

Table 5. Soil organic carbon (C_{org}), microbial biomass C (C_{mic}) and C_{mic}-to-C_{org} ratio of conventional and organic systems, at 0–10 cm depth (Arau´ jo *et al*., 2008).

Management system	C_{org} (g kg^{-1})	C_{mic} (mg g^{-1} soil)	$C_{mic\text{-}to\text{-}Corg}$ (%)
CNV	11.6 ±2.1 b	64.0±21 c	0.5±0.09 b
ORG6	12.5±2.9 b	97.1±29 b	0.8±0.10 a
ORG12	11.2±1.9 b	121.2±27a	1.1±0.13 a
ORG18	13.1±2.0 b	129.4±2.6 a	0.9±0.10 a
ORG24	17.8±2.6 a	142.5±22 a	0.8±0.11 a

a Mean_ standard error. Means followed by the same letter within each column are not significantly different at 5% level by Duncan's test.

b The management systems evaluated were (1) under 12 months of soil conventional management (CNV); (2) under six months of soil organic management (ORG6); (3) under 12 months of soil organic management (ORG12); (4) under 18 months of soil organic management (ORG18); and (5) under 24 months of soil organic management (ORG24).

Studies by Liu *et al*. (2007) indicated that total and active fungal and bacterial biomass was also measured in soils from organic, sustainable, and conventional than sustainable and conventional farms. In contrast, total bacterial biomass was higher in soils from conventional than sustainable and organic farms for all three years of the study. However, active bacterial biomass and the ratio of active to total bacterial biomass were higher in soils from organic and sustainable than conventional farms.

Table 6. Total and active fungal and bacterial biomass measurements and biomass ratios in organic, sustainable, and conventional North Carolina 2001, 2002, and 2003 (Liu *et al*., 2007)

Soil Microbial Biomass	2001	P-value	2002	P-value	2003	P-value
Total fungal biomass (µg/g)						
Organic	165.9	0.0557	170.9	0.0001	206.7	0.2894
Sustainable	186.9		128.9	**	196.2	
Conventional	138.8		79.3		180	
Active fungal biomass (µg/g)						
Organic	10.7	0.0006	5.4	0.0001	36.6	0.1485
Sustainable	32.1	**	27.1	**	55	
Conventional	25.3		12.8		55.1	
Active/Total fungal biomass ratio						
Organic	0.09	0.0190	0.04	0.0001	0.18	0.1011
Sustainable	0.27	*	0.37	**	0.27	
Conventional	0.16		0.15		0.3	
Total bacterial biomass (µg/g)						
Organic	110.7	<0.0001	175.4	<0.0001	287.3	0.0439
Sustainable	121.6	**	155.2	**	299.5	*
Conventional	152.8		212.9		375.5	
Active bacterial biomass (µg/g)						
Organic	41.2	0.0001	35.9	0.0001	59.4	0.0582
Sustainable	38.8	**	63	**	50	
Conventional	16.7		25.7		44.5	
Active/Total bacterial biomass ratio						
Organic	0.37	0.0001	0.2	0.0001	0.22	0.0071
Sustainable	0.33	**	0.39	**	0.19	*
Conventional	0.11		0.13		0.12	

3. Significance of Organic Farming on Food Quality

3.1. Food Quality

Quality can be defined from either a product orientation or a consumer orientation. Food quality is the quality characteristics of food that is acceptable to consumers. Abbot (1999) defines the term quality as the degree of excellence of a product or it's suitability for a particular use. This quality of produce encompasses sensory properties (appearance, texture, taste and aroma), nutritive values, chemical constituents, mechanical properties, functional properties and defects. Food quality is an issue of increasing public interest. The subject targets not only the content of nutritional compounds, health promoting or otherwise beneficial substances and features, but more and more the way food is produced.

Agriculture was associated positively with food production and food security less than a century ago. In comparison, it is nowadays commonly linked to problems such as eutrophication of water bodies, enrichment of pesticides in soils and plants contamination. The developing popularity of organically grown foods has originated, in part, from an increasingly widespread perception that this production method results in food of higher nutritional quality. However, evidence that can clearly support or negate this perception remains equivocal, with the number of systematically controlled studies that have compared organic versus conventionally grown crops being very small.

3.2. Factors affecting the quality of crops

Several factors can directly or indirectly affect the nutritional quality of crops. Among these are soil factors, such as pH, available nutrients, texture, organic matter content and soil-water relationships; weather and climatic factors, including temperature, rainfall and light intensity; the crop and cultivar; harvesting stage, post-harvest handling and storage; and fertilizer applications and cultural practices. This paper review deals primarily with fertilizer and cultural management practices that affect the nutritional quality of fruits and vegetables and field crops.

3.3. Nutritional value (Primary nutrients)

3.3.1. Proteins

Protein content seems to be affected in some vegetables by the production system. In their review of literature, Woese *et al.* (1997) stated that no trend could be identified for total protein (crude protein), pure protein and relative protein content (% of total protein that consists of pure protein). Total protein, total nitrogen and the total amino acid content tend to be higher in conventionally grown vegetables (Kumpulainen, 2001). This is especially true in nitrophilic vegetables (leaf, roots and tubers). Studies on potatoes and corn have shown the most significant results with respect to protein content. Protein content may be higher in conventionally grown vegetables (Bordeleau *et al*., 2002).

For protein levels, it has been reported that organically grown cereals, especially wheat, can have comparable protein levels with conventional ones (Shier *et al*., 1984 in Bordeleau *et al*., 2002) but generally have somewhat lower levels of protein than the conventional ones (Woese *et al*., 1997). Nonetheless, it is noteworthy that the cultivars selected by organic farmers are mostly high protein ones (e.g. for bread-making) and that optimized fertilization practices can maintain reasonably high protein levels. Moreover, a 25–30% increase in lysine has been reported in organic wheat (Wolfson and Shearer, 1981 and Brandt *et al*., 2000 in Bordeleau *et al*., 2002).

3.3.2. Sugar, Starch, Acid and Dry Matter

Some other parameters have also been examined in a few studies. These include organic acids, starch, dry matter content and various sugars. For organic acids and sugars, no clear difference was found by Kumpulainen (2001). Woese *et al.* (1997) also found no differences for both for the proportion of monosaccharides in total sugar and total sugar content itself. In studies on spinach, beetroot, carrots, celery and leeks, no difference was found in organic acids (malic, citric, oxalic, and total acid) (Woese *et al.*, 1997).

The available data mostly refer to vegetables and fruit. For leafy vegetables as well as root vegetables and tubers, a trend for higher dry matter contents in organic foodstuffs has been found while no significant difference has been identified for fruit vegetables and fruit (Woese *et al*., 1997; Bourn and Prescott, 2002 and AFSSA, 2003).

Table 7. Vitamin C, calcium, potassium and dry matter content of organically and conventionally grown fruits and vegetables (Masamba and Nguyen, 2008)

Sample	Vitamin C (mg/100g)		Calcium (mg/100 g)		Potassium (mg/100 g)		Dry matter (%)	
	ORG	CNV	ORG	CNV	ORG	CNV	ORG	CNV
Cabbage	31.3	32.1	44.0	39.0	287.7	253.2	10.0	10.1
Carrot	4.8	4.9	36.3	31.7	326.8	320.7	11.0	10.7
Cos lettuce	10.3	10.3	35.7	30.7	326.2	278.3	5.2	5.1
Valencia Orange	51.8	43.4	51.8	54.5	189.5	192.0	13.6	13.4

ORG- organic CNV-conventional

Dry matter content seems to differ between production methods for some produce. In general, the dry matter content of above-ground (leaf) vegetables (studies done on spinach, chard, and savoy and white cabbage) was higher in organic crops, whereas no difference was detected in the dry matter and starch content of belowground (root and tuber) vegetables (Woese *et al.*, 1997). Also, no differences were observed either in dry matter content and sensory properties between organic and conventional fruits in experiments done by Vetter *et al.* (1983 in Woese *et al.*, 1997). Higher dry matter content in organic products can be explained by the fact that fertilization is generally less intense in organic agriculture, and therefore organic fruit and vegetables are smaller and thus contain less water. However, this does not explain why dry matter content was only found to be affected by production method in above-ground vegetables (Bordeleau *et al*., 2002).

The content of acids, sugars and dry matter is variable between fruit grown under the same production system. These variables are influenced by microclimate, maturity and other factors, making it difficult to differentiate based on production system alone. There does, however, seem to be a significant difference in dry matter content for some produce, between organic and conventional production.

3.3.3. Vitamin contents

There are 27 studies, reviewed by Woese *et al.*, (1997), that examine levels of vitamins in organic and conventionally produced vegetables. The vitamins that were the studied between organic and conventional food are vitamin A, (B-carotene), B1 (thiamine), B2 (riboflavine), C, and E.

Kumpulainen (2001) also reviewed literature that compared vitamin contents in organic and conventional production. No difference in vitamin A/B-carotene, thiamine, riboflavine were found if carrots and potatoes in the study by Kumpulainen (2001). Also, no differences in vitamin B content were detected in the 2 studies reviewed by Woese *et al.* (1997).

The number of studies dedicated to vitamin contents is limited to some fruits and vegetables and eggs. Regarding water soluble vitamins, the most studied one has been Vitamin C (ascorbic acid), a key vitamin for which higher daily intakes are recommended. Studies performed on potato (Fischer and Richter, 1986; Kolbe *et al.,* 1995), tomato (Pither and Hall, 1990; Caris-Veyrat *et al*., 2004), celeriac (Leclerc *et al*., 1991) cited in (Bordeleau *et al*., 2002) and kale showed higher vitamin C levels in organically-grown products. According to Worthington (2001) higher vitamin C content were observed on lettuce, Spinach, potato and Cabbage shown on Table 8 below.

In general, Woese *et al.* (1997) observed strong evidence of higher vitamin C levels in leafy green vegetables. On a more general basis, in another review of literature, Lampkin (1990) noted higher vitamin C content (28% higher on average) in organic vegetables.

Table 8. Differences in Nutritional Content between Organic and Conventional Vegetables: Mean Percent Difference for Four Nutrients in Five Frequently Studied Vegetables (Worthington, 2001)

Vegetables	Nutrients*			
	Vitamin C	Iron	Magnesium	Phosphorus
Lettuce	+17	+17	+29	+14
Spinach	+52	+25	-13	+14
Carrot	-6	+12	+69	+13
Potato	+22	+21	+5	0
Cabbage	+43	+41	+40	+22

*Plus and minus signs refer to conventional crops as the baseline for comparison. For example, vitamin C is 17.0% more abundant in organic lettuce (conventional 100%, organic 117%).

In conclusion, no differences were found in studies examining vitamin A (B-carotene), vitamin B1 and B2. However, there often seems to be a difference in vitamin C (higher in organic), mostly in potatoes and leaf vegetables such as lettuce, savoy cabbage, spinach and chard (leaf beet) (Woese *et al.*, 1997).

Table 9. Overview of Differences in the Nutrient Content in Organic and Conventional Foods in 191 Matched Pairs adopted from Benbrook *et al*. (2008)

Nutrient	Number of matched pairs	Number organic higher	Number conventional Higher	Percent Organic higher	Percent conventional higher
Vitamins					
Vitamin C/ascorbic acid	46	29	17	63	37
B-carotene	8	4	4	50	50
a- Tocopherol (Vitamin E)	13	8	5	62	38

3.3.4. Mineral contents

The most important mineral elements are calcium (Ca), magnesium (Mg), potassium (K), iron (Fe), zinc (Zn), copper (Cu), manganese (Mn), selenium (Se) and iodine (I). Phosphorus (P) and sodium (Na) are generally found in sufficient quantity (Lairon, 2009).

On fruit and vegetables, 22 scientific publications were considered in the AFSSA report (2003). Regarding fruit, and especially apples, it is noteworthy that the mineral composition is generally not noticeably altered by the production system. Regarding vegetables (potato, carrot, beetroot, lettuce, kale, leek, turnip, onion, celeriac and tomato), a trend has been observed for higher levels of iron and magnesium expressed on a fresh matter basis in organic foodstuffs, with no other marked change.

Regarding Cereals, from two long-term fertilization trials, it appears that the mineral composition (P, K, Ca, Mg, Mn, Zn, Fe, Cu and Cr) of cereals is not markedly affected by the cropping regime (Miller and Dema, 1958; Morel *et al*., 1984 cited in Bordeleau *et al*., 2002). Another study did not show any marked difference but a trend for higher levels of Ca, Cu and Zn in organic barley (Alföldi *et al*., 1996 cited in Bordeleau *et al*., 2002). In a recent review (Rembialkowska, 2007), it was estimated that organic crops overall contain 21% more iron and 29% more magnesium than their conventional counterparts.

In 2001, Worthington standardized and statistically analyzed data obtained from 41 studies that compared organic with conventional crops (2001).

The author found statistical significance in higher levels of vitamin C, iron, magnesium, and phosphorus, and lower levels of nitrates among organic crops (Table 10). Another trend that was observed was a lower amount of protein in organic crops, but of higher quality, as well as a higher content of nutritionally significant minerals and lower amounts of some heavy metals. Worthington did not review sensory data these findings were attributed to that fact that organic fertilizers, in contrast to synthetic fertilizers, contain less nitrates and deliver nutrients in a more consistent manner (Worthington, 2001).

Table 10. Nutrient Content of Organic versus Conventional Crops: Mean Percent difference, Level of Significance, Number of Comparisons, And Number of Studies for Statistically Significant Nutrients adopted from Worthington (2001)

Nutrient	Means % difference	Level of significance	Number of comparisons+		
			Organic higher	Organic lower	No difference
Vitamin C	+27%	<0.0001	83	38	11
Iron	+21.1	<0.001	51	30	2
Magnesium	+29.3	<0.001	59	31	12
Phosphorus	+13.6	<0.01	55	37	10
Nitrates	-15.1	<0.0001	43	127	6

*Plus and minus signs refer to conventional crops as the baseline for comparison. For example, vitamin C is 27.0% more abundant in the organic crop (conventional 100%, organic 127%).

+A comparison consists of a single nutrient in single organic crops grown in one season compared to the same conventionally grown crop from the same season, for example, 0.30 mg of zinc in organic cabbage compared to 0.25 mg of zinc in conventional cabbage, both grown in 1986.

First, there appears to be higher amounts of nutritionally significant minerals in organic compared to conventional crops. The organic crop had a higher mean mineral content for all 21 minerals considered in this analysis. Figure 2 shows the mean percent additional mineral content in organic crops by mineral for some of these minerals. In addition, there may be less of the toxic heavy metals in organic crops than in conventional crops. For all four heavy metals considered, the organic crop contained lower amounts of the heavy metals more often than comparable conventional crops.

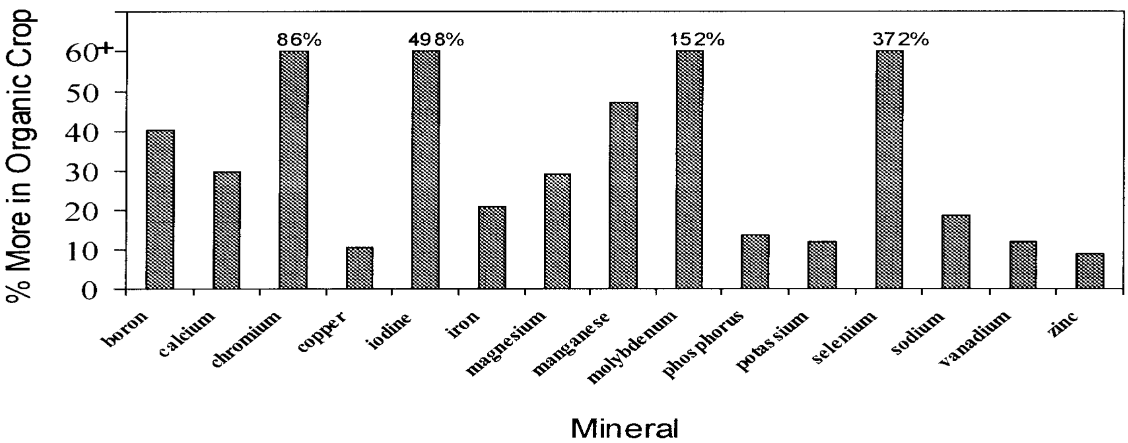

Figure 2. Mean percent additional mineral content in organic compared to conventional crops (Worthington, 2001).

3.4. Secondary plant metabolites

Fruit and vegetables contain a large variety of micro-compounds which are secondary metabolites in plants such as polyphenols, resveratrol and some non-pro-vitaminic carotenoids. These compounds have increasingly been shown to have drastic regulatory effects at cellular level and are thus involved in prevention of certain diseases such as cancers, chronic inflammation and other pathologies. Some of them are phytoalexins which are produced in plants as a response to external stress such as fungal disease. While several factors can modulate their plant level such as cultivar, maturity, light or temperature, some studies have compared the levels of some of these phyto-microcompounds in fruit or vegetables depending on the cropping system (Lairon, 2009).

For phenols and polyphenols, a majority of studies showed higher levels in organic foodstuffs such as apple (Lucarini *et al.*, 1999), peach (Carbonaro *et al.*, 2002), pear (Carbonaro *et al.,* 2002), potatoes (Hamouz *et al.,* 1999), onion (Ren *et al*., 2001), tomato (Mitchell *et al.,* 2007), pepper (Pérez-López *et al*., 2007), orange (Tarozzi *et al*., 2006) and olive oil (Gutierrez *et al.,* 1999), while some others did not show any difference.

It has been estimated in a recent review (Rembialkowska, 2007) that organic plant foods overall contain double the amount of phenolic compounds. One study reported higher levels of resveratrol in organic wines (Levite *et al.,* 2000).

For five nutrients, Figure 3 below shows the percent of total matched pairs for which the organic sample nutrient level exceeded the conventional sample level by eleven percent or more. Almost one-half of the 57 organic samples in these matched pairs exceeded the conventional sample nutrient level by 21% or more. Another perspective reinforces the basic point. About 22% of the 145 matched pairs in which the organic samples were more nutrient dense fell within a difference of only 0% to 10%, which can be regarded as minor. Almost two-thirds of the conventional matched pairs found to be more nutrient dense fell within the 0% to 10% difference range. The differences documented in this study are sufficiently consistent and sizable to justify a new answer to the original question– *Yes; organic plant-based foods are, on average, more nutritious (*Benbrook *et al*., 2008).

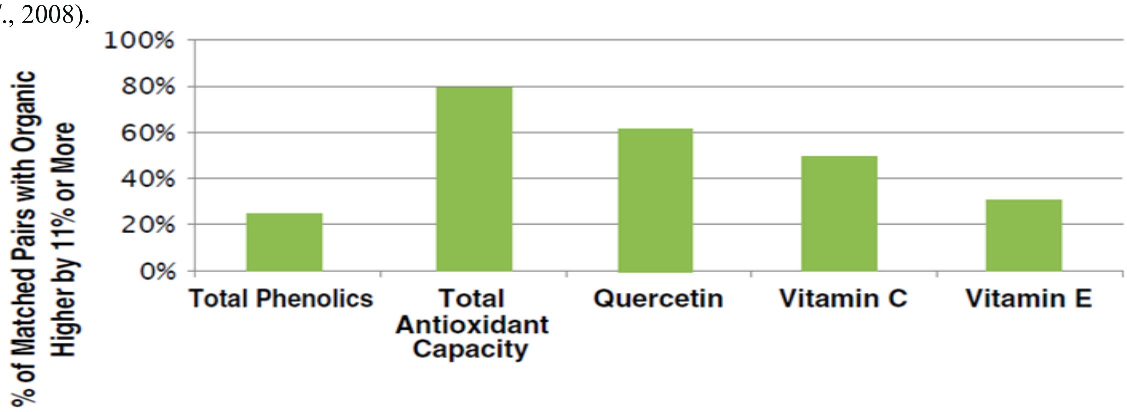

Figure 3. Percent of total matched pairs for a nutrient in which the organic sample nutrient levels exceeded the conventional samples by more than 10% (Benbrook *et al*., 2008).

Among the identified 191 matched pairs with valid comparisons of antioxidant, vitamin and mineral levels. Of these, 119 organic samples within the matched pairs had higher nutrient levels, or 62% of the total matched pairs. The conventional samples contained higher levels of nutrients in 68 matched pairs, or 36%, as shown in Table 11. Nutrient levels were reported as equal in 2% of the matched pairs.

Table 11. Overview of Differences in the Nutrient Content in Organic and Conventional Foods in 191 Matched Pairs adopted from Benbrook *et al*. (2008)

Nutrient	Number of matched pairs	Number organic higher	Number conventional Higher	Percent Organic higher	Percent conventional higher
Antioxidants					
Total phenolics	25	18	6	72	24
Total antioxidant capacity	8	7	1	88	13
Quercetin	15	13	1	87	7
Kaempferol	11	6	5	55	45

Worthington reviewed the literature produced over the last 50 years comparing the nutritional quality of organic with conventional crops (Worthington, 1998). The author concluded that the evidence for nutritional superiority of organically versus conventionally grown crops based on nutrient content alone is suggestive, though not conclusive. An overall trend showed higher nutrient content in organically grown crops, possibly due to lower water content in organic crops. Only vitamin C and nitrates were clearly affected by fertilization method, with higher levels of vitamin C and lower levels of nitrates occurring in organically grown crops.

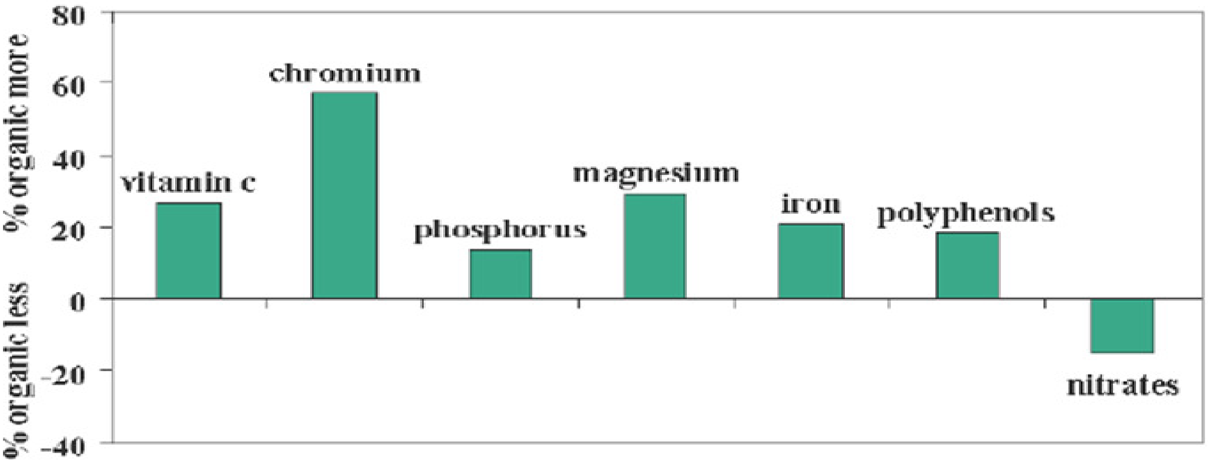

Figure 4. Organic compared to conventional crops. Percent difference in nutrient content, selected nutrients (Worthingon, 1998).

3.5. Sensory characteristics

Rembialkowska (2000) states that particularly fresh organic vegetables had significantly better sensory features (taste, scent) than conventional products. Marckmann (2000) expects a higher intake of organic food because of favorable sensory features, which in return may positively affect diseases such as obesity and type 2 diabetes. It is known that sensory features of vegetables are linked to plant nutritional factors: glucosinolates and alliins cause for instance the pungency of mustard, radish, onion and garlic. Both components contain S and experimentation proved that their content was closely linked to the S nutritional status (Bloem *et al.*, 2004). Besides that both components are supposed to have a high health protective effect.

The Food and Agriculture Organization of the United Nations summarized the sensory differences as follows: "Many sensory analysis studies have been carried out to investigate differences in selected organoleptic parameters between organically and conventionally grown products, and on the whole these indicate that there is no clear difference between the two Certain studies have shown significant differences for selected products, as in the case of the sensory differences between organically and conventionally grown apples of the Golden Delicious variety. The organically grown apples were found to be firmer and received higher taste scores than conventionally grown apples. The content of flavanoids in the organic apples was higher. Another study showed that organic tomatoes were sweeter and conventional carrots had more 'carrot taste' (Woese *et al*., 1997).

Bourn and Prescott provide a detailed and extensive analysis of the sensory qualities of organically and conventionally grown food (Bourn and Prescott, 2002). After reciting the many issues with sensory evaluation techniques – discrimination tests, descriptive analysis techniques, and preference/ acceptability measures – they concluded that there is yet to be convincing evidence that organic produce differs in sensory terms from conventional produce, let alone that there is any taste advantage (Theuer, 2006).

4. Significance of Organic Farming on Human Health

Any comparison of the quality of foods from different agricultural systems must begin with a foundation of food safety, given its prominence in the public perception of organic food. Risk assessment is a scientific approach aiming at identifying known hazards and related risks. Contaminations by bacteria, viruses, worms, mycotoxins and agro-chemicals are mainly involved. Not all aspects have yet been comparatively studied such as hazards due to viruses or worms. This paper will therefore take some relevant examples on hazards and related risks based on more reliable information.

4.1. Contaminants

4.1.1. Pesticide residues

Organic fruits and vegetables are believed to be healthier by many because organic farming methods prohibit the use of most synthetic pesticides used in conventional farming methods. Given their method of production, it makes intuitive sense that organic produce should contain less pesticides than conventional produce. However, until the last few years there was little to no published data on whether this intuition was correct, and if it was, exactly how much organic produce differed quantitatively from conventional produce (Chen *et al.*, 2005). While many in agriculture believe that pesticides are necessary to produce and protect crops, it is universally agreed that consumer exposure to these toxins should be minimized on safety grounds.

In two reviews, examining over 35 papers and 9,100 samples respectively, pesticide residues were found much less often in organically produced vegetables than typical non-organic levels, and contamination of organic samples appeared more often than not to have originated from environmental pollution (Chen *et al.*, 2005). A review by Baker *et al.* (2002) and Pussemier *et al.* (2006) indicated that Pesticide residues were 3.2 times more likely to be found in conventional produce than in organic produce, according to PDP data; 4.8 times more prevalent in CDPR data; 2.9 times greater in the Consumers Union data; and 4.1 times more likely than organic samples in Belgian data (Table 12). The levels of pesticide residues in organic foods also appear to be lower than those in conventional foods.

Table 12. Detection of pesticide residues in conventional and organic produce: summary of different monitoring programs (Baker *et al*., 2002 and Pussemier *et al*., 2006).

	USDA pesticide data program	CDPR marketplace Surveillance program	Consumers Union	Belgian
Conventional, %	73	31	79	49
Organic, %	23	6.5	27	12
Conventional/organic, ratio	3.2	4.8	2.9	4.1

Effects of pesticides on health

As many are fat-soluble, pesticides can accumulate in lipid-rich tissue. Biological half lives of several years have been reported in human beings for some compounds and there is particular concern regarding possible neurobehavioral and neurotoxic effects, mutagenicity, teratogenicity, carcinogenicity, and allergic and other immuno-regulatory disorders. The amount of pesticides found on fruits and vegetables is lower for organic crops than for conventional ones. However, often the concentrations of pesticide residues are well below the allowable limits (Woese *et al.*, 1997).

4.1.2. Heavy metals

High concentrations of heavy metals are another major concern among people who buy organic food. Lead, mercury and cadmium are often measured when considering food quality. The main sources of heavy metals are fertilizers and pesticides. According to Woese *et al.* (1997), there was no clear difference for any of the heavy metals (cadmium, lead, mercury) or environmental pollutants studied in any of the reviewed papers, which concerned vegetables and fruit. Lead and mercury do not differ significantly between organic and conventional production because these heavy metals are normally found in very low concentrations in mineral fertilisers. These heavy metals are also not taken up by plants readily. No difference in lead and mercury were detected between organically and conventionally grown potatoes and carrots (Kumpulainen, 2001). Many studies deal with cadmium. It is present naturally in the environment, and cadmium levels vary greatly between different areas and soil types. The main sources of cadmium contamination are aerial deposition and phosphate fertilizer. Though, another potential source of cadmium is sewage sludge (Woese *et al.*, 1997).

Cadmium is present in the soil in varying amounts. Cd uptake by plants depends on soil conditions (soil type and pH) as well as the amount of precipitation during the growing season (Jorhem and Slanina, 2000 in Lairon, 2009). In acidic soils, Cd uptake by plants can be significant. Therefore it is very possible to find some cadmium residues in conventional fruit and vegetables. However, conventional products are not the only ones affected. Indeed, some organic farmers are allowed to use slowly-dissolving phosphate, which may or may not contain cadmium. Jorhem and Slanina (2000) also studied the cadmium and other heavy metals contents of organic and conventional potatoes and carrots in Uppsala, Sweden. They did not find any difference in Cd, Pb, Cr, and Zn between organically and conventionally grown potatoes.

Yeshiwas and Tadele, (2017) reported that Prolonged human consumption of unsafe concentrations of heavy metals in food stuffs may lead to the disruption of numerous biological and biochemical processes in the human body, the chronic accumulation of heavy metals in the kidney and liver of humans causing disruption of numerous biochemical processes, leading to cardiovascular, nervous, kidney and bone diseases.

In summary, no significant difference in heavy metal content was found between organic and conventional products for Fe, Pb, Hg, Zn, and Cr. Very often, the levels of these compounds were below the minimal detection limit. Also, results concerning cadmium were insignificant due to the very many environmental factors influencing cadmium contents of plants, such as the amount of Cd in fertilizer, soil conditions and weather.

4.1.3. Nitrates

Nitrate represents the most oxidized chemical form of nitrogen found in natural systems. Nitrate is a negatively charged ion (anion) and so must be paired with a positively charged ion (cation). Nitrate is a wide spread contaminant of ground and surface waters worldwide. Nitrates are a matter of concern for public health due to their easy transformation into nitrites. Nitrites are highly reactive molecules capable of competing with oxygen in blood circulation for binding to hemoglobin, thus leading to methemoglobinemia and possible anoxia and, binding to secondary amines to generate nitrosamines which are among the most powerful natural cancer-promoting moities (Lairon, 2009). In the human diet, about 80% of nitrates are provided by vegetables, while nitrate levels in fruits, cereals and legumes are very low (Stopes *et al*., 1988; and Cornee *et al.,* 1992 in Lairon, 2009). Worthington (2001) summarized the results of 18 studies comparing nitrate levels of organic and conventional foods and found 127 cases where nitrate levels were higher in conventional foods, 43 cases where nitrate levels were higher in organic foods and 6 cases where no difference was observed.

The ratio of nitrate levels in conventional foods relative to organic foods ranged from 97 to 819%. A review by Woese *et al.* (1997) also concluded that "conventionally cultivated or minerally fertilized vegetables normally have far higher nitrate content than organically produced or fertilized vegetables. The review of literature conducted by Heaton (2001) found 14 studies showing lower nitrate content (averaging 50% lower) in organically grown crops. Across 18 matched pairs, nitrate levels in the conventional samples were higher in 83% of the pairs (undesirable), while protein levels were higher in 85% of the conventional samples in 27 matched pairs (desirable). These differences are shown in Table 13 below.

Table 13. Differences in Nitrate Levels in 18 Matched Pairs and Protein in 27 Matched Pairs

Nutrient	Number of matched pairs	Number organic higher	Number conventional Higher	Percent Organic higher	Percent conventional higher
Nitrates	18	3	15	16.7	83.3
Proteins	27	4	23	14.8	85.2

Source: Benbrook *et al*. (2008)

4.1.4. Microbiological Toxins

Microbiological health hazards are more important than toxicological dangers, and may be more likely to occur in organic than in conventional farming because of the frequent use of organic fertilisers. However, Williams *et al.* (2000) state that there is currently no reliable data that can prove organic food is more likely to be contaminated with harmful microbiota. According to McMahon and Wilson (2001 cited in Chen *et al.,* 2005) tested 86 samples of organic vegetables, obtained from markets in Ireland, and detected no presence of *Salmonella*, *Campylobacter*, *Escherichia coli*, *E. coli O157:H7*, or *Listeria* in any of the samples. In the other study, Sagoo *et al* (2001 cited in Chen *et al.,* 2005) tested 3,200 samples of organic vegetables obtained from markets throughout the UK and found that *E. coli* was present in a low prevalence of 1.5% of the samples, but *Listeria monocytogenes*, *Salmonella*, *Campylobacter*, and *E. coli O157:H7* were all absent. It has been suggested that organically produced food has higher levels of mycotoxin contamination because organic farming prohibits the use of fungicides. There is no evidence to support this claim (Heaton, 2001). In fact, organic farmers would contend that their crops are less prone to fungal diseases because high doses of nitrogen increase the growth rate of crops leading to a thinning of the plant cell walls making the crop more vulnerable to fungal attack (Heaton, 2001).

5. Organic Farming in Ethiopia

Spurred by the successes of the Tigray Project, the Ethiopian government has stated its interest to increase the capacity of farmers to use organic methods of crop production. The Rural Development Policy, meanwhile, emphasizes the need to improve local marketing infrastructure, and also to develop agricultural products to diversify the economic base of the country. In 2003, the government announced it will support the development of organic agriculture, and a task force was established to draw up an Ethiopian Organic Agriculture Regulation, which can become law, and a Regulation for Organic Agriculture Products to describe how organic products are defined, and what may or may not be used in their growing and processing. (Edwards, 2005).

The international trade in organic products is an expanding niche market that Ethiopia is geographically well situated to exploit. Already, some communities in the south and southwest have started to develop and export Arabica coffee with an organic and fair trade label. There is also expanding awareness of the importance of producing healthy fruits and vegetables for the expanding educated middle-class and expatriate market in Addis Ababa. For example, Genesis Farm started three years ago and production now covers over 40 hectares. The farm combines dairy and poultry production with growing vegetables, fruits and ornamental plants. It is totally organic and sells certified products on the export market (Edwards, 2005).

Study by Devi *et al*. (2007) indicated that Ethiopia is a country of farmers and 85% of its population is engaged in farming activities. From the ongoing research, it is clear that the scope of organic farming is bright in this country and it is about 40.6% more economical than inorganic farming. Organic farming will help the farmers to maintain the similar returns with less input. It is also environmental friendly and at the same time, maintains the soil fertility and its integrity. This farming system will also help farmers on control over their means of production and greater independence. Finally, it can be concluded that organic farming is the way towards sustainable development for a developing country like Ethiopia.

In Ethiopia, there are both certified and organically grown crops. There are around 141,374 ha of lands certified with a total production around 41,462 tonnes and 105,325 farmers are certified organic. The major organic products are: Coffee, Sesame, Honey and bee wax, Herbal tea (mainly for export) and Vegetables, Processed food (mainly for domestic market)

5.1. Ethiopia and the Future of Organic Agriculture

Ethiopia is a country of mostly smallholder farmers. Its population is mostly rural. Its agricultural systems mix animal and crop production. It is one of the 12 major Vavilov centres of crop genetic diversity in the world. Because of these strengths, it has suffered relatively insignificant crop genetic erosion. This makes it easy to intensify agricultural production in Ethiopia without resorting to industrial agriculture. This option for the intensification of agricultural production is indeed an economic advantage because agrochemicals are already expensive and are going to continue getting even more expensive (Tewolde Berhan, 2007).

The large crop genetic diversity will also enable Ethiopia to adapt to climate change more easily than most other countries in the world. Ethiopia has an abundance of hydro, geothermal, solar and wind power. It can thus industrialize by harnessing its wealth of renewable energy resources without polluting the atmosphere. Strengthening its existing organic agriculture with needed scientific inputs will, therefore, give Ethiopia a globally competitive edge in agriculture. Developing a formal system of certification of organic agricultural products will then also give it a globally competitive edge in trade in this era of climate change. That is why organic agriculture is the erstwhile symbol of Ethiopia's underdevelopment, becoming its effective lever in shifting to an adapted and adaptive modernity. Ethiopia should, therefore, reorganize its agricultural research capacity away from supporting a mistakenly expected growth in industrial agriculture to supporting the strengthening and fine-tuning of its widespread but mistakenly sidelined organic agriculture. Not only Ethiopian, but also global need requires that it does so. It will be easy for Ethiopia to manoeuvre this global need to a national advantage in development (Tewolde Berhan, 2007).

Summary and Conclusion

Farming is part of every land. It produces the food on which human life depends and has been fundamental to civilization in providing the foundation from which economic activity has developed. Majority of the world population are greatly concerned about the deterioration of the world's land resources and our capacity to produce food for the ever-increasing world population due chemically based farming. It is in this context that the term sustainable (organic) agriculture has developed as a solution. Modern farming systems involves high inputs of synthetic fertilizers and pesticide to support high-yielding, hybrid varieties of crops have contributed to soil erosion, environmental pollution, loss of indigenous crop diversity and poorer health among rural people. In general, Organic agriculture is intended to produce high quality, nutritious food that contributes to preventive health care and well-being.

Soil is a key element in increasing crop yields. Maintaining its quality is therefore of great importance for the sustainable management of agricultural lands. The management according to organic and conventional systems resulted in changes in soil physical, chemical and microbial properties. The review results showed that the organic farming practices resulted in good soil aggregation, greater fragment size, aggregate stability, water-holding capacity, hydraulic conductivity, lower bulk density, resistance to water and wind erosion, higher total and minerizable carbon and nitrogen, higher potassium, phosphorus, calcium, cation exchange capacity (CEC), phosphatase, hygrogenase, soil microbial biomass, total fungal and bacterial populations.

The wide range of factors that can affect plant composition (e.g., genetics, agronomic practices, climate, and post-harvest conditions) makes investigations of the nutritional value of organically and conventionally grown food difficult to carry out and interpret. Nonetheless, because of the significant interest in this topic internationally, both in the past and perhaps even more so currently with the increasing production and consumption of organic foods, many studies have been conducted. Overall, any differences in nutrient concentrations of organic and conventional foods have varied from study to study along with the considerable variation in study designs and study duration. The majority of studies have tended to focus on a narrow range of nutrients, which only give a very limited indication of nutritional value.

In general, taking into account the issues of soil quality, nutrient content, pesticides, and microbiological safety, the current reviewed evidences seems to suggest that organic produce can potentially be more beneficial, but it is difficult to draw conclusion and recommendation, due to the wide range of factors that can affect plant composition (e.g., genetics, agronomic practices, climate, harvest and post-harvest conditions). Therefore, to give conclusive answer on the topic (organic versus conventional management systems) a well-designed experiment and survey should be conducted including different crops, different management condition for several years across wide environment.

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